



**Department of Computer Science
University of Lucknow
Master of Computer Science Programme
Regulation 2020**

1. Applicability

These regulations shall apply to the Master in Computer Science Programme from the session 2020-21 or 2021-22.

2. Minimum Eligibility for Admission

A three/four-year Bachelor's degree or equivalent in B.Sc (Computer Science /Information Technology/Electronics/Mathematics/Statistics), B.Tech. (Computer Science and Engineering/ Information Technology) or BCA awarded by an University or Institute established as per law and recognised as equivalent by this University with minimum 50 percentage marks for equivalent grade, shall constitute the minimum requirement for admission to the Master in Computer Science Programme.

- There shall be 20 seats for M.Sc. (C.S.) course.
- The existing reservation rules of the University shall apply in admitting the students to this course.

Fee: The fees per semester Rs. 15,000.00. (Rs. Fifteen Thousand Only)

3. Programme Objectives

M.Sc. in computer science is four semesters self finance/Regular program with total 96 credits. This four semester program is focused on academic, research and application which follows directives of UGC/MHRD.

Objective of program is to prepare students with the knowledge in the field of ICT such as Software engineering, Network Security, Cyber security, Data Science and Artificial Intelligence etc. This program contains wide range of advance courses and emerging technologies. To enable students pursue a professional career in academia, research and software industries.

4. Programme Outcomes

Student shall able to use the principles of computer science for various applications such as development of software, Managing Computer Network, Database and real time systems. At the end of this Program, the successful students will be able to work with

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real time projects related to computer science, Data Science, Information Science and Networking.

5. Specific Programme Outcomes

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

- Manage database and retrieving data from it.
- Understand various software engineering concepts.
- Understand Cloud Computing concepts.
- Understand artificial intelligence.
- Understand the need of Cyber Security and its related concepts.
- Know various networking models and key standards.

6. Course Structure

The course structure of the Master in Computer Science shall be as under:

Course No.	Paper No.	Credits	Name of the Course	Course Type
Semester-I				
CSCC-101	Paper-1	04	Database (oracle)	Core Course
CSCC-102	Paper-2	04	Data warehouse and Data mining	Core Course
CSCC-103	Paper-3	04	Theory of Computation	Core Course
CSCC-104	Paper-4	04	Practical: Lab based on CSCC 101	Core Course
CSCC-105	Paper-5	04	Practical: Lab based on CSCC 102	Core Course
CSVC-101	Paper-6	04	Project Management	Value Added Courses (Credited)
Semester Total		24		

Course No.	Paper No.	Credits	Name of the Course	Course Type
Semester-II				
CSCC-201	Paper-7	04	Advance Operating System	Core Course
CSCC-202	Paper-8	04	Software Engineering	Core Course
CSCC-203	Paper-9	04	Compiler Design	Core Course
CSCC-204	Paper-10	04	Information Security	Core Course
CSCC-205	Paper-11	04	Advance Web Technology	Core Course
CSCC-206	Paper-12	04	Practical: Lab based on CSCC 205	Core Course
CSVNC-201	Paper-13	00	Internet of Things	Value Added Courses (Non-Credited)
Semester Total		24		

Course No.	Paper No.	Credits	Name of the Course	Course Type
Semester-III				
CSCC-301	Paper-14	04	Computer Network/ MOOC	Core Course
CSCC-302	Paper-15	04	Artificial Intelligence	Core Course
CSEL-301 A/B	Paper-16	04	Data Science / Computer Graphics	Elective
CSEL-302 A/B	Paper-17	04	Cloud Computing/Python Programming	Elective
CSIN-301	Paper-18	04	Project / Entrepreneurship Training Assessment	Internship
CSIER-301	Paper-19	04	Research Methodology	Inter-Departmental Course
Semester Total		24		

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Course No.	Paper No.	Credits	Name of the Course	Course Type
	Semester-IV			
CSCC- 401	Paper-20	04	Cyber Security	Core Course
CSEL- 401 A/B	Paper-21	04	Big Data Analytics/ Software Project Management	Elective
CSEL – 402A/B	Paper-22	04	Mobile Computing/ Advance Programming	Elective
CSMT- 401	Paper-23	08	Major Project : synopsis preparation Dissertation & Contribution in the form of Publication, Literature Review, Presentation	Master Thesis
CSIRA- 401	Paper-24	04	Management Information System	Intra-Departmental Course
	Semester Total	24		
	GRAND TOTAL	96		

CS-Computer Science**CSCC- Computer Science Core Course****CSVC- Computer Science Value Added Course (Credited)****CSVNC- Computer Science Value Added Course (Non-Credited)****CSEL- Computer Science Elective****CSIER- Computer Science Inter-Departmental Course****CSIRA-Computer Science Intra-Departmental Course****Internship**

For M.Sc. Computer Science students internship during vacation after second semester will be mandatory. Assessment will be done in third semester for four credits with 100 marks.

List of MOOCs Papers:

MOOCs Papers for third Semester Paper Code: CSCC-301
After completing any one of the following listed or online courses under MOOC's (MCS 301) student must submit the self-attested pass/satisfactory certificate to COE office University of Lucknow CSCC-301A-Animation CSCC-301B-Communication Skill CSCC-301C-Academic Writing CSCC-301D-Academic and Research Report CSCC-301E-Advertising and Marketing

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7. Course Outlines

Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) First Semester Syllabus	
Course Title: Database(Oracle)	Objective: The objective of this course is to impart sound knowledge of Database theory and hands on practical skills to work on various DBMS and RDBMS. The students are taught to manage data effectively and to access efficiently.
Course No: CSCC -101	
Paper-1	
Credit : 04	
Maximum Marks: 80+20=100	
Unit -I	
Database Definition, Purpose of Database, DBMS Versus RDBMS, F. Codd's twelve rules, Database Modelling for a Database, Entities and attributes, Entity-relationship model, Three level of data abstraction, Characteristics of Database.	
Unit -II	
Data Models, Instances and Schemas, Data Independence. Structure of DBMS, Advantages and Disadvantages of DBMS. Data Dictionary, Database components, Data definition language, Data Manipulation language, Keys: primary keys, candidate keys, composite keys,	
Unit -III	
Generalization and aggregation, Relational Data Model, Network Data Model, Hierarchical Model, Normalization, Transaction Processing and Concurrency Control, Database Recovery concepts, Definition of Transaction and ACID properties, Normalization through Synthesis, Functional dependencies and semantics, Synthesis approach, Synthesis Algorithm, Multivalued Dependencies.	
Unit -IV	
Study of various Concurrency Control Techniques, Deadlocks, Database security and Authorization, Database Security issues, Views, Clustering, Joins Parallel Databases: I/O Parallelism, Inter and Intra Query Parallelism – Inter and Intra operation Parallelism, De-normalization for performance, ACID properties.	
Unit -V	
Distributed Database system, Implementation of DDL and DML with Oracle software, Insertion and retrieving records from oracle database, database connection with web application, Relational Database Design, Features of Good Relational Designs, Decomposition using Functional Dependencies, Boyce-Codd normal form, BCNF and Dependency Preservation.	
Outcome of Course:	
At the end of this Course, the successful student will be:	
<ul style="list-style-type: none">able to understand the database concepts and DBMS components and their functions, RDBMS software.able to model an application's data requirements using conceptual modelling tools like ER diagrams and design database schemas based on the conceptual model.	

Recommended Books

- [1] Elmasri, Navathe, Somayajulu and Gupta, "Fundamentals of Database Systems", Fifth Edition, Pearson Education/Addison Wesley, 2006.
- [2] Henry F Korth, Abraham Silberschatz, S. Sudharshan, "Database System Concepts", Sixth Edition, McGraw Hill, 2013.
- [3] Bipin C. Desai, "An Introduction to Database Systems", Revised Edition, Galgotia Publication, 2017.
- [4] Jason Price, "Oracle Database 12c SQL", first Edition, McGraw Hill, 2017.

