Manav Rachna International Institute of Research and Studies

(Deemed to be University under section 3 of the UGC Act, 1956)

School of Engineering & Technology

Department of Computer Science & Engineering

Curriculum
And
Scheme of Examination

M.TECH COMPUTER SCIENCE & ENGINEERING (With Electives in AI-ML/DATA SCIENCE/INFORMATION SECURITY)

Batch: - 2023-2025

FOREWORD

This is to certify that this booklet contains the entire Curriculum and Scheme of Examination of M.Tech (Computer Science and Engineering) being offered at the School of Engineering and Technology (SET) of this University. This has been duly vetted and finally approved by the Academic Council of the University vide its 43rd meeting held on 05.08.2023 and changes, if any deemed appropriate, shall be duly incorporated after the necessary approval by the Academic Council.

This Curriculum and Scheme of Examination of M.Tech (Computer Science and Engineering with electives in AI-ML/Data Science/Information Security) shall be implemented w.e.f. AY 2023-25.

Prof. (Dr.) Brijesh Kumar
Dean-Academics, MRIIRS

Date:

Preamble:

The Department of Computer Science & Engineering (CSE) was established in 1997. The Department of CSE is dedicated to equipping students with a comprehensive grasp of both theoretical and practical fundamentals. The Department has been offering M.Tech in computer Science since 2005. The Department focuses on mastering the fundamental concepts both theoretically and practically. The course curriculum is based on regional, national, and global needs. Keeping in view the growth in industry and increasing demand for computer professionals, it motivates learning, intellectual efficacy, and self-reliance, which provides the best foundation for continuing professional achievement. M.Tech (Computer Science and Engineering with electives in AI-ML/Data Science/Information Security) programme provides intensive training to the students at an advanced level to enable them to take up research and development activities. The course curriculum has been specially tailored to fulfill the growing global outlook and focus on upcoming technologies in the field of Computer Science and Engineering to cater to the needs of the industry and R&D organizations. Also, there is a provision to opt for various MOOC courses.

The Department also interacts regularly with Information Technology organizations like Infosys, Dell-EMC, Amazon, Microsoft, Intel, and more for providing the latest technology updates to the students. These collaborations help the students to work on the technologies which are currently being used in the industry.

INDEX

VISION OF THE DEPARTMENT

To empower the graduates to be technologically adept, innovative, self-motivated and responsible citizens, possessing human values and contribute significantly towards being a center of excellence in providing global standard education, through a conducive Teaching and Research environment, that responds swiftly to the challenges of the ever-changing world.

MISSION OF THE DEPARTMENT

- To achieve academic excellence by imparting in-depth knowledge to the students through effective pedagogies and hands-on experience on the latest tools and technologies.
- To pursue interdisciplinary research that will serve the needs of the entire global community.
- To prepare students to be continuous learners in a connected world and imbibe professional skills and ethical responsibilities in them.
- To strengthen the Industry-Academia interface that will help the graduates to emerge as leaders in academics or an inspiring revolutionary in entrepreneurship.

ABOUT THE DEPARTMENT

The Department of Computer Science & Engineering was established in 1997. The Department has been offering M.Tech in computer Science since 2005. The B. Tech (CSE) programme offered by the Department had been accredited by the National Board of Accreditation (NBA) in 2004, 2007, 2018, and 2022 under Tier I Category. The Department focuses on mastering the fundamental concepts both theoretically and practically. It motivates for learning, intellectual efficacy, and self-reliance, which provides the best foundation for continuing professional achievement. M.Tech (Computer Science and Engineering with electives in AI-ML/Data Science/Information Security) programme provides intensive training to the students at an advanced level to enable them to take up research and development activities. The course curriculum has been specially tailored to fulfill the growing global outlook and focus on upcoming technologies in the field of Computer Science and Engineering to cater to the needs of the industry and R&D organizations. The faculty members of the Department are actively involved in research and development activities and continuously participating and contributing to National and International Conferences and Seminars. The faculty members of the Department are well published, experienced, conferred with M. Tech/Ph. D degree.

The Department is having several student chapters of the professional bodies like IEEE, CSI, ACM & ISTE. Students are participating in various activities regularly to enhance their technical and interpersonal skills under the banner of these professional societies. The Department has up to date laboratory facilities for postgraduate (PG) programme. The laboratories are equipped with state of the art computing facilities. The Department also interacts regularly with Information Technology organizations like TCS, IBM, Sun Microsystems, L&T, Infosys, HCL, Tech Mahindra, Dell-EMC, R Systems International, etc. This interaction provides the latest technology updates to the students, Learning Management System, Industry Projects for students, Expert Lectures, Industry connectivity for students & teachers to enable them to experience the live IT environment. This interaction also helps students to acquire domain skills in the most advanced areas of IT and preferential placements by IT companies. Students undertake live projects under the mentorship of industry experts and go for industry visits in software development and testing centers. They also attend extensive training programme in which hands-on training is provided by IT company experts. This leads to a big increase in job opportunities and industry readiness for the students. The Department has also collaborated with other leading industries like Infosys, Dell-EMC & R-Systems International Ltd. to give exposure to the students. These collaborations help the students to work on the technologies which are currently being used in the industry.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The Department of Computer Science and Engineering (CSE), in consultation with various stakeholders, has formulated the Programme Educational Objectives (PEOs). These are broad statements describing the career and professional accomplishments of the graduates, that the programme is preparing them to achieve, after receiving the degree. The PEOs of the M.Tech Programme in Computer Science and Engineering are as follows:

PEO-1: To impart knowledge and skills to analyze, design, test and implement various softwares and be engaged in life-long learning.

PEO-2: To promote the development of innovative systems and optimized solutions by professional practices.

PEO-3: To work collaboratively on multidisciplinary projects and exhibit high levels of professional and ethical values within organization and society globally.

PEO-4: To Enhance skills and adapt new computing technologies for attaining professional excellence and carrying research.

PROGRAMME OUTCOMES (POs)

PO1.Critical Thinking: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

PO2. Effective Communication: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.

PO3. Social Interaction: Elicit views of others, mediate disagreements and help reach conclusions in group settings.

PO4. Effective Citizenship: Demonstrate empathetic social concern and equity centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

PO5. Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

PO6. **Environment and Sustainability**: Understand the issues of environmental contexts and sustainable development.

PO7. Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-longlearning in the broadest context socio-technological changes.

PROGRAMME SPECIFIC OUTCOMES (PSOs)-

PSO-1: To apply Software Engineering Principles and Practices to provide software solutions.

PSO-2: To design and Develop Network, Mobile and Web-based Computational systems under realistic constraints.

MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES TO PROGRAMME OUTCOMES

POs / PEOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
PEO 1	3	2	2	2	2	2	3	3	3
PEO 2	3	2	2	2	2	1	3	2	3
PEO 3	2	3	3	2	2	2	2	3	3
PEO 4	3	2	2	2	2	2	2	3	3

Semester system and Choice Based Credit System (CBCS)

The Credit-Based system of study and students' performance/progress is measured by the number of credits earned, i.e. completed satisfactorily by the students. Based on the course credits and grades obtained by the student, Grade Point Average (GPA) is calculated.

(a) Course credits assignment

Each course has a certain number of credits assigned to it depending upon its duration in periods for a lecture, tutorial, and laboratory/clinical practice in a week. A few courses/activities are without credit (s) and are referred to as Audit Pass Courses (APC) but are mandatory to pass as partial fulfillment of the award of the degree.

(b) Earning of credits

At the end of every course, a letter "Grade" shall be awarded in each course for which a student has registered. On obtaining a minimum Pass Grade, the student shall accumulate the course credits as Earned Credits. A student's performance shall be measured by the number of credits that he/she has earned and by the weighted grade point average. Grades obtained in the audit courses shall not be counted for computation of grade point average, however shall be mandatory to pass as partial fulfillment of the award of the degree.

For the award of M.Tech Degree in Computer Science and Engineering, the student has to earn a minimum of 68- credits during the two-year duration of the programme in 4 semesters. The total credits required to be earned have been further classified under two baskets of courses: "Compulsory Courses Basket", and "Elective Courses Basket". A total of 46- credits are required to be earned under the "Compulsory Courses Basket" and 22- credits under the "Elective Courses Basket".

All courses under the "Compulsory Courses Basket" are required to be qualified and cleared/passed by each student enrolled under the programme and are semester-wise listed in the study scheme along with the credits assigned to each course.

Under the "Elective Courses Basket", there will be three types of courses:

· Semester-wise courses offered by the parent department

· Open/Inter-disciplinary courses offered at the Institute/University level notified from the office of Dean-Academics.

· Massive Open Online Courses (MOOCs) available on the SWAYAM platform or any other platform as recommended by UGC/AICTE and notified from the office of Dean-Academics.

Each course shall have credits assigned to it. The Students are required to register in courses every semester for as many courses/credits specified under the "Elective Courses Basket" depending upon an individual interest, capability/pace of learning, and availability of non-clashing time slot as per the time table to earn the requisite credits under the "Elective Courses Basket" during the entire programme duration.

However, for registration of courses including courses under the "Compulsory Courses Basket", "Elective Courses Basket", and Previous Semester Courses wherein the student was declared in-eligible based on attendance or could not clear the course within permissible given chances, if any, the maximum limit in a semester is 30 credits.

Study Scheme of M.Tech (Computer Science and Engineering with electives in AI-ML/Data Science/Information Security)

SEMESTER I										
		Periods/Week				Marks				
Subject Code	Subject	L	T	P	Total	Continuous Evaluation	End Semester Examination	Total	Duration of Exam	Credits
MCS-101	Mathematical foundations of Computer Science	3	0	0	3	100	100	200	3 hrs	3
MCS-102	Advanced Data Structures	3	0	0	3	100	100	200	3 hrs	3
	Program Elective I	3	0	0	3	100	100	200	3 hrs	3
	Program Elective II	3	0	0	3	100	100	200	3 hrs	3
M-MC-100	Research Methodology and IPR	2	0	0	2	50	50	100	3 hrs	2
	Audit Course(Stress Management by Yoga)	2	0	0	2	50	50	100	2 hrs	0
MCS-112	Advanced Data Structures Lab	0	0	4	4	50	50	100	3 hrs	2
	Program Elective III	0	0	4	4	50	50	100	3 hrs	2
	TOTAL	**16**	**0**	**8**	**24**	**600**	**600**	**1200**		**18**

SEMESTER II										
		Periods/Week				Marks				
Subject Code	Subject	L	T	P	Total	Continuous Evaluation	End Semester Examination	Total	Duration of Exam	Credits
MCS-201	Advance Algorithms	3	0	0	3	100	100	200	3 hrs	3
MCS-202	Soft Computing	3	0	0	3	100	100	200	3 hrs	3
	Program Elective IV	3	0	0	3	100	100	200	3 hrs	3
	Program Elective V	3	0	0	3	100	100	200	3 hrs	3
	Audit Course	2	0	0	2	50	50	100	2 hrs	0
MCS-211	Advance Algorithms Lab	0	0	4	4	50	50	100	3 hrs	2
	Program Elective VI (Lab Course Based on Elective)	0	0	4	4	50	50	100	3 hrs	2
CS-M-200	Mini Project with Seminar	2	0	0	2	100	50	150	3 hrs	2
	TOTAL	**16**	**0**	**8**	**24**	**650**	**600**	**1250**		**18**

SEMESTER-III										
		Periods/Week				Marks				
Subject Code	Subject	L	T	P	Total	Continuous Evaluation	End Semester Examination	Total	Duration of Exam	Credits
	Program Elective VII	3	0	0	3	100	100	200	3 hrs	3
	Open Elective 1	3	0	0	3	100	100	200	3 hrs	3
CS-M-350	Colloquium	0	2	0	2	50	0	50	-	0
MCS-300	Dissertation-Phase-I/ Industrial Project	0	0	20	20	200	100	300	-	10
	TOTAL	**6**	**2**	**20**	**28**	**450**	**300**	**750**		**16**

*Students going for Industrial Project/Thesis will complete these courses through MOOCs.

