Kurukshetra University, Kurukshetra

(Established by the State Legislature Act XII of 1956)
('A+' Grade, NAAC Accredited)

|| योगस्थ: कुरु कर्माणि ||

समबुद्धि व योग युक्त होकर कर्म करो

(Perform Actions while Stead fasting in the State of Yoga)

Scheme of Examination and Syllabus of

Master of Science (M.Sc.) Computer Science (Software) (CBCS)
in Phased Manner

DEPARTMENT OF COMPUTER SCIENCE & APPLICATIONS

CBCS CURRICULUM (2020-21)

Program Name: Master of Science (M.Sc.) Computer Science (Software) (CBCS)

(For the Batches Admitted From 2020-2021)

DEPARTMENT OF COMPUTER SCIENCE & APPLICATIONS
KURUKSHETRA UNIVERSITY, KURUKSHETRA

VISION

Pursue conducive advancement towards nurturing globally competent and ethically conscientious professionals and entrepreneurs in agile computing technologies and allied spheres for unceasing evolution of Nations IT affiliated commercial and research endeavours.

MISSION

Thrive to establish a strong foundation for technical competency in spheres concordant to software oriented design and development. Nurture skills and competency for administering expertise gained in computing discipline to a wide horizon of interdisciplinary application domains, thus supporting sustainable development of the society. Habituate the students to strive for technological innovations and successful endeavours ethically, supported by sustained learning continuance and problem solving proficiency that may promote nations welfare in terms of economic acceleration leading to the growth of society.

NAME OF THE PROGRAMME: MASTER OF SCIENCE
(COMPUTER SCIENCE (SOFTWARE))
DURATION : TWO YEARS

PROGRAMME OUTCOMES (POs)	
PO1	Knowledge Capable of demonstrating comprehensive disciplinary knowledge gained during course of study.
PO2	Research Aptitude Capability to ask relevant/appropriate questions for identifying, formulating and analyzing the research problems and to draw conclusion from the analysis.
PO3	Communication Ability to communicate effectively on general and scientific topics with the scientific community and with society at large.
PO4	Problem Solving Capability of applying knowledge to solve scientific and other problems.
PO5	Individual and Team Work Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings.
PO6	Investigation of Problems Ability of critical thinking, analytical reasoning and research based knowledge including design of experiments, analysis and interpretation of data to provide conclusions.
PO7	Modern Tool usage Ability to use and learn techniques, skills and modern tools for scientific practices.
PO8	Science and Society Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices.

PROGRAMME OUTCOMES (POs)	
PO9	Life-Long Learning Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life.
PO10	Ethics Capability to identify and apply ethical issues related to one's work, avoid unethical behaviour such as fabrication of data, committing plagiarism and unbiased truthful actions in all aspects of work.
PO11	Project Management Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects.

PROGRAMME SPECIFIC OUTCOMES (PSOs)	
PSO1	Provide exposure to the hardware and software environment of computer systems along with a comprehensive strengthening of computational expertise in programming languages and open source platforms.
PSO2	Enhance competency in designing and modeling software based applications with enrichment of proficiency in software design skills.
PSO3	Strengthen technical skills and professional expertise in adopting contemporary trends and technological developments for the application of innovative approaches and propositions to real-world problem scenario.
PSO4	Inspire pursuance of skillful expertise for careers in Commercial/ Government Sectors, Academics/ Consultancy/ Research and Development for technological innovations, and collateral fields related to Computer Science and Information Technology.

KURUKSHETRA UNIVERSITY, KURUKSHETRA

SCHEME OF EXAMINATION FOR MASTER OF SCIENCE
(COMPUTER SCIENCE (SOFTWARE))
CHOICE BASED CREDIT SYSTEM (CBCS)
W. E. F. ACADEMIC SESSION 2020-21 IN PHASED MANNER

Paper Code	Nomenclature of Paper	Credits	Workload Per Week (Hrs.)	Exam Time (Hrs.)	External Marks		Internal Marks	Total Marks	Pass Marks
					Max.	Pass			
First Semester									
MS-20-11	Web Engineering	4	4	3	75	30	25	100	40
MS-20-12	Advanced Database Systems	4	4	3	75	30	25	100	40
MS-20-13	Linux and Shell Programming	4	4	3	75	30	25	100	40
MS-20-14	Discrete Mathematical Structures	4	4	3	75	30	25	100	40
MS-20-15	S/W Lab – I Based on MS-20-11 and MS-20-12	2.5	5	3	100	40	-	100	40
MS-20-16	S/W Lab – II Based on MS-20-13	2.5	5	3	100	40	-	100	40
	Total	**21**	**26**		**500**	**200**	**100**	**600**	**240**
Second Semester									
MS-20-21	Data Structures and Algorithms	4	4	3	75	30	25	100	40
MS-20-22	Programming in Java	4	4	3	75	30	25	100	40
MS-20-23	Object Oriented Analysis and Design using UML	4	4	3	75	30	25	100	40
MS-20-24	Data Communication and Computer Networks	4	4	3	75	30	25	100	40
MS-20-25	S/W Lab – III Based on MS-20-21	2.5	5	3	100	40	-	100	40
MS-20-26	S/W Lab – IV Based on MS-20-22	2.5	5	3	100	40	-	100	40
*OE-20-27	Open Elective Based on MOOCs (The selected course should not be directly related with Computer Science) Or As Per University Guidelines	2	2	3	35	14	15	50	20
	Total	**23**	**28**		**535**	**214**	**115**	**650**	**260**
Third Semester									
MS-20-31	Data Mining and Analytics using R	4	4	3	75	30	25	100	40
MS-20-32	Computer Graphics and Animation	4	4	3	75	30	25	100	40
MS-20-33	Elective-I	4	4	3	75	30	25	100	40
MS-20-34	Elective-II	4	4	3	75	30	25	100	40
MS-20-35	S/W Lab – V Based on MS-20-31	2.5	5	3	100	40	-	100	40
MS-20-36	S/W Lab – VI Based on MS-20-32	2.5	5	3	100	40	-	100	40
**MS-20-37	Summer Training / Internship	8	-	Viva Voce	150	60	50	200	80

Paper Code	Nomenclature of Paper	Credits	Workload Per Week (Hrs.)	Exam Time (Hrs.)	External Marks		Internal Marks	Total Marks	Pass Marks
					Max.	Pass			
*OE-20-38	Open Elective Based on MOOCs (The selected course should not be directly related with Computer Science) Or As Per University Guidelines	2	2	3	35	14	15	50	20
Total		**31**	**28**		**685**	**274**	**165**	**850**	**340**
Elective – I									
MS-20-33(i)	Compiler Design	4	4	3	75	30	25	100	40
MS-20-33(ii)	Advanced Computer Architecture	4	4	3	75	30	25	100	40
MS-20-33(iii)	Principles of Programming Languages	4	4	3	75	30	25	100	40
Elective – II									
MS-20-34 (i)	Mobile Computing	4	4	3	75	30	25	100	40
MS-20-34 (ii)	Theory of Computation	4	4	3	75	30	25	100	40
MS-20-34(iii)	Artificial Intelligence	4	4	3	75	30	25	100	40
Fourth Semester									
MS-20-41	Mobile Application Development	4	4	3	75	30	25	100	40
MS-20-42	Machine Learning using Python	4	4	3	75	30	25	100	40
MS-20-43	Elective-III	4	4	3	75	30	25	100	40
MS-20-44	Elective-IV	4	4	3	75	30	25	100	40
MS-20-45	S/W Lab–VII Based on MS-20-41	2.5	5	3	100	40	-	100	40
MS-20-46	S/W Lab-VIII Based on MS-20-42	2.5	5	3	100	40	-	100	40
Total		**21**	**26**		**500**	**200**	**100**	**600**	**240**
Grand Total		**96**	**108**		**2220**	**888**	**480**	**2700**	**1080**
Elective – III									
MS-20-43 (i)	Cryptography and Network Security	4	4	3	75	30	25	100	40
MS-20-43 (ii)	Big Data and Pattern Recognition	4	4	3	75	30	25	100	40
MS-20-43(iii)	Cyber Security and Blockchain Technology	4	4	3	75	30	25	100	40
Elective – IV									
MS-20-44 (i)	Optimization Techniques	4	4	3	75	30	25	100	40
MS-20-44 (ii)	Soft Computing	4	4	3	75	30	25	100	40
MS-20-44(iii)	Cloud Computing and IoT	4	4	3	75	30	25	100	40

***Note 1:** In addition to the credits earned by compulsory and elective courses, every student has to earn 2 more credits by selecting an open elective/MOOC course during second and third semester.

****Note 2:** Summer Training / Internship will be held immediately after 2nd Semester Examination and will be having a minimum duration of 45 days and maximum duration of 60 days. Students have to submit the Summer Training / Internship Report latest by 30th August. Evaluation of the Report and Viva-Voce shall be held during 3rd Semester. The Evaluation and Viva-Voce shall be held by one External and one Internal examiner.

Note 3: The credits for the first year are 44(21+23) and for the second year are 52(31+21). Total credits of the course shall be 44+52 = 96.

Note 4: For the purpose of computation of work-load the following mechanism shall be adopted:

- 1 Credit = 1 Theory period of one hour duration.
- 1 Credit = 1 Practical period of two hour duration.

Note 5: Evaluation procedure for internal assessment marks:

Two Mid Term Examinations should be conducted by the concerned teacher each of 10 marks. Five marks may be given by the concerned teacher on the basis of performance during the course (puzzles/ assignments/ interactions/ attendance etc).

Note 6: Size of groups in all practical courses should not be more than thirty students.

MS-20-11: Web Engineering

Type: Compulsory
Course Credits: 04
Contact Hours: 4 hours/week
Examination Duration: 3 Hours
Mode: Lecture
External Maximum Marks: 75
External Pass Marks: 30 (i.e. 40%)
Internal Maximum Marks: 25
Total Maximum Marks: 100
Total Pass Marks: 40 (i.e. 40%)

Instructions to paper setter for End semester examination:
Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to provide fundamentals concepts of Web Services, JavaScript and lays foundations for the advanced studies in the area of web services.

Course Outcomes (COs)	At the end of this course, the student will be able to:
MS-20-11.1	design web pages using HTML5 and CSS;
MS-20-11.2	understand objects and data validation in JavaScript;
MS-20-11.3	build Dynamic web site using server side PHP Programming and Database connectivity;
MS-20-11.4	create web applications with Ajax.

CO-PO Mapping Matrix for Course Code: MS-20-11

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-11.1	3	1	2	3	2	3	3	1	2	2	2
MS-20-11.2	3	1	2	3	2	3	3	1	2	2	2
MS-20-11.3	3	1	2	3	2	3	3	1	2	2	2
MS-20-11.4	3	1	2	3	2	3	3	1	2	2	2
Average	**3**	**1**	**2**	**3**	**2**	**3**	**3**	**1**	**2**	**2**	**2**

CO-PSO Mapping Matrix for Course Code: MS-20-11

COs	PSO1	PSO2	PSO3	PSO4
MS-20-11.1	3	3	2	3
MS-20-11.2	3	3	2	3
MS-20-11.3	3	3	2	3
MS-20-11.4	3	3	2	3
Average	**3**	**3**	**2**	**3**

Unit – I

Introduction: Web browsers and its functions, web optimizations; Static page design; designing static web pages with HTML5.0-HTML basic, multimedia, Graphics, Form tags, CSS 2.0 concept and its properties & CSS 3.0 properties i.e. borders, backgrounds, fonts, text effects, Buffering, Weblog, Web Cache Poisoning.

Unit – II

JavaScript: Document Object Model (DOM), Obtaining user inputs, memory concepts, Operators, Control Structures, Looping constructs, break, continue statements, Programmer defined functions, Scoping rules, Recursion and iteration, Array declaration and allocation, passing arrays to function, Objects: String, Date, Boolean, Window, document; using cookies, form validation in Java Script, Handling Events Using JavaScript.

Unit – III

PHP: Installing and Configuring MySQL and PHP, Basic Security Guidelines, Variables, Data Types, Operators and Expressions, Constants, Flow Control Functions; Switching Flow, Loops, Code Blocks and Browser Output, Objects, Strings Processing, Form processing, Connecting to database, cookies, Session, dynamic contents.

Unit – IV

Introduction to AJAX: Exploring different web technologies, Creating a simple AJAX application, Interacting with the Web Server Using the XMLHttpRequest Object, Create an XMLHttpRequest Object, Interact with the Web Server. Differentiating AJAX and Non-AJAX application.

Search engine optimization for individual web pages: header entries, tags, selection of URL, alt tags, Search engine optimization for entire website: Hyperlinks and link structure, page rank of Google, click rate, residence time of website

Text Books:

1. Deitel H.M., Deitel P.J., Internet & World Wide Web: How to program, Pearson Education.
2. Kogent Learning, Web Technologies: HTML, JavaScript, PHP, Java, JSP, XML, AJAX – Black Book, Wiley India Pvt. Ltd.

Reference Books:

1. Boronczyk, Naramore, Beginning PHP, Apache, MySQL Web Development, Wiley India Pvt. Ltd.
2. Thomas Powell, Ajax: The Complete Reference.
3. Maro Fischer, Website Boosting: Search Engine, Optimization, Usability, Website Marketing, Firewall Media, New Delhi.

MS-20-12: Advanced Database Systems	
Type: Compulsory **Course Credits:** 04 **Contact Hours:** 4 hours/week **Examination Duration:** 3 Hours **Mode:** Lecture **External Maximum Marks:** 75 **External Pass Marks:** 30 (i.e. 40%) **Internal Maximum Marks:** 25 **Total Maximum Marks:** 100 **Total Pass Marks:** 40 (i.e. 40%)	**Instructions to paper setter for End semester exam:** Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to provide an in- depth knowledge of SQL and PL/SQL to design database for an organization. This course focuses on advance topics of the database including EER model, object oriented database, and emerging concepts of database.

Course Outcomes (COs)	At the end of this course, the student will be able to:
MS-20-12.1	review the fundamental aspects of database along with EER model;
MS-20-12.2	get the practical exposure to SQL and PL/SQL to implement database management system in an organization;
MS-20-12.3	learn normalization and concurrency control techniques;
MS-20-12.4	acquire knowledge of different kind of emerging databases in real life scenario.