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) First Semester Syllabus	
Course Title: Data Warehouse and Data Mining	Objective: The objective of this course is to learn how data warehousing and data mining work together to extract precious insights from vast data. This course helps students to pull raw data from different sources and store it in a cleaned, standardized form, to facilitate real time data analysis for scientific purpose.
Course No: CSCC -102	
Paper-2	
Credit : 04	
Maximum Marks: 80+20=100	
Unit –I	
Data Warehousing Definition, Need for data warehousing, Characteristics of data warehouse, paradigm shift, Operational and Informational data stores, Database versus Data warehouse, advantages of Data warehousing, Benefits of data warehouse (tangible and Non-tangible) Multi-Dimensional Data Model, Data Cubes, Data mart.	
Unit –II	
Data warehouse architecture and Components, Meta Data, Data warehouse and operational data stores, Multi-layered data ware house architecture, Overview of Client/Server Architecture, Host based processing, Master-slave Processing, first generation client/server Processing.	
Unit –III	
Second generation client/server Processing, Server function, Access tools, Query and Reporting tools, Stars Schema, Multi-Star schema , Data warehousing Process Architecture, 3 Tier Architecture,. Need for OLAP, OLAP Guidelines, OLAP function and Tools, OLAP Servers, ROLAP, MOLAP, HOLAP, Information Delivery system, Building a Data warehouse,	
Unit –IV	
Design consideration, Nine Decisions in designing data warehouse, Data warehouse Implementation consideration, Data extraction, Cleanup, transformation and migration, data warehouse Administration and Management, Relational Database technology for Data warehouse, Types of Parallelism, Data partitioning,	
Unit –V	
Database architectures for parallel Processing: shared memory architecture and shared disk architecture, shared nothing architecture, parallel RDBMS features, Sybase, STAR join and STAR index. Oracle server architecture. Data Mining Definition and interface, data mining process, mining techniques, , Cluster analysis and web data mining, support vector machines.	
Outcome of Course:	
At the end of this Course, the successful students will be able to:	
<ul style="list-style-type: none">• Create a clean, consistent repository of data within a data warehouse for large corporations.• discover interesting patterns in large databases with the help of data mining techniques.• Use existing commercial or public-domain tools to perform data mining tasks to solve real problems in business and commerce.	

Recommended Books

- [1] Alex Berson and Stephen J. Smith, "Data warehousing, Data Mining & OLAP", Second edition, Tata McGraw-Hill Publication, 2006.
- [2] Arun K Pujari, " Data Mining Techniques", Second edition, University press 2009.
- [3] Rajan Chattamvelli, " Data Mining Methods", Second edition, Narosa Publishing, 2016.
- [4] G. K Gupta, "Introduction to data mining with case studies", second edition, PHI publication, 2017.

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) First Semester Syllabus	
Course Title: Theory of Computation	Objective: The objective of this course is to impart the knowledge of mathematical foundations of computation including automata theory, theory of formal languages and grammars, notions of algorithm, complexity, and computability.
Course No: CSCC -103	
Paper-3	
Credit : 04	
Maximum Marks: 80+20=100	
Unit –I	
Fundamentals – alphabets, strings, languages, problems, graphs, trees, Finite State Systems, definitions, Finite Automaton model, acceptance of strings, and languages, Deterministic finite automaton and Nondeterministic finite automaton, transition diagrams, transition tables, proliferation trees and language recognizers, equivalence of DFA's and NFA's. Finite Automata with ϵ -moves, Moore and Melay machines.	
Unit –II	
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 and its applications, closure properties of regular sets. Grammar Formalism: Regular grammars–right linear and left linear grammars,	
Unit –III	
Equivalence between regular linear grammar and finite automata, inter conversion, Context free grammar, derivation trees, sentential forms, right most and leftmost derivation of strings, ambiguity, Context Free Grammars: Simplification of Context Free Grammars, Chomsky normal form, Greibach normal form, Pumping lemma for context free languages and its applications,	
Unit –IV	
Closure of properties of CFL (proofs omitted). Push Down Automata: PDA definition, model, acceptance of CFL, acceptance by final state and acceptance by empty state and its equivalence. Equivalence of PDA's and CFL's, inter-conversion. (Proofs not required), Membership Algorithm (CYK Algorithm) for Context Free Grammars. Turing Machine, TM definition, model, design of TM, computable functions.	
Unit –V	
Unrestricted grammars, recursively enumerable languages. Church's hypothesis, counter machine, types of Turing machines (proofs omitted). Linear bounded automata and Context sensitive language. Computability Theory: Chomsky hierarchy of languages, Parsing, types of parsing, DPDA, LR(0) grammar, decidability and undecidable problems. Definitions of P and NP problems, NP complete and NP hard problems.	
Outcome of Course: At the end of this Course, the successful students will be able to:	
<ul style="list-style-type: none">• Perform computation and Implement the automata Theory.• Develop the models of Computation, including formal languages, grammar and automata.• Analyze and design finite automata, pushdown automata, Turing machines, formal languages.	

Recommended Books

- [1] John E. Hopcroft, Rajeev Motwani and Jeffery D. Ullman, Automata Theory, Languages, and Computation, Third Edition, Pearson Education, 2008.
- [2] Michael Sipser, Introduction to the Theory of Computation, Third Edition, Cengage Learning, 2012.
- [3] Peter Linz, "An Introduction to Formal Language and Automata", Six Edition, Cengage Learning, 2016.
- [4] A.M Natarajan, A. Tamilarasi, P. Balasubramani, "Theory of Computation", First Edition, New Age International publishers, 2014.

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) First Semester Syllabus	
Course Title: Lab based on CSCC- 101	Objective: The objective of this lab is to impart the knowledge of how to store and organize the data in various DBMS and RDBMS software, and to retrieve the stored data efficiently to fulfil the individuals and organizational needs.
Course No: CSCC - 104	
Paper - 4	
Credit : 04	
Maximum Marks: 100	
Practical Paper	
List of Exercise based on Database (Oracle)	
<ol style="list-style-type: none">1. Creating Database.2. Creating database with schema.3. Implementation of DML and DDL Command.4. Implementation of Primary key,5. Implementation of foreign key,6. Implementation of Candidate key7. Implementation of composite key.8. Submitting and retrieval of records through firing queries from/to database.9. Implementation of inner joins.10. Implementation of left outer joins.11. Implementation of right outer joins.12. Implementation of right outer joins.13. Implementation of full outer joins.14. Implementation of creating, updating and dropping Views15. Implementation of Clustering16. Database Connection with web application.17. Implementation of Database recovery.18. Implementation of Database extraction and authentication.	
Outcome of Course:	
At the end of this Course, the successful students will be able to:	
<ul style="list-style-type: none">• Storing data and organizing it for future purpose.• Securing and backing up data• Normalizing data.• Managing relationships between data-tables and databases.	

Recommended Books

- [1] Elmasri, Navathe, Somayajulu and Gupta, "Fundamentals of Database Systems", Fifth Edition, Pearson Education/Addison Wesley, 2006.
- [2] Henry F Korth, Abraham Silberschatz, S. Sudharshan, "Database System Concepts", Sixth Edition, McGraw Hill, 2013.
- [3] Bipin C. Desai, "An Introduction to Database Systems", Revised Edition, Galgotia Publication, 2017.
- [4] Jason Price, "Oracle Database 12c SQL", first Edition, McGraw Hill, 2017.

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) First Semester Syllabus	
Course Title: Lab based on CSCC - 102	Objective: The objective of this course is to make students aware about the various data mining techniques and algorithms and providing them practical exposure in order to implement these techniques and algorithms to know the pros and cons of each one and selecting appropriate data mining techniques for solving real time problem.
Course No: CSCC- 105	
Paper - 5	
Credit : 04	
Maximum Marks: 100	
Practical Paper	
List of Exercise based on Data Warehouse and Data Mining.	
<ol style="list-style-type: none">1. Create an Employee Table with the help of Data Mining Tool.2. Create a Weather Table with the help of Data Mining Tool.3. Apply Pre-Processing techniques to the training data set of Weather Table.4. Apply Pre-Processing techniques to the training data set of Employee Table.5. Normalize Weather Table data using Knowledge Flow.6. Normalize Employee Table data using Knowledge Flow.7. Finding Association Rules for Buying data.8. Finding Association Rules for Banking data9. Finding Association Rules for Employee data.10. To Construct Decision Tree for Weather data and classify it.11. To Construct Decision Tree for Customer data and classify it.12. To Construct Decision Tree for Location data and classify it.13. Write a procedure for Visualization for Weather Table.14. Write a procedure for Visualization of Banking Table.	
Outcome of Course:	
At the end of this Course, the successful students will be able to:	
<ul style="list-style-type: none">• Understand the functionality of the various data mining and data warehousing component.• Identify strengths and limitations of various data mining and data warehousing models.• Describe different methodologies used in determining and data ware housing.	

Recommended Books

- [1] Alex Berson and Stephen J. Smith, "Data warehousing, Data Mining & OLAP", Second edition, Tata McGraw-Hill Publication, 2006.
- [2] Arun K Pujari, "Data Mining Techniques", Second edition, University press 2009.
- [3] Rajan Chattamvelli, "Data Mining Methods", Second edition, Narosa Publishing, 2016.
- [4] G. K Gupta, "Introduction to data mining with case studies", second edition, PHI publication, 2017.