Semester- IV										
		Periods/Week				Marks				
Subject Code	Subject	L	T	P	Total	Continuous Assessment	End Semester Examination	Total	Duration of Exam	Credits
MCS-400	Dissertation-Phase-II	**20 weeks (minimum)**				400	200	600	3 hrs	16
	TOTAL					**400**	**200**	**600**		**16**

Notes:

1. Any Elective course to be offered from the above lists will be finalized by HOD, depending on the availability of the expertise as well as the faculty strength in the Department. The choice of the student for any elective will be considered but shall not be binding for the department to offer it.

2. For Course colloquium each Student would be required to give atleast Three Seminars under the supervision of some of faculty member on current emerging areas of Computer Science among which atleast one would be research oriented.

Audit course 1 & 2	
M-MC-001	Stress Management by Yoga
M-MC-002	English for Research Paper Writing
M-MC-003	Disaster Management
M-MC-004	Sanskrit for Technical Knowledge
M-MC-005	Value Education
M-MC-006	Constitution of India
M-MC-007	Pedagogy Studies
M-MC-008	Personality Development through Life Enlightenment Skills

Open Elective	
M-ID-001	Business Analytics
M-ID-002	Industrial Safety

M-ID-003	Operations Research
M-ID-004	Cost Management of Engineering Projects
M-ID-005	Composite Materials
M-ID-006	Waste to Energy

Programme Electives

Specialization	**Program Elective I**	**Program Elective II**	**Program Elective III**	**Program Elective IV**	**Program Elective V**	**Program Elective VI**	**Program Elective VII**
Data Science	Data Preparation and Analysis	Data Science	Data Science Lab	Machine Learning	Big data Analytics	Machine Learning Lab	Business Intelligence and Data Visualization n
	Data Storage Technologies and Networks	Data Warehouse & Data Mining	Data Warehouse & Data Mining Lab	Web Analytics & Development	Data base Security and Access Control	Web Analytics & Development	Deep Learning
Information Security	Intrusion Detection	Digital Forensics and Malware Analysis	Digital Forensics and Malware Analysis Lab	Secure Communication and Cryptography	Security Analysis and Risk Assessment	Secure Communication and Cryptography Lab	Blockchain
	Ethical Hacking	Network security	Network security Lab	Machine Learning	Data base security and Access Control	Machine Learning Lab	Cloud Security Essentials
AL/ML	Introduction to Statistical Method	Information Retrieval and Knowledge Discovery	Information Retrieval and Knowledge Discovery Lab	Machine Learning	Computational Linguistics and Natural Language Processing	Machine Learning Lab	Computer Vision
	Applied Artificial Intelligence and Expert Systems	Data Science	Data Science Lab	Reinforcement Learning	Big Data Analytics	Reinforcement Learning Lab	Deep Learning

SEMESTER –I

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-101: MATHEMATICAL FOUNDATION OF COMPUTER SCIENCE

Periods/week	Credits		Max. Marks	: 200
L: 3 T: 0	3		Continuous Evaluation	: 100
Duration of Examination: 3 Hrs			End Sem Examination	: 100

Pre-requisites: The students must have the knowledge of mathematical concepts of Intermediate level.

Course Outcomes: The students will be able to-
MCS-101.1: Understand the mathematical fundamentals that is prerequisites for avariety of courses like Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.
MCS-101.2: Develop the understanding of the mathematical and logical basis to many modern techniques in information technology like machine learning, programming language design and concurrency.
MCS-101.3: Study various sampling and classification Problems.

Unit-1: Probability
1.1 Probability mass, density
1.2 Cumulative distribution functions,
1.3 Parametric families of distributions
1.4 Expected value, variance
1.5 Conditional expectation
1.6 Applications of the univariate and multivariate Central Limit Theorem
1.7 Probabilistic inequalities
1.8 Markov chains

Unit-2: Random Samples
2.1 Random samples
2.2 sampling distributions of estimators
2.3 Methods of Moments and Maximum Likelihood

Unit-3: Statistical inference
3.1 Statistical inference
3.2 Introduction to multivariate statistical models regression and classification problems
3.3 Principal components analysis
3.4 The problem of over fitting model assessment.

Unit-4: Graph Theory
4.1 Graph Theory
- 4.1.1 Isomorphism,
- 4.1.2 lanar graphs
- 4.1.3 Graph coloring
- 4.1.4 Hamilton circuits and Euler cycles.

4.2 Permutations and Combinations with and without repetition.
4.3 Specialized techniques to solve combinatorial enumeration problems

Unit-5: Computer science and engineering applications
5.1 Data mining,

5.1.1 Network protocols
5.1.2 Analysis of Web traffic
5.2 Computer security,
5.3 Software engineering
5.4 Computer architecture
5.5 Operating systems, distributed systems
5.6 Bioinformatics
5.7 Machine learning.

Unit-6: Recent Trends

6.1 Recent Trends in various distribution functions in Mathematical field of computer science for varying fields
6.1.1 Bioinformatics
6.1.2 Soft computing
6.1.3 Computer vision.

Text Books/Reference Books:

1. John Vince, 2015, Foundation Mathematics for Computer Science, 1st edition, Springer.
2. K. Trivedi, 2016, Probability and Statistics with Reliability, Queuing, and Computer Science Applications, 2nd edition, Wiley.
3. M. Mitzenmacher and E. Upfal, 2012, Probability and Computing: Randomized Algorithms and Probabilistic Analysis, Cambridge University press.
4. Alan Tucker, 2012, Applied Combinatorics, 6th edition,Wiley

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:

Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-101.1	3	2	1	3	2	2	1	2	2
MCS-101.2	3	2	3	2	1	1	1	2	2
MCS-101.3	3	1	2	1	2	2	1	2	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-102: ADVANCED DATA STRUCTURES

Periods/week	Credits		
L: 3 T: 0	3	Continuous Evaluation	: 100
Duration of Examination: 3 Hrs		End Sem Examination	: 100

Pre-requisites: The students must have the knowledge of Data Structures

Course Outcomes: The students will be able to-
MCS-102.1. Define the concepts of Advanced data structure
MCS-102.2. Understand the Advanced data structure like skip list and their applications
MCS-102.3. Apply the Advanced data structures to real life problems
MCS-102.4. Analyze the complexity of different data structure operations, Text Processing
MCS-102.5. Evaluate the Advanced data structures based on their applicability
MCS-102.6. Design the best solution for real life problems using various data structures

Unit-1: Dictionaries & Hashing
1.1 Dictionaries: Definition, Dictionary Abstract Data Type
    1.1.1 Implementation of Dictionaries.
1.2 Hashing**:** Review of Hashing and Hash Function
1.3 Collision Resolution Techniques in Hashing
1.4 Separate Chaining
1.5 Open Addressing
1.6 Linear Probing
1.7 Quadratic Probing
1.8 Double Hashing
1.9 Rehashing and Extendible Hashing.

Unit-2: Skip Lists
2.1 Need for Randomizing Data Structures and Algorithms
2.2 Search and Update Operations on Skip Lists
2.3 Probabilistic Analysis of Skip Lists
2.4 Deterministic Skip Lists

Unit-3: Trees
3.1 Binary Search Trees
3.2 AVL Trees
3.3 Red Black Trees
3.4 2-3 Trees
3.5 B-Trees
3.6 Splay Trees

Unit-4: Text Processing
4.1 Sting Operations
    4.1.1 Brute-Force Pattern Matching
    4.1.2 The Boyer- Moore Algorithm
    4.1.3 The Knuth-Morris-Pratt Algorithm,
4.2 Standard Tries
    4.2.1 Compressed Tries

4.2.2 Suffix Tries
4.2.3 The Huffman Coding Algorithm
4.3 The Longest Common Subsequence Problem (LCS)
4.4 Applying Dynamic Programming to the LCS Problem.

Unit-5: Computational Geometry:
5.1 One Dimensional Range Searching
5.2 Two Dimensional Range Searching
5.3 Constructing a Priority Search Tree
5.4 Searching a Priority Search Tree
5.5 Priority Range Trees
5.6 Quadtrees, k-D Trees.

Unit 6 Recent Trends
6.1 Recent Trends in Hashing
6.2 Trees and various computational geometry methods for efficiently solving the new evolving problem

Text Books/ Reference Books:
1. Mark Allen Weiss, 2004, Data Structures and Algorithm Analysis in C++, 2nd Edition, Pearson.
2. M T Goodrich, Roberto Tamassia, 2002, Algorithm Design,1ST Edition John Wiley.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-102.1	1	1	1	1	1	1	1	1	1
MCS-102.2	1	1	1	1	1	2	2	2	2
MCS-102.3	1	1	1	1	1	3	1	2	3
MCS-102.4	3	1	1	1	2	1	2	2	3
MCS-102.5	3	1	1	1	2	2	2	3	2
MCS-102.6	2	1	1	1	1	2	1	3	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

M-MC-100: RESEARCH METHODOLOGY AND IPR

Periods/week	Credits	Max. Marks	: 100
L: 2 T: 0	2	Continuous Evaluation	: 50
Duration of Examination: 2 Hrs		End Sem Examination	: 50

Pre-requisites: The students must have the knowledge to interpret the problems of various domains

Course Outcomes: The students will be able to-

M-MC-100.1. Understand research problem formulation.
M-MC-100.2. Analyze research related information
M-MC-100.3. Follow research ethics
M-MC-100.4. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
M-MC-100.5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasize the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
M-MC-100.6. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Unit-1:

1.1 Meaning of research problem, Sources of research problem,
1.2 Criteria Characteristics of a good research problem,
1.3 Errors in selecting a research problem,
1.4 Scope and objectives of research problem.
1.5 Approaches of investigation of solutions for research problem,
1.6 data collection, analysis, interpretation, Necessary instrumentations

Unit-2:

2.1 Effective literature studies approaches, analysis
2.2 Plagiarism,
2.3 Research ethics

Unit-3:

3.1 Effective technical writing,
3.2 how to write report, Paper
3.3 Developing a Research Proposal,
3.4 Format of research proposal, a presentation and assessment by a review committee

Unit-4:

4.1 Nature of Intellectual Property: Patents, Designs, Trade and Copyright.
4.2 Process of Patenting and Development: technological research, innovation, patenting, development.
4.3 International Scenario: International cooperation on Intellectual Property.
4.4 Procedure for grants of patents,
4.5 Patenting under PCT.

Unit-5:

5.1 Patent Rights: Scope of Patent Rights.
5.2 Licensing and transfer of technology.
5.3 Patent information and databases.
5.4 Geographical Indications.

Unit-6:

6.1 New Developments in IPR: Administration of Patent System.
6.2 New developments in IPR; IPR of Biological Systems, Computer Software etc.
6.3 Traditional knowledge Case Studies,
6.4 IPR and IITs.

Text Books/ Reference Books:

1. Stuart Melville and Wayne Goddard, 1996, Research methodology: an introduction for science & engineering students, Juta Academic.
2. Wayne Goddard and Stuart Melville,2004, Research Methodology: An Introduction, 2nd Edition, Juta and Company Ltd.
3. Ranjit Kumar, 2014, Research Methodology: A Step by Step Guide for beginners, 2nd Edition, SAGE.
4. Debora J. Halbert, 2005, Resisting Intellectual Property, 1st edition, Taylor & Francis Ltd.
5. W. H. Mayall, 1992, Industrial Design, McGraw Hill.
6. Benjamin W. Niebel and Alan B. Draper, 1974, Product design and process engineering, Mc GrawHill.
7. Morris Asimov, 1962, Introduction to Design, 1st edition Prentice Hall.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, 2012, Intellectual Property in New Technological Age, 6th edition, Aspen Publishers.
9. T. Ramappa, 2008, Intellectual Property Rights Under WTO, S. Chand.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:

Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-MC-100.1	1	1	1	2	3	3	3	2	1
M-MC-100.2	1	2	1	2	1	2	1	2	2
M-MC-100.3	1	2	2	2	3	3	1	1	1
M-MC-100.4	1	1	3	2	3	3	1	2	2
M-MC-100.5	2	1	2	3	1	1	2	2	1
M-MC-100.6	1	2	3	2	1	2	1	1	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-112: ADVANCED DATA STRUCTURES LAB

Periods/week	Credits		
P: 4	2	Continuous Evaluation	: 50
Duration of Examination: 2 Hrs		End Sem Examination	: 50

Pre-requisites: The students must have the knowledge of Data Structures

Course Outcomes: The students will be able to-
MCS-112.1. Define the elementary and advanced data structure
MCS-112.2. Understand the various Data structures using C
MCS-112.3. Deploy the advance C programming techniques to developing solutions for particular problems
MCS-112.4. Analyze various operation performed on elementary and advanced data structures
MCS-112.5. Select the appropriate data structure based upon problem environment
MCS-112.6. Design the solutions for the real world problems

Following are some of the suggested topics for the Lab Practicals:
Practical 1: Design, Develop and Implement a menu driven program in C for the following ARRAY operations:

a) Creating an array of N integer elements.
b) Inserting an element at a given valid position
c) Deleting an element from a given valid position
d) Exit

Support the programs with functions for each of the above operations.