CO-PO Mapping Matrix for the Course Code : MS-20-12

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-12.1	3	3	3	3	2	2	1	3	2	2	3
MS-20-12.2	3	2	3	1	3	2	3	3	2	2	1
MS-20-12.3	3	2	2	3	2	2	2	1	3	2	2
MS-20-12.4	2	3	3	2	3	1	3	3	3	2	3
Average	**2.75**	**2.5**	**2.75**	**2.25**	**2.5**	**1.75**	**2.25**	**2.5**	**2.5**	**2**	**2.25**

CO-PSO Mapping Matrix for the Course Code : MS-20-12

COs	PSO1	PSO2	PSO3	PSO4
MS-20-12.1	3	3	3	3
MS-20-12.2	2	2	2	2
MS-20-12.3	3	3	2	3
MS-20-12.4	2	3	1	2
Average	**2.5**	**2.75**	**2**	**2.5**

Unit – I

Database System Concepts and Architecture: Three - Schema Architecture and Data Independence, Entity Relationship Model: Entity Types, Entity Sets, Attributes & keys, Relationships Types & instances ER Diagrams, Naming conventions and Design Issues. Relational Model Constraints, Enhanced Entity Relationship Model: Subclasses, Super classes, Inheritance, Specialization and Generalization.

Unit – II

SQL: Data Definition and Data Types, DDL, DML, and DCL, Join Operations, Views & Queries in SQL, Specifying Constraints & Indexes in SQL. PL/SQL: Architecture of PL/SQL, Basic Elements of PL/SQL, PL/SQL Transactions, Cursors and Triggers. Relational Algebra: Unary and Binary Relational Operations.

Unit – III

Functional Dependencies, Normal Forms Based on Primary Keys- (1NF, 2NF, 3NF, BCNF), Multi-valued Dependencies, 4 NF, Join dependencies, 5 NF, Domain Key Normal Form. Query Processing and Optimization**,** Introduction to Transaction Processing, and Desirable Properties of Transactions, Concurrency Control Techniques, Database Backup and Recovery.

Unit – IV

Overview Object Oriented Database Model, Databases for Advance Applications: Architecture for Parallel Database and Distributed Database, Active Database Concept and Triggers, Temporal Databases Concepts, Spatial and Multimedia Databases, Geographical Information System, Mobile Databases, Web Databases, XML Schema, XML Query.

Text Books:

1. Elmasri and Navathe, Fundamentals of Database Systems, Pearson Education.
2. Jules J. Berman, Principles of Big Data, Elsevier India.

Reference Books:

1. Date C.J., An Introduction to Database Systems, Pearson Education.
2. Hector G.M., Ullman J.D., Widom J., Database Systems: The Complete Book, Pearson Education.
3. Silberschatz A., Korth H., Sudarshan S., Database System Concepts, McGraw Hill.

MS-20-13: Linux and Shell Programming

Type: Compulsory
Course Credits: 04
Contact Hours: 4 hours/week
Examination Duration: 3 Hours
Mode: Lecture
External Maximum Marks: 75
External Pass Marks: 30 (i.e. 40%)
Internal Maximum Marks: 25
Total Maximum Marks: 100
Total Pass Marks: 40 (i.e. 40%)

Instructions to paper setter for End semester examination:
Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: The objectives of this course are to provide the in-depth coverage of various concepts of Linux. Linux administration is an essential course for the students.

Course Outcomes (COs)	At the end of this course, the student will be able to:
MS-20-13.1	understand the basic concepts and commands of Linux;
MS-20-13.2	understand the file management and process manipulation in Linux;
MS-20-13.3	understand the C environment under Linux and do the system administration and communication in Linux;
MS-20-13.4	develop shell programs in Linux.

CO-PO Mapping Matrix for Course Code: MS-20-13

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-13.1	3	2	3	3	3	2	1	1	3	1	2
MS-20-13.2	3	2	3	3	3	2	1	1	3	1	2
MS-20-13.3	3	2	3	3	3	2	2	1	3	1	2
MS-20-13.4	3	2	3	3	3	3	2	1	3	1	2
Average	**3**	**2**	**3**	**3**	**3**	**2.25**	**1.5**	**1**	**3**	**1**	**2**

CO-PSO Mapping Matrix for Course Code: MS-20-13

COs	PSO1	PSO2	PSO3	PSO4
MS-20-13.1	3	2	3	2
MS-20-13.2	3	2	3	2
MS-20-13.3	3	2	3	3
MS-20-13.4	3	2	3	3
Average	**3**	**2**	**3**	**2.5**

Unit – I

Introduction: History, Basic features, architecture, distributions. Installing Linux, Logging in / Logging out.
File System: Introduction to files, Organization, Assessing File systems, Structure - boot block, super block, inode

block, data block.
Basic and Advanced Commands: Directory oriented commands, File oriented commands, File access permissions: chmod, umask, chgrp, groups. General purpose commands.

Unit – II

File management and Compression: Computer devices, Disk related commands: dd, du, df, dfspace, fdisk, compressing and uncompressing files.
Manipulating Processes and Signals: Basics, process states and transitions, zombie and orphan processes, process oriented commands. Handling foreground and background jobs. Process scheduling using cron, crontab, at, batch. Changing priority. Signal generation and Handling.
System calls: Files related system calls for opening, creating, reading, writing, relocating file descriptors, closing, duplicating file descriptors, linking, unlinking, accessing file status information, checking permissions, changing ownership, groups and permissions of files. Process related system calls: exec, fork, wait, exit.

Unit – III

System Administration: Booting and shutting down process. Creating, mounting and unmounting file systems. Managing User accounts**:** creating, modifying & deleting user accounts and groups.
Networking Tools: Communication oriented commands. ping, nslookup, telnet, arp, netstat, route, ftp, trivial file transfer protocol, finger, rlogin.
C language compiler, the make command and makefiles, general debugging techniques, debugging with gdb.

Unit – IV

Pipes and filters: Connecting processes with pipes, redirecting input and output. Filters: sort, grep, egrep, fgrep, uniq, more, pr, cut, paste, tr.
Shell Programming: Shell meaning & types; Introduction to shell scripting, shell variables, exporting shell variables, Escape mechanisms, Shell meta characters, read command, conditional statements, looping and case statements, expr statement, command line arguments, sleep and basename commands, Bourne Shell Commands, string handling, arrays, shell functions, shell programs to automate system tasks.

Text Books:

1. Harwani B.M., Unix and Shell Programming, Oxford University Press.
2. Goerzen John, Linux Programming Bible, IDG Books, New Delhi.

Reference Books:

1. Matthew Neil, Stones Richard, Beginning Linux Programming, Wiley India Pvt. Ltd.
2. Christopher Negus, Linux Bible, Wiley India Pvt. Ltd.
3. Das Sumitabha, You UNIX – The Ultimate Guide, Tata McGraw Hill
4. Richard Peterson, Linux – The Complete Reference, Tata McGraw Hill

MS-20-14: Discrete Mathematical Structures

Type: Compulsory
Course Credits: 04
Contact Hours: 4 hours/week
Examination Duration: 3 Hours
Mode: Lecture
External Maximum Marks: 75
External Pass Marks: 30 (i.e. 40%)
Internal Maximum Marks: 25
Total Maximum Marks: 100
Total Pass Marks: 40 (i.e. 40%)

Instructions to paper setter for End semester exam:
Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to provide in-depth coverage of discrete mathematical structures. It focuses on learning about sets, logics, analysis techniques, and graphs and their use in the field of computer science.

Course Outcomes (COs)	At the end of this course, the student will be able to:
MS-20-14.1	understand the basic concepts of sets, function and relations;
MS-20-14.2	understand logics and counting principles;
MS-20-14.3	understand the lattices, Boolean algebra and their use in computer science;
MS-20-14.4	design and understand the working with graphs and trees.

CO-PO Mapping Matrix for the Course Code : MS-20-14

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-14.1	3	2	1	1	2	2	1	2	2	1	2
MS-20-14.2	3	3	1	3	1	3	1	2	3	1	2
MS-20-14.3	3	1	1	2	1	2	1	1	2	1	2
MS-20-14.4	3	2	1	2	1	2	1	1	2	1	2
Average	**3**	**2**	**1**	**2**	**1.25**	**2.25**	**1**	**1.5**	**2.25**	**1**	**2**

CO-PSO Mapping Matrix for the Course Code : MS-20-14

COs	PSO1	PSO2	PSO3	PSO4
MS-20-14.1	2	2	2	3
MS-20-14.2	2	3	3	3
MS-20-14.3	3	3	3	3
MS-20-14.4	3	2	2	3
Average	**2.5**	**2.5**	**2.5**	**3**

Unit – I

Set Theory: Basic Set Theory, Operations on Sets, Algebra of sets, Venn Diagrams.
Relations: Binary Relations, Complement of relations, Inverse of relations, Composite relations, Properties,

Equivalence, Partial Order and Total order relations.
Functions: Functions on Set, Domain, Co-domain, Representation of Functions, Types, Identity and Inverse Functions, Composition of Functions.

Unit – II

Propositional Calculus: Propositional logic, Equivalences, Predicates, Quantifiers, Nested Quantifiers, Rules of Inference, Normal Forms, Proofs: Methods, Strategy.
Counting: Pigeonhole Principle, Inclusion-Exclusion Principle, Permutations and Combinations, Binomial Coefficients, Counting Principles.

Unit – III

Advanced Counting Techniques: Recurrence Relations, Solving Recurrence Relations
Lattices and Boolean algebra: Lattices, Hasse Diagram, Principle of Duality, Types of Lattices, Special Lattices, Boolean Expression, Equivalent circuits, Dual, Normal Forms.

Unit – IV

Graphs: Introduction, Terminology, Types of Graphs, Representation of Graphs, Paths and Circuits, Cut-set and Cut - Vertices, Graph Isomorphism, Homomorphism, Connectivity, Bipartite Graphs, Subgraphs, Operations on Graphs, Euler and Hamiltonian Graphs, Shortest Path Problem, Planar & Dual Graphs, Coloring.
Tree: Tree Notations, Properties of tree, Types of Tree, Operations, Minimum Spanning Tree (MST).

Text Books:

1. Kenneth G. Rosen, Discrete Mathematics and Its Applications, Tata McGraw Hill.
2. Koshy T., Discrete Mathematics with Applications, Elsevier India.

Reference Books:

1. Eric Gosett, Discrete Mathematics with proof, Wiley India Pvt. Ltd.
2. Seymour Lipshutz, Schaum Outlines of Discrete Mathematics, Tata McGraw-Hill.
3. Kenneth Ross, Discrete Mathematics, Pearson Educations India.

MS-20-21: Data Structures and Algorithms

Type: Compulsory
Course Credits: 04
Contact Hours: 4 hours/week
Examination Duration: 3 Hours
Mode: Lecture
External Maximum Marks: 75
External Pass Marks: 30 (i.e. 40%)
Internal Maximum Marks: 25
Total Maximum Marks: 100
Total Pass Marks: 40 (i.e. 40%)

Instructions to paper setter for End semester exam:
Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to provide in-depth coverage of advanced data structures and algorithm design techniques. It focuses on learning about analysing and designing algorithms to solve a problem and learn to find the asymptotic efficiency of an algorithm.

Course Outcomes (COs)	At the end of this course, the student will be able to:
MS-20-21.1	analyse worst-case running times of algorithms using asymptotic analysis;
MS-20-21.2	understand the basic and advanced data structures and to implement them;
MS-20-21.3	understand and implement various techniques for problem solving;
MS-20-21.4	identify the type of problem and solving using appropriate technique.

CO-PO Mapping Matrix for the Course Code : MS-20-21

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-21.1	3	3	1	3	1	3	2	3	3	1	2
MS-20-21.2	3	2	1	3	1	3	2	3	3	1	2
MS-20-21.3	3	3	1	3	3	3	2	3	3	1	3
MS-20-21.4	3	2	1	3	3	3	2	3	3	1	3
Average	**3**	**2.5**	**1**	**3**	**2**	**3**	**2**	**3**	**3**	**1**	**2.5**

CO-PSO Mapping Matrix for the Course Code : MS-20-21

COs	PSO1	PSO2	PSO3	PSO4
MS-20-21.1	2	3	2	3
MS-20-21.2	2	3	2	3
MS-20-21.3	2	3	3	3
MS-20-21.4	2	3	3	3
Average	**2**	**3**	**2.5**	**3**

Unit – I

Introduction to Data Structures: Classification of Data Structures, Arrays.

Stacks & Queues: Representation of Stacks, Stack Operations, Applications, Queues, Operations on Queues, Circular Queues, Dequeue, Priority Queues, Applications.
Introduction to Algorithms: Role of algorithms in computing, Complexity of algorithms, analysing algorithms, designing algorithms, asymptotic notations.

Unit – II

Linked Lists: Introduction, Types, and Operations (Insertion, Deletion, Traversal, Searching), Applications, Dynamic Memory Management, and Implementation of Linked Representations.
Trees: Binary Tree Traversals, Threaded Binary Trees, Binary Search Trees and Operations, AVL Trees, Heap, M-way Search Trees, B-Trees, B+ Trees, Applications.

Unit – III

Divide and Conquer: Solving recurrence equations: back substitution method, recursion tree method, master's theorem.
Analysis of heap sort and quick sort; Counting sort, Radix sort, Bucket sort, Lower bounds for sorting.
Dynamic Programming (DP): Elements of DP, Matrix chain multiplication, Longest common subsequence, optimal binary search trees.

Unit – IV

Greedy Techniques (GT): Elements of GT, Activity selection problem, Huffman codes, Knapsack Problem.
Graph Algorithms: Negative weight cycle, Bellman-Ford algorithm. All Pairs Shortest Path.
Maximum Flow: Flow network, Ford-Fulkerson method.
Strings: Storage of strings, Naive string-matching algorithm, Rabin-Karp algorithm, String matching with finite automata, Knuth-Morris-Pratt algorithm

Text Books:

1. G.A.V Pai, Data Structures and Algorithms, McGraw-Hill.
2. Cormen, Leiserson, Rivest, Introduction to Algorithms, PHI India.

Reference Books:

1. Neapolitan R., Foundations of Algorithms, Jones and Bartlett Learning.
2. Seymour Lipschutz, Data Structures, McGraw-Hill, Schaum's Outlines, New Delhi.
3. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, Data Structures and Algorithms, Pearson Education.

MS-20-22: Programming in JAVA

Type: Compulsory
Course Credits: 04
Contact Hours: 4 hours/week
Examination Duration: 3 Hours
Mode: Lecture
External Maximum Marks: 75
External Pass Marks: 30 (i.e. 40%)
Internal Maximum Marks: 25
Total Maximum Marks: 100
Total Pass Marks: 40 (i.e. 40%)

Instructions to paper setter for End semester exam:
Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: The course aims is to equip the students with JAVA programming language concepts with object-oriented programming principles. In this course student will be able to learn the basic syntax and semantics of the Java language and programming environment, build robust applications using Java's object-oriented features, implement the interface, Packages and inheritance, understand exceptional handling and multi-threading concepts and implementation using Applets, AWT and Event Handling and concepts of JAVA beans, Swing.

Course Outcomes (COs)	At the end of this course, the student will be able to:
MS-20-22.1	learn the basic features of Java;
MS-20-22.2	develop program using different concepts of OOPs;
MS-20-22.3	develop programming using Java I/O stream classes;
MS-20-22.4	design and Implement Graphics programming using Applet, AWT and Layouts.