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) First Semester Syllabus	
Course Title: Project Management	Objective: The objective of this course is to make student understand the concepts of Project Management for planning to execution of projects.
Course No: CSVN - 101	
Paper - 6	
Credit : 04	
Maximum Marks: 80+20=100	
Unit –I	
Basics of Project Management: Introduction, Need for Project Management, Project Management Knowledge Areas and Processes, The Project Life Cycle, The Project Manager (PM), Phases of Project Management Life Cycle, Project Management Processes, Impact of Delays in Project Completions, Essentials of Project Management Philosophy, Project Management Principles	
Unit –II	
Project Identification and Selection: Introduction, Project Identification Process, Project Initiation, Pre-Feasibility Study, Feasibility Studies, Project Break-even point.	
Unit –III	
Project Planning: Introduction, Project Planning, Need of Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS).	
Unit –IV	
Organisational Structure and Organisational Issues: Introduction, Concept of Organisational Structure, Roles and Responsibilities of Project Leader, Relationship between Project Manager and Line Manager, Leadership Styles for Project Managers, Conflict Resolution, Team Management and Diversity Management, Change management.	
Unit –V	
Project Risk Management: Introduction, Risk, Risk Management, Role of Risk Management in Overall Project Management, Steps in Risk Management, Risk Identification, Risk Analysis, Reducing Risks.	
Outcome of Course: At the end of this Course, the students will be able to:	
<ul style="list-style-type: none">• Manage the cost, timing, and quality of the project• Understand project characteristics and various stages of a project.• Use the various techniques for Project planning, scheduling and execution.	

Recommended Books

- [1] Royce, "Software Project Management", First edition, pearson, 2002.
- [2] Bob Hughes, Mike Cotterell and Rajib Mall, "Software Project Management", sixth edition, 2017.
- [3] Rishabh Anand, "Software Project Management", First Edition, S.K. Kataria & Sons, 2013

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) Second Semester Syllabus	
Course Title: Advance Operating system	Objective: The objective of the course to teach various operating systems such as Unix, Mac and Android to use computer in efficient manner. This course is also useful to understand the structure and organization of operating system, process and their synchronization and scheduling too.
Course No: CSCC -201	
Paper - 7	
Credit : 04	
Maximum Marks: 80+20= 100	
Unit –I	
Operating system and its necessity, Unix kernel architecture diagram, Major Command line User interface operating systems, GUI based operating systems, Single and Multiprocessor system, symmetric and asymmetric multiprocessing , symmetric and asymmetric clustering, System Call, MS-DOS layer structure, UNIX system structure, microkernel architecture, Hybrid Systems,	
Unit –II	
Mac OS X, Mobile operating system: iOS, architecture of Apple's iOS, Android and its architecture, Linux Process States and System Calls, Process Groups, Sessions, Foreground and Background Processes, Operating system Debugging, System Boot, Process States diagram, process scheduling with queuing diagram representation, process schedulers and context switching.	
Unit –III	
Process creation and termination, inter-process communication, synchronization and buffering Signals, Pipes and Naming Pipes (FIFOs), Threads and pthread library, Mutexes and Condition Variables, Semaphores, Producer-Consumer Problem	
Unit –IV	
Study and Solutions using mutexes, condition variables and semaphores, File and File Meta-data, File Naming Systems, File System Operations, File System Implementation, File System Structures, Booting an OS, File System Optimisation, Devices and Types of Devices, Terminal, Disk,	
Unit –V	
SCSI, Tape and CD devices, Unification of Files and Devices, Device Drivers: Concepts and Implementation Details, Resource Management Issues, Types of Resources, Integrated Resource Scheduling, Queuing Models of Scheduling, Protection of Resources –hardware, software, and attacks, Security Policies.	
Outcome of Course: At the end of this Course, the successful students will be able to:	
<ul style="list-style-type: none">• Make the computer system convenient to use in an efficient manner.• Provide users a convenient interface to use the computer system.• Manage the resources of a computer system.• Provide efficient and fair sharing of resources among users and programs.	

Recommended Books

- [1] Abaaham Silberschatz, peter B Galvin and Gerg Gagne, "Operating system concepts", Ninth edition, WILEY publication, 2015.
- [2] Charles Crowley, "Operating Systems: A Design-Oriented Approach", Third edition, Tata McGraw-Hill, 2011.
- [3] Richard Stevens, Stephen Rago, "Advanced Programming in the Unix Environment", fourth edition , Addison-Wesley., 2007.

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) Second Semester Syllabus		
Course Title: Software Engineering		Objective: The objective of this course to learn software development process and models, in order to develop quality software with in specified cost and time. It also provides the knowledge of testing tools and management.
Course Code: CSCC -202		
Paper - 8	Credit : 04	
Maximum Marks: 80+20 = 100		
Unit –I		
Introduction to System Engineering, A layered technology, A process framework, Systems and their Environment, Process models and System Modelling, System Engineering Process, System Procurement.		
Unit –II		
Software Processes: Software Process Models, Process Iteration, Software Specification, Design and Implementation, Building the analysis model, Software Requirements: Functional and Non-Functional Requirements, User Requirements, System Requirements, Software Requirements Document, Requirements Engineering Processes:		
Unit –III		
Feasibility Studies, Requirements Elicitation and Analysis, Requirements Validation, Requirements Project Management, Project planning, Project scheduling, Design within the context of Software Engineering, Design concerts, Design models, Pattern-based software design.		
Unit –IV		
Software architecture, data design, Architectural styles and patterns, Architectural design, mapping dataflow into software architecture, User interface analysis and design, Verification and Validation: Verification and Validation Planning, Software Inspections, Automated Static Analysis, Clean-room Software Development		
Unit –V		
Software Testing: Defect Testing, Integration Testing, Object-Oriented Testing, Testing Workbenches, Software Cost estimation, availability and Reliability.		
Outcome of Course:		
At the end of this Course, the successful students will be able to:		
<ul style="list-style-type: none">• Understand and demonstrate basic knowledge in software engineering.• Identify requirements, analyse and prepare models.• Plan, schedule and track the progress of the projects.• Design & develop the software projects.• Identify risks, manage the change to assure quality in software projects.• Apply testing principles on software project and understand the maintenance concepts.		

Recommended Books

- [1] Ian Sommerville, "Software Engineering", Sixth edition, Addison Wesley publication, 2000.
- [2] Roger S. Pressman, "Software Engineering, eight edition, McGRAW-HILL publication, 2010.
- [3] K. K. Aggarwal and Y. Singh, "Software Engineering", Third edition, New Age publication, 2008.

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) Second Semester Syllabus	
Course Title: Compiler Design	Objective: The Objective of this course is to provide a comprehensive knowledge about compiler construction as well as to learn finite automata and construction of canonical LR parsing techniques, implementation of block structure languages.
Course No: CSCC -203	
Paper - 9	
Credit : 04	
Maximum Marks: 80+20 = 100	
Unit –I	
Introduction to compilers.- Compilers and Translators - Assembly language Macros – Structure of compilers - Compiler writing tools - Boot strapping. Lexical analysis - Role of lexical analyzer - Regular expression, Deterministic finite automata, Nondeterministic Finite automata, Equivalence of Deterministic and Nondeterministic Finite Automata.	
Unit –II	
Finite Automata - Implementation of lexical analyzer -context free grammars - Derivation and parse trees Parser - Shift reduce parsing - Operator precedence parsing -Top down parsing – Predictive parsers - LR Parsers - Constructing SLR Parsing tables, Algebraic Laws for Regular Expression, Associativity and Commutativity, Identities and Annihilators, Distributive Laws, Idempotent Law.	
Unit –III	
Constructing canonical LR Parsing tables - Constructing LALR Parsing tables - Using ambiguous grammar. Syntax directed translation schemes Symbol table - Contents of symbol table - Data structures for symbol tables Implementation of simple stack allocation scheme.	
Unit –IV	
Implementation of block structure languages - Storage allocation in FORTRAN - Storage allocation in block structured language Errors - Lexical phase errors – Syntactic phase errors - Semantic errors. Code optimization: The Principle sources of optimization - Loop optimization.	
Unit –V	
DAG Representation in basic blocks Code generation - Problem in code generation - A simple code generator - Register allocation and assignment - Code generation from DAG's - Peephole optimization, Pumping Lemma for Regular Languages, Application for Pumping Lemma, Closure Properties of Regular Languages.	
Outcome of Course: At the end of this Course, the successful students will be able to: <ul style="list-style-type: none">Understand how real compilers work and how high-level language program are systematically translated into low-level assembly;Implement compiler analysis, transformation and code generation approaches based on real compiler infrastructures;	

Recommended Books

- [1] Aho, Lam, Sethi, and Ullman, "Compilers: Principles, Techniques and Tools", Second Edition, Pearson Publication, 2006.
- [2] A.V. Aho and Jeffery Ullman, "The Principles of Compiler Design", Second edition, Narosa Publishing House, 2008.
- [3] John E JHopcroft, Rajeev Motwani, Jeffrey D Ullman, "Introduction to Automata Theory, Languages and Computation", Pearson Third edition, 2013.