Practical 2: Design, Develop and Implement a menu driven program in C for the following operations on strings:

a) Read a main String(STR), a Pattern String (PAT) and a Replace string(REP)
b) Perform Pattern Matching Operation: Find all occurrences of PAT in STR using
    a. Brute-Force Pattern Matching
    b. The Boyer- Moore Algorithm
    c. The Knuth-Morris-Pratt Algorithm,
c) Replace all occurrences of PAT in STR with REP if PAT exists in STR. Report suitable messages in case PAT does not exist in STR

Support the program with functions for each of the above operations. Don't use Built-in functions.

Practical 3: Design, Develop and Implement a menu driven Program in C for the following operations on Binary Search Tree (BST) of Integers

a) Create a BST of N Integers: 6, 9, 5,2, 8,15, 24, 14,7,8, 5, 2
b) Traverse the BST in Inorder, Preorder and Post Order
c) Search the BST for a given element (KEY) and report the appropriate message
d) Delete anelement(ELEM) from BST
e) Exit

Practical 4: Design, Develop and Implement a Program in C for the following operations on Graph (G) of Cities

a) Create a Graph of N cities using Adjacency Matrix.
b) Print all the nodes reachable from a given starting node in a digraph using BFS method
c) Check whether a given graph is connected or not using DFS method.

Practical 5: Given a File of N employee records with a set K of Keys (4-digit) which uniquely determine the records in file F. Assume that file F is maintained in memory by a Hash Table(HT) of m memory locations with L as the set of memory addresses(2-digit) of locations in HT. Let the keys in K and addresses in L are Integers. Design and develop a Program in C that uses Hash function H:K ® L as H(K)=K mod m(remainder method), and implement hashing technique to map a given key K to the address space L . Resolve the collision (if any)using linear probing.

Note: At least 5 more exercises to be given by the teacher concerned.

Distribution of Continuous Evaluation:

Viva- I	30%
Viva- II	30%
File/Records	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Experiments in lab
File work/Class Performance
Viva (Question and answers in lab)
End Term Practical Exam

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-112.1	-	-	-	-	1	-	-	1	1
MCS-112.2	-	-	-	-	-	1	2	2	2
MCS-112.3	1	-	-	-	-	2	1	2	3
MCS-112.4	3	-	-	-	1	-	2	2	3
MCS-112.5	3	-	-	-	1	2	2	3	2
MCS-112.6	2	-	-	-	-	2	1	3	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

M-MC-002: ENGLISH FOR RESEARCH PAPER WRITING

Periods/week	Credits		
L: 2 T: 0	0	Max. Marks	: 100
		Continuous Evaluation	: 50
		End Sem Examination	: 50

Pre-requisites: The students must have the knowledge of Basic English

Course Outcomes: The students will be able to-
M-MC-002.1. Understand that how to improve your writing skills and level of readability
M-MC-002.2. Learn about what to write in each section
M-MC-002.3. Understand the skills needed when writing a Title
M-MC-002.4. Ensure the good quality of paper at very first-time submission

Unit-1:
- 1.1 Planning and Preparation, Word Order,
- 1.2 Breaking up long sentences,
- 1.3 Structuring Paragraphs and Sentences,
- 1.4 Being Concise and Removing Redundancy,
- 1.5 Avoiding Ambiguity and Vagueness

Unit-2:
- 2.1 Clarifying Who Did What,
- 2.2 Highlighting Your Findings,
- 2.3 Hedging and Criticising,
- 2.4 Paraphrasing and Plagiarism,
- 2.5 Sections of a Paper, Abstracts. Introduction

Unit-3:
- 3.1 Review of the Literature,
- 3.2 Methods, Results, Discussion, Conclusions,
- 3.3 The Final Check.

Unit-4:
- 4.1 key skills are needed when writing a Title,
- 4.2 key skills are needed when writing an Abstract,
- 4.3 key skills are needed when writing an Introduction,
- 4.4 skills needed when writing a Review of the Literature

Unit-5:
- 5.1 skills are needed when writing the Methods,
- 5.2 skills needed when writing the Results,
- 5.3 skills are needed when writing the Discussion,
- 5.4 skills are needed when writing the Conclusions.

Unit-6:
- 6.1 useful phrases,
- 6.2 how to ensure paper is as good as it could possibly be the first- time submission

Text Books/ Reference Books:

1. R. Goldbort, 2006, Writing for Science, Yale University Press (available on Google Books).
2. Robert A. Day, 2011, How to Write and Publish a Scientific Paper, 7th edition Cambridge University Press.
3. N. Highman, 1998, Handbook of Writing for the Mathematical Sciences, 2nd edition, SIAM. Highman'sbook.
4. Adrian Wallwork, 2011, English for Writing Research Papers, 1st edition, Springer New York Dordrecht Heidelberg London.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:

Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PS O 1	PS O 2
M-MC-002.1	1	3	1	2	1	1	2	1	1
M-MC-002.2	1	3	1	1	1	2	1	1	1
M-MC-002.3	1	3	2	1	1	2	1	1	1
M-MC-002.4	1	3	1	1	2	1	1	1	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

M-MC-001: STRESS MANAGEMENT BY YOGA

Periods/week	Credits		
L: 2 T: 0	0	Max. Marks	: 100
		Continuous Evaluation	: 50
		End Sem Examination	: 50

Pre-requisites: Nil

Course Outcomes: The students will be able to-
M-MC-001.1. Develop healthy mind in a healthy body thus improving social health also.
M-MC-001.2. Improve efficiency.

Unit 1(8 Hours):
Definitions of Eight parts of yoga. (Ashtanga)

Unit 2(8 Hours) :
Yam and Niyam. Do`s and Don't's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan.

Unit 3(8 Hours) :
Asan and Pranayam i) Various yoga poses and their benefits for mind & body ii) Regularization of breathing techniques and its effects-Types of pranayam

Text Books/ Reference Books:
1. Ackers J, Hardman F , 2001, Classroom interaction in Kenyan primary schools, Compare, 31 (2), 245-261.
2. Agrawal M, 2004, Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3), 361-379.
3. Akyeampong K, 2003, Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J,2013, Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3), 272–282.
4. Alexander RJ, 2001, Culture and pedagogy: International comparisons in primary education. Oxford and Boston, Blackwell.
5. Chavan M, 2003, Read India: A mass scale, rapid, 'learning to read' campaign, www.pratham.org/images/resource%20working%20paper%202.pdf.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PS O 1	PS O 2	PS O 3
M-MC-001.1	3	2	2	2	3	2	2	3	2	2
M-MC-001.2	3	3	2	2	2	3	2	1	1	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-221A: DATA PREPARATION AND ANALYSIS

Periods/week	Credits		Max. Marks	: 200
L: 3 T: 0	3		Continuous Evaluation	: 100
Duration of Examination: 3 Hrs			End Sem Examination	: 100

pre-requisites: NIL

Course Outcomes: The students will be able to-
MCS-221A.1. Understand and implement classical algorithms in data mining and data warehousing;
MCS-221A.2. Assess the strengths and weaknesses of the algorithms,
MCS-221A.3. Identify the application area of algorithms, and apply them.
MCS-221A.4. Learn data mining techniques as well as methods in integrating and interpreting the data sets.
MCS-221A.5. Improve effectiveness, efficiency and quality for data analysis.

Unit-1: Data Gathering and Preparation:
1.1 Data formats,
1.2 parsing and transformation,
1.3 Scalability and real-time issues

Unit-2: Data Cleaning:
2.1 Consistency checking,
2.2 Heterogeneous and missing data,
2.3 Data Transformation and segmentation

Unit-3: Exploratory Analysis:
3.1 Descriptive and comparative statistics,
3.2 Clustering and association,
3.3 Hypothesis generation

Unit-4: Visualization:
4.1 Designing visualizations, Time series,
4.2 Geolocated data, Correlations and connections,
4.3 Hierarchies and networks, interactivity

Unit-5:Data Modeling:
5.1 Linear regression
5.2 Logistic Regression
5.3 K-Nearest Neighbor
5.4 Classification and Regression trees

Unit-6: Data preparation using SPSS
6.1 Preapring Data File
6.2 Preliminary analysis
6.3 statistical techniques to explore relationship among variables.

Text Books/ Reference Books:
1. Glenn J. Myatt, Wayne P. Johnson, 2014, Making sense of Data : A practical Guide to Exploratory Data Analysis and Data Mining, 2nd edition, Wiley.

2. Julie Pallant,2007, SPSS Survival Manual:A Step –by-step Guide to Data Analysis using SPSS version 15, Third edition.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**
MCS-221A.1	1	2	2	1	1	1	1	1	1
MCS-221A.2	1	2	2	2	1	1	1	2	1
MCS-221A.3	1	1	2	2	2	2	1	1	1
MCS-221A.4	1	1	1	1	2	2	2	1	1
MCS-221A.5	2	1	1	1	2	1	2	2	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

NAAC 'A' Grade University

MCS-127 : DATA STORAGE TECHNOLOGIES & NETWORKS

Periods/week	Credits	Max. Marks	: 200
L : 3 T:0	3.0	Continuous Evaluation	: 100
Duration of Exam: 3 Hrs		End Sem Examination	: 100

Pre-Requisite: Computer Networks
Course Type: Program Elective

Course Outcomes: The students will be able to-

MCS127.1. explain the design of a data center and storage requirements
MCS127.2. discuss the various types of storage and their properties
MCS127.3. explain physical and virtualization of storage
MCS127.4. explain the backup, archiving with regard to recovery and business continuity

Unit-1: Storage Media And Technologies & Access:

1.1 Storage Media and Technologies -Magnetic, Optical and Semiconductor Media,
1.2 Techniques for read/write Operations, Issues and Limitations.
1.3 Usage and Access – Positioning in the Memory Hierarchy,
1.4 Hardware and Software Design for Access,
1.5 Performance issues.

Unit-2: Data Centre:
1.1 Introduction, Site Selection and Environmental Considerations,
1.2 Hierarchical or Layered Architecture, Architect Roles, Goals and Skills,
1.3 Architecture Precursors

Unit-3: Storage Management:

1.1 Introduction to Storage Technology,
1.2 Storage Systems Architecture,
1.3 Physical and logical components of a connectivity environment,
1.4 Major physical components of a disk drive and their functions,
1.5 Concept of RAID and its components,
1.6 Different RAID levels and their suitability for different application environments: RAID 0, RAID 1, RAID 3, RAID 4, RAID 5, RAID 0+1, RAID 1+0, RAID 6,
1.7 Integrated and Modular storage systems, high-level architecture and working of an intelligent storage systems

Unit-4: Networked Storage:

1.1 Evolution of networked storage, Architecture,
1.2 components, and topologies of FC-SAN, NAS, and IP-SAN,
1.3 Benefits of the different networked storage options,
1.4 Need for long-term archiving solutions and describe how CAS fulfill the need,
1.5 Appropriateness of the different networked storage options for different application environments

Unit-5: Securing Storage And Storage Virtualization:

1.1 Information Security, Critical security attributes for information systems,
1.2 Storage security domains, Analyze the common threats in, each domain,
1.3 Storage Virtualization: Forms, Configurations and Challenges,
1.4 Types of Storage Virtualization: Block-level and File-Level.