CO-PO Mapping Matrix for Course Code: MS-20-22

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-22.1	3	1	3	3	3	2	1	2	3	1	2
MS-20-22.2	3	2	3	3	3	2	2	2	3	2	2
MS-20-22.3	2	2	3	3	3	2	2	2	3	2	2
MS-20-22.4	3	3	3	3	3	2	1	2	3	1	2
Average	**2.75**	**2**	**3**	**3**	**3**	**2**	**1.5**	**2**	**3**	**1.5**	**2**

CO-PSO Mapping Matrix for Course Code: MS-20-22

Cos	PSO1	PSO2	PSO3	PSO4
MS-20-22.1	3	2	2	3
MS-20-22.2	3	3	2	3
MS-20-22.3	3	3	2	3
MS-20-22.4	3	3	2	3
Average	**3**	**2.75**	**2**	**3**

UNIT – I

Introduction to Java: Importance and features of Java, Java virtual machine, Byte code, JDK, Keywords, constants,

variables and Data Types, Operators and Expressions, Decision Making, Branching and Looping, jump statements: break, continue, and return. Introducing classes, objects and methods: defining a class, adding variables and methods, creating objects, constructors, class inheritance. Arrays and String: Creating an array, one and two dimensional arrays, string array and methods.

UNIT – II

Packages and interfaces, Exception Handling: Fundamentals exception types, uncaught exceptions, throw exception, built in exception, creating your own exceptions, Multithreaded Programming: Fundamentals, Java thread model: synchronization, messaging, thread classes, Runnable interface, inter thread Communication, suspending, resuming and stopping threads.

UNIT – III

I/O Streams: String and String Buffer classes, Wrapper classes: Basics types, using super, Multilevel hierarchy abstract and final classes. Input/Output Programming: Basics, Streams, Byte and Character Stream, predefined streams, Reading and writing from console and files.

UNIT –IV

Event Handling: Different Mechanism, the Delegation Event Model, Event Classes, Event Listener Interfaces, Adapter and Inner Classes, Working with windows, Graphics and Text, using AWT controls, Layout managers, handling Image, animation, sound and video, Beans: Introduction to Java Beans.

Text Books:

1. E. Balaguruswamy, Programming with JAVA- A Primer, Tata Mc-Graw Hill.
2. Patrick Naughton, Herbert, Schild, The Complete reference Java 2, Tata Mc-Graw Hill.

Reference Books:

1. Patrick Nieaneyer and Joshna Peck, Exploring Java, O, Reilley.
2. Hareliy Hahn, Teacher the Internets, P.H.I.
3. Barry Boone, William Stanck, Java 2 exam Guide, Tata Mc-Graw Hill.

MS-20-23: Object Oriented Analysis and Design Using UML

Type: Compulsory
Course Credits: 04
Contact Hours: 4 hours/week
Examination Duration: 3 Hours
Mode: Lecture
External Maximum Marks: 75
External Pass Marks: 30 (i.e. 40%)
Internal Maximum Marks: 25
Total Maximum Marks: 100
Total Pass Marks: 40 (i.e. 40%)

Instructions to paper setter for End semester examination:
Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: To understand the concepts of UML and its applications for class modeling, state modeling, use case modeling, interaction modeling, activity modeling etc. and to analyse & design software systems using object-oriented approach.

Course Outcomes (COs)	At the end of this course, the student will be able to:
MS-20-23.1	understand basics of modeling and fundamentals of UML such as things, relationships, diagrams, extensibility mechanisms and views;
MS-20-23.2	to practically apply knowledge of class modeling and state modeling using object-oriented analysis and design methods with a clear emphasis on UML;
MS-20-23.3	to practically apply knowledge of use case modeling, interaction modeling and activity modeling using UML;
MS-20-23.4	have a working ability and grasping attitude to analyse and design software systems based on object-oriented thinking using UML.

CO-PO Mapping Matrix for Course Code: MS-20-23

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-23.1	3	2	3	3	3	2	2	2	3	1	2
MS-20-23.2	3	2	3	3	3	2	2	2	3	1	2
MS-20-23.3	3	2	3	3	3	2	2	3	3	1	2
MS-20-23.4	3	2	3	3	3	2	3	3	3	1	3
Average	**3**	**2**	**3**	**3**	**3**	**2**	**2.25**	**2.5**	**3**	**1**	**2.25**

CO-PSO Mapping Matrix for Course Code: MS-20-23

COs	PSO1	PSO2	PSO3	PSO4
MS-20-23.1	2	3	3	3
MS-20-23.2	2	3	3	3
MS-20-23.3	2	3	3	3
MS-20-23.4	2	3	3	3
Average	**2**	**3**	**3**	**3**

Unit – I

Modeling as a Design Technique: Principles of modeling, abstraction, encapsulation, modularity, hierarchy, typing, concurrency, persistence of objects, purpose of modeling

UML: Principles of modeling, UML things – structural, behavioral, grouping, annotational. Relationships in UML – dependency, association, generalization, realization. Overview of UML diagrams, Mechanisms in the UML – specifications, adornments, common divisions, Extensibility mechanisms - stereotypes, tagged values, constraints, UML profiles, UML views.

Unit – II

Class Modeling: Object & Class, Links & Associations, Generalization & Inheritance, Association Ends - scope, visibility, Multiplicity, Role names, Ordering, bags & sequences, Qualified association, Aggregation, association attributes & association classes, propagation of operations,Abstract class, Metadata, reification, Constraints, derived data, packages, elements of class diagrams, constructing class diagrams.

State Modeling: Events, States, Transitions & Conditions, Activity Effects, Do-Activities, Entry & Exit Activities, Completion Transitions, Sending Signal, Elements of State diagrams, Nested state diagrams, signal generalization, concurrency, constructing state diagrams.

Unit – III

Use Case modeling: Actors, Use Cases, relationships - between actors, between use cases and between actor and use case, elements of use case diagram, constructing use case diagrams.

Interaction Modeling: Elements of sequence diagram and communication diagram, constructing sequence diagram and communication diagram

Activity Modeling: Elements of activity diagram, constructing activity diagram

Unit – IV

System Analysis & design: System development stages, system conception, analysis, domain class model, domain state model, iterating the analysis.

Application interaction model, application class model, application state model, adding operations

System Design: estimating performance, make a reuse plan, organize the system into subsystem, identifying concurrency, allocating subsystems to processors and tasks, management of data stores, handling global resources, choosing software control strategies, handling boundary conditions, setting trade-off priorities, selecting an architect style.

Class Design: bridging gap, realize use cases with operations, designing algorithms, design optimization, adjustment of inheritance.

Text Books:

1. Grady Booch, James Rumbaugh, Ivar Jacobson, The Unified Modeling Language User Guide, Pearson education.
2. M. Blaha, J. Rumbaugh, Object-Oriented Modeling and Design with UML, Pearson Education.

Reference Books:

1. J. Rumbaugh, M. Blaha, W. Premerlani, F. Eddy, W. Lorensen, Object-Oriented Modeling and Design, Prentice Hall of India.
2. Satzinger, Jackson, Burd, Object-Oriented Analysis & Design with the Unified Process, Thomson.
3. Grady Booch, Object Oriented Analysis & Design, Pearson Education.

MS-20-24 Data Communication and Computer Networks

Type: Compulsory
Course Credits: 04
Contact Hours: 4 hours/week
Examination Duration: 3 Hours
Mode: Lecture
External Maximum Marks: 75
External Pass Marks: 30 (i.e. 40%)
Internal Maximum Marks: 25
Total Maximum Marks: 100
Total Pass Marks: 40 (i.e. 40%)

Instructions to paper setter for End semester examination:
Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives:
Provide an in-depth coverage of various concepts, components, and technologies of Computer Networks and Data Communication. Provide the architectural overview of the Internet. Enable the exposure of students to the current trends in wired and wireless communication technologies and real-world networking scenario

Course Outcomes: At the end of this course, the student will be able to:	
MS-20-24.1	characterize various types of computer networks and standards along with an insight into the principles of networking by using protocol layering of the Internet and the TCP/IP protocol suite;
MS-20-24.2	comprehend the notion of data communication and its related functional components and aspects;
MS-20-24.3	understand design issues related to Local area Networks and get acquainted with the prevailing wired and wireless LAN technology standards;
MS-20-24.4	get versed with the routing, addressing, congestion control, and security issues in Networks and the Internet architecture.

CO-PO Mapping Matrix for Course Code: MS-20-24

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-24.1	3	1	3	3	2	1	1	2	3	-	1
MS-20-24.2	3	1	3	3	2	2	1	2	3	-	2
MS-20-24.3	3	2	3	3	2	2	2	2	3	-	2
MS-20-24.4	3	3	3	3	2	2	2	2	3	-	2
Average	**3**	**1.75**	**3**	**3**	**2**	**1.75**	**1.5**	**2**	**3**	**-**	**1.75**

CO-PSO Mapping Matrix for Course Code: MS-20-24

COs	PSO1	PSO2	PSO3	PSO4
MS-20-24.1	1	1	1	3
MS-20-24.2	1	1	3	3
MS-20-24.3	1	2	3	3
MS-20-24.4	1	2	3	3
Average	**1**	**1.5**	**2.5**	**3**

Unit – I

Network Characterization: Goals and Applications; Categorization according to Size, Purpose, Design issues & Transmission Technologies; Network Architecture and Service Models; Design issues for the Layers; Reference Models: OSI and TCP/IP; Functions of layers and protocols of TCP/IP; Comparison of OSI & TCP/IP ; Data Transmission using TCP/IP.

Networking Models & Applications: Centralized, Decentralized, and Distributed; Client-Server and Peer-to-Peer; File sharing & Web- based; Content Distribution Networks.

Introduction to Example Networks: The Internet and its Conceptual View ; Applications of Internet; Accessing The Internet; Connection-Oriented Networks: X.25, Frame Relay and ATM.

Unit – II

Data Communication Concepts & Components: Digital and Analog Data and Signals, Asynchronous and Synchronous transmission; bit rate & baud, bandwidth & Channel Capacity; Nyquist Bit Rate, Shannon Capacity; Network Performance Parameters; Transmission Impairment.

Connecting Devices & Transmission Media: Network Interface Cards, Connectors, Hubs, Transceivers & Media Connectors; Link-Layer Switches, Bridge, Routers, Gateways, Virtual LANs; Guided Transmission Media; Wireless transmission; Satellite communication.

Data Encoding & Modulation Techniques: NRZ, NRZ-I, Manchester and Differential Manchester encoding; 4B/5B ; Pulse Code Modulation & Delta Modulation; Digital to Analog encoding.

Switching and Bandwidth Utilization: Methods of Switching; Virtual Circuit & Datagram Networks; Multiplexing; Spread Spectrum.

Wired Networks and the Local Loop: Telephone Networks; Modems; Broadband and ADSL; ADSL Versus Cable; Hybrid Fiber-Coaxial Network ; Fiber-to-the-Home Broadband.

Unit – III

Data Link Layer: Communication at the Data Link Layer; Nodes and Links; Link Layer Addressing; Examples of Data Link layer protocols.

Design Issues: Framing techniques: Byte Oriented and Bit Oriented Protocols; Error Detection and Correction; Sliding Window Flow Control Protocols.

Media Access Control: Random Access: Aloha, CSMA , CSMA/CD; Collision free protocols with Controlled Access; Limited Contention Protocols; Wavelength Division Multiple access for Fiber-Optic Data Communication.

IEEE LAN standards: Ethernet (Physical specifications, Encoding, Frame Format & MAC protocol); Binary Exponential Backoff algorithm; Token Ring and FDDI.

Introduction to Wireless Networks: IEEE 802.11 Wireless LAN; Wi-Max; Wireless LAN Protocol: MACA; Bluetooth and other wireless PAN technologies; Cellular Networks: Generations.

Unit – IV

Transport layer: Addressing, Services and Protocols; TCP and UDP services & header formats.

Network Layer: Services, Routing Algorithms: Shortest Path Routing, Flooding, Distance Vector Routing, Link State Routing, Hierarchical Routing, Multi Cast Routing, Routing for Mobile hosts.

Network Layer in TCP/IP: Basic characteristics of IP protocol; addressing and header format of IPv4; IPv6.

Congestion Control & Quality of Service: General Principals; Congestion control in Virtual – Circuit Subnets; Congestion Control in Datagram Subnets: Choke packets, Load Shedding; Random Early Detection, Jitter Control; Over provisioning, Buffering, Traffic Shaping, Leaky Bucket, Token Bucket, Resource Reservation, Admission Control, Packet Scheduling.

Network Security: Security Goals; Attacks; Cryptography; Confidentiality: Symmetric-Key and Asymmetric –Key Ciphers; Message Integrity & Authentication; Digital Signature; Certificates; IPSec; Firewalls; SSL.

Text Books:

1. Andrew S. Tanenbaum, Computer Networks, PHI.

2. Behrouz A Forouzan, Data Communications and Networking, Mc-Graw Hill Education.

Reference Books:

1. Michael A. Gallo, William M. Hancock, Computer Communications and Networking Technologies – CENGAGE learning.
2. William Stallings, Data and Computer Communications, PHI.

MS-20-31: Data Mining and Analytics using R

Type: Compulsory
Course Credits: 04
Contact Hours: 4 hours/week
Examination Duration: 3 Hours
Mode: Lecture
External Maximum Marks: 75
External Pass Marks: 30 (i.e. 40%)
Internal Maximum Marks: 25
Total Maximum Marks: 100
Total Pass Marks: 40 (i.e. 40%)

Instructions to paper setter for End semester examination:
Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to provide the in- depth coverage of data mining and analytics aspects along with its implementation in R programming language.

Course Outcomes (COs)	At the end of this course, the student will be able to:
MS-20-31.1	understand the fundamental concepts of data warehousing and data mining;
MS-20-31.2	learn data mining techniques for prediction/ forecasting;
MS-20-31.3	acquire knowledge of variety of data and analytical strategies;
MS-20-31.4	to implement data mining techniques in R to perform analytical operations.

CO-PO Mapping Matrix for Course Code: MS-20-31

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-31.1	3	3	3	3	2	2	1	3	2	2	3
MS-20-31.2	3	2	3	2	3	2	2	3	3	2	1
MS-20-31.3	2	2	2	3	1	2	1	2	3	3	2
MS-20-31.4	2	3	3	2	3	3	1	1	3	2	3
Average	2.5	2.5	2.75	2.5	2.25	2.25	1.25	2.25	2.75	2.25	2.25

CO-PSO Mapping Matrix for Course Code: MS-20-31

COs	PSO1	PSO2	PSO3	PSO4
MS-20-31.1	3	3	1	3
MS-20-31.2	2	2	3	1
MS-20-31.3	3	2	1	3
MS-20-31.4	3	3	1	2
Average	2.75	2.5	1.5	2.25

Unit – I

Data Warehouse: A Brief History, Characteristics, Architecture for a Data Warehouse. Fact and Dimension Tables, Data

Mining: Introduction, Motivation, Importance, Knowledge Discovery Process, Data Mining Functionalities, Interesting Patterns, Classification of Data Mining Systems, Major issues, Data Preprocessing: Overview, Data Cleaning, Data Integration, Data Reduction, Data Transformation and Data Discretization, Data Visualization, Outliers.