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) Second Semester Syllabus	
Course Title: Information Security	Objective: The objective of this course is to learn basics of information security and network security. Identify various types of security incidents and attacks, and learn methods to prevent and detect. Students shall also learn Hardware security, software security and Database security.
Course No: CSCC -204	
Paper - 10	
Credit : 04	
Maximum Marks: 80+20 =100	
Unit –I	
Information Security and Information System: Overview, need for information security, objectives of Information security, Security Attacks, Global information systems and their evolution, basics of information systems, role of the Internet and the World Wide Web -Understanding about the threats to information systems security Building blocks of InfoSec.	
Unit –II	
How Organizations manage security of their information systems, Information security risk analysis fundamentals, Importance of physical security and biometrics controls for protecting information systems assets, Security Policy, Security Procedures, Building a security plans, System Security Management. Authentication application, Kerberos, PGP, SSL and TLS	
Unit –III	
Goals of Security infrastructure, Data confidentiality, Data Integrity, Data availability, Security Models. Cryptography, Terminology, Encryption Algorithm, Cryptanalysis, Data encryption methods, cryptographic algorithm, Secret key Cryptography, Public key Cryptography.	
Unit –IV	
Hardware Security, Software Security, Intrusion Detection Systems and Firewalls, security of virtual private networks - Security issues in application development with emphasis on integration of enterprise applications, database security, operating security and security of electronic mailing systems, E-commerce Security.	
Unit –V	
Database security, Cyberspace security, Host based security, Network based Security, Host-Base IDS versus Network-Based IDS, Critical National Infrastructure and its security, Confidentiality-Integrity-Availability Triad, Defensive Life-Cycle, Critical Intrusion Detection and Prevention Principles.	
Outcome of Course:	
At the end of this Course, the students will be able to:	
<ul style="list-style-type: none"> Develop an understanding of security policies for various information systems (such as authentication, integrity and confidentiality), as well as protocols to implement such policies in the form of message exchanges. Students able to develop security methods such as encryption, decryption and IDS. Determine appropriate mechanisms for protecting information systems ranging from operating systems to database management systems. 	

Recommended Books

- [1] Brijendra Singh, "Network Security and Management", Third edition, PHI publication, 2012.
- [2] W. Stallings, "Network Security Essentials: Applications and Standards", First edition, Pearson Publications, 2015.
- [3] Nina Godbole, "Information Systems Security Management: Security Management, Metrics, Frameworks and Best Practices, Second edition, Wiley Publication, 2017.

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) Second Semester Syllabus	
Course Title: Advance Web Technology	Objective: The objective of this course is to provide students with a basic understanding of web technologies and multimedia systems.
Course No: CSCC -205	
Paper - 11	
Credit : 04	
Maximum Marks: 80+20= 100	
Unit –I	
Introduction and Web Development Strategies, History of Web and Internet, Protocols governing Web, Writing Web Projects, Connecting to Internet, Introduction to Internet services and tools, Introduction to client-server computing, HTML: list, table, images, frames, forms, CSS, Document type definition, XML: DTD, XML schemes, Object Models, presenting and using XML,	
Unit –II	
Using XML Processors: DOM and SAX, Dynamic HTML, Introduction to active server pages (ASP), Introduction to Java Server Page (JSP), JSP Application Design, JSP objects, Conditional Processing, Declaring variables and methods, Sharing data between JSP pages	
Unit –III	
Multimedia, Multimedia Objects, Multimedia in business and work, Multimedia hardware, Memory & Storage devices, Communication devices, Presentation tools, object generation which includes video sound; image capturing, Authoring tools, card and page based authoring tools.	
Unit –IV	
Perception of sound, hearing sensitivity, frequency range, sound- wave length, the speed of sound, measuring the sound, musical sounds, noise signal, dynamic range, pitch, harmonics-equalization reverberation time, Sound isolation and room acoustics- treatments- studio layout –room dimensions. The Basic set-up of recording system; The production chain and responsibilities. Microphones types -phantom power, noise, choosing the right mike; Mixing console; Input devices; Output devices; Audio Publishing	
Unit –V	
image file formats and how and where it is used, Principles of animation, 2D and 3D animation, Morphing, Kinematics, tweening, Motion capture, character animation, modelling, special effects, and compositing, Video Conferencing, Web Streaming, Video Streaming, Internet Telephony - Virtual Reality - Artificial intelligence.	
Outcome of Course: At the end of this Course, the students will be able to:	
<ul style="list-style-type: none">• Develop web and window applications.• Develop Multimedia application• Use JavaScript to add dynamic content to pages.• Apply a structured approach to identifying needs, interests, and functionality of a website.•	

Recommended Books

- [1] Tay Vaughan, "Multimedia: Making it Work", 8th Edition, McGraw Hill Education, 2011
- [2] Ivan Bayross, "Web Enabled Commercial Application Development using HTML, JavaScript, DHTML and PHP", BPB Publication, 2016.
- [3] Ivan Bayross, "GTU-introduction to Internet & HTML Scripting", BPB Publication, 2010.
- [4] Jeffrey C. Jackson, "Web Technologies: A Computer Science Perspective", 1st Edition, Pearson, 2013.

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) Second Semester Syllabus	
Course Title: Practical Lab based on CCCC - 205	Objective: The objective of this course is to enable student to construct an interactive and user-friendly Web-site and Web-application.
Course No: CCCC -206	
Paper - 12 Credit : 04	
Maximum Marks: 100	
Practical Paper	
List of Exercise based on Advance Web Technology <ol style="list-style-type: none">1. Working with TABLES in HTML2. Working with frames in HTML3. Attaching Images to Web Page.4. Constructing Static Web Pages.5. Working with Cascading Style Sheet (CSS)6. Attaching Cascading Style Sheet (CSS) to Web-Pages7. Constructing header and footer of Web-Pages.8. Attaching flash file to Web-Page.9. Embed Java script to Web-Page.10. Construction of Static Web-Site.11. Construction of Dynamic Web- Site.12. Attaching Visitor Clock and Calender to Web-Page.13. Working with Xampp Server14. Linking Web-Pages for navigation of a website.15. Transferring Web-Pages from Local Computer to Server.16. Attaching Window Media Player to Web-Page.17. Constructing WebPages that Supports Broadcasting.18. Working with FTP to transfer file from local Computer to Server.	
Outcome of Course: <p>At the end of this Course, the students will be able to:</p> <ul style="list-style-type: none">• Construct WebPages.• Develop Static Web Sites.• Work with Web Server.• Fetch Data from Server.• Work with JavaScript and attach with Web Pages.	

Recommended Books

- [1] Ivan Bayross, "Web Enabled Commercial Application Development using HTML, JavaScript, DHTML and PHP", BPB Publication, 2016.
- [2] Ivan Bayross, "GTU-introduction to Internet & HTML Scripting", BPB Publication, 2010.