Unit-6: Recent Trends:

1.1 Recent Trends related to Copy data management,
1.2 Erasure coding, and Software defined storage appliances.

Text Books/ Reference Books:

1. Mauricio Arregoces, 2003, Data Center Fundamentals, Cisco Press; 1st edition.
2. Robert Spalding, 2003, Storage Networks: The Complete Reference, Tata McGraw Hill, Osborne.
3. Marc Farley, 2001, Building Storage Networks, Tata McGraw Hill, Osborne.
4. Meeta Gupta, 2002, Storage Area Network Fundamentals, Pearson Education Limited.
5. G. Somasundaram, Alok Shrivastava, 2011, Information Storage and Management, EMC Education Series, Wiley, Publishing Inc.
6. Gustavo Santana,2013, Data Center Virtualization Fundamentals: Understanding Techniques and Designs for Highly Efficient Data Centers with Cisco Nexus, UCS, MDS, and Beyond, Cisco Press; 1st edition.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
End Semester Examination

Course Articulation Matrix:

CO Statement (MCS- 127)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-127.1	3	2		3		1			
MCS-127.2	3		2	2		2			
MCS-127.3	3	3	2	2	1	3			
MCS-127.4	3	2		3	1				

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A++' Grade University

MCS-129: INTRUSION DETECTION

Periods/week	Credits		Max. Marks	: 200
L :3	3.0	3	Continuous Evaluation	: 100
Duration of Exam: 3 Hrs			End Sem Examination	: 100

Pre-Requisite: Basic Knowledge of Information Security

Course Type: Program Elective

Course Outcomes: The students will be able to-

MCS-129.1. Understand the fundamental concepts of intrusion detection and its role in information security.
MCS-129.2. Apply different intrusion detection techniques for identifying and analyzing potential security breaches.
MCS-129.3. Analyze network traffic and system logs to identify potential intrusions and security vulnerabilities.
MCS-129.4. Design and deploy effective network and host-based intrusion detection systems.
MCS-129.5. Evaluate the performance and effectiveness of intrusion detection systems and propose optimization strategies.
MCS-129.6. Explore emerging trends and advancements in intrusion detection, and analyze their implications on information security.

Unit 1: Introduction to Intrusion Detection Systems (IDS)

1.1 Overview of intrusion detection and its importance in information security
1.2 Types of attacks and their impact on computer systems, Intrusion detection principles and concepts
1.3 Components of an IDS: sensors, analyzers, and responders
1.4 IDS classification: host-based and network-based IDS
1.5 Intrusion prevention systems (IPS) vs. intrusion detection systems (IDS)

Unit 2: Intrusion Detection Techniques

2.1 Signature-based detection: pattern matching and rule-based detection
2.2 Anomaly-based detection: statistical models and machine learning algorithms
2.3 Hybrid detection approaches combining signature and anomaly-based techniques
2.4 Log analysis for intrusion detection: event correlation and log monitoring
2.5 Traffic analysis techniques for network-based IDS

Unit 3: Network Intrusion Detection Systems (NIDS)

3.1 Network IDS architecture and deployment strategies
3.2 Packet capture and analysis for NIDS
3.3 NIDS evasion techniques and countermeasures
3.4 Snort: an open-source NIDS and its rule-based detection system
3.5 Bro: a powerful network analysis framework for NIDS

Unit 4: Host Intrusion Detection Systems (HIDS)
4.1 HIDS architecture and deployment considerations
4.2 File integrity monitoring for HIDS
4.3 Registry monitoring and system call monitoring
4.4 Audit logs analysis for HIDS
4.5 Windows Security Event Log and its relevance in HIDS

Unit 5: Intrusion Detection System Management

5.1 IDS management and administration best practices
5.2 IDS rule and signature creation and customization
5.3 Alert handling and incident response in IDS
5.4 IDS performance tuning and optimization
5.5 Integration of IDS with other security systems (firewalls, SIEM)

Unit 6: Emerging Trends in Intrusion Detection

6.1 Advanced persistent threats (APTs) and targeted attacks
6.2 Machine learning for intrusion detection
6.3 Big data analytics for IDS
6.4 Cloud-based intrusion detection systems
6.5 Internet of Things (IoT) and intrusion detection challenges

Reference Books

1. "Intrusion Detection Systems" by Rebecca Gurley Bace
2. "Network Intrusion Detection: An Analyst's Handbook" by Stephen Northcutt and Judy Novak
3. "Intrusion Detection in Wireless Ad-Hoc Networks" by Sushil Jajodia, Jianwei Niu, and Cliff Wang
4. "Host-Based Intrusion Detection" by Barbara Guttman, Tim Grance, and Karen Scarfone
5. "Intrusion Detection Systems with Snort: Advanced IDS Techniques Using Snort, Apache, MySQL, PHP, and ACID" by Rafeeq Ur Rehman

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
End Semester Examination

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-129.1	1	2	2	1	1	1	1	1	1
MCS-129.2	1	2	2	2	1	1	1	2	1
MCS-129.3	1	1	2	2	2	2	1	1	1
MCS-129.4	1	1	1	1	2	2	2	1	1
MCS-129.5	2	1	1	1	2	1	2	2	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

NAAC 'A' Grade University

MCS-130: ETHICAL HACKING

Periods/week	Credits		
L :3 T: 0	3.0	Max. Marks	: 200
		Continuous Evaluation	: 100
Duration of Exam: 3 Hrs		End Sem Examination	: 100

Pre-Requisite: Computer Networks
Course Type: Program Elective

Course Outcomes: The students will be able to-
MCS-130 .1. Understand the principles and concepts of ethical hacking and cybersecurity.
MCS-130 .2. Apply ethical hacking techniques to identify and mitigate vulnerabilities in computer systems and networks.
MCS-130.3. Analyze and evaluate the legal and ethical implications of hacking activities and cybersecurity practices.
MCS-130.4. Develop skills in securing computer systems and networks from potential threats and attacks.

Unit-1: Introduction to Ethical Hacking

1.1 Overview of ethical hacking and its significance in cybersecurity
1.2 Legal and ethical aspects of ethical hacking
1.3 Hacking methodologies: reconnaissance, scanning, enumeration, and exploitation
1.4 Introduction to various hacking tools and their applications

Unit-2: Network Security and Penetration Testing

2.1 Network security fundamentals: firewalls, intrusion detection systems, etc.
2.2 Network mapping and scanning techniques
2.3 Vulnerability assessment and penetration testing methodologies
2.4 Exploiting network vulnerabilities and countermeasure

Unit-3: Web Application Security

3.1 Introduction to web application security and common vulnerabilities
3.2 Injection attacks: SQL injection, XSS, etc.
3.3 Authentication and session management vulnerabilities
3.4 Web application security best practices and secure coding techniques

Unit-4: Wireless Network Security

4.1 Wireless network security concepts: WEP, WPA, WPA2, etc.
4.2 Wireless network reconnaissance and attacks
4.3 Wireless network encryption cracking techniques
4.4 Wireless network security countermeasures and best practices

Unit-5: Malware Analysis and Reverse Engineering

5.1 Introduction to malware analysis and types of malware
5.2 Static and dynamic malware analysis techniques

5.3 Reverse engineering: disassembling and debugging malware
5.4 Malware detection and prevention strategies

Unit-6: Cybersecurity Governance and Ethics

6.1 Cybersecurity governance frameworks: ISO 27001, NIST Cybersecurity Framework, etc.
6.2 Legal and regulatory aspects of cybersecurity
6.3 Privacy and data protection considerations
6.4 Ethical considerations in ethical hacking and cybersecurity practices

Text Books/ Reference Books:

1. Dafydd Stuttard and Marcus Pinto,"The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws", Wiley.
2. Jon Erickson, "Hacking: The Art of Exploitation", No Starch Press.
3. Patrick Engebretson, "The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made Easy", Syngress.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
End Semester Examination

Course Articulation Matrix:

CO Statement (MCS- 130)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-130.1	2		1	2	2		2		
MCS-130.2	2	1		1	2		2	1	
MCS-130.3	3			2	3		3	2	2
MCS-130.4	3	1	1	1	3		3	3	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

NAAC 'A' Grade University

MCS-132 : NETWORK SECURITY

Periods/week	Credits		
L :3 T:0	3.0	Continuous Evaluation	: 100
Duration of Exam: 3 Hrs		End Sem Examination	: 100

Pre-Requisite: Computer Networks
Course Type: Program Elective

Course Outcomes: The students will be able to-
MCS-132 .1 Understand the fundamental principles and concepts of network security.
MCS-132 .2 Analyze and evaluate network vulnerabilities and threats, and apply appropriate countermeasures.
MCS-132 .3 Design and implement secure network architectures and protocols.
MCS-132 .4 Develop skills in using network security tools and techniques for monitoring, detecting, and responding to security incidents.

Unit-1: Introduction to Network Security

1.1 Overview of network security concepts, goals, and principles
1.2 Common network vulnerabilities and threats
1.3 Introduction to security policies and risk management
1.4 Legal and ethical considerations in network security

Unit-2: Network Security Technologies and Protocols

2.5 Secure network architecture and design principles
2.6 Firewalls, IDS/IPS, and other network security devices
2.7 Virtual Private Networks (VPNs) and secure remote access
2.8 Secure protocols: SSL/TLS, IPsec, SSH, etc.

Unit-3: Network Access Control and Authentication

3.1 Access control models: MAC, DAC, RBAC, etc.
3.2 Network authentication mechanisms: passwords, biometrics, certificates, etc.
3.3 Network access control protocols: RADIUS, TACACS+, 802.1X, etc.
3.4 Single Sign-On (SSO) and identity management

Unit-4: Network Intrusion Detection and Prevention

4.1 Intrusion Detection Systems (IDS) and Intrusion Prevention Systems (IPS)
4.2 Network traffic analysis and anomaly detection
4.3 Signature-based and behavior-based intrusion detection techniques
4.4 Incident response and handling network security incidents

Unit-5: Wireless Network Security

5.1 Wireless network vulnerabilities and threats
5.2 Secure wireless network architectures: WPA2, EAP, etc.
5.3 Wireless network encryption and authentication mechanisms
5.4 Wireless network penetration testing and security auditing

Unit-6: Network Security Management and Compliance

6.1 Network security planning and implementation
6.2 Security assessment and compliance frameworks (e.g., ISO 27001)
6.3 Network security monitoring and auditing
6.4 Security incident response and recovery

Text Books/ Reference Books:

1. William Stallings and Lawrie Brown , "Computer Security: Principles and Practice", Pearson Edition: 4th Edition.
2. William Stallings, "Network Security Essentials: Applications and Standards", Pearson, Edition: 7th Edition

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
End Semester Examination

Course Articulation Matrix:

CO Statement (MCS- 132)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS132.1	2	1		2	2		2		
MCS132.2	2		1	1	2		2	1	
MCS132.3	3	1		2	3		3	1	1
MCS132.4	3		1	1	3		3	3	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

NAAC 'A' Grade University

MCS-142 : NETWORK SECURITY LAB

Periods/week	Credits	Max. Marks	: 100
P:4	2.0	Continuous Evaluation	: 50
Duration of Exam: 2Hrs		End Sem Examination	: 50

Pre-Requisite:Computer Networks
Course Type: Program Elective

Course Outcomes: The students will be able to-
MCS-142.1 Develop practical skills in configuring and managing network security devices and technologies.
MCS-142 .2 Perform network vulnerability assessments and penetration testing..
MCS-142 .3 Analyze and respond to network security incidents using various security tools.
MCS-142 .4 Apply network security best practices in real-world scenarios.

List of Practicals:

1. Setting up the network security lab environment
2. Introduction to packet capture and analysis tools (e.g., Wireshark)
3. Intrusion Detection and Prevention System (IDS/IPS) setup and configuration
4. Configuring and managing VPNs using different protocols (e.g., IPsec, SSL/TLS)
5. Testing and troubleshooting VPN connections and secure remote access
6. Collecting and analyzing network logs for security monitoring
7. Implementing security monitoring solutions (e.g., SIEM)
8. Penetration testing methodologies and techniques
9. Conducting network vulnerability assessments using scanning tools (e.g., Nmap, Nessus)
10. Hands-on exercises and projects based on real-world network security challenges

Course Articulation Matrix:

CO Statement (MCS- 142)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-142.1	2	1		2	2		2		
MCS-142.2	2		1	1	2		2	1	
MCS-142.3	3	1		2	3		3	1	1
MCS-142.4	3		1	1	3		3	3	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-136 : INTRODUCTION TO STATISTICAL METHODS

Periods/week	Credits	Max. Marks	: 200
L :3 T: 0	3.0	Continuous Evaluation	: 100
Duration of Exam: 3 Hrs		End Sem Examination	: 100

Pre-Requisite: Basic Knowledge of general mathematical and analytical aptitude
Basic knowledge of probability and data presentation

Course Type: Program Elective

Course Outcomes: The students will be able to-
MCS136.1: Familiarize students with basic statistical concepts and terminologies.
MCS136.2: Develop an understanding of data collection, organization, and presentation.
MCS136.3: Introduce students to descriptive statistical measures and their interpretations.
MCS136.4: Provide an overview of probability theory and its applications in statistical analysis.
MCS136.5: Enable students to perform hypothesis testing and make inferences about populations, & statistical techniques such as regression analysis and ANOVA.
MCS136.6: To enhance students' ability to use statistical software for data analysis.