Unit – II

Data Mining Techniques: Statistical Perspective on Data Mining, Similarity Measures, Clustering- Requirement for Cluster Analysis, Clustering Methods, Decision Tree- Decision Tree Induction, Attribute Selection Measures, Tree Pruning. Association Rule Mining: Frequent Item-set Mining using Apriori Algorithm, Nearest Neighbour Classification: Performance of Nearest Neighbour Classifiers.

Unit – III

Data Analytics: Ways of Thinking About Data, Qualitative and Quantitative Data, And Data Strategies, Conceptualizing Data Analysis as a Process, Managing Data Analysis Process, Exploratory Data Analysis: Exploring a New Dataset, Summarizing Numeric Data, Anomalies in Numeric Data, Visualizing Relations between Variables. Working with External Data: Manual Data Entry, CSV Files, Other Files, Merging Data from Different Sources.

Unit – IV

R Programming: Advantages of R over other Programming Languages, Working with Directories and Data Types in R, Control Statements, Loops, Data Manipulation and integration in R, Exploring Data in R: Data Frames, R Functions for Data in Data Frame, Loading Data Frames, Decision Tree packages in R, Issues in Decision Tree Learning, Hierarchical and K-means Clustering functions in R, Mining Algorithm interfaces in R.

Text Books:

1. J Hanes, M. Kamber, Data Mining Concepts and Techniques, Elsevier India.
2. Ronald K. Pearson, Exploratory Data Analysis Using R, CRC Press.
3. S. Acharya, Data Analytics Using R, McGraw Hill Education (India) Private Limited.

Reference Books:

1. G.S. Linoff, M.J.A. Berry, Data Mining Techniques, Wiley India Pvt. Ltd.
2. Berson, S.J. Smith, Data Warehousing, Data Mining & OLAP, Tata McGraw-Hill.
3. J.Horbulyk, Data Integration Best Practices, elastic.io
4. Jared P. Lander, R For Everyone, Perason India Education Services Pvt. Ltd.

MS-20-32: Computer Graphics and Animation

Type: Compulsory
Course Credits: 04
Contact Hours: 4 hours/week
Examination Duration: 3 Hours
Mode: Lecture
External Maximum Marks: 75
External Pass Marks: 30 (i.e. 40%)
Internal Maximum Marks: 25
Total Maximum Marks: 100
Total Pass Marks: 40 (i.e. 40%)

Instructions to paper setter for End semester examination:
Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: Provide an introduction to the theory and practice of computer graphics. Provide an insight to applications of Graphics and the graphics hardware devices and software used. Introduce the use of the components and principles needed to design a graphics system and the algorithms related with them. To comprehend and analyse the fundamentals of animation and underlying techniques and principles

Course Outcomes: At the end of this course, the student will be able to:	
MS-20-32.1	have a knowledge of graphics applications and components and devices required to support the applications;
MS-20-32.2	develop algorithms for scan converting geometrical primitives such as lines, circles, ellipses, and curves along with algorithms for filling polygons, required for designing real-world applications;
MS-20-32.3	design algorithms for carrying out manipulations in pictures using geometric transformations, viewing transformations, and clipping operations;
MS-20-32.4	model 3-dimensional objects and apply viewing, visible –surface determination, and shading techniques to the models for achieving realism. The student will also learn to design and develop animation sequences.

CO-PO Mapping Matrix for Course Code: MS-20-32

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-32.1	3	1	3	2	1	1	1	1	3	-	1
MS-20-32.2	3	2	3	3	1	1	2	1	3	-	1
MS-20-32.3	3	2	3	3	1	1	2	1	3	-	1
MS-20-32.4	3	2	3	3	1	1	2	1	3	-	2
Average	**3**	**1.75**	**3**	**2.75**	**1**	**1**	**1.75**	**1**	**3**	**-**	**1.25**

CO-PSO Mapping Matrix for Course Code: MS-20-32

COs	PSO1	PSO2	PSO3	PSO4
MS-20-32.1	2	1	1	3
MS-20-32.2	1	3	3	3
MS-20-32.3	1	3	3	3
MS-20-32.4	1	3	3	3
Average	**1.25**	**2.5**	**2.5**	**3**

Unit – I

Introduction to Computer Graphics and its Components: Overview of Computer Graphics, its functions & elements; Introduction to GUI, Computer Vision, Augmented Reality and other Applications of Graphics; Popular Graphics Software; Components and Working of Interactive Graphics; Raster Scan and Random Scan Systems and Display Processors; Look-up table; Loading the Frame Buffer; Coordinate Systems.

Graphics Devices: Display Technologies: Resolution, Aspect Ratio, Refresh CRT, Color CRT, Flat Panel Displays; Interactive Input Devices for Graphics, Image and Video Input Devices.

Unit – II

Scan Conversion: Drawing Geometry; Output Primitives; Lines and Pixel Graphics; AntiAliasing; Scan Converting Lines: DDA line drawing algorithms, Bresenham's line Algorithm; Scan Converting Circles: DDA algorithm for circle drawing, Polynomial method for circle drawing, circle drawing using polar coordinates, Bresenham's circle drawing; Algorithms for Generation of ellipse; Line Styles; Generation of Bar Charts, Pie-Charts.

Curve Representation: Parametric Curves, Parametric Representation of a Circle, Parametric representation of cubic curves, drawing Bezier curves.

Filled-Area Primitives: Basic Stack based fill algorithms: Flood fill algorithm, Boundary fill algorithm; Scan-line polygon fill algorithm and its computational structures.

Unit – III

Two-Dimensional Transformations: Coordinate and Geometric Transformations; Translation, Rotation, Scaling; Matrix representations and Homogeneous coordinates, Composite transformations, General Pivot Point rotation, General Fixed Point Scaling, Shearing; Reflection ; Reflection about an arbitrary line.

2-D Viewing: Viewing pipeline; Window, Viewport, Window-to-Viewport transformation; Zooming, Panning; Pointing and Positioning techniques; Rubber band technique; Dragging.

Clipping operations: Point and Line clipping, Cohen-Sutherland line clipping, Mid-Point Subdivision line clipping, Liang-Barsky line clipping, Sutherland-Hodgman polygon clipping; Weiler-Atherton polygon clipping.

Unit – IV

3-D Graphics & Modeling: 3-D modeling of objects; Solid Model Representation Schemes: Euclidean Geometry methods and Procedural Methods: Fractals, Shape Grammars, Visualization techniques; 3D transformation matrices for Translation, Scaling and Rotation.

Three-Dimensional Viewing: Viewing Pipeline**; P**arallel Projection: Orthographic and Oblique projection; Perspective Projection.

Visible-Surface Determination: Z-buffer, depth-sorting, Area Subdivision, BSP-Tree method; Ray casting.

Illumination and Shading: Modeling Light Intensities, Basic Illumination Models; Gouraud Shading, Phong Shading;

Introduction to Animation: Designing of Animation Sequences; Key-Frame Systems; Animation Techniques: Tweening, Morphing.

Text Books:

1. Donald Hearn, M. Pauline Baker, Computer Graphics, Pearson Education.
2. J. D. Foley, A. Van Dam, S. K. Feiner and J. F. Hughes, Computer Graphics - Principles and Practice, Pearson Education.

Reference Books:

1. Newmann & Sproull, Principles of Interactive Computer Graphics, McGraw Hill.
2. Rogers, David F., Procedural Elements of Computer Graphics, McGraw Hill.
3. Zhigang Xiang, Roy Plastock, Computer Graphics, Tata McGraw Hill.
4. Malay K. Pakhira, Computer Graphics, Multimedia and Animation, PHI
5. Steven Harrington, Computer Graphics, A Programming Approach, McGraw Hill

MS-20-33(i): Compiler Design	
Type: Elective **Course Credits:** 04 **Contact Hours:** 4 hours/week **Examination Duration:** 3 Hours **Mode:** Lecture **External Maximum Marks:** 75 **External Pass Marks:** 30 (i.e. 40%) **Internal Maximum Marks:** 25 **Total Maximum Marks:** 100 **Total Pass Marks:** 40 (i.e. 40%)	**Instructions to paper setter for End semester exam:** Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: The objective of the course is to provide in-depth coverage of underlying concepts & techniques used in compiler design and to cover major topics in compilation Theory. This course will make students ready for job assignments involving compilers and prepare students to undertake projects on compilers Construction.

Course Outcomes (COs)	At the end of this course, the student will be able to:
MS-20-33(i).1	understand overall process of compilation;
MS-20-33(i).2	understand the process of parsing in compilers;
MS-20-33(i).3	analyze semantic analysis, building a symbol table, handling storage management and error-detection in the process of compiler designing;
MS-20-33(i).4	design a compiler and understand the concept of code generation and optimization.

CO-PO Mapping Matrix for the Course Code : MS-20-33(i)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-33(i).1	3	2	2	2	1	2	2	2	3	1	2
MS-20-33(i).2	3	2	2	2	2	2	2	2	3	1	2
MS-20-33(i).3	3	2	2	2	2	2	2	2	3	1	2
MS-20-33(i).4	3	2	2	2	2	3	2	2	3	1	2
Average	**3**	**2**	**2**	**2**	**1.75**	**2.25**	**2**	**2**	**3**	**1**	**2**

CO-PSO Mapping Matrix for the Course Code : MS-20-33(i)

COs	PSO1	PSO2	PSO3	PSO4
MS-20-33(i).1	3	3	3	3
MS-20-33(i).2	3	3	3	3
MS-20-33(i).3	3	3	3	3
MS-20-33(i).4	3	3	3	3
Average	**3**	**3**	**3**	**3**

Unit – I

Compilers and Translators, Need of Translators, Tools used for compilation, Structure of Compiler, Single-Pass and Multi-Pass Compilers, Bootstrapping, Compiler Construction Tools, Phases of Compilation process, Classification of grammars.

Lexical Analysis: Design, Finite Automata and Regular Expressions, Process of Lexical Analysis, Lexical Analyzer generators, Derivations and parse trees.

Unit – II

Parsing Techniques: Top down Parsing- Predictive Parsers, Left Recursion and its removal, Recursive Descent Parsers, LL Grammars.

Bottom-up parsing: Shift Reduce Parsing, Operator Precedence Parsing, LR Parsers, LR grammars, Comparison of parsing methods, Parser Generators.

Unit – III

Semantic Analysis: Syntax-Directed Translation Schemes.

Building Symbol Table, Data Structures for symbol table, representing scope information.

An overview of Run-time Storage Administration.

Error Detection and Recovery: Errors, Lexical-Phase Errors, Syntactic Phase Errors, Semantic Errors.

Unit – IV

Intermediate Source Forms: Postfix Notation, Syntax Trees, Triples & Quadruples.

Code Optimization: Potential cases of Code Optimization, Optimization of basic blocks, Local and Global optimizations, Code Improving Transformation.

Code Generator: Issues in the design of a code generator.

Text Books:

1. Alfred V Aho, Principles of Compiler Design, Narosa Publishing House.
2. Jean Paul Tremblay and Sorenson, The Theory and Practice of Compiler Writing, McGraw Hill.

Reference Books:

1. Dhamdhere D.M, System programming and operating system, McGraw Hill.
2. Beck L. Leland, System Software, Pearson Education.
3. Aho, Sethi, & Ullman, Compilers Principles, Techniques and Tools, Pearson Education.
4. Fischer, Crafting a compiler in C, Pearson Education.

MS-20-33 (ii): Advanced Computer Architecture

Type: Elective
Course Credits: 04
Contact Hours: 4 hours/week
Examination Duration: 3 Hours
Mode: Lecture
External Maximum Marks: 75
External Pass Marks: 30 (i.e. 40%)
Internal Maximum Marks: 25
Total Maximum Marks: 100
Total Pass Marks: 40 (i.e. 40%)

Instructions to paper setter for End semester examination:
Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: To know parallel processing and new trends and developments in computer architectures. Understand design and development of ILP based processors and evaluate their performance. Understand MIMD architectures and different topologies used in these architectures. Study the cache coherence problems and their solutions

Course Outcomes (COs)	At the end of this course, the student will be able to:
MS-20-33 (ii).1	learn the concepts of parallel architectures and exploitation of parallelism at instruction level;
MS-20-33 (ii).2	understand architectural features of multi-issue ILP processors;
MS-20-33 (ii).3	learn MIMD architectures and interconnection networks used in them and evaluate their comparative performances;
MS-20-33 (ii).4	analyze causes of cache coherence problem and learn algorithm for its solution.

CO-PO Mapping Matrix for Course Code: MS-20-33 (ii)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-33 (ii).1	3	1	3	3	3	1	1	2	3	1	1
MS-20-33 (ii).2	3	2	3	3	3	1	1	2	3	1	1
MS-20-33 (ii).3	3	2	3	3	3	2	1	2	3	1	2
MS-20-33 (ii).4	3	3	3	3	3	2	1	2	3	1	2
Average	**3**	**2**	**3**	**3**	**3**	**1.5**	**1**	**2**	**3**	**1**	**1.5**

CO-PSO Mapping Matrix for Course Code: MS-20-33 (ii)

COs	PSO1	PSO2	PSO3	PSO4
MS-20-33 (ii).1	2	1	3	3
MS-20-33 (ii).2	2	1	3	3
MS-20-33 (ii).3	2	1	3	3
MS-20-33 (ii).4	2	1	3	3
Average	**2**	**1**	**3**	**3**

Unit – I

Computational Model: Basic computational models, evolution and interpretation of computer architecture, concept of computer architecture as a multilevel hierarchical framework. Classification of parallel architectures, Relationships between programming languages and parallel architectures

Parallel Processing: Types and levels of parallelism, Instruction Level Parallel (ILP) processors, dependencies between instructions, principle and general structure of pipelines, performance measures of pipeline, pipelined processing of integer, Boolean, load and store instructions, VLIW architecture, Code Scheduling for ILP- Processors - Basic block scheduling, loop scheduling, global scheduling.

Unit – II

Superscalar Processors: Emergence of superscalar processors, Tasks of superscalar processing – parallel decoding, superscalar instruction issue, shelving, register renaming, parallel execution, preserving sequential consistency of instruction execution and exception processing, comparison of VLIW & superscalar processors Branch Handling: Branch problem, Approaches to branch handling – delayed branching, branch detection and prediction schemes, branch penalties and schemes to reduce them, multiway branches, guarded execution.

Unit – III

MIMD Architectures: Concepts of distributed and shared memory MIMD architectures, UMA, NUMA, CC-NUMA & COMA models, problems of scalable computers.