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) Second Semester Syllabus	
Course Title: Internet of Things	Objective: The objective of this course gives a foundation in the Internet of Things, including the components, tools, and analysis by teaching the concepts behind the IoT and to look at real-world solutions.
Course No: CSVNC- 201	
Paper - 13	
Credit : 00	
Maximum Marks: 00	
Unit –I	
What is the Internet of Things? : History of IoT, About IoT, Overview and Motivations, Examples of Applications, Internet of Things Definitions and Frameworks : IoT Definitions, IoT Architecture, General Observations, ITU-T Views, Working Definition, IoT Frameworks, Basic Nodal Capabilities	
Unit –II	
Identification of IoT Objects and Services, Structural Aspects of the IoT, Environment Characteristics, Traffic Characteristics, Scalability, Interoperability, Security and Privacy, Open Architecture, Key IoT Technologies, Device Intelligence, Communication Capabilities, Mobility Support, Device Power, Sensor Technology, RFID Technology, Satellite Technology,	
Unit –III	
RFID: Introduction, Principle of RFID, Components of an RFID system, Issues EPCGlobal Architecture Framework: EPCIS & ONS, Design issues, Technological challenges, Security challenges, IP for IoT, Web of Things. Wireless Sensor Networks: History and context, WSN Architecture, the node, Connecting nodes, Networking Nodes, Securing Communication WSN specific IoT applications, challenges: Security, QoS, Configuration, Various integration approaches, Data link layer protocols, routing protocols and infrastructure establishment.	
Unit –IV	
Host based intrusion and network based intrusion, intrusion prevention system, function of prevention system, Cooperative Intrusion Traceback and Response Architecture (CITRA), attribution in cyber security, major attribution techniques. Stepping stones in cyber security, Connection chain, Direct and Indirect stepping stones, Stepping stone detection parameters.	
Unit –V	
Vulnerabilities of IoT, Security requirements, Threat analysis, Use cases and misuse cases, IoT security tomography and layered attacker model, Identity establishment, Access control, Message integrity, Non-repudiation and availability, Security model for IoT, Business Models and Business Model Innovation, Value Creation in the Internet of Things, Business Model Scenarios for the Internet of Things. Internet of Things Application : Smart Metering Advanced Metering Infrastructure, e-Health Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards,	
Outcome of Course: At the end of this Course, the successful students will be able to:	
<ul style="list-style-type: none">• Understand the definition and significance of the Internet of Things• Discuss the architecture, operation, and business benefits of an IoT solution• Examine the potential business opportunities that IoT can uncover• Explore the relationship between IoT, cloud computing, and big data• Identify how IoT differs from traditional data collection systems	

Recommended Books

- [1] Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.
- [2] Vijay Madiseti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) Third Semester Syllabus	
Course Title: Computer Network	Objective: The course objective include learning about computer network organization and implementation, obtaining a theoretical understanding of data communication and computer networks, and gaining practical experience in installation, monitoring, and troubleshooting of current LAN systems
Course No : CCCC -301	
Paper - 14	
Credit : 04	
Maximum Marks: 80+20=100	
Unit –I	
Data communication, Application of a Computer Networks; Classification of Computer Networks; Network Topology, Virtual private network, need for Standards. Network architecture and OSI model, TCP/IP Model	
Unit –II	
Communication media and Data transmission, Analog and Digital Transmission, Modulation and demodulation, Transmission media, Wireless Communication, Transmission Mode, Interfacing, Multiplexing, Error Detection and Correction. Data link control and protocol concepts, Transmission Impairment, Attenuation, Decibel, Distortion, Noise, Data rate limits, Noiseless Channel: Nyquist Bit Rate, Noisy Channel: Shannon Capacity, Performance of Channel: Bandwidth, Throughput, Latency, Propagation time and Transmission Time.	
Unit –III	
Network Interconnections with repeaters, Switches, Bridges, Routers and gateways, cable modems IEEE Standard 802.3, IEEE 802.4, IEEE 802.5, FDDI, DQDB, Ethernet Technology, Wan Transmission methods, Virtual LANs, Network Layer services, Packetizing, Routing and forwarding,	
Unit –IV	
Error Control, Flow Control, Congestion Control, switching, packet switching, Circuit switching, Message Switching, Integrated Services and Routing protocols, Internetworking, Global system for Mobile communication, Universal Mobile telecommunication system,	
Unit –V	
Global packet radio system, TCP, FTP, IPv4, IPv6, Resource Management Issues, Types of Resources.	
Outcome of Course:	
At the end of this Course, the successful students will be able to:	
<ul style="list-style-type: none">• Understand the various topologies and its importance for networking.• Understand the OSI Reference Model and TCP/IP model for networking as well as the functions of various layers.• Know the functions of various devices of networking such as switches, Hubs, routers etc.• Understand various protocols which are involved for functioning of layers.	

Recommended Books

- [1] Brijendra Singh, "Data Communication and Computer Networks", PHI Publication, Third Edition, 2011.
- [2] Behrouz A. Forouzan, "Data Communication and Networking", McGraw Hill Publication, Fifth Edition, 2017.
- [3] Andrew S. Tanenbaum, "Computer Network", PHI publication, Fifth Edition, 2013.

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) Third Semester Syllabus	
Course Title: Artificial Intelligence	Objective: The objective of the course is to present an overview of artificial intelligence (AI) principles and approaches. Develop a basic understanding of the building blocks of AI as presented in terms of intelligent agents: Search, Knowledge representation, inference, logic, and learning.
Course No: CSCC - 302	
Paper - 15	
Credit : 04	
Maximum Marks: 80+20=100	
Unit –I	
Introduction of artificial Intelligence, AI techniques, problem solving with AI, AI models, data acquisition and learning aspects in AI. Scope of AI: Games, Theorem proving, Natural Language Processing, Computer Vision and Speech Processing, Robotics, Introduction to Intelligent agents and expert system.	
Unit –II	
Knowledge Representation: Procedural Vs Declarative Knowledge, Representations & Approaches to Knowledge Representation, Forward Vs Backward Reasoning, Matching Techniques, Partial Matching, Fuzzy Matching Algorithms and RETE Matching Algorithms; Logic Based Programming- AI Programming languages: Overview of LISP, Search Strategies in LISP, Pattern matching in LISP, An Expert system Shell in LISP, Over view of Prolog, Production System using Prolog	
Unit –III	
Symbolic Logic: Propositional Logic, First Order Predicate Logic: Representing Instance and is-a Relationships, Computable Functions and Predicates, Syntax & Semantics of FOPL, Normal Forms, Unification & Resolution, Representation Using Rules, Natural Deduction; Structured Representations of Knowledge: Semantic Nets, Partitioned Semantic Nets, Frames, Conceptual Dependency, Conceptual Graphs, Scripts, CYC.	
Unit –IV	
Reasoning under Uncertainty: Introduction to Non-Monotonic Reasoning, Truth Maintenance Systems, Logics for Non-Monotonic Reasoning, Model and Temporal Logics; Statistical Reasoning: Bayes Theorem, Certainty Factors and Rule-Based Systems, Bayesian Probabilistic Inference, Bayesian Networks, Dempster-Shafer Theory, Fuzzy Logic: Crisp Sets, Fuzzy Sets, Fuzzy Logic Control, Fuzzy Inferences & Fuzzy Systems.	
Unit –V	
Experts Systems: Overview of an Expert System, Structure of an Expert Systems, Different Types of Expert Systems- Rule Based, Model Based, Case Based and Hybrid Expert Systems, Knowledge Acquisition and Validation Techniques, Black Board Architecture, Knowledge Building System Tools, Expert System Shells, Fuzzy Expert systems.	
Outcome of Course:	
At the end of this Course, the successful students will be able to:	
<ul style="list-style-type: none">• Design a knowledge based system,• Familiar with terminology used in this topical area,• have read and analysed important historical and current trends addressing artificial intelligence.	

Recommended Books

- [1] Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", second edition, PHI publication, 2002.
- [2] Nils Nilsson, "Artificial Intelligence: A New Synthesis", first edition, Morgan Kaufmann Publication, 1998.
- [3] Elaine Rich, Kevin Knight, Shivashankar B. Nair, "Artificial Intelligence", Third edition, McGraw Hill publication, 2017.

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) Third Semester Syllabus	
Course Title: Data Science	Objective: The key objective of Data Science is to extract valuable information for use in strategic decision making, product development, trend analysis, and forecasting.
Course No: CSEL -301 A	
Paper - 16	
Credit : 04	
Maximum Marks: 80+20=100	
Unit –I	
Introduction to Data Science: Data Science Process, roles, Stages in Data Science Project, working with data from files, working with database, exploring data, managing data, cleaning and sampling for modelling and validation.	
Unit –II	
Visualization- Basic Charts and Plots- Multivariate Data Visualization- Data Visualization Techniques– Pixel-Oriented Visualization Techniques- Geometric Projection Visualization Techniques- Icon-Based Visualization Techniques- Hierarchical Visualization Techniques- Visualizing Complex Data and Relations- Data Visualization Tools– Rank Analysis Tools- Trend Analysis Tools Multivariate Analysis Tools- Distribution Analysis Tools- Correlation Analysis Tools Geographical Analysis Tools.	
Unit –III	
Modelling Methods: Choosing and evaluating models, Mapping Problem to Machine learning, evaluating clustering models, validating models, cluster analysis, K-means Algorithm, Naive Byes, Memorization Methods, Linear and logistic Regression, Unsupervised methods	
Unit –IV	
Relational database design, features of good relational design, Design alternative: large schemas and smaller schemas, Atomic domains and first normal form, Decomposition using functional dependencies, keys and functional dependencies, boyce-codd normal form, BCNF and Dependency preservation, third normal form, higher normal forms.	
Unit –V	
Introduction to Different Tools used for data Science Ex. SPSS, STATISTICA, R, Python	
Outcome of Course: At the end of this Course, the successful students will be able to: <ul style="list-style-type: none">• Create effective mathematical solutions to analytical problems.• Create effective solutions to computing challenges in analytical projects.• Effectively organize and manage datasets for analytical projects.• Critically analyze problems and identify analytical solutions.• Communicate analytics problems, methods, and findings effectively orally, visually, and in writing.• Critically evaluate ethical, privacy and security challenges in data analytics.	