Unit-1 : Introduction To Statistics
1.1 Definition, Scope, And Importance Of Statistics
1.2 Types Of Data And Levels Of Measurement
1.3 Populations And Samples

Unit-2 : Data Collection And Presentation
2.1 Primary And Secondary Data
2.2 Data Sources And Sampling Techniques
2.3 Data presentation techniques: tables, graphs, and charts

Unit-3: Descriptive Statistics
3.1 Measures Of Central Tendency: Mean, Median, Mode
3.2 Measures Of Variability: Range, Variance, Standard Deviation
3.3 Measures Of Relative Position: Percentiles, Quartiles

Unit-4: Probability Theory
4.1 Basic Concepts Of Probability
4.2 Probability Rules And Laws
4.3 Probability Distributions: Discrete And Continuous

Unit-5: Statistical Inference
5.1 Sampling Distributions And The Central Limit Theorem
5.2 Estimation: Point Estimation And Interval Estimation
5.3 Hypothesis Testing: Null And Alternative Hypotheses, Type-I And Type-Ii Errors

Unit-6: Statistical Techniques

6.1 Correlation Analysis And Simple Linear Regression
6.2 Analysis Of Variance (Anova)
6.3 Nonparametric Tests
6.4 Introduction To Statistical Software
    6.4.1 Overview Of Statistical Software Packages
    6.4.2 Hands-On Practice Using Statistical Software For Data Analysis
6.5 Project Work: A Statistical Analysis Project To Apply The Learned Concepts To Real-World Data

Text Books/ Reference Books:

TEXTBOOKS:

1. M. F. Triola and L. Iossi, 2019, **Essentials of statistics,** 6th ed./Student edition. New York, New York: Pearson.
2. D. S. Starnes, J. Tabor, D. S. Yates, and D. S. Moore,2015, **The practice of statistics**, 5th ed. New York: W.H. Freeman and Company/BFW.
3. W. Mendenhall, R. J. Beaver, and B. M. Beaver,2009, ***Introduction to probability and statistics***, 13th ed. Belmont, CA: Brooks/Cole, Cengage Learning.
4. A. P. Field, 2018, ***Discovering statistics using IBM SPSS statistics***, 5th ed., North American ed. Thousand Oaks, California: Sage Publications Inc.
5. R. Peck, C. Olsen, and J. L. Devore, 2005, ***Introduction to statistics and data analysis***, 2nd ed. Belmont, CA: Thomson Brooks/Cole.
6. P. S. Mann, 2017, ***Mann's introductory statistics***, Global edition. Hoboken, NJ: Wiley.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:

Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
End Semester Examination

Course Articulation Matrix:

CO Statement (MCS-136)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-136.1	3	2	1	2	2	3	2	2	2
MCS-136.2	3	2	2	2	2	3	3	3	3
MCS- 136.3	2	1	2	1	2	2	1	3	2
MCS- 136.4	1	3	2	2	3	1	1	2	2
MCS- 136.5	1	1	1	3	1	2	2	2	3
MCS- 136.6	1	1	3	1	3	2	2	1	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-124: DATA SCIENCE

Periods/week	Credits		Max. Marks	: 200
L: 3	T: 0	3	Continuous Evaluation	: 100
Duration of Examination: 3 Hrs			End Sem Examination	: 100

Pre-requisites: The students must have the knowledge of statistical concepts

Course Outcomes: The students will be able to-
MCS-124.1. Study the core concepts and technologies used for data Science.
MCS-124.2. Understand the Data collection and management techniques.
MCS-124.3. Identify the concept of data Analysis and machine learning algorithms for Data Science.
MCS-124.4. Categorize different types of Data visualization Techniques.
MCS-124.5. Compare and Analyze different Data Science Applications.
MCS-124.6. Discuss Recent trends in various data collection and analysis techniques.

Unit-1: Introduction to core concepts and technologies
- 1.1 Introduction
- 1.2 Terminology
- 1.3 Data science process
- 1.4 Data science toolkit
- 1.5 Types of data
- 1.6 Example applications.

Unit-2: Data collection and management
- 2.1 Introduction
- 2.2 Sources of data
- 2.3 Data collection and APIs
- 2.4 Exploring and fixing data
- 2.5 Data storage and management
- 2.6 Using multiple data sources

Unit-3: Data Analysis
- 3.1 Introduction
- 3.2 Terminology and concepts
- 3.3 Introduction to statistics
- 3.4 Central tendencies and distributions
- 3.5 Variance
- 3.6 Distribution properties and Arithmetic
- 3.7 Samples/CLT
- 3.8 Basic machine learning algorithms
- 3.9 Linear regression
- 3.10 Naive Bayes
- 3.11 SVM

Unit 4: Data visualization
- 4.1 Introduction
- 4.2 Types of data visualization
- 4.3 Data for visualization : Data types

4.4 Data encodings
4.5 Retinal variables
4.6 Mapping variables to encodings
4.7 Visual encodings

Unit 5: Applications of Data Science
5.1 Applications of Data Science
5.2 Technologies for visualization
5.3 Bokeh (Python)

Unit-6: Recent trends in various data collection and analysis techniques
6.1 Recent trends in various data collection
6.2 Analysis techniques
6.3 Various visualization techniques
6.4 Application development methods of used in data science.

Text Books/ Reference Books:
1. Cathy O'Neil and Rachel Schutt., 2013, Doing Data Science, Straight Talk From The Frontline, O'Reilly.
2. Jure Leskovek, AnandRajaraman and Jeffrey Ullman,2014, Mining of Massive Datasets, 3rd edition, Cambridge University Press.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2
MCS-124.1	2	2	2	1	2	1	2	2	2
MCS-124.2	2	2	2	2	2	1	2	1	2
MCS-124.3	2	2	2	1	2	1	2	2	2
MCS-124.4	2	2	2	2	2	1	2	1	2
MCS-124.5	2	2	2	1	2	1	2	2	2
MCS-124.6	2	2	2	2	2	1	2	1	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-134: DATA SCIENCE LAB

Periods/week	Credits		
P: 4	2	Continuous Evaluation	: 50
Duration of Examination: 2 Hrs		End Sem Examination	: 50

Pre-requisites: The students must have the knowledge of statistics and probability

Course Outcomes: The students will be able to-
MCS-134.1. Study the Basic of for data analysis.
MCS-134.2. Understand the Qualitative Data Analysis and Quantitative Data Analysis techniques.
MCS-134.3. Identify the concept of Numerical Measures and Probability Distribution.
MCS-134.4. Categorize different types of Data as statistical Inference.
MCS-134.5. Compare and Analyze different classification and Clustering Techniques.
MCS-134.6. Design a Text Mining problem dealing with Text based data set.

List of Experiments:
Experiment 1: Basic of for data analysis R:Basic data types, Vector, Matrix, List, Data Frame.

Experiment 2: *Qualitative* Data Analysis:Frequency Distribution of Qualitative Data, Relative Distribution of Qualitative Data, Bar Chart, Pie Chart.

Experiment 3: Quantitative Data Analysis: Frequency Distribution of Quantitative Data, Histogram, Cumulative Frequency Distribution.

Experiment 4: Numerical Measures: Mean, Median, Modes, Variance, Standard Deviation, Correlation Coefficient.
Experiment5: Probability Distribution: Binomial Distribution, Poisson Distribution, Continuous Uniform Distribution, Normal Distribution, Chi-Squared Distribution.
Experiment 6: Statistical inference:comparison between two independent samples, Population Mean Between two matched samples.
Experiment 7: Goodness Fit:Chi Square Test of independence
Experiment 8: Classification:Naïve Bayesian, Support Vector Machine, Maximum Likelihood Estimators.
Experiment 9: Clustering:K-Mean
Experiment 10: Text Mining:Text Classification, TF-IDF.

Text Books/ Reference Books:

1. R Statistical Application Development by Example Beginner's Guide Kindle Edition byPrabhanjanNarayanacharTattar.
2. John Vince, Foundation Mathematics for Computer Science, Springer.
3. K. Trivedi.Probability and Statistics with Reliability, Queuing, and Computer Science Applications.Wiley.
4. M. Mitzenmacher and E. Upfal.Probability and Computing: Randomized Algorithms and Probabilistic Analysis.
5. Alan Tucker, Applied Combinatorics, Wiley
6. Practical Statistics for Data Scientists: 50 Essential Concepts 1st Edition, Kindle Edition

Note: At least 5 more exercises to be given by the teacher concerned.

Distribution of Continuous Evaluation:

Viva- I	30%
Viva- II	30%
File/Records	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:

Experiments in lab
File work/Class Performance
Viva (Question and answers in lab)
End Term Practical Exam

Course Articulation Matrix:

CO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2
MCS-134.1	2	2	2	1	2	1	2	2	2
MCS-134.2	2	2	2	2	2	1	2	1	2
MCS-134.3	2	2	1	1	2	1	2	2	2
MCS-134.4	2	2	1	2	2	1	2	1	2
MCS-134.5	2	2	1	1	2	1	2	2	2
MCS-134.6	2	2	2	2	2	1	2	1	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

NAAC 'A' Grade University

MCS-128 : Data Warehouse & Data Mining

Periods/week	Credits		
L : 3 T: 0	3	Continuous Evaluation	: 100
Duration of Exam: 3 Hrs		End Sem Examination	: 100

Pre-Requisite: DBMS & Fundamental concepts of Statistics

Course Type: Program Elective

Course Outcomes: After completion of this course the students will be able to

MCS-128.1 Understand the concepts and principles of data warehousing and data mining.

MCS-128.2 Learn how to design and implement data warehouses for effective data storage and retrieval.

MCS-128.3 Comprehend and apply the various data preprocessing methods.

MCS-128.4 Explore various data mining techniques and algorithms for knowledge discovery.

MCS-128.5 Develop skills in using data mining tools and software for real-world applications.

Unit-1: Data Warehousing

1.1 Introduction to Data Warehousing and its Benefits,
1.2 Comparison of OLTP and Data Warehousing,
1.3 Problems of Data Warehousing,
1.4 Data integration
1.5 ETL (Extract, Transform, Load) processes,
1.6 OLAP and Multidimensional Data Analysis

Unit-2: Data Warehousing Architecture, Tools & Technology

2.1 Architecture: Operational Data and Datastore,
2.2 Load, Warehouse & Query Manager,
2.3 Detailed Data, Lightly and Highly summarized Data,
2.4 Archive/Backup Data, Meta-Data,
2.5 Architecture model, 2-tier, 3-tier and 4-tier data warehouse,
2.6 End user Access tools,
2.7 OLAP & DSS support in data warehouse,
2.8 ETL tools and techniques

Unit-3: Data Mining Concepts and Techniques

3.1 Introduction to data mining,
3.2 Knowledge Discovery in databases,
3.3 Data exploration and visualization,
3.4 Classification and prediction,
3.5 Clustering and segmentation,
3.6 Association analysis & Anomaly detection

Unit-4: Data Pre-processing Concepts

4.1 Data Preprocessing & Data Cleaning,
4.2 Data Integration & Transformation,
4.3 Data Reduction,
4.4 Data Discretization
4.5 Concept Hierarchy Generation- Architecture of A Typical Data Mining Systems-,
4.6 Classification of Data Mining Systems
4.7 Association Rule Mining

Unit-5: Data Mining Algorithms and Models

5.1 Decision trees and random forests
5.2 Naive Bayes classifiers
5.3 Support Vector Machines (SVM)
5.4 Neural networks and deep learning
5.5 K-means clustering
5.6 Apriori algorithm
5.7 Time series analysis

Unit-6: Data Mining Tools & advance concepts

6.1 Introduction to popular data mining tools e.g., Weka, RapidMiner, Python, R etc.,
6.2 Multidimensional Analysis and Descriptive Mining of Complex Data Objects,
6.3 Spatial Data Mining,
6.4 Multimedia Data Mining,
6.5 Text Mining,
6.6 Mining the World Wide Web.