Direct Interconnection Networks: Linear array, ring, chordal rings, star, tree, 2D mesh, barrel shifter, hypercubes.

Unit – IV

Dynamic interconnection networks: single shared buses, comparison of bandwidths of locked, pended & split transaction buses, arbiter logics, crossbar, multistage networks – omega, butterfly

Cache coherence problem, hardware based protocols – snoopy cache protocol, directory schemes, and hierarchical cache coherence protocols.

Text Books:

1. Sima, Fountain, Kacsuk, Advanced Computer Architecture, Pearson Education.
2. D. A. Patterson and J. L. Hennessey, Computer Architecture – A Quantitative Approach, Elsevier India.

Reference Books:

1. Kai Hwang, Advanced Computer Architecture, McGraw Hill.
2. Nicholas Carter, Computer Architecture, McGraw Hill.
3. Harry F. Jordan, Gita Alaghband, Fundamentals of Parallel Processing, Pearson Education.

MS-20-33(iii): Principles of Programming Languages

Type: Elective
Course Credits: 04
Contact Hours: 4 hours/week
Examination Duration: 3 Hours
Mode: Lecture
External Maximum Marks: 75
External Pass Marks: 30 (i.e. 40%)
Internal Maximum Marks: 25
Total Maximum Marks: 100
Total Pass Marks: 40 (i.e. 40%)

Instructions to paper setter for End semester exam:
Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this paper is to make the students familiar with different elements of programming languages such as data types/operators/statements/control constructs and their implementation with the understanding that it will help them in becoming a better programmer.

Course Outcomes (COs)	At the end of this course, the student will be able to:
MS-20-33(iii).1	understand the programming language hierarchy and basics of compilation;
MS-20-33(iii).2	understand the different types of grammar;
MS-20-33(iii).3	understand the features of object oriented language and different methods of sequence control;
MS-20-33(iii).4	understand the implementation of different type of functions.

CO-PO Mapping Matrix for the Course Code : MS-20-33(iii)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-33(iii).1	3	3	1	3	1	3	2	3	3	1	3
MS-20-33(iii).2	3	3	1	3	1	3	2	3	3	1	3
MS-20-33(iii).3	3	3	1	3	1	3	3	3	3	1	3
MS-20-33(iii).4	3	3	1	3	1	3	3	3	3	1	3
Average	**3**	**3**	**1**	**3**	**1**	**3**	**2.5**	**3**	**3**	**1**	**3**

CO-PSO Mapping Matrix for the Course Code : MS-20-33(iii)

COs	PSO1	PSO2	PSO3	PSO4
MS-20-33(iii).1	3	3	3	2
MS-20-33(iii).2	3	3	3	2
MS-20-33(iii).3	3	3	3	2
MS-20-33(iii).4	3	3	3	2
Average	**3**	**3**	**3**	**2**

Unit – I

Preliminaries: History, Impact of Programming Paradigms, Role of Programming Languages, Good Language, Effects of Programming Environment, Translators and virtual architectures, Binding and Binding time, Language Syntax, Analysis of Program, Synthesis of Object program, Formal translation models: BNF Grammars, General parsing, Language translation, Recursive descent parsing.

Unit – II

Formal languages and automata: The Chomsky hierarchy of formal languages, regular grammars, Regular expressions, Finite State Automata, Context-free grammars, Pushdown automata, Ambiguous grammars.

Language Semantics: Attribute grammars, Denotational semantics, Program verification and validation, Data objects, variables, constants, data types, declaration, type checking, type casting, type promotion, Enumerators, Composite data types.

Unit – III

Object Orientated concepts: Structured data types, Abstract data types, Information hiding, Subprogram concepts, Good program design, Type definitions, Type equivalence, Inheritance, Derived classes, Abstract classes, Polymorphism, Inheritance and software reuse.

Sequence control: Implicit and explicit sequence control, Sequence control within arithmetic expressions, sequence control between statements, sequencing with non-arithmetic expressions, Subprogram Sequence control.

Unit – IV

Miscellaneous topics: Parameter passing techniques, Static & Dynamic Scoping, Storage of variables, Static storage, Heap Storage management, Distributed Processing, Exceptions and Exception handlers, Co-routines, Scheduled subprograms, Parallel programming, Processor design, Hardware and Software architectures, Network Programming, Evolution of scripting languages, Applets, XML.

Text Books:

1. Pratt T.W., Zelkowitz M.V., Gopal T.V., Programming Languages Design and Implementation, Pearson Education.
2. Sebesta W. Robert, Concepts of Programming Languages, Pearson Education.

Reference Books:

1. Appleby Doris & Vande Kopple J. Julius, Programming Languages-Paradigm and practice", Tata McGraw Hill.
2. Sethi Ravi, Programming Languages: Concepts & Constructs, Pearson Education
3. Scott M., Programming Language Pragmatics, Elsevier India.

MS-20-34 (i) Mobile Computing

Type: Elective
Course Credits: 04
Contact Hours: 4 hours/week
Examination Duration: 3 Hours
Mode: Lecture
External Maximum Marks: 75
External Pass Marks: 30 (i.e. 40%)
Internal Maximum Marks: 25
Total Maximum Marks: 100
Total Pass Marks: 40 (i.e. 40%)

Instructions to paper setter for End semester examination:
Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: Introduce the notion and concepts of Mobile Computing and its Applications. Provide an exposure to the latest trends and technologies related to Mobile Computing.

Course Outcomes: At the end of this course, the student will be able to:

MS-20-34(i).1	characterize and categorize Mobile Computing Environments along with the knowledge of their deployment and applications;
MS-20-34(i).2	learn the operational and architectural aspects of Mobile telephony and its generations;
MS-20-34(i).3	gain knowledge of the architectural issues of contemporary wireless LANs and the reformations accomplished in the Network and Transport layers of TCP/IP model for adaptation to Mobile Networks;
MS-20-34(i).4	get familiar with the application level support for mobility in Networks along with pertinent design issues related with Mobile Adhoc Networks and Wireless Sensor Networks.

CO-PO Mapping Matrix for Course Code: MS-20-34 (i)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-34(i).1	3	2	3	2	1	1	1	1	3	-	2
MS-20-34(i).2	3	3	3	2	1	1	2	1	3	-	2
MS-20-34(i).3	3	3	3	3	1	2	2	1	3	-	2
MS-20-34(i).4	3	3	3	3	1	2	2	1	3	-	2
Average	**3**	**2.75**	**3**	**2.5**	**1**	**1.5**	**1.75**	**1**	**3**	**-**	**2**

CO-PSO Mapping Matrix for Course Code: MS-20-34 (i)

COs	PSO1	PSO2	PSO3	PSO4
MS-20-34(i).1	2	1	2	3
MS-20-34(i).2	2	1	2	3
MS-20-34(i).3	2	2	2	3
MS-20-34(i).4	2	2	2	3
Average	**2**	**1.5**	**2**	**3**

Unit – I

Mobile Communications and Mobile Computing: Overview & Classification; Mobile Computing Applications; Characteristics of Mobile Computing; Data Dissemination; Wireless Transmission & Cellular Systems; Mobile Devices; Mobile Computing Architecture; Mobile Computing through Telephony; Multiple Access Procedures; Emerging Technologies; Generations of Mobile Communication Technologies.

Satellite Communication: Basics, Applications, Personal Satellite Communications; Routing, Localization, Handover, Future Wideband Access Systems.

The Cellular Concept: Components & Architecture; Call Setup, Frequency reuse, Cell Design; Interference in Cellular System; Channel Assignment & Handoff; Mobility Management; Application of Smart Antennas in Cellular Telephony.

Unit – II

Mobile Telecommunication System: GSM: Services & Architecture; Protocols; Localization & Calling; GSM Channels; GSM Addresses and Identifiers; Frequency Allocation, Call Routing; Mobility Management; Security; New Data Services; EDGE; General Packet radio Service (GPRS): Architecture, Operations, Data Services, Applications; IS-95; Universal Mobile Telecommunication System (UMTS): Architecture, Handover, Security; DECT; TETRA.

Wireless Media Access Control: Multiplexing & Modulation; Frequency Hopping Spread Spectrum (FHSS); Direct Sequence Spread Spectrum; Code Division Multiple Access (CDMA) in Mobile Communication Systems; 3G Wireless Communication Standards; WCDMA, OFDM, High Speed Packet Access (HSPA); Long Term Evolution (LTE); Broadband Wireless Access Standards.

Introduction to 4G & 5G Networks: Introduction, Applications & Architecture of 4G & 5G Networks.

Unit – III

Wireless LANs: Infrastructure & Ad hoc Networks; IEEE 802.11: Architecture & Services; Physical & MAC layer; HIPERLAN1/2; Bluetooth: User Scenario, Architecture & Security.

Mobile Network Layer: Mobile IP: Packet Delivery and Handover Management, Location Management, Registration, Tunneling and Encapsulation, Route Optimization, DHCP, VoIP.

Mobile Transport Layer: Conventional TCP/IP Protocols, Indirect TCP, Snooping TCP, Mobile TCP, TCP over 2.5/3G Wireless networks.

Unit – IV

Support for Mobility: File Systems; World Wide Web; Wireless Application Protocol (WAP).

Application Servers and Management: Mobile Agent; Application Framework; Application Server; gateways; Device Management; Overview of Mobile Application Development Platforms.

Mobile Ad-hoc and Wireless Sensor Networks: Introduction to MANETs and their Applications; Routing & Routing Algorithms; Security in Ad-hoc Networks; Wireless Sensor Networks: Overview and Data Dissemination; Applications; Vehicular Ad Hoc networks(VANET); MANET vs VANET.

Text Books:

1. Jochen Schiller, Mobile Communications, Addison-Wesley.
2. Asoke K Talukder, Hasan Ahmed, Roopa R Yavagal, Mobile Computing, Technology Applications and Service Creation, Mc Graw Hill.

Reference Books:

1. Raj Kamal, Mobile Computing, Oxford University Press
2. Krzysztof Wesolowski, Mobile Communication Systems, Wiley
3. William Stallings ,Wireless Communications & Networking, Second Edition, Pearson
4. Uwe Hansmann, Lother Merk, Martin S. Nicklaus, Thomas Stober, Principles of Mobile Computing, Springer.
5. William.C.Lee, Mobile Cellular Telecommunications-Analog and Digital Systems, Tata Mc Graw Hill Edition.
6. C.K.Toh, AdHoc Mobile Wireless Networks, Pearson Education

7. Prasant Kumar Pattnaik, Rajib Mall, Fundamentals of Mobile Computing, PHI Learning
8. Tomasz Imielinski ,Henry F. Korth, Mobile Computing, Kluwer Academic Publishers

MS-20-34(ii): Theory of Computation	
Type: Elective **Course Credits:** 04 **Contact Hours:** 4 hours/week **Examination Duration:** 3 Hours **Mode:** Lecture **External Maximum Marks:** 75 **External Pass Marks:** 30 (i.e. 40%) **Internal Maximum Marks:** 25 **Total Maximum Marks:** 100 **Total Pass Marks:** 40 (i.e. 40%)	**Instructions to paper setter for End semester exam:** Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to provide the in-depth coverage of theoretical computer science. It provides an insight about design of all types of machines and their applications.

Course Outcomes (COs)	At the end of this course, the student will be able to:
MS-20-34(ii).1	design various finite state machines for real life problems;
MS-20-34(ii).2	differentiate between the applications of different kind of machines;
MS-20-34(ii).3	solve the tractable and intractable problems using various approaches;
MS-20-34(ii).4	understand the need and importance of Turing machines and their suitability.

CO-PO Mapping Matrix for the Course Code : MS-20-34(ii)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-34(ii).1	3	2	1	3	1	3	2	2	3	1	3
MS-20-34(ii).2	3	2	1	3	1	3	2	2	3	1	3
MS-20-34(ii).3	3	2	1	3	1	3	2	3	3	1	3
MS-20-34(ii).4	3	2	1	3	1	3	2	3	3	1	3
Average	**3**	**2**	**1**	**3**	**1**	**3**	**2**	**2.5**	**3**	**1**	**3**

CO-PSO Mapping Matrix for the Course Code : MS-20-34(ii)

COs	PSO1	PSO2	PSO3	PSO5
MS-20-34(ii).1	3	3	3	3
MS-20-34(ii).2	3	3	3	3
MS-20-34(ii).3	3	3	3	3
MS-20-34(ii).4	3	3	3	3
Average	**3**	**3**	**3**	**3**

Unit – I

Finite State Machines: Finite Automata, Designing of DFA and NDFA, NFA with E-Transitions, Equivalence of DFA and NFA with proof, Regular Expressions and Regular languages, Laws of Regular Expressions, Kleene's Theorem 1 and 2, Properties and Limitations of FSM

FSM with Output: Moore and Mealy Machines, Arden's Theorem with proof, Closure Properties of Regular Sets, Pumping Lemma for Regular Grammers, Minimization of FA.

Unit – II

Formal Grammars: Definition, Construction of Regular & Context Free Grammar, Derivation, Parse Trees, Ambiguity, Removal of Ambiguity, Simplification of Context Free Grammar, CNF and GNF, Closure properties of CFL, Pumping Lemma for CFL.

Pushdown Automaton: Introduction, Types of PDA, Designing of PDA's, Conversion from PDA to CFG and vice-versa.

Unit – III

Linear Bounded Automata (LBA), Turing Machines (TM), General Model of Computation, TM as Language Acceptors, TM as Computing Partial Functions, Combining TM, Multi-Tape TM, Restricted and Universal TM; TM and Computers.

Recursive and recursively-enumerable languages and Properties, More General Grammars

Unit – IV

Reductions and the Halting Problem, Post's correspondence problem, Rice's theorem, Cook's Theorem, decidability of membership, emptiness and equivalence problems of languages, Decidable languages and problems, Diagonalization method.

Computable Functions: Primitive recursive functions, Godel Numbering, Tractable and Intractable problems, Computable Complexity.

Text Books:

1. John C. Martin, Introduction to Languages and the Theory of Computation, McGraw Hill.
2. Peter Linz, An introduction to formal language & automata, Jones & Bartlett publications.

Reference Books:

1. Hopcroft J. E. & Ullman J. D, Formal languages and their relation to Automata, Pearson Education.
2. Lewis, H.R. & Papadimitrious, C. H., Elements of the theory of computation, PHI Learning.
3. Michael Sipser, Introduction to the Theory of Computation, Cengage Learning.

MS-20-34(iii): Artificial Intelligence

Type: Elective
Course Credits: 04
Contact Hours: 4 hours/week
Examination Duration: 3 Hours
Mode: Lecture
External Maximum Marks: 75
External Pass Marks: 30 (i.e. 40%)
Internal Maximum Marks: 25
Total Maximum Marks: 100
Total Pass Marks: 40 (i.e. 40%)

Instructions to paper setter for End semester exam:
Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to provide the in-depth coverage of Artificial Intelligence techniques and their applications. It focuses on various search techniques and expert systems along with other parts of artificial intelligence in computer science.