Recommended Books

- [1] G. Golemund, H. Wickham, "R for Data Science", first edition, O'Reilly publication, 2016.
- [2] Cathy O'Neil, Rachel Schutt, "Doing Data Science: Straight Talk from the Frontline", First Edition, O'Reilly Media, 2013.

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) Third Semester Syllabus		
Course Title: Computer Graphics		Objective: the objective of this course is to focus on the theoretical aspects and implementation of computer graphics. This course shall explain the core concepts of computer graphics, including viewing, projection, perspective, modelling and transformation in two and three dimensions.
Course No: CSEL -301 B		
Paper - 16	Credit : 04	
Maximum Marks: 80+20=100		
Unit –I		
Introduction, What is computer Graphics?, Computer ART, Entertainment, Education and Training, Visualization, Image Processing, Graphical User Interface, Refresh Cathode-Ray Tubes, Raster-Scan Display, Random-Scan Displays, Color CRT Monitors.		
Unit –II		
Geometric Liquid Crystal Display (LCD), Three Dimensional Viewing Devices, Stereoscopic and Virtual-Reality Systems, Raster-Scan Systems, Video Controller., Architecture of a raster-graphics system with a display processor, Raster-scan Display Processor.		
Unit –III		
Random-scan systems, Graphic Monitors and workstations, Data Glove, Digitizers, Points and Lines, Line Drawing Algorithms, DDA Algorithms, Bresenham's Line Algorithm, Circle-Generating Algorithms, Properties of Circles, Midpoint Circle Algorithms.		
Unit –IV		
Filled-Area Primitives, Scan-Line Polygon Fill Algorithm, Inside-Outside Tests, Scan-Line fill of Curved Boundary Areas, Boundary-Fill Algorithms,, 4-Connected, 8-Connected, Flood Fill Algorithm.		
Unit –V		
Basic Transformation, Translation, Rotation, Scaling, Matrix Representation and Homogeneous Coordinates , Composite Transformations, Reflection, Shear, The Viewing Pipeline, Window to view port coordinate transformation.		
Outcome of Course:		
At the end of this Course, the students will be able to:		
<ul style="list-style-type: none">• Understand the basic objectives of computer graphics and its application.• Understand the basic structures of 2D and 3D graphics systems.• Understand 2D coordinate systems and equations of graphs.• Implement translation, rotation, scaling, shearing, and reflection.		

Recommended Books

- [1] D. F. Rogers, "Procedural Elements for Computer Graphics", Second Edition, McGraw-Hill Publication, 2008.
- [2] D. F. Rogers and J. Alan Adams, "Mathematical Elements for Computer Graphics", Second edition, Tata McGraw Hill Publication, 2004.
- [3] Anil K. Jain, "Fundamentals of Digital Image processing", first edition, Pearson Publication, 2015.
- [4] Donald D. Hearn and M. Pauline Baker, "Computer Graphics", Second edition, Pearson Education, 2002.

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) Third Semester Syllabus		
Course Title: Cloud Computing		Objective: The objective of this course is to make students familiar with Cloud Environment and introduce them with remote services that are being hired to share computing resources and storages to cut Development Costs.
Course No: CSEL – 302 A		
Paper - 17	Credit : 04	
Maximum Marks: 80+20=100		
Unit –I		
Cloud Computing, Characteristics of Cloud Computing, Benefits of Cloud Computing, Cloud Service Model, Cloud Deployment Models, IaaS, PaaS, SaaS.		
Unit –II		
Virtualization, Load Balancing, Scalability & Elasticity, Deployment, Replication, Monitoring, Identity and Access Management, Service Level Agreements, Billing, Cloud Services and Platforms, Computer Services, Platform services, Storage services, Application Services, Content Delivery services, Analytics Services, Deployment and Management services, Identity and Access Management Services.		
Unit –III		
Cloud Reference Model, Cloud service architecture, Cloud Service Features, Cloud Application Design, Basic Consideration for Cloud Application, Reference architecture for Cloud Application, Cloud deployment architecture for Content Delivery application, Cloud Application Design Methodologies.		
Unit –IV		
Cloud Layers of service oriented architecture, Cloud Component Model, Cloud Component model for e-commerce, service Oriented architecture (SOA), Model View Controller, Similarities and Differences between service Oriented architecture (SOA) and Cloud Component Model (CCM).		
Unit –V		
Cloud platform security, Information security at clouds, Security measures for protecting information at clouds, Challenges in Cloud services Protection, Cloud Content Delivery, Cloud as an e-commerce Platform, Cloud services from end user point of view, Cloud Services in managerial view.		
Outcome of Course:		
At the end of this Course, the students will be able to:		
<ul style="list-style-type: none">• Understand Cloud Infrastructure.• Interact and avail knowledge sharing used to develop advanced Web and Window Application.• Work with hired and remotely installed software by removing distance barrier.• Work with remote server.		

Recommended Books

- [1] Arshdeep Bahga and Vijay Madisetti, "Cloud Computing: A Hands-on Approach", first edition, University Press, 2017.
- [2] K. Chandrasekaran, "Essentials of Cloud Computing", First Edition, CRC Press, 2014.

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) Third Semester Syllabus		
Course Title: Python Programming		Objective: The objective of this course is to impart programming skills of Python language in students and to sharpen their ability to write Web Applications with on Object Oriented Concepts.
Course No: CSEL -302 B		
Paper - 17	Credit : 04	
Maximum Marks: 80+20=100		
Unit –I		
Introduction to Python Programming: How a Program Works, Using Python, Program Development Cycle, Input, Processing, and Output, Displaying Output with the Print Function, Comments, Variables, Reading Input from the Keyboard, Performing Calculations(Operators. Type conversions, Expressions), More about Data Output .Decision Structures and Boolean Logic: if, if-else, if-elif-else Statements, Nested Decision Structures, Comparing Strings, Logical Operators,		
Unit –II		
Boolean Variables. Repetition Structures: Introduction, while loop, for loop, Calculating a Running Total, Input Validation Loops, Nested Loops, Functions: Introduction, Defining and Calling a Void Function, Designing a Program to Use Functions, Local Variables, Passing Arguments to Functions, Global Variables and Global Constants, Value-Returning Functions-Generating Random Numbers,		
Unit –III		
Writing Our Own Value-Returning Functions, The math Module, Storing Functions in Modules. File and Exceptions: Introduction to File Input and Output, Using Loops to Process Files, Processing Records, Exceptions, Lists and Tuples: Sequences, Introduction to Lists, List slicing, Finding Items in Lists with the in Operator, List Methods and Useful Built-in Functions, Copying Lists, Processing Lists,		
Unit –IV		
Two-Dimensional Lists, Tuples, Strings: Basic String Operations, String Slicing, Testing, Searching, and Manipulating Strings. Dictionaries and Sets: Dictionaries, Sets, Serializing Objects. Recursion: Introduction, Problem Solving with Recursion, Examples of Recursive Algorithms, Object-Oriented Programming: Procedural and Object-Oriented Programming, Classes.		
Unit –V		
Working with Instances, Techniques for Designing Classes, Inheritance, Polymorphism. GUI Programming: Graphical User Interfaces, Using the tkinter Module, Display text with Label Widgets, Organizing Widgets with Frames, Button Widgets and Info Dialog Boxes, Getting Input with Entry Widget, Using Labels as Output Fields, Radio Buttons, Check Buttons.		
Outcome of Course:		
At the end of this Course, the students will be able to:		
<ul style="list-style-type: none">• Acquire programming skills in core Python.• Acquire Object Oriented Skills in Python.• Design Graphical user Interface.• Develop Web Application.		

Recommended Books

- [1] Charles Dierach, Introduction to Computer Science using Python
- [2] D. F Paul Gries, Practical Programming: An Introduction to Computer Science using Python 3
- [3] Kenneth A. Lambert, Fundamentals of Python

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) Third Semester Syllabus	
Course Title: Project/Entrepreneurship Training Assessment	Objective: The objective of this course is to make student Industry familiar and providing them opportunity to inspect all aspects of an organization where computation is required.
Course No: CSIN -301	
Paper - 18 Credit : 04	
Maximum Marks: 100	
Project/Entrepreneurship Training Assessment	
<p>After the second semester examination the students shall immediately join any the government/semi-government/private organizations for their entrepreneurship training and prepare a summary report about the work performed there. Candidate must inform the department about the place where he/she is doing entrepreneurship. In summary report the candidate shall attach a certificate from that organisation. The evaluation of this report and work shall be done with third semester examination.</p>	
Outcome of Course: At the end of this Course, the students will be able to:	
<ul style="list-style-type: none">• Know structure of an organization.• Role of software within Industry.• Know manual process which requires computation.• Learn to be a part of an organization and to work within a team.	