Textbooks/ Reference Books:

1. Jiawei Han, Micheline Kamber and Jian Pei, 2011,"Data Mining Concepts and Techniques", Third Edition, Elsevier.
2. Alex Berson and Stephen J. Smith, 2007, "Data Warehousing, Data Mining & OLAP", Tata McGraw – Hill Edition, Tenth Reprint.
3. G. K. Gupta, 2006, "Introduction to Data Mining with Case Studies", Easter Economy Edition, Prentice Hall of India.
4. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, 2007, "Introduction to Data Mining", Pearson Education.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
End Semester Examination

Course Articulation Matrix:

CO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2
MCS-128.1	2	2	1	1	2	1	1	2	2
MCS-128.2	2	2	1	1	2	1	2	2	2
MCS-128.3	2	2	1	1	2	1	2	2	2
MCS-128.4	2	2	1	1	1	1	2	2	2
MCS-128.5	2	2	1	1	2	1	2	2	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

NAAC 'A' Grade University

MCS-138: Data Warehouse & Data Mining Lab

Periods/week	Credits	Max. Marks	: 100
P: 4	2.0	Continuous Evaluation	: 50
Duration of Exam: 2 Hrs		End Sem Examination	: 50

Pre-Requisite: Python
Course Type: Program Elective

Course Outcomes: The students will be able to-

MCS-138.1 Develop proficiency in performing matrix operations, including addition, subtraction, scalar multiplication, matrix multiplication, and solving systems of linear equations.

MCS-138.2 Gain hands-on experience in preprocessing and analyzing data, including handling missing values, computing correlation matrices, and exploring data using visualization techniques.

MCS-138.3 Apply association rule mining techniques, such as the Apriori algorithm, to discover interesting patterns and associations within datasets.

MCS-138.4 Demonstrate proficiency in classification algorithms, including logistic regression, K-nearest neighbors (KNN), decision trees, Bayesian networks, and support vector machines (SVM).

MCS-138.5 Utilize appropriate data preprocessing techniques and classification algorithms to solve real-world problems, evaluate their performance, and interpret the results accurately.

LIST OF EXPERMENTS

Program 1: Matrix Operations

Introduction to Python libraries for Data Mining: NumPy, SciPy, Pandas, Matplotlib, Scikit-Learn
Write a Python program to do the following operations: Library: NumPy
a) Create multi-dimensional arrays and find its shape and dimension
b) Create a matrix full of zeros and ones
c) Reshape and flatten data in the array
d) Append data vertically and horizontally
e) Apply indexing and slicing on array
f) Use statistical functions on array - Min, Max, Mean, Median and Standard Deviation

Program 2: Linear Algebra On Matrices

Write a Python program to do the following operations:
Library: NumPy
a) Dot and matrix product of two arrays
b) Compute the Eigen values of a matrix
c) Solve a linear matrix equation such as $3 * x^0 + x^1 = 9$, $x^0 + 2 * x^1 = 8$
d) Compute the multiplicative inverse of a matrix
e) Compute the rank of a matrix
f) Compute the determinant of an array

Program 3: Understanding Data

Write a Python program to do the following operations:
Data set: brain_size.csv
Library: Pandas
a) Loading data from CSV file

b) Compute the basic statistics of given data - shape, no. of columns, mean
c) Splitting a data frame on values of categorical variables
d) Visualize data using Scatter plot

Program 4: Correlation Matrix
Write a python program to load the dataset and understand the input data
Dataset: Pima Indians Diabetes Dataset
Library : Scipy
a) Load data, describe the given data and identify missing, outlier data items
b) Find correlation among all attributes
c) Visualize correlation matrix

Program 5: Data Preprocessing – Handling Missing Values
Write a python program to impute missing values with various techniques on given dataset.
a) Remove rows/ attributes
b) Replace with mean or mode
c) Write a python program to perform transformation of data using Discretization (Binning) and normalization (MinMaxScaler or MaxAbsScaler) on given dataset.

Program 6: Association Rule Mining- Apriori

Write a python program to find rules that describe associations by using the Apriori algorithm.
Libraries: NumPy, SciPy, Matplotlib, Pandas
Dataset: Kaggle

Program 7: Classification – Logistic Regression

Write a python program to find different classes by using logistic regression algorithm.
Libraries: Pandas, NumPy, Sklearn, Seaborn
Write a python program to
a) Explore data and visualize each attribute
b) Predict the test set results and find the accuracy of the model
c) Visualize the confusion matrix
d) Compute precision, recall, F-measure, and support

Program 8: Classification – KNN

Write a python program to find different classes by using KNN algorithm.
Libraries: import numpy as np
Write a python program to
a) Get Nearest Neighbors b) Make Predictions.

Program 9: Classification - Decision Trees
Write a python program
a) to build a decision tree classifier by using given dimensions.
b) training with various split measures (Gini index, Entropy and Information Gain)
c) Compare the accuracy.

Program 10: Clustering – K-Means

Write a python program to find different clusters by using k-mean algorithm.
Libraries: Pandas, NumPy, Sklearn, Seaborn, Matplotlib
Write a python program

a) to perform preprocessing
b) to perform clustering using k-means algorithm to cluster the records two.

Program 11. Classification – Support Vector Machines (SVM)

Develop an SVM model on medical data resource available on UCI Machine Learning Repository for data set.

References:

1. https://www.dataquest.io/blog/sci-kit-learn-tutorial/
2. https://www.ibm.com/support/knowledgecenter/en/SS3RA7_sub/modeler_tutorial_ddita/modeler_tutorial_ddita-gentopic1.html
3. https://archive.ics.uci.edu/ml/datasets.php
4. Kaggle databases
5. https://www.python.org/

Software required/Weblinks:

Python tutorial
Matplotlib and Seaborn libraries
NumPy: NumPy is a fundamental library for numerical computations in Python,
www.tutorialspoint.com

Distribution of Continuous Evaluation:

Viva- I	30%
Viva- II	30%
File/Records	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:

Experiments in lab
File work/Class Performance
Viva (Question and answers in lab)
End Term Practical Exam

Course Articulation Matrix:

CO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2
MCS-138.1	2	2	1	1	2	1	1	2	2
MCS-138.2	2	1	2	1	1	2	2	2	2
MCS-138.3	2	2	1	1	2	1	2	2	2
MCS-138.4	2	2	1	1	1	1	2	2	2
MCS-138.5	2	2	1	1	2	1	2	2	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

NAAC 'A' Grade University

MCS-236: INFORMATION RETRIEVAL AND KNOWLEDGE DISCOVERY

Periods/week	Credits		Max. Marks	: 200
L : 3 T: 0	3		Continuous Evaluation	: 100
Duration of Exam: 3 Hrs			End Sem Examination	: 100

Pre-Requisite: Data Mining Concepts
Course Type: Program Elective

Course Outcomes: After completion of this course the students will be able to

MCS-236.1 Define the Information retrieval system along with various capabilities.
MCS-236.2 Understand to apply IR principles to locate relevant information from large collections of data.
MCS-236.3 Analyze different retrieval systems for web search tasks.

Unit-1: Introduction to Information Retrieval
1.1 Introduction, History of IR,
1.2 Data vs Information Retrieval,
1.3 Logical view of the documents,
1.4 Architecture of IR System,
1.5 Information Retrieval Vs Information Extraction,
1.6 Web search system

Unit-2: Fundamental IR Models
2.1 Classes of Retrieval Model,
2.2 Boolean model,
2.3 Term weighting mechanism – TF, IDF, TF-IDF weighting,
2.4 Cosine Similarity, Vector space model,
2.5 Probabilistic models (the 2binary independence model,
2.6 Language models · KL-divergence; · Smoothing),
2.7 Non-Overlapping Lists, Proximal Nodes Mode

Unit-3: Text PreProcessing and Indexing
3.1 Text Preprocessing(tokenization, stemming, stop words)
3.2 Inverted Indexing
3.3 Compression Techniques

Unit-4: Web Search
4.1 Search Engines:working principle,
4.2 Spidering, Structure of a spider,
4.3 Spidering algorithm, Directed spidering
4.4 Basic crawler architecture,
4.5 Link analysis (HITS, Page ranking), Query log analysis

Unit-5: Knowledge Discovery
5.1 Data Preprocessing
5.2 Association rule mining
5.3 Clustering and classification
5.4 Feature selection and extraction

Unit-6: IR Applications
6.1 Information extraction
6.2 Question answering
6.3 Opinion summarization
6.4 Social Network

Textbooks/ Reference Books:

1. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, 2008. Introduction to Information Retrieval, Cambridge University Press.
2. Thomas Roelleke, 2013. Information Retrieval Models: Foundations and Relationships (1st. ed.). Morgan & Claypool Publishers.
3. Ricardo Baeza-Yates and Berthier Ribeiro-Neto, 2011. Modern Information Retrieval: The concepts and technology behind search (2nd. ed.). Addison-Wesley Publishing Company, USA.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
End Semester Examination

Course Articulation Matrix:

CO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2
MCS-236.1	2	2	1	1	2	1	1	2	2
MCS-236.2	2	2	1	1	2	1	2	2	2
MCS-236.3	2	2	1	1	2	1	2	2	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-246: INFORMATION RETRIEVAL AND KNOWLEDGE DISCOVERY LAB

Periods/week	Credits	Max. Marks	: 100
P: 4	2	Continuous Evaluation	: 50
Duration of Examination: 2 Hrs		End Sem Examination	: 50

Pre-requisites: The students must have the knowledge of statistics and probability

Course Outcomes: The students will be able to-
MCS-246.1. Apply various Classification techniques on different data sets.
MCS-246.2. Implement preprocessing techniques.
MCS-246.3. Design simple crawlers and implement various ranking algorithm
MCS-246.4. Design a Text Mining problem dealing with Text based data set.

List of Experiments:

Experiment 1: Implement various Classification algorithms on various data sets.
Experiment 2: Implement Page Rank Algorithm.
Experiment 3: Write a program to Compute Similarity between two text documents.
Experiment 4: Write a program for Pre-processing of a Text Document: stop word removal.
Experiment 5: Write a program to implement simple web crawler.
Experiment 6: Write a program to parse XML text, generate Web graph and compute topic specific page rank.
Experiment 7: Implement Information Retrieval using Boolean Query.
Experiment 8: Rank the documents in collection {d1, d2} for query q using the language model approach to IR introduced in class. Use the mixture coefficient $\lambda = 0.4$. Ignore punctuation marks.
d1: In Financial Crisis, No Prosecution of Top Figures
d2: Wall Street and the Financial Crisis: Anatomy of a Financial Collapse
Query q: Financial Crisis
Experiment 9: Clustering:K-Mean
Experiment 10: Text Mining:Text Classification, TF-IDF.

Note: At least 5 more exercises to be given by the teacher concerned.

Distribution of Continuous Evaluation:

Viva- I	30%
Viva- II	30%
File/Records	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Experiments in lab

File work/Class Performance
Viva (Question and answers in lab)
End Term Practical Exam

Course Articulation Matrix:

CO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2
MCS-246.1	2	2	2	1	2	1	2	2	2
MCS-246.2	2	2	2	2	2	1	2	1	2
MCS-246.3	2	2	1	1	2	1	2	2	2
MCS-246.4	2	2	1	2	2	1	2	1	2

SEMESTER –II

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-201: ADVANCE ALGORITHMS

Periods/week Credits	Max. Marks : 200
L: 3 T: 0 3	Continuous Evaluation : 100
Duration of Examination: 3 Hrs	End Sem Examination : 100

Pre-requisites: The students must have the knowledge of design of algorithms.