Course Outcomes (COs)	At the end of this course, the student will be able to:
MS-20-34(iii).1	understand the different knowledge representation schemes specially FOPL;
MS-20-34(iii).2	apply various search methods to solve AI problems efficiently;
MS-20-34(iii).3	understand the Expert System and techniques to manage the uncertainty in Expert Systems;
MS-20-34(iii).4	understand the learning techniques and Genetic Algorithm.

CO-PO Mapping Matrix for the Course Code : MS-20-34(iii)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-34(iii).1	3	2	1	3	1	3	2	2	3	1	3
MS-20-34(iii).2	3	2	1	3	1	3	2	2	3	1	3
MS-20-34(iii).3	3	2	1	3	1	3	2	3	3	1	3
MS-20-34(iii).4	3	3	1	3	1	3	2	3	3	1	3
Average	**3**	**2.25**	**1**	**3**	**1**	**3**	**2**	**2.5**	**3**	**1**	**3**

CO-PSO Mapping Matrix for the Course Code : MS-20-34(iii)

COs	PSO1	PSO2	PSO3	PSO4
MS-20-34(iii).1	3	3	3	2
MS-20-34(iii).2	3	3	3	2
MS-20-34(iii).3	3	3	3	2
MS-20-34(iii).4	3	3	3	2
Average	**3**	**3**	**3**	**2**

Unit – I

Introduction: Background and history, Overview of AI applications areas.

The predicate calculus: Syntax and semantic for propositional logic and FOPL, Clausal form, inference rules, resolution and unification.

Knowledge representation: Network representation-Associative network & conceptual graphs, Structured representation- Frames & Scripts.

Unit – II

Search strategies: Strategies for state space search-data driven and goal driven search; Search algorithms- uninformed search (depth first, breadth first, depth first with iterative deepening) and informed search (Hill climbing, best first, A* algorithm, mini-max etc.), computational complexity, Properties of search algorithms - Admissibility, Monotonicity, Optimality, Dominance.

Unit – III

Production system: Types of production system-commutative and non-commutative production systems, Decomposable and non-decomposable production systems, Control of search in production systems.

Rule based expert systems: Architecture, development, managing uncertainty in expert systems - Bayesian probability theory, Stanford certainty factor algebra, Nonmonotonic logic and reasoning with beliefs, Fuzzy logic, Dempster/Shaffer and other approaches to uncertainty.

Unit – IV

Knowledge acquisition: Types of learning, learning by automata, intelligent editors, learning by induction.

Genetic algorithms: Problem representation, Encoding Schemes, Operators: Selection, Crossover, Mutation, Replacement etc.

Text Books:

1. George F. Luger, Artificial Intelligence, Pearson Education.
2. Dan W. Patterson Introduction to Artificial Intelligence and Expert system, PHI.

Reference Books:

1. Ben Coppin, Artificial Intelligence Illuminated, Narosa Publishing House.
2. Eugene Charniak, Drew McDermott Introduction to Artificial Intelligence, Pearson Education.
3. Nils J. Nilsson Principles of Artificial Intelligence, Narosa Publishing House.
4. Jackson Peter, Introduction to Expert systems, Pearson-Education.

MS-20-41: Mobile Application Development

Type: Compulsory
Course Credits: 04
Contact Hours: 4 hours/week
Examination Duration: 3 Hours
Mode: Lecture
External Maximum Marks: 75
External Pass Marks: 30 (i.e. 40%)
Internal Maximum Marks: 25
Total Maximum Marks: 100
Total Pass Marks: 40 (i.e. 40%)

Instructions to paper setter for End semester examination:
Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to provide the in-depth coverage of various concepts of mobile application development especially android based applications. This course will help the students in learning to develop and publish their own mobile applications.

Course Outcomes (COs)	At the end of this course, the student will be able to:
MS-20-41.1	know the components and structure of mobile application development frameworks for Android based mobiles;
MS-20-41.2	design and implement the user interfaces of mobile applications;
MS-20-41.3	evaluate multimedia and location based services in Android application;
MS-20-41.4	develop the interactive graphics in mobile applications.

CO-PO Mapping Matrix for Course Code: MS-20-41

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-41.1	3	1	2	3	2	2	1	1	1	1	1
MS-20-41.2	3	1	2	2	2	3	2	2	1	1	1
MS-20-41.3	3	1	2	3	2	3	2	2	1	1	1
MS-20-41.4	3	1	2	3	2	3	2	2	1	1	1
Average	**3**	**1**	**2**	**2.75**	**2**	**2.75**	**1.75**	**1.75**	**1**	**1**	**1**

CO-PSO Mapping Matrix for Course Code: MS-20-41

COs	PSO1	PSO2	PSO3	PSO4
MS-20-41.1	3	3	2	3
MS-20-41.2	3	3	2	3
MS-20-41.3	1	3	3	3
MS-20-41.4	3	3	3	3
Average	**2.5**	**3**	**2.5**	**3**

Unit – I

Introduction: Mobile Applications, Characteristics and Benefits, Application Models, Mobile devices Profiles. Basics of Android, Importance and scope, Android Versions, Features of Android, Android Architecture, Android Stack, Android Applications Structure, Android Emulator, Android SDK, Overview of Android Studio, Android and File Structure, Android Virtual Device Manager, DDMS, LogCat, Understanding Activities.

Android User Interface: Measurements – Device and pixel density independent measuring units. Layouts – Linear, Relative, Grid and Table Layouts.

Unit – II

User Interface (UI) Components – Editable and non-editable Text Views, Buttons, Radio and Toggle Buttons, Checkboxes, Spinners, Dialog and pickers, List View, Spinner View.

Event Handling – Handling clicks or changes of various UI components.

Intents and Broadcasts: Intent – Using intents to launch Activities, Explicitly starting new Activity, Implicit Intents, Passing data to Intents, Getting results from Activities, Native Actions, using Intent to dial a number or to send SMS

Services- Callbacks and Override in application, Application Signing, API keys for Google Maps, Publishing application to the Android Market.

Unit – III

Fragments – Creating fragments, Lifecycle of fragments, Fragment states, Adding fragments to Activity, adding, removing and replacing fragments with fragment transactions, interfacing between fragments and Activities, Multi-screen Activities

Location and Mapping: location based services, Mapping, Google Maps activity, Working with MapView and MapActivity; Playing and Recording of Audio and Video in application; Sensors and Near Field Communication; Native libraries and headers, Building client server applications.

Unit – IV

Using Graphics: Canvas Drawing, Shadows, and Gradients.

Persisting Data to files: Saving to Internal Storage, Saving to External Storage

Introduction to SQLite database: creating and opening a database, creating tables,
inserting retrieving and deleting data, Registering Content Providers, Using content Providers
(insert, delete, retrieve and update)

Text Books:

1. Zigurd Mednieks, Laird Dornin, G,Blake Meike and Masumi Nakamura "Programming Android", O'Reilly Publications.
2. Wei-Meng Lee, "Beginning Android Application Development", Wiley India Ltd.

Reference Books:

1. James C.S. "Android Application development for Java Programmer", CENGAGE Learning.
2. Pradeep Kothari, "Android Application Development: Black Book", Wiley India Ltd.
3. Gargenta M., Nakamura M., "Learning Android", O'Reilly Publications.

MS-20-42: Machine Learning using Python

Type: Compulsory
Course Credits: 04
Contact Hours: 4 hours/week
Examination Duration: 3 Hours
Mode: Lecture
External Maximum Marks: 75
External Pass Marks: 30 (i.e. 40%)
Internal Maximum Marks: 25
Total Maximum Marks: 100
Total Pass Marks: 40 (i.e. 40%)

Instructions to paper setter for End semester exam:
Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to enable student to perform experiments in Machine Learning using real-world data using Python.

Course Outcomes (COs)	At the end of this course, the student will be able to:
MS-20-42.1	construct and execute various programs using different data structures in Python;
MS-20-42.2	use the Python programming for machine learning;
MS-20-42.3	understand the machine learning along with concept learning and decision trees;
MS-20-42.4	understand Bayesian, Computational and Instance-based learning;

CO-PO Mapping Matrix for the Course Code : MS-20-42

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-42.1	3	3	2	3	2	3	3	1	3	1	3
MS-20-42.2	3	3	2	3	2	3	3	1	3	1	3
MS-20-42.3	3	3	2	2	1	2	2	3	3	1	2
MS-20-42.4	3	3	2	2	1	2	2	3	3	1	2
Average	**3**	**3**	**2**	**2.5**	**1.5**	**2.5**	**2.5**	**2**	**3**	**1**	**2.5**

CO-PSO Mapping Matrix for the Course Code : MS-20-42

COs	PSO1	PSO2	PSO3	PSO4
MS-20-42.1	3	3	3	3
MS-20-42.2	3	3	3	3
MS-20-42.3	2	3	3	3
MS-20-42.4	2	3	3	3
Average	**2.5**	**3**	**3**	**3**

Unit – I

Python Programming: Strings - String slices, immutability, string functions and methods, string module; Lists, Tuples, Dictionaries: Lists - Lists as arrays Traversing a List, list operations, list slices, list methods, Map, Filter and Reduce, list

loop, mutability, aliasing, cloning lists, list parameters; Dictionaries - operations and methods; advanced list processing - list comprehension; Tuples - tuple assignment, tuple as return value.
Files and Modules: Files and exception - text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules.

Unit – II

Packages in Python: PANDAS, NUMPY, SCIKIT-LEARN, MATPLOTLIB.
NumPy - Introduction, Ndarray Object ,Data types, Array Attributes, Array Creation Routines, Indexing & Slicing, Advanced Indexing, Broadcasting, Iterating Over Array, Array Manipulation, Binary Operators, String Functions, Mathematical Functions, Mathematical Functions, Arithmetic Operations, Statistical Functions, Linear Algebra, Matplotlib(Used for data visualization), Histogram Using Matplotlib.
Pandas: Performing data cleaning and analysis, Loading data with Pandas (data manipulation and analysis), Working with and Saving data with Pandas.
Using Scikit-Learn for Linear Regression, Logistic Regression, Decision Tree, Naive Bayes, KNN, SVN, k Mean Clustering, Random Forest.

Unit – III

Introduction to Machine Learning – Well defined learning problems, Designing a Learning System, Issues in Machine Learning.
The Concept Learning Task - General-to-specific ordering of hypotheses, Find-S, List then eliminate algorithm, Candidate elimination algorithm, Inductive bias
Decision Tree Learning - Decision tree learning algorithm-Inductive bias- Issues in Decision tree learning.

Unit – IV

Bayesian Learning: Bayes theorem, Concept learning, Bayes Optimal Classifier, Naïve Bayes classifier, Bayesian belief networks, EM algorithm.
Computational Learning Theory: Sample Complexity for Finite Hypothesis spaces, Sample Complexity for Infinite Hypothesis spaces, The Mistake Bound Model of Learning.
Instance-Based Learning – k-Nearest Neighbour Learning, Locally Weighted Regression, Radial basis function networks, Case-based learning.

Text Books:

1. Tom M. Mitchell, Machine Learning, McGraw-Hill Education (India) Private Limited.
2. Ethem Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press.
3. John V Guttag, Introduction to Computation and Programming Using Python, MIT Press.
4. Robert Sedgewick, Kevin Wayne, Robert Dondero, Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd.

Reference Books:

1. Stephen Marsland, Machine Learning: An Algorithmic Perspective, CRC Press.
2. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, Updated for Python 3, Shroff/O,,Reilly Publishers.
3. Peter Flach, Machine Learning: The Art and Science of Algorithms that Make Sense of Data, Cambridge University Press.
4. Python Machine Learning, Sebastian Raschka.

MS-20-43 (i) Cryptography and Network Security

Type: Elective
Course Credits: 04
Contact Hours: 4 hours/week
Examination Duration: 3 Hours
Mode: Lecture
External Maximum Marks: 75
External Pass Marks: 30 (i.e. 40%)
Internal Maximum Marks: 25
Total Maximum Marks: 100
Total Pass Marks: 40 (i.e. 40%)

Instructions to paper setter for End semester examination:
Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: Provide an understanding of Security and its goals including classical and modern algorithms. Give an insight into the various techniques and algorithms related to maintaining confidentiality and integrity of information in computers and communication in Networks.

Course Outcomes: At the end of this course, the student will be able to:	
MS-20-43(i).1	have an understanding of the basic terms, concepts, and principles of cryptography and network security including threats, vulnerability, and controls along with a familiarization of various Cryptographic tools that include classical and contemporary mechanisms;
MS-20-43(i).2	learn the mechanisms and algorithms related to confidentiality, Integrity, and access control;
MS-20-43(i).3	gain awareness of the threats and attacks to which networks/Internet may be vulnerable and the security mechanisms and policies that are detailed at the network layer of the Internet architecture;
MS-20-43(i).4	have exposure to the security issues, mechanisms, and protocols related to the Transport layer of the Internet architecture, Wireless Networks, as well as E-Mails.

CO-PO Mapping Matrix for Course Code: MS-20-43(i)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-43(i).1	3	2	3	3	2	1	2	2	3	-	2
MS-20-43(i).2	3	3	3	3	2	2	2	2	3	-	2
MS-20-43(i).3	3	3	3	3	2	2	2	2	3	-	2
MS-20-43(i).4	3	3	3	3	2	2	2	2	3	-	2
Average	**3**	**2.75**	**3**	**3**	**2**	**1.75**	**2**	**2**	**3**	**-**	**2**

CO-PSO Mapping Matrix for Course Code: MS-20-43(i)

COs	PSO1	PSO2	PSO3	PSO4
MS-20-43(i).1	1	3	2	3
MS-20-43(i).2	1	3	3	3
MS-20-43(i).3	1	3	3	3
MS-20-43(i).4	1	3	3	3
Average	**1**	**3**	**2.75**	**3**

Unit – I

Computer & Network Security Concepts: Overview; Security Goals; Threats, Attacks, & Assets; Vulnerabilities; Security Functional Requirements; Security Services; Security Mechanism; Secure Communications; Model for Network Security; The OSI Security Architecture.

Cryptographic Tools: Symmetric and Asymmetric Key Ciphers; Classical Encryption Techniques; Symmetric Ciphers: Confidentiality with Symmetric Encryption; One-Time Pads; User Authentication Methods; Block Cipher and Data Encryption Standard; Advanced Encryption Standard; RC2, RC4, RC5 & RC6; Block Cipher Operation; Random and Pseudo Random Numbers.

Unit – II

Asymmetric Ciphers: Public Key Cryptography and RSA; Diffie-Hellman Key Exchange; Elliptic Curve Cryptography.

Cryptographic Data integrity: Cryptographic Hash Functions and Applications; Message Authentication Codes; Digital signatures & Schemes; Hashing & Signing; Message Digests; Digital Signature Standard; Birthday attacks on Signatures.