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) Third Semester Syllabus	
Course Title: Research Methodology	Objective: The objective of this course is to introduce students with the foundational methods and techniques of research in field of computer science. this course facilitate students to examine and be practically exposed to the main components of a research framework such as problem definition, research design, data collection, report writing, and presentation.
Course No: CSIER -301	
Paper - 19	
Credit : 04	
Maximum Marks: 80+20=100	
Unit –I	
Meaning of Research, Objectives, Motivation, and Utility. Type of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of good research. Definition of Research Problem, Selecting the Problem, Necessity of defining the problem, Technique involved in defining a problem.	
Unit –II	
Research Design: Concept and Importance in Research – Features of a good research design –Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables. Research Design: Concept and Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, and replication.	
Unit –III	
Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample– Practical considerations in sampling and sample size.	
Unit –IV	
Methods of data collection: Experimental, Surveys, Primary Data, Secondary Data, Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.	
Unit –V	
Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Use of tools, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism, Presentation: Power point for oral and poster presentations.	
Outcome of Course:	
At the end of this Course, the students will be able to:	
<ul style="list-style-type: none"> Identify appropriate research topics Select and Define appropriate research problem and parameters. Write Synopsis. Write Research Proposal. 	

Recommended Books

- [1] C R Kothari and Gaurav Garg, "Research Methodology: Methods and Techniques", New Age publisher, 2014.
- [2] Supino, Phyllis G., Borer, Jeffrey S, "Principles of Research Methodology", Second Edition", 2018.
- [3] Jonker, Jan, Pennink, Bartjan Pennink, "The Essence of Research Methodology: A Concise Guide for Master and PhD Students in Management Science", Springer, 2009.

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) Fourth Semester Syllabus	
Course Title: Cyber Security Course No: CSCC-401 Paper - 20 Credit : 04 Maximum Marks: 80+20=100	Objective: The objective of this course is to prepare students with the technical knowledge and skills needed to protect and defend computer systems and networks. With this course graduates can plan, implement, and monitor cyber security mechanisms in order to ensure the protection of information technology assets. This course helps graduates to identify, analyze, and remediate computer security breaches.
Unit –I	
Network, Internet, world wide web, threat, vulnerability, information and its security, security of internet, network and worldwide web, cyber crime and its origin, cyber attack, motivation behind cyber crime, cyber terrorism and botnet, cyberspace and its security, cyber security as an international problem, need of cyber security, cyber security as an shared responsibility.	
Unit –II	
Major types of cyber crimes: Cyber Various forms of Cybercrimes: Cyber Stalking, Spoofing, Salami Attack, e-Mail Bombing, Identity theft, Denial of Services(DoS), Distributed Denial of Services (DDoS) Pornography, Intellectual Property theft, OSI model layer architecture, vulnerabilities in OSI layers,	
Unit –III	
Vicious Architecture of Cyber crime, information to cyber security, Risk analysis in cyber security, Methods of cyber attack: Physical attack conventional, Electronic cyber attack, computer network attack. Challenges in information security, Intrusion, Intrusion Detection, Intrusion detection system architecture and its components, function of intrusion detection system,	
Unit –IV	
Host based intrusion and network based intrusion, intrusion prevention system, function of prevention system, Cooperative Intrusion Traceback and Response Architecture (CITRA), attribution in cyber security, major attribution techniques. Stepping stones in cyber security, Connection chain, Direct and Indirect stepping stones, Stepping stone detection parameters.	
Unit –V	
False positives and false negatives, Importance of real time traffic detection, stepping stone Detection algorithms: Timing Based Algorithm, Brute force content based Algorithm, Content based algorithm, Role of Jitter and Chaff in Detection Algorithm.	
Outcome of Course: At the end of this Course, the students will be able to: <ul style="list-style-type: none"> Analyze and evaluate the cyber security needs of an organization. Conduct a cyber security risk assessment. Measure the performance and troubleshoot cyber security systems. Implement cyber security solutions. 	

Recommended Books

- [1] William Stallings, "Effective Cybersecurity: A Guide to Using Best Practices and Standards", First Edition, Addison-Wesley Professional publication, 2018.
- [2] Raef Meeuwisse, "Cybersecurity for Beginners", Second Edition", Cyber Simplicity Ltd publication, 2017.
- [3] Nina Godbole and Sunit Belpure, "Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley, First edition, 2009.
- [4] Ross J. Anderson, "Security Engineering: A Guide to Building Dependable Distributed Systems", Wiley, 2008.

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) Fourth Semester Syllabus	
Course Title: Big Data Analytics	Objective: The objective of this course is to teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability, and to enable students to have skills that will help them to solve complex real-world problems in for decision support.
Course No: CSEL -401 A	
Paper - 21	
Credit : 04	
Maximum Marks: 80+20=100	
Unit –I	
Introduction to big data : Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis – Nature of Data - Analytic Processes and Tools, Analysis vs Reporting.	
Unit –II	
Mining data streams, Introduction To Streams Concepts, Stream Data Model and Architecture, Stream Computing Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Estimating Moments, Counting Oneness in a Window, Decaying Window, Real time Analytics Platform(RTAP) Applications, Case Studies - Real Time Sentiment Analysis-Stock Market Predictions.	
Unit –III	
Hadoop: History of Hadoop, the Hadoop Distributed File System, Components of Hadoop Analysing the Data with Hadoop Scaling Out, Hadoop Streaming, Design of HDFS-Java interfaces to HDFS Basics- Developing a Map Reduce Application-How Map Reduce Works-Anatomy of a Map Reduce Job run-Failures-Job Scheduling-Shuffle and Sort – Task execution - Map Reduce Types and Formats- Map Reduce Features Hadoop environment.	
Unit –IV	
Business Intelligence, Decision Support Systems, Data Warehousing; Definition of Big Data, Big data characteristics & considerations, Introduction to Hadoop, Big data analytics, Drivers of Big data analytics, Big Data Stack, Typical analytical architecture, Virtualization & Big Data, Virtualization Approaches, Business Intelligence Vs Data science, Applications of Big data analytics.	
Unit –V	
Need of Data analytic lifecycle, Key roles for successful analytic projects, various phases of Data analytic lifecycle: Discovery, Data Preparation, Model Planning, Model Building, Communicating Results, Operationalization.	
Outcome of Course: At the end of this Course, the students will be able to:	
<ul style="list-style-type: none">Understand the key issues in big data management and its associated applications.Achieve adequate perspectives of big data analytics in various applications.	

Recommended Books

- [1] Arshdeep Bahga, Vijay Madiseti, "Big Data Science & Analytics: A Hands-On Approach", first edition, Import publication, 2016.
- [2] Radha Shankarmani, M. Vijayalakshmi, "Big Data Analytics", first edition, Wiley publication, 2ed Paperback, 2016.
- [3] Subhashini Chellappan, Seema Acharya, "Big Data and Analytics", first edition, Wiley, 2019.

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) Fourth Semester Syllabus	
Course Title: Software Project Management	Objective: The objective of this course is to make student understand the concepts of Project Management for planning to execution of projects.
Course No: CSEL – 401 B	
Paper - 21	
Credit : 04	
Maximum Marks: 80+20=100	
Unit –I	
Basics of Project Management: Introduction, Need for Project Management, Project Management Knowledge Areas and Processes, The Project Life Cycle, The Project Manager (PM), Phases of Project Management Life Cycle, Project Management Processes, Impact of Delays in Project Completions, Essentials of Project Management Philosophy, Project Management Principles	
Unit –II	
Project Identification and Selection: Introduction, Project Identification Process, Project Initiation, Pre-Feasibility Study, Feasibility Studies, Project Break-even point.	
Unit –III	
Project Planning: Introduction, Project Planning, Need of Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS).	
Unit –IV	
Organisational Structure and Organisational Issues: Introduction, Concept of Organisational Structure, Roles and Responsibilities of Project Leader, Relationship between Project Manager and Line Manager, Leadership Styles for Project Managers, Conflict Resolution, Team Management and Diversity Management, Change management.	
Unit –V	
Project Risk Management: Introduction, Risk, Risk Management, Role of Risk Management in Overall Project Management, Steps in Risk Management, Risk Identification, Risk Analysis, Reducing Risks.	
Outcome of Course: At the end of this Course, the students will be able to:	
<ul style="list-style-type: none">• Manage the cost, timing, and quality of the project• Understand project characteristics and various stages of a project.• Use the various techniques for Project planning, scheduling and execution.	