Course Outcomes: The students will be able to-
MCS-201.1. Understand advanced methods of designing and analyzing algorithms.
MCS-201.2. Choose appropriate algorithms and use it for a specific problem.
MCS-201.3. Understand basic paradigms and data structures used to solve advanced algorithmic problems.
MCS-201.4. Describe different classes of problems concerning their computation difficulties.
MCS-201.5. Analyze recent developments in the area of algorithmic design.

Unit-1:
1.1. **Sorting:** Review of various sorting algorithms,
1.2. topological sorting
1.3. **Graph:** Definitions and Elementary Algorithms: Shortest path by BFS,
1.4. shortest path in edge-weighted case (Dijkasra's),
1.5. depth-first search and computation of strongly connected components,
1.6. emphasis on correctness proof of the algorithm and time/space analysis,
1.7. example of amortized analysis.

Unit-2:
2.1. **Matroids:** Introduction to greedy paradigm,
2.2. algorithm to compute a maximum weight maximal independent set.
2.3. Application to MST.
2.4. **Graph Matching:** Algorithm to compute maximum matching.
2.5. Characterization of maximum matching by augmenting paths,
2.6. Edmond's Blossom algorithm to compute augmenting path.

Unit-3:
3.1. **Flow-Networks:** Maxflow-mincut theorem,
3.2. Ford-Fulkerson Method to compute maximum flow,
3.3. Edmond-Karp maximum-flow algorithm.
3.4. **Matrix Computations:** Strassen's algorithm and introduction to divide and conquer paradigm,
3.5. inverse of a triangular matrix, relation between the time complexities of basic matrix operations,
3.6. LUP-decomposition.

Unit-4:
4.1. **Shortest Path in Graphs:** Floyd-Warshall algorithm and introduction to dynamic programming paradigm.
4.2. More examples of dynamic programming.
4.3. **Modulo Representation of integers/polynomials:** Chinese Remainder Theorem,
4.4. Conversion between base-representation and modulo-representation.
4.5. Extension to polynomials. Application: Interpolation problem.

4.6. **Discrete Fourier Transform (DFT):** In complex field, DFT in modulo ring.
4.7. Fast Fourier Transform algorithm.
4.8. Schonhage-Strassen Integer Multiplication algorithm

Unit-5:
5.1. **Linear Programming:** Geometry of the feasibility region and Simplex algorithm
5.2. **NP-completeness:** Examples, proof of NP-hardness and NP-completeness.
5.3. **One or more of the following topics based on time and interest:** Approximation algorithms,
5.4. Randomized Algorithms, Interior Point Method,
5.5. Advanced Number Theoretic Algorithm

Unit-6:
6.1. Recent Trands in problem solving paradigms using recent searching and sorting techniques by applying recently proposed data structures.

Text Books/ Reference Books:
1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein,2009, Introduction to Algorithms, 3rd edition, MIT Press.
2. Aho, Hopcroft, Ullman, 1974, The Design and Analysis of Computer Algorithms, Pearson.
3. Kleinberg and Tardos, 2005, Algorithm Design, Addison Wesley.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-201.1	3	2	2	2	2	2	3	2	3
MCS-201.2	3	2	2	1	2	1	2	2	3
MCS-201.3	3	1	2	1	1	1	1	2	3
MCS-201.4	3	2	2	2	2	1	1	2	3
MCS-201.5	3	1	2	1	2	2	1	2	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-202: SOFT COMPUTING

Periods/week	Credits	Max. Marks	: 200
L: 3 T: 0	3	Continuous Evaluation	: 100
Duration of Examination: 3 Hrs		End Sem Examination	: 100

Pre-requisites: The students must have the knowledge of mathematics

Course Outcomes: The students will be able to-

MCS-202.1. Define Soft Computing and Machine Learning Basics
MCS-202.2. Understand Soft Computing Constituents, Fuzzy Logic,NN,GA, etc.
MCS-202.3. Identify the concept of Fuzzy Inference Systems
MCS-202.4. Categorize different types of Machine Learning Using Neural Network
MCS-202.5. Apply GA in Machine Learning
MCS-202.6. Implement Arrays and array operations, Functions and Files, Study of neural network Toolbox using Python Lib.

Unit-1:

1.1. **INTRODUCTION TO SOFT COMPUTING AND NEURAL NETWORKS:** Evolution of Computing:
1.2. Soft Computing Constituents,
1.3. From Conventional AI to Computational Intelligence: Machine Learning Basics.

Unit-2:

2.1. **FUZZY LOGIC:** Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations,
2.2. Membership Functions: Fuzzy Rules and Fuzzy Reasoning,
2.3. Fuzzy Inference Systems, Fuzzy Expert Systems,
2.4. Fuzzy Decision Making.

Unit-3:

3.1. **NEURAL NETWORKS:** Machine Learning Using Neural Network,
3.2. Adaptive Networks, Feed forward Networks, Supervised Learning Neural Networks,
3.3. Radial Basis Function Networks : Reinforcement Learning,
3.4. Unsupervised Learning Neural Networks,
3.5. Adaptive Resonance architectures, Advances in Neural networks.

Unit-4:

4.1. **GENETIC ALGORITHMS:** Introduction to Genetic Algorithms (GA),
4.2. Applications of GA in Machine Learning : Machine Learning Approach to Knowledge Acquisition.

Unit-5:

5.1. **Matlab/Python Lib:** Introduction to Matlab/Python,
5.2. Arrays and array operations,
5.3. Functions and Files, Study of neural network toolbox and fuzzy logic toolbox,
5.4. Simple implementation of Artificial Neural Network and Fuzzy Logic.

Unit-6:

6.2. Recent Trands in deep learning, various classifiers,
6.3. neural networks and genetic algorithm.
6.4. Implementation of recently proposed soft computing techniques.

Text Books/ Reference Books:

1. Jyh:Shing Roger Jang, Chuen:Tsai Sun, EijiMizutani,2003, Neuro:Fuzzy and Soft Computing, Prentice:Hall of India.
2. George J. Klir and Bo Yuan,1995, Fuzzy Sets and Fuzzy Logic:Theory and Applications, Prentice Hall.
3. MATLAB Toolkit Manual

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:

Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-202.1	2	1	1	1	1	1	2	2	2
MCS-202.2	2	1	1	1	1	1	2	2	2
MCS-202.3	3	1	1	1	1	1	2	1	2
MCS-202.4	3	1	1	1	1	1	2	1	3
MCS-202.5	3	1	1	1	1	1	2	1	3
MCS-202.6	2	1	1	1	1	1	3	2	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-121: MACHINE LEARNING

Periods/week	Credits		Max. Marks	: 200
L: 3 T: 0	3		Continuous Evaluation	: 100
Duration of Examination: 3 Hrs			End Sem Examination	: 100

Pre-requisites: The students must have the knowledge of statistical concepts

Course Outcomes: The students will be able to-
MCS-121.1. Gain knowledge about basic concepts of Machine Learning
MCS-121.2. Identify machine learning techniques suitable for a given problem
MCS-121.3. Solve the problems using various machine learning techniques
MCS-121.4. Apply Dimensionality reduction techniques.
MCS-121.5. Design application using machine learning techniques

Unit-1: Supervised Learning (Regression/Classification)
1.1 Basic methods: Distance-based methods, Nearest-Neighbours, Decision Trees, Naive Bayes
1.2 Linear models: Linear Regression, Logistic Regression, Generalized Linear Models ·
1.3 Support Vector Machines, Nonlinearity and Kernel Methods ·
1.4 Beyond Binary Classification: Multi-class/Structured Outputs, Ranking

Unit-2: Unsupervised Learning
2.1 Clustering: K-means/Kernel K-means ·
2.2 Dimensionality Reduction: PCA and kernel PCA ·
2.3 Matrix Factorization and Matrix Completion ·
2.4 Generative Models (mixture models and latent factor models

Unit-3:
3.1 Evaluating Machine Learning algorithms and Model Selection
3.2 Introduction to Statistical Learning Theory,
3.3 Ensemble Methods (Boosting, Bagging, Random Forests)

Unit-4:
4.1 Sparse Modeling and Estimation,
4.2 Modeling Sequence/Time-Series Data,
4.3 Deep Learning and Feature Representation Learning

Unit-5:
5.1 Scalable Machine Learning (Online and Distributed Learning) A selection from some other advanced topics, e.g., Semi-supervised Learning
5.2 Active Learning,
5.3 Reinforcement Learning,
5.4 Inference in Graphical Models,
5.5 Introduction to Bayesian Learning and Inference

Unit-6:
6.1 Recent trends in various learning techniques of machine learning and classification methods for IOT applications.
6.2 Various models for IOT applications

Text Books/ Reference Books:

1. Kevin Murphy,2012, Machine Learning: A Probabilistic Perspective, MIT Press.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, 2009, The Elements of Statistical Learning, Springer (freely available online).
3. Christopher Bishop, 2007, Pattern Recognition and Machine Learning, Springer.
4. Han, Kamber & Pei**,** 2013, Data Mining: Concepts and Techniques, Third Edition, Morgan Kaufmann Publishers

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:

Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**
MCS-121.1	1	1	1	1	1	1	2	1	2
MCS-121.2	3	1	2	1	1	1	2	1	2
MCS-121.3	3	1	1	1	1	1	2	1	2
MCS-121.4	3	1	1	1	1	1	2	1	3
MCS-121.5	3	2	1	1	1	1	3	1	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-131: MACHINE LEARNING LAB

Periods/week Credits	Max. Marks : 100
P: 4 2	Continuous Evaluation : 50
Duration of Examination: 2 Hrs	End Sem Examination : 50

Pre-requisites: The students must have the knowledge of R/Python

Course Outcomes: The students will be able to-
MCS-131.1. Preprocess the dataset for building a model.
MCS-131.2. Implement various machine learning techniques suitable for a given problem.
MCS-131.3. Gain understanding of weka machine learning toolkit.
MCS-131.4. Evaluate machine learning model performance.

Following are some of the suggested topics for the Lab Practicals:

1) Implement classification of Dataset using K nearest neighbor algorithm.
2) Implement decision tree based algorithm and
   a) Calculate Gini Index
   b) Create Split
   c) Build a Tree
   d) Make a Prediction using any Dataset.
3) Implement Bayes Classifier.
4) Implement Euclidean Distance for two features then perform clustering using K-means algorithm and visualize the clusters.
5) Write a program to classify the tuples using linear regression.
6) Introduction to weka Machine Learning ToolKit.
7) Classification using the weka ToolKit.

Note: At least 5 more exercises to be given by the teacher concerned.

Distribution of Continuous Evaluation:

Viva- I	30%
Viva- II	30%
File/Records	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Experiments in lab
File work/Class Performance
Viva (Question and answers in lab)
End Term Practical Exam

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-131.1	2	1	1	1	1	1	2	1	2
MCS-131.2	2	1	1	1	1	1	2	1	2
MCS-131.3	2	1	1	1	1	1	2	1	2
MCS-131.4	1	1	1	1	1	1	2	1	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-211: ADVANCE ALGORITHMS LAB

Periods/week	Credits	Max. Marks	: 100
P: 4	2	Continuous Evaluation	: 50
Duration of Examination: 2 Hrs		End Sem Examination	: 50

Pre-requisites: The students must have the knowledge of Basic data structures

Course Outcomes: The students will be able to-
MCS-211.1. Choose appropriate advanced data structure for given problem.
MCS-211.2. Calculate complexity.
MCS-211.3. Select appropriate design techniques to solve real world problems.
MCS-211.4. Apply the dynamic programming technique to solve the problems.
MCS-211.5. Apply the greedy programming technique to solve the problems.
MCS-211.6. Select a proper pattern matching algorithm for given problem.

Following are some of the suggested topics for the Lab Practicals:

1. Implement DFS and BFS procedures to search a node in a graph.
2. Implement a solution to find maximum weight maximal independent set from a set of connected nodes.
3. Implement Edmond's Blossom algorithm for computing augmenting path.
4. Implement Strassen's algorithm for matrices multiplication using divide and conquer paradigm.
5. Implement Prim's algorithm to find minimum spanning tree.
6. Implement matrix chain multiplication solution using dynamic approach.
7. Implement Floyd-Warshall algorithm to find the shortest path in a graph.
8. Implement Fast Fourier Transform procedure.
9. Implement approximate solution for Travelling Salesman Problem.
10. Implement approximate solution for set covering problem.