Key Management and Distribution: Symmetric Key Distribution using Symmetric Encryption & Asymmetric Encryption; Distribution of Public Keys; X.509 Certificates; Public Key Infrastructure.

User Authentication Protocols: Remote User Authentication Principles; Remote User Authentication using Symmetric & Asymmetric Encryption; Kerberos.

Unit – III

Network Security: Threats & Attacks; Denial-of Service; Distributed Denial-of-Service; Cryptography in Network Security: Network & Browser Encryption, Onion Routing, IP Security protocol Suite (IPSec), Virtual Private Networks; Firewalls: Design & Types, Personal Firewalls, Network Address Translation (NAT); Intrusion Detection and Prevention Systems.

IP Security: Overview; IP Security Policy; Encapsulating Security Payload; Combining Security Associations; Internet Key Exchange.

Unit – IV

Transport-Level Security: Web Security: Issues & Threats; Secure Naming; Secure Socket layer (SSL); Transport Layer Security (TLS); HTTPS; Secure Shell(SSH).

Wireless Network Security: Vulnerabilities in Wireless Networks; IEEE 802.11 Wireless LAN Securities; Wireless Application Protocol Overview; Wireless Transport Layer Security; WEP & WPA.

Electronic-mail Security: E-Mail Attacks; Pretty Good Privacy (PGP); Privacy Enhanced Mail (PEM); S/MIME; DomainKeys Identified Mail (DKIM).

Text Books:

1. William Stallings, Cryptography and Network Security, Pearson Education
2. Charles P. Pfleeger, Shari Lawrence Pfleeger, Jonathan Margulies , Security in Computing, PHI

Reference Books:

1. Charlie Kaufman, Radia Perlman, Mike Speciner, Network Security, PHI
2. Bruce Schneier, Neils Ferguson, Practical Cryptography, Wiley
3. Behrouz A. Forouzan, Cryptography & Network Security, Tata McGraw Hill.
4. Trappe, W., Washingotn, L.C., Introduction to Cryptography with Coding theory, PHI
5. Stinson, D., Cryptography. Theory and Practice, CRC Press.
6. Man Young Rhee, Internet Security: Cryptographic Principles, Algorithms and Protocols, Wiley.

MS-20-43(ii): Big Data and Pattern Recognition

Type: Elective
Course Credits: 04
Contact Hours: 4 hours/week
Examination Duration: 3 Hours
Mode: Lecture
External Maximum Marks: 75
External Pass Marks: 30 (i.e. 40%)
Internal Maximum Marks: 25
Total Maximum Marks: 100
Total Pass Marks: 40 (i.e. 40%)

Instructions to paper setter for End semester examination:
Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to help students learn, understand and practice the basic and advanced methods to big data technology and tools required to manage and analyze big data including MapReduce, NoSQL and Hadoop. The course provides an idea about pattern recognition approaches and gives the practical exposure of NoSQL.

Course Outcomes (COs)	At the end of this course, the student will be able to:
MS-20-43(ii).1	understand fundamental concept of big data & business architecture;
MS-20-43(ii).2	learn data governance for big data along with big data tools and techniques;
MS-20-43(ii).3	understand pattern recognition strategies in big data environment;
MS-20-43(ii).4	develop solutions of big data in NoSQL programming environment.

CO-PO Mapping Matrix for Course Code: MCA-20-43(ii)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-43(ii).1	3	3	3	3	2	2	1	3	2	2	1
MS-20-43(ii).2	3	2	3	2	3	3	2	1	3	2	2
MS-20-43(ii).3	3	3	2	2	2	1	3	3	2	3	1
MS-20-43(ii).4	3	3	3	2	3	1	3	2	3	2	2
Average	**3**	**2.75**	**2.75**	**2.25**	**2.5**	**1.75**	**2.25**	**2.25**	**2.5**	**2.25**	**1.5**

CO-PSO Mapping Matrix for Course Code: MCA-20-43(ii)

COs	PSO1	PSO2	PSO3	PSO4
MS-20-43(ii).1	3	3	1	3
MS-20-43(ii).2	3	2	2	2
MS-20-43(ii).3	2	2	2	3
MS-20-43(ii).4	3	2	1	2
Average	**2.75**	**2.25**	**1.5**	**2.5**

Unit – I

Understanding Big Data: Concepts and Terminology, Big Data Characteristics, Different Types of Data, Identifying Data Characteristics, Business Motivations and Drivers for Big Data Adoption: Business Architecture, Business Process Management, Information and Communication Technology, Big Data Analytics Lifecycle, Enterprise Technologies and

Big Data Business Intelligence, Industry examples of big data.

Unit – II

Data Governance for Big Data Analytics: Evolution of Data Governance, Big Data and Data Governance, Big Datasets, Big Data Oversight, Big Data Tools and Techniques: HDFS, Map Reduce, YARN, Zookeeper, HBase, HIVE, Pig, Mahout, Developing Big Data Applications, Stepwise Approach to Big Data Analysis, Big Data Failure: Failure is common, Failed Standards, Legalities.

Unit – III

Pattern Recognition: Preview of Inductive Learning, Bigotry and Inductive Learning, Pattern Recognition Systems, Fundamental Problems in Pattern Recognition, Feature Extraction and Reduction, Paradigms, Pattern Recognition Approaches, Importance and Applications. Classifying using Decision Trees, Obtaining Patterns Rules from Decision Trees, Syntactic Pattern Recognition.

Unit – IV

An Overview of NoSQL, Characteristics of NoSQL, NoSQL Storage Types, Advantages and Drawbacks, Comparison of NoSQL Products, The CAP Theorem, Partitioning, Storage Layout, Introduction to Key-Value Store, Document Databases and Column-Oriented Databases, NoSQL Misconceptions, NoSQL over RDBMS.

Text Books:

1. Thomas Erl, Wajid Khattak and Paul Buhler, Big Data Fundamentals Concepts, Drivers & Techniques Prentice Hall.
2. David Loshin, Big Data Analytics from Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph, Morgan Kaufmann.
3. Jules J. Berman, Principles of Big Data Preparing, Sharing and Analyzing Complex Information, Morgan Kaufmann.
4. Gaurav Vaish, Getting Started with NoSQL, Packt Publishing.
5. Rajjan Shinghal, Pattern Recognition Techniques and Applications, Oxford Higher Education

Reference Books:

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer.
2. Jay Liebowitz, Big Data and Business Analytics, Auerbach Publications, CRC press.
3. Pete Warden, Big Data Glossary, O'Reily.
4. Michael Mineli, Michele Chambers, Ambiga Dhiraj, Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses, Wiley Publications.

MS-20-43(iii): Cyber Security and Blockchain Technology

Type: Elective
Course Credits: 04
Contact Hours: 4 hours/week
Examination Duration: 3 Hours
Mode: Lecture
External Maximum Marks: 75
External Pass Marks: 30 (i.e. 40%)
Internal Maximum Marks: 25
Total Maximum Marks: 100
Total Pass Marks: 40 (i.e. 40%)

Instructions to paper setter for End semester examination:
Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: The course has been designed to give students an extensive overview of cyber security issues, tools and techniques that are critical in solving problems in cyber security domains. The course also covers the technological underpinning of block Chain operations.

Course Outcomes (COs)	At the end of this course, the student will be able to:
MS-20-43 (iii).1	understand IT ACT (Cyber law) to the given case/problem and analyse it;
MS-20-43 (iii).2	demonstrate the use of standards and cyber laws to enhance information security in the development process and infrastructure protection;
MS-20-43 (iii).3	understand block chain technology;
MS-20-43 (iii).4	investigate the influence of Block chain technology for the cyber security problem and evaluate its role.

CO-PO Mapping Matrix for Course Code: MS-20-43(iii)

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
MS-20-43 (iii).1	3	2	2	3	-	2	-	1	1	1	1
MS-20-43 (iii).2	2	3	2	2	2	3	1	2	-	-	3
MS-20-43 (iii).3	3	2	1	-	-	1	-	-	-	-	-
MS-20-43 (iii).4	2	3	2	2	2	3	-	1	1	1	2
Average	**2.5**	**2.5**	**2**	**2.25**	**2**	**2.25**	**1**	**1.75**	**1**	**1**	**2**

CO-PO Mapping Matrix for Course Code: MS-20-43(iii)

COs	**PSO1**	**PSO2**	**PSO3**	**PSO4**
MS-20-43 (iii).1	2	3	1	3
MS-20-43 (iii).2	2	3	2	3
MS-20-43 (iii).3	2	1	1	1
MS-20-43 (iii).4	2	2	1	3
Average	**2**	**2.25**	**1.25**	**2.5**

Unit – I

Introduction to Cybercrime and Laws: Definition and Origins of Cybercrime, information Security, Who are

Cybercriminals? Classifications of Cybercrimes. How Criminals Plan Them – Introduction, How Criminals Plan the Attacks, Cybercafe and Cybercrimes, Botnets, Attack Vector, The Indian IT ACT 2000 and amendments.

Tools and Methods used in Cybercrime

Introduction, Proxy Server and Anonymizers, Password Cracking, Keyloggers and Spyware, Virus and Warms, Trojan and backdoors, Steganography, DOS and DDOS attack, SQLinjection, Buffer Overflow.

Unit – II

Phishing and Identity Theft: Introduction, Phishing – Methods of Phishing, Phishing Techniques, Phishing Toolkits and Spy Phishing. Identity Theft – PII, Types of Identity Theft, Techniques of ID Theft. Digital Forensics Science, Need for Computer Cyber forensics and Digital Evidence, Digital Forensics Life Cycle.

Network Defense tools: Firewalls and Packet Filters: Firewall Basics, Packet Filter Vs. Firewall, How a Firewall Protects a Network, Packet Characteristic to Filter, Stateless Vs Stateful Firewalls, Network Address Translation (NAT) and Port Forwarding, the basic of Virtual Private Networks, Linux Firewall, Windows Firewall, Snort: Introduction Detection System.

Unit – III

Introduction: Overview of Block chain, Public Ledgers, Bitcoin, Smart Contracts, Block in a Block chain, Transactions, Distributed Consensus, Public vs. Private Block chain, Understanding Crypto currency to Block chain, Permissioned Model of Block chain, Overview of Security aspects of Block chain, Basic Crypto Primitives: Cryptographic Hash Function, Properties of a hash function, Hash pointer and Merkle tree, Digital Signature, Public Key Cryptography, A basic cryptocurrency.

Unit – IV

Bitcoin and Block chain: Creation of coins, Payments and double spending, Bitcoin Scripts, Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay. Working with Consensus in Bitcoin: Distributed consensus in open environments, Consensus in a Bitcoin network, Proof of Work (PoW) – basic introduction, Hashcash PoW, Bitcoin PoW, Attacks on PoW and the monopoly problem, Proof of Stake, Proof of Burn and Proof of Elapsed Time, The life of a Bitcoin Miner, Mining Difficulty, Mining Pool.

Text Books:

1. Marjie T. Britz, Computer Forensics and Cyber Crime: An Introduction, Pearson
2. Chwan-Hwa (John) Wu,J. David Irwin, Introduction to Computer Networks and Cyber security, CRC Press
3. Josh Thompsons, Block Chain: The Block Chain for Beginners- Guide to Block chain Technology and Leveraging Block Chain Programming.

Reference Books:

1. Bill Nelson, Amelia Phillips, Christopher Steuart, Guide to Computer Forensics and Investigations, Cengage Learning
2. Daniel Drescher, Block Chain Basics, Apress.
3. Anshul Kaushik, Block Chain and Crypto Currencies, Khanna Publishing House, Delhi.

MS-20-44 (i): Optimization Techniques	
Type: Elective **Course Credits:** 04 **Contact Hours:** 4 hours/week **Examination Duration:** 3 Hours **Mode:** Lecture **External Maximum Marks:** 75 **External Pass Marks:** 30 (i.e. 40%) **Internal Maximum Marks:** 25 **Total Maximum Marks:** 100 **Total Pass Marks:** 40 (i.e. 40%)	**Instructions to paper setter for End semester exam:** Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: The objective of this course is to provide the in-depth coverage of various linear programming problems and their solution techniques. It focuses on various optimization techniques and their applications in problem solving.

Course Outcomes (COs)	At the end of this course, the student will be able to:
MS-20-44(i).1	understand the role and principles of optimization techniques in business world;
MS-20-44(i).2	understand the techniques to solve and use LPP and IPP;
MS-20-44(i).3	analyse the optimization techniques in strategic planning for optimal gain;
MS-20-44(i).4	understand the techniques to solve networking and inventory issues;

CO-PO Mapping Matrix for the Course Code : MS-20-44 (i)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-44(i).1	3	2	1	2	1	2	1	1	2	1	1
MS-20-44(i).2	3	2	1	3	1	3	1	1	2	1	1
MS-20-44(i).3	3	2	1	3	1	3	1	2	3	1	3
MS-20-44(i).4	3	2	1	3	2	3	1	2	3	1	3
Average	**3**	**2**	**1**	**2.75**	**1.25**	**2.75**	**1**	**1.5**	**2.5**	**1**	**2**

CO-PSO Mapping Matrix for the Course Code : MS-20-44 (i)

COs	PSO1	PSO2	PSO3	PSO4
MS-20-44(i).1	2	2	2	2
MS-20-44(i).2	2	2	2	2
MS-20-44(i).3	2	2	2	2
MS-20-44(i).4	2	2	3	2
Average	**2**	**2**	**2.25**	**2**

Unit – I

Introduction: The Historical development, Nature, Meaning and Management Application of Operations research. Modelling, Its Principal and Approximation of O.R. Models, Main characteristic and phases, General Methods of solving models, Scientific Methods, Scope, Role on Decision Making and Development of Operation Research in India.
Linear Programming: Formulation, Graphical solution, standard and matrix form of linear programming problems, Simplex method and its flow chart, Two-phase Simplex method, Degeneracy.

Unit – II

Duality in LPP: Definition of Dual Problem, General Rules for converting any Primal into its Dual, Dual Simplex method and its flow chart.
Integer Programming: Importance, Applications and Classification, Gomory's all integer programming problem technique and its flow chart, Branch and Bound Method.

Unit – III

Transportation Models: Formulation of problem, Obtaining Initial Basic feasible solution, Optimality tests, Progressing towards optimal solution, Unbalanced Transportation Problems.
Assignment Models: Formulation of problem, Hungarian Method for Assignment Problems, Unbalanced Assignment Problems.

Unit – IV

Inventory theory Costs involved in inventory problems - single item deterministic models-economic lot size models without shortages and with shortages having production rate infinite and finite.
PERT and CPM: Basic steps in PERT/CPM, Techniques, Network Diagram Representation, Forward and Backward Pass-computation, Representation in Tabular form, Determination of Critical path, Critical activity, Floats and Slack Times, Implementation in any programming language.