Recommended Books

- [1] Royce, "Software Project Management", First edition, pearson, 2002.
- [2] Bob Hughes, Mike Cotterell and Rajib Mall, "Software Project Management", sixth edition, 2017.
- [3] Rishabh Anand, "Software Project Management", First Edition, S.K. Kataria & Sons, 2013

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) Fourth Semester Syllabus	
Course Title: Mobile Computing Course No: CSEL – 402 A Paper No- 22 Credit : 04 Maximum Marks: 80+ 20=100	Objective: The objective of this course is to provide an opportunity to students to understand the key components and technologies involved and to gain hands-on experiences in building mobile applications.
Unit –I	
Mobile computing vs wireless network, Mobile computing Applications, Characteristics of Mobile computing, Structure of Mobile computing Application. MAC protocols- wireless MAC issues, Fixed Assignment schemes, Random assignment schemes, Reservation based schemes.	
Unit –II	
Mobile Internet protocol and Transport layer Overview of mobile IP- Features of mobile IP, Key mechanism in mobile IP route optimization, Overview of TCP/IP- Architecture of TCP/IP, Adaptation of TCP window, Improvement in TCP performance.	
Unit –III	
Mobile Telecommunication system Global system for Mobile communication (GSM), General Packet Radio Service (GPRS), Universal Mobile Telecommunication System (UMTS).	
Unit –IV	
Mobile Adhoc Network Ad-Hoc basic concepts, Characteristics, Applications, Design issues, routing, Essential of traditional routing protocol, Popular routing protocols, Vehicular AdHoc network VANET, MANET vs VANET, security.	
Unit –V	
Mobile platforms and applications Mobile device operating system, special constraints and requirements, commercial mobile operating system, software development kit- iOS, Android, BlackBerry, windows phone, Mcommerce, structure, pros & Cons, Mobile payment system, Security issues.	
Outcome of Course: At the end of this Course, the students will be able to: <ul style="list-style-type: none"> • Understand fundamentals of wireless communications. • Analyze security, energy efficiency, mobility, scalability, and their unique characteristics in wireless networks. • Demonstrate basic skills for cellular networks design. • Apply knowledge of TCP/IP extensions for mobile and wireless networking. 	

Recommended Books

- [1] Raj Kamal, Mobile Computing, Third Edition, Oxford University press, 2013.
 [2] Ashoke K Talukder, Hasan Ahamed, "Mobile Computing Technology- Application and service creation", Second edition, McGraw Hill Education, 2017.

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Course Title: Advance Programming		Objective: The objective of this course is to provide the fundamental concepts and techniques necessary to write high-quality programs, including basic concepts of object-oriented programming, modular design, exception handling, and class libraries.
Course No: CSEL-402 B		
Paper - 22	Credit : 04	
Maximum Marks: 80+20=100		
Unit –I		
Pointers, Pointers in general, memory organization, Indirection (*) and address-of (&) operators, Pointers in struct, pointers to struct, Pointers of pointers, advanced usage, Static vs. Dynamic Arrays (1D, 2D and more), Creating & destroying arrays, Array of pointers, Pointers of arrays.		
Unit –II		
Classes and Objects, Composition: Class vs. struct, Primitive types vs. Objects, Functions vs. Methods, Data fields, constructor & destructor, overloading constructors		
Unit –III		
Instantiating objects: creating on stack / heap, new, delete, new [], delete [] commands, Static keyword, Pointers and objects Referencing (.) vs. Dereferencing (->) operators, .*, ->*		
Unit –IV		
Class notations, header files, Cloning classes: assigning objects, shallow copy, deep copy, copy constructor, Inheritance, Subclasses in general, Defining and creating subclasses, construction and destruction chain, Construct base class by non-default constructor, Overriding, overloading vs. overriding.		
Unit –V		
Inheritance, Encapsulation, Visibility modifiers: public, private, protected, Abstraction, get and set methods, Polymorphism Polymorphism in general, Benefits, software design, Class hierarchy, conversion from sub-to-base and base-to-sub classes.		
Outcome of Course:		
At the end of this Course, the students will be able to:		
<ul style="list-style-type: none">• Understand advanced concepts for handling runtime errors using stack unwinding, uncaught exception and automatic cleanup.• Apply logical constructs for branching and loops as well as use iterator objects when appropriate.• Create and access arrays and array lists, including.• learn how to handle exceptions and errors.		

Recommended Books

- [1] John W. Perry, "Advanced Programming", Pws Pub Co, first edition, 1998.
 [2] W. Richard Stevens, "Advanced Programming in the UNIX Environment", Third edition, Addison-Wesley Professional, 2013.

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) Fourth Semester Syllabus	
Course Title: Major Project	Objective: The objective of this course is to enable student to work with real time project to enhance their requirement gathering skills, determining objectives and converting requirements into quality product with in given time constraints.
Course No: CSMT - 401	
Paper - 23	
Credit : 08	
Maximum Marks: 200	
Major Project	
In Major Project Student shall perform following tasks.	
<p>Major Project: In this course student shall prepare synopsis, dissertation, make demonstration and contribution in the form of publication.</p> <p>Literature Review: Students shall collect at least 10 research papers from various journals of repute and prepare the summary report.</p> <p>Monthly Presentation: Student shall demonstrate their progress of project with Power Point slides before Departmental committee.</p>	
<p>Outcome of Course: At the end of this Course, the students will be able to:</p> <ul style="list-style-type: none"> • The methods of Information gathering. • Perform Requirement Analysis. • Convert requirements into objectives. • Develop Desired System. 	

Recommended Books

- [1] Ivan Bayross, "Web Enabled Commercial Application Development using HTML, JavaScript, DHTML and PHP", BPB Publication, 2016.
- [2] Ivan Bayross, "GTU-introduction to Internet & HTML Scripting", BPB Publication, 2010.
- [3] Henry F Korth, Abraham Silberschatz, S. Sudharshan, "Database System Concepts", Sixth Edition, McGraw Hill, 2013.
- [4] Bipin C. Desai, "An Introduction to Database Systems", Revised Edition, Galgotia Publication, 2017.
- [5] James A O'Brien, George M Marakas, "Management Information Systems", Seventh Edition, McGraw Hill, 2006

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Department of Computer Science University of Lucknow, Lucknow M.Sc. (Computer Science) Fourth Semester Syllabus	
Course Title: Management Information System	Objective: The objective of this course is to introduce students with variety of systems, their components and the method of interactions. Students learn these basics and map these concepts in system Development.
Course No: CSIRA - 401	
Paper - 24	
Credit : 04	
Maximum Marks: 80+20= 100	
Unit –I	
System Definition, Management Information System, Need for MIS, Objectives of MIS, Information System Resources, Dynamic system, Cybernetic System, Components of Information System, Information System Activities, Various Kinds of Information, Quality of Information, Operational Support System, Management support system, Difference between Operations support system Vs Management support System, Knowledge Management system.	
Unit –II	
Structure Management Information System, Characteristics of Information System, Importance of Information System, Limitation of Information System, Fundamental of Data Processing, Decision support system, Difference between Management Information System Versus Decision Support System, Characteristics of Decision Support System, Components of Decision Support System.	
Unit –III	
Human Resource System or Management, End User Computing, Executive Information System, Expert System, Strategic Information System, Competitive Strategy Concepts, Competitive Forces, Electronic Business System, Enterprise Business System.	
Unit –IV	
Developing Business/ IT strategies, Management Challenges, Security and Ethical Challenges, Security Management of Information Technology, System software and Computer System Management, Data Resource management, Transaction Processing Cycle.	
Unit –V	
Customer Relationship Management, Enterprise Resource Planning, Benefits and Challenges of ERP, Supply Chain Management, Electronic Commerce System, e-commerce Technologies, Categories of e-Commerce.	
Outcome of Course: At the end of this Course, the students will be able to:	
<ul style="list-style-type: none">• Understand the interaction between different components of systems.• Know Managerial requirements of a system, needs to be developed• Know End User requirements.• Develop a quality system with in minimum Cost in given time-constraints.	

Recommended Books

- [1] James A O'Brien, George M Marakas, "Management Information Systems", Seventh Edition, McGraw Hill, 2006.
[2] Brijendra Singh, "System Analysis and Design", New Age Publication, 2016.

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