Note: At least 5 more exercises to be given by the teacher concerned.

Distribution of Continuous Evaluation:

Viva- I	30%
Viva- II	30%
File/Records	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Experiments in lab
File work/Class Performance
Viva (Question and answers in lab)
End Term Practical Exam

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-211.1	3	2	2	2	2	2	3	2	3
MCS-211.2	3	2	2	1	2	1	2	2	3
MCS-211.3	3	1	2	1	1	1	1	2	3
MCS-211.4	3	2	2	2	2	1	1	2	3
MCS-211.5	3	1	2	1	2	2	1	2	3
MCS-211.6	3	2	2	2	2	1	1	2	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-228: Big Data Analytics

Periods/week	Credits		Max. Marks	: 200
L: 3 T: 0	3		Continuous Evaluation	: 100
Duration of Examination: 3 Hrs			End Sem Examination	: 100

Pre-requisites: NIL

Course Outcomes: The students will be able to-
MCS-228.1. Understand the fundamental concepts and characteristics of big data analytics.
MCS-228.2. Gain knowledge of distributed computing and storage technologies for handling big data.
MCS-228.3. Explore data preprocessing techniques and data integration methods for big data analytics.
MCS-228.4. Learn various data mining algorithms and machine learning techniques applicable to big data.
MCS-228.5. Develop skills in implementing and evaluating big data analytics solutions.
MCS-228.6. Familiarize with data visualization techniques for effectively presenting and interpreting big data insights.

Unit 1: Introduction to Big Data Analytics

1.1 Definition and characteristics of big data
1.2 Challenges and opportunities in big data analytics
1.3 Applications and case studies of big data analytics

Unit 2: Big Data Storage and Processing

2.1 Distributed file systems (Hadoop HDFS, Apache HBase, etc.)
2.2 MapReduce and its variants (Apache Spark, Apache Flink, etc.)
2.3 Scalable data processing frameworks

Unit 3: Data Preprocessing for Big Data

1.1 Data cleaning and filtering techniques
1.2 Data transformation and normalization
1.3 Dimensionality reduction techniques

Unit 4: Data Integration and Data Warehousing

1.1 Data integration approaches for big data
1.2 Extract, transform, load (ETL) processes
1.3 NoSQL databases and data warehousing concepts

Unit 5: Machine Learning for Big Data Analytics

1.1 Supervised and unsupervised learning algorithms
1.2 Deep learning approaches
1.3 Ensemble methods

Unit 6: Big Data Visualization

1.1 Visualization techniques for big data
1.2 Interactive visual analytics
1.3 Visual representation and storytelling

Text Books/ Reference Books:

1. Viktor Mayer-Schönberger and Kenneth Cukier, "Big Data: A Revolution That Will Transform How We Live, Work, and Think"
2. Arshdeep Bahga and Vijay Madisetti ,"Big Data Analytics: A Hands-On Approach"
3. Jure Leskovec, Anand Rajaraman, and Jeff Ullman , "Mining of Massive Datasets"
4. Steve Hoberman et al., "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph".
5. Jiawei Han, Micheline Kamber, and Jian Pei, "Data Mining: Concepts and Techniques"

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-228.1	3	2	2	2	2	2	3	2	3
MCS-228.2	3	2	2	1	2	1	2	2	3
MCS-228.3	3	1	2	1	1	1	1	2	3
MCS-228.4	3	2	2	2	2	1	1	2	3
MCS-228.5	3	1	2	1	2	2	1	2	3
MCS-228.6	3	2	2	2	2	1	1	2	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

NAAC 'A++' Grade University

MCS-229:Web Analytics & Development

Periods/week Credits	Max. Marks : 200
L : 3 T: 0 3.0	Continuous Evaluation : 100
Duration of Exam: 3 Hrs	End Sem Examination : 100

Pre-Requisite: HTML

Course Outcomes: The students will be able to-
MCS-229.1 Understand the Internet basic concepts and HTML fundamentals.
MCS-229.2 Design and implement web application using JavaScript, JQuery and DTD.
MCS-229.3 Design and implement web application using PHP.
MCS-229.4 Develop applications using SQL/MYSQL and advanced techniques.

Unit-1: Introduction to Internet Basics

1.1 Overview of protocols, servers
1.2 Internet clients
1.3 Introduction to network security
1.4 Design Functional Internet site & Business Concepts

Unit-2: HTML Fundamentals

2.1 HTML Basics, Text formatting on Web Pages
2.2 Incorporate images, Creating hyperlinks, complex image maps
2.3 Tables and nested tables, Inserting web page
2.4 Setting & modifying field properties, Validating HTML

Unit-3: Java Script

3.1 Designing with Style Sheets, Introduction to JavaScript, Variables and Objects
3.2 Decision Making Statement, Loops
3.3 Arrays, Functions & Prototypes, Core JavaScript Objects
3.4 DOM Introduction, Event Model, Function

Unit-4: JQuery

4.1 Introduction, Installing & Configuration, jQuery Syntax
4.2 Selectors, Events
4.3 jQuery Callback & Chaining, DTD

Unit-5: PHP HyperTextPreProcessor

5.1 Introduction, PHP Document, Language Fundamentals
5.2 Decision Making Statement, Loops, Statements, Operators
5.3 PHP functions, Arrays & Functions, String Functions, Server-Side Processing
5.4 Introduction to PHP Frameworks & Basic OOP

Unit-6: SQL & MySQL/ Advanced Techniques

6.1 Introduction to SQL & MySQL & its Versions
6.2 Administration & Query Browser, Creating Databases & Tables
6.3 Data Types, Deleting databases and tables, Inserting, Retrieving, Updating & Deleting
6.4 Progressive Web Apps, cross-platform Apps, Static websites, Optimization

Text Books/ Reference Books:

1. Jon Duckett , 2011, HTML and CSS: Design and Build Webs, 2nd Edition.
2. Robin Nixon, 2021, Learning PHP, MySQL & JavaScript: A Step-by-Step Guide to Creating Dynamic Websites, Sixth Edition (Indian Edition).

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
End Semester Examination

Course Articulation Matrix:

CO Statement (MCS- 229)	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**
MCS-229.1	2	1		1	2		1		
MCS-229.2	2		1	2	2		2	2	
MCS-229.3	3	1		2	3		3	2	1
MCS-229.4	3		1	1	3		3	3	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

NAAC 'A++' Grade University

MCS-239 :WEB ANALYTICS & DEVELOPMENT LAB

Periods/week	Credits	Max. Marks	: 100
L :4	2.0	Continuous Evaluation	: 50
Duration of Exam: 2Hrs		End Sem Examination	: 50

Pre-Requisite: HTML

Course Outcomes: The students will be able to-

MCS-239.1 Develop practical skills in designing and implementing static and dynamic website

MCS-239.2 Use JavaScript for dynamic effects

MCS-239.3 Prepare PHP scripts

MCS-239.4 Use SQL/MYSQL and advanced techniques

List of Practicals:

1 Write an XML file to display the Book information which includes the following:
   1) Title of the book 2) Author Name 3) ISBN number 4) Publisher name 5) Edition 6) Price

2 Design an XML document to store information about a student in an engineering college

3 JDBC:
   a. Write a program to select a query using JDBC.
   b. Write a program to update customer information using JDBC.

4 SERVLETS: a. Write a program to generate a plain text.
b. Write a program to display cookie id.

5 JAVA SERVER PAGES: a. Write a program to represent basic arithmetic functions.
b. Write a program to display a string.
c. Write a program to create check boxes.

6 JAVA BEANS:
   a. Write a program to generate plain text.
   b. Write a simple web-based Hello World application using Spring MVC framework.
   c. Write a simple web-based Hello World application using Spring Django framework

7. Design a web application using PHP scripts.

8. Design and implement web applications using SQL/MYSQL and advanced techniques.

Note: At least 5 more exercises to be given by the teacher concerned.

Distribution of Continuous Evaluation:

Viva- I	30%
Viva- II	30%
File/Records	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:

Experiments in lab
File work/Class Performance
Viva (Question and answers in lab)
End Term Practical Exam

Course Articulation Matrix:

CO Statement (MCS- 239)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-239.1	2	1		1	2		1		
MCS-239.2	3		1	2	2		2	2	
MCS-239.3	3	2		2	3		3	2	1
MCS-239.4	3		2	1	3		3	3	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-238 :SECURE COMMUNICATION AND CRYPTOGRAPHY

Periods/week Credits	Max. Marks : 200
L :3 T:0 4.0	Continuous Evaluation : 100
Duration of Exam: 3 Hrs	End Sem Examination : 100

Pre-Requisite: Knowledge of Data Communication
Course Type: Program Elective

Course Outcomes: The students will be able to-
MCS-238.1 Understand cryptography and network security concepts and application
MCS-238.2 Apply security principles to system design
MCS-238.3 Identify and investigate network security threat
MCS-238.4 Analyze and design network security protocols
MCS-238.5 Conduct research in network security
MCS-238.6 Apply methods for authentication, access control, intrusion detection and prevention

Unit-1: Introduction to Cryptography

1.1 Introduction to Cryptography
1.2 Security Threats, Vulnerability
1.3 Active and Passive attacks
1.4 Security services and mechanism
1.5 Conventional Encryption Model
1.6 CIA model

Unit-2: Math Background and Classical Cryptography

Modular Arithmetic
Euclidean and Extended Euclidean algorithm
Prime numbers, Fermat and Euler's Theorem
Dimensions of Cryptography
Classical Cryptographic Techniques

Unit-3: Block Ciphers (DES, AES)

3.1 Feistal Cipher Structure
3.2 Simplifies DES, DES, Double and Triple DES
3.3 Block Cipher design Principles
3.4 AES, Modes of Operations

Unit-4: Public-Key Cryptography

4.1 Principles Of Public-Key Cryptography
4.2 RSA Algorithm, Key Management
4.3 Diffie- Hellman Key Exchange
4.4 Elgamal Algorithm
4.5 Elliptic Curve Cryptography

Unit-5: Hash and MAC Algorithms

5.1 Authentication Requirement
5.2 Functions, Message Authentication Code
5.3 Hash Functions, Security Of Hash Functions And Macs
5.4 MD5 Message Digest Algorithm
5.5 Secure Hash Algorithm, Digital Signatures

Unit-6:Security in Networks

6.1 Threats in networks, Network Security Controls – Architecture, Encryption
6.2 Content Integrity, Strong Authentication
6.3 Access Controls, Wireless Security, Honeypots
6.4 Traffic flow security
6.5 Firewalls – Design and Types of Firewalls, Personal Firewalls, IDS, Email Security – PGP, S/MIME

Text Books/ Reference Books:
1. William Stallings, Cryptography And Network Security Principles And Practice Fourth Edition, Pearson Education
2. Wenbo Mao, Modern Cryptography: Theory and Practice, Prentice Hall PTR
3. William Stallings, Network Security Essentials: Applications and Standards. Prentice Hall
4. Douglas R. Stinson, Cryptography: Theory and Practice,CRC press

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
End Semester Examination

Course Articulation Matrix:

CO Statement (MCS- XXX)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-238.1	1		3				1		
MCS-238.2	1			1				1	1
MCS-238.3	1					2			
MCS-238.4		1			2				1
MCS-238.5			1		3				1
MCS-238.6	2			3			1		1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

NAAC 'A' Grade University

MCS-248 :SECURE COMMUNICATION AND CRYPTOGRAPHY LAB

Periods/week	Credits	Max. Marks	: 100
P :4	2.0	Continuous Assessment	: 50
Duration of Exam: 2 Hrs		End Term Examination	: 50

Pre-Requisite: Data Communication

Course Type : Program Elective

Course Outcomes: The students will be able to-

MCS-248.1 Understand the fundamental principles of access control models and techniques, authentication and secure system design.

MCS-248.2 understand different cryptographic protocols and techniques and be able to use them.

MCS-248.3 Apply methods for authentication, access control, intrusion detection and prevention.

MCS-248.4 Identify and mitigate software security vulnerabilities in existing systems.

List of Practicals:

1 Write a program to implement Ceaser Cipher
2 Write a program to implement Affine Cipher