Text Books:

1. Sharma, S.D., Operations Research, Kedar Nath and Ram Nath, Meerut.
2. Gupta P.K., Hira and D.S., Operation Research, Sultan Chand & Sons, New Delhi.

Reference Books:

1. Kanti Swarup, Gupta P.K. & Man Mohan, Operation Research, Sultan Chand & sons, New Delhi.
2. Rao S.S., Optimization Theory and Applications, Wiley Eastern Ltd. New Delhi.
3. Taha, H.A., Operation Research – An Introduction, McMillan Publishing Co, New York.
4. Gillet, B.E., "Introduction to Operations Research: A Computer Oriented Algorithmic Approach". Tata McGraw Hill, New York.

MS-20-44(ii): Soft Computing

Type: Elective
Course Credits: 04
Contact Hours: 4 hours/week
Examination Duration: 3 Hours
Mode: Lecture
External Maximum Marks: 75
External Pass Marks: 30 (i.e. 40%)
Internal Maximum Marks: 25
Total Maximum Marks: 100
Total Pass Marks: 40 (i.e. 40%)

Instructions to paper setter for End semester examination:
Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: Introduce fundamental soft computing concepts with an exposure to non-traditional techniques for problem solving and optimization. Provide Soft Computing based research oriented direction for solving imprecisely defined problems. Provide a comprehensive introduction to nature-inspired metaheuristic methods for search and optimization, including the latest trends in evolutionary algorithms and other forms of natural computing.

Course Outcomes: At the end of this course, the student will be able to:	
MS-20-44(ii).1	have a knowledge of soft computing techniques along with their applications and non-traditional metaheuristic optimization and data clustering techniques & algorithms for obtaining optimized solutions to optimization, computational intelligence, and design/scheduling applications;
MS-20-44(ii).2	apply fuzzy logic theory to imprecisely defined problems;
MS-20-44(ii).3	use Neural Networks concepts to find solutions to problems where normally algorithmic methods do not exist or are costly;
MS-20-44(ii).4	design high-quality solutions using Genetic Algorithms for optimization and search problems and have exposure to MATLAB environment for implementing solutions to problems using soft computing techniques.

CO-PO Mapping Matrix for Course Code: MS-20-44(ii)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-44(ii).1	3	3	3	3	2	3	3	2	3	-	3
MS-20-44(ii).2	3	3	3	3	2	3	3	2	3	-	3
MS-20-44(ii).3	3	3	3	3	2	3	3	2	3	-	3
MS-20-44(ii).4	3	3	3	3	2	3	3	2	3	-	3
Average	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**-**	**3**

CO-PSO Mapping Matrix for Course Code: MS-20-44(ii)

COs	PSO1	PSO2	PSO3	PSO4
MS-20-44(ii).1	3	3	3	3
MS-20-44(ii).2	3	3	3	3
MS-20-44(ii).3	3	3	3	3
MS-20-44(ii).4	3	2	3	3
Average	**3**	**2.75**	**3**	**3**

Unit – I

Soft Computing : Conventional AI to Computational Intelligence; Soft Computing Constituents and Applications ;
Introduction to Non-traditional Metaheuristic Optimization Techniques: Random Optimization, Simulated Annealing, Tabu Search, Ant Colony Optimization, Particle Swarm Optimization, Harmony Search, Memetic Algorithms, Other Evolutionary Algorithms such as Firefly Algorithm, Bee Algorithm, Shuffled Frog Leap algorithm, Bat algorithm etc.
Data Clustering Algorithms: K-Means, Fuzzy C-Means, Mountain Clustering, Subtractive Clustering.

Unit – II

Fuzzy Set theory: Fuzzy Sets & Classical Sets; Operations on Fuzzy Sets, Fuzzy Relations, Linguistic Variables;
Membership Functions: Introduction, Features, & Fuzzification, Methods of Membership Value Assignment; Defuzzification.
Fuzzy Systems: Crisp Logic, Predicate Logic, Fuzzy Logic; Fuzzy Rule Base and Approximate Reasoning, Fuzzy Quantifiers; Fuzzy Inference Systems, Fuzzy Decision Making, Fuzzy Logic Control System; Fuzzy Expert Systems.

Unit – III

Neural Networks: Fundamental Concepts, Basic Models and Architecture; Machine Learning Using Neural Networks; Associative Memory Networks and their Applications.
Supervised Learning Neural Networks: Perceptron Networks, Radial Basis Function Networks: Back Propagation Neural Network: Architecture, Learning, Applications, & Research Directions; The Boltzman Machine.
Unsupervised Learning Networks: Competitive Learning networks; Kohonen Self-Organizing Networks; Hebbian learning; The Hopfield Network; Counter propagation Networks; Adaptive Resonance Theory: Introduction, Architecture, & Applications; Feed forward Networks; Reinforcement Learning.

Unit – IV

Genetic Algorithms: Introduction to Genetic Algorithms (GA) and their Terminology; Traditional Optimization and Search Techniques vs Genetic Algorithm ; Operators in Genetic Algorithms; Problem Solving using Genetic Algorithm; Classification of Genetic Algorithms; Holland's Classifier Systems; Genetic Programming; Advantages and Limitations of Genetic Algorithm; Applications of Genetic Algorithm; Applications of GA in Machine Learning.
Introduction to Hybrid Systems; MATLAB Environment for Soft Computing Techniques.

Text Books:

1. S. N. Sivanandam & S. N. Deepa, Principles of Soft Computing, Wiley - India.
2. Jyh Shing Roger Jang, Chuen Tsai Sun, Eiji Mizutani, Neuro Fuzzy and Soft Computing, Prentice Hall

Reference Books:

1. S.Rajasekaran and G.A.Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, Prentice-Hall of India Pvt. Ltd.
2. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall.
3. George J. Klir, Ute St. Clair, Bo Yuan, Fuzzy Set Theory: Foundations and Applications Prentice Hall.
4. Simon O. Haykin, Neural networks: a comprehensive foundation, Pearson Education.
5. Mitchell Melanie, An Introduction to Genetic Algorithm, Prentice Hall
6. Goldberg D. E., Genetic Algorithms in Search, Optimization, and Machine Learning, Pearson Education.
7. Ahmad Lotfi, Jonathan Garibaldi, Applications and Science in Soft Computing, Springer.
8. Rajkumar Roy, Mario Koppen, Soft Computing and Industry: Recent Applications, Springer.
9. James A. Freeman, David M. Skapura, Neural Networks Algorithms, Applications, and Programming Techniques, Pearson Education India.
10. Du, Ke-Lin, Swamy, M. N. S., Search and Optimization by Metaheuristics: Techniques and Algorithms, Springer
11. Omid Bozorg-Haddad, Mohammad Solgi, Hugo A. Loaiciga, Meta-heuristic and Evolutionary Algorithms for Engineering Optimization, Wiley

MS-20-44 (iii): Cloud Computing and IoT

Type: Elective
Course Credits: 04
Contact Hours: 4 hours/week
Examination Duration: 3 Hours
Mode: Lecture
External Maximum Marks: 75
External Pass Marks: 30 (i.e. 40%)
Internal Maximum Marks: 25
Total Maximum Marks: 100
Total Pass Marks: 40 (i.e. 40%)

Instructions to paper setter for End semester examination:
Total number of questions shall be nine. Question number one will be compulsory and will be consisting of short/objective type questions from complete syllabus. In addition to compulsory first question there shall be four units in the question paper each consisting of two questions. Student will attempt one question from each unit in addition to compulsory question. All questions will carry equal marks.

Course Objectives: To study the fundamental concepts of cloud computing, enabling technologies, cloud service models and security concerns. To learn core issues of Internet of Things, IOT communication protocols and security concerns.

Course Outcomes (COs)	At the end of this course, the student will be able to:
MS-20-44 (iii).1	understand core issues of cloud computing and enabling technologies;
MS-20-44 (iii).2	design services based on cloud computing platforms;
MS-20-44 (iii).3	understand concepts, architecture, applications and design principles for connected devices in IoT;
MS-20-44 (iii).4	explain, analyze and design IoT-oriented communication protocols and security concerns.

CO-PO Mapping Matrix for Course Code: MS-20-44 (iii)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MS-20-44 (iii).1	3	2	3	3	3	2	2	2	3	2	1
MS-20-44 (iii).2	3	3	3	3	3	2	3	3	3	2	3
MS-20-44 (iii).3	3	2	3	3	3	2	2	2	3	2	1
MS-20-44 (iii).4	3	3	3	3	3	2	3	3	3	2	3
Average	**3**	**2.5**	**3**	**3**	**3**	**2**	**2.5**	**2.5**	**3**	**2**	**2**

CO-PSO Mapping Matrix for Course Code: MS-20-44 (iii)

COs	PSO1	PSO2	PSO3	PSO4
MS-20-44 (iii).1	2	2	3	2
MS-20-44 (iii).2	3	3	3	3
MS-20-44 (iii)3	2	2	3	2
MS-20-44 (iii).4	3	3	3	3
Average	**2.5**	**2.5**	**3**	**2.5**

Unit – I

Cloud Computing: Definition, roots of cloud computing, characteristics, cloud architecture, deployment models, service models.

Virtualization: Benefits & drawbacks of virtualization, server virtualization, virtualization of - operating system, platform, CPU, network, application, memory and I/O devices etc.

Unit – II

Cloud Computing Service Platforms – Compute services, storage services, database services, application services, queuing services, e-mail services, notification services, media services, content delivery services, analytics services, deployment & management services, identity & access management services and their case studies.

Security in cloud computing: issues, threats, data security and information security.

Unit – III

Internet of Thing (IoT): Overview, conceptual framework, architecture, major components, common applications

Design principles for connected devices: Modified OSI Model for IoT/M2M systems, ETSI M2M Domains and High-level capabilities, wireless communication technologies - NFC, RFID, Bluetooth BR/EDR and Bluetooth low energy, ZigBee, WiFi, RF transceiver and RF modules. Data enrichment, data consolidation & device management at gateway.

Unit – IV

Design principles for web connectivity: web communication protocols for connected devices: constrained application protocol, CoAP Client web connectivity, client authentication, lightweight M2M communication protocol. Message communication protocols for connected devices - CoAP-SMS, CoAP-MQ, MQTT, XMPP.

IoT privacy, security and vulnerabilities and their solutions.

Text Books:

1. Arshdeep Bahga, Vijay Madisetti, Cloud Computing – A Hands-on Approach, University Press.
2. Rajkumar Buyya, James Broberg, Andrzej Goscinski, Cloud Computing – Principles and Paradigms, Wiley India Pvt. Ltd.
3. Raj Kamal, Internet of Things - Architecture and Design Principles, McGraw Hills

Reference Books:

1. Kai Hwang, Geoffrey C.Fox, and Jack J. Dongarra, Distributed and Cloud Computing, Elsevier India Private Limited
2. Saurabh Kumar, Cloud Computing, Wiley India Pvt. Ltd.
3. Shailendra Singh, Cloud Computing, Oxford
4. Coulouris, Dollimore and Kindber, Distributed System: Concept and Design, Addison Wesley
5. Michael Miller, Cloud Computing, Dorling Kindersley India
6. Anthony T. Velte, Toby J. Velte and Robert Elsenpeter, Cloud computing: A practical Approach, McGraw Hill
7. Dimitrios Serpnos, Marilyn Wolf, Internet of Things (IoT) Systems, Architecture, Algorithms, Methodologies, Springer
8. Vijay Madisetti and Arshdeep Bahga, Internet of Things (A Hands-on Approach), VPT
9. Francis daCosta, Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, Apress Publications

CO-PO-PSO MAPPING MATRIX FOR ALL THE COURSES OF

MASTER OF SCIENCE (COMPUTER SCIENCE (SOFTWARE))

SEMESTER	COURSE CODE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3	PSO4
I	**MS-20-11**	3	1	2	3	2	3	3	1	2	2	2	3	3	2	3
	MS-20-12	2.75	2.5	2.75	2.25	2.5	1.75	2.25	2.5	2.5	2	2.25	2.5	2.75	2	2.5
	MS-20-13	3	2	3	3	3	2.25	1.5	1	3	1	2	3	2	3	2.5
	MS-20-14	3	2	1	2	1.25	2.25	1	1.5	2.25	1	2	2.5	2.5	2.5	3
II	**MS-20-21**	3	2.5	1	3	2	3	2	3	3	1	2.5	2	3	2.5	3
	MS-20-22	2.75	2	3	3	3	2	1.5	2	3	1.5	2	3	2.75	2	3
	MS-20-23	3	2	3	3	3	2	2.25	2.5	3	1	2.25	2	3	3	3
	MS-20-24	3	1.75	3	3	2	1.75	1.5	2	3	-	1.75	1	1.5	2.5	3
III	**MS-20-31**	2.5	2.5	2.75	2.5	2.25	2.25	1.25	2.25	2.75	2.25	2.25	2.75	2.5	1.5	2.25
	MS-20-32	3	1.75	3	2.75	1	1	1.75	1	3	-	1.25	1.25	2.5	2.5	3
	MS-20-33(i)	3	2	2	2	1.75	2.25	2	2	3	1	2	3	3	3	3
	MS-20-33(ii)	3	2	3	3	3	1.5	1	2	3	1	1.5	2	1	3	3
	MS-20-33(iii)	3	3	1	3	1	3	2.5	3	3	1	3	3	3	3	2
	MS-20-34(i)	3	2.75	3	2.5	1	1.5	1.75	1	3	-	2	2	1.5	2	3
	MS-20-34(ii)	3	2	1	3	1	3	2	2.5	3	1	3	3	3	3	3
	MS-20-34(iii)	3	2.25	1	3	1	3	2	2.5	3	1	3	3	3	3	2
IV	**MS-20-41**	3	1	2	2.75	2	2.75	1.75	1.75	1	1	1	2.5	3	2.5	3
	MS-20-42	3	3	2	2.5	1.5	2.5	2.5	2	3	1	2.5	2.5	3	3	3
	MS-20-43(i)	3	2.75	3	3	2	1.75	2	2	3	-	2	1	3	2.75	3
	MS-20-43(ii)	3	2.75	2.75	2.25	2.5	1.75	2.25	2.25	2.5	2.25	1.5	2.75	2.25	1.5	2.5
	MS-20-43(iii)	2.5	2.5	2	2.25	2	2.25	1	1.75	1	1	2	2	2.25	1.25	2.5
	MS-20-44(i)	3	2	1	2.75	1.25	2.75	1	1.5	2.5	1	2	2	2	2.25	2
	MS-20-44(ii)	3	3	3	3	2	3	3	2	3	-	3	3	2.75	3	3
	MS-20-44(iii)	3	2.5	3	3	3	2	2.5	2.5	3	2	2	2.5	2.5	3	2.5
I to IV	**Average**	**2.94**	**2.23**	**2.26**	**2.73**	**1.96**	**2.26**	**1.89**	**1.98**	**2.69**	**1.32**	**2.11**	**2.39**	**2.59**	**2.49**	**2.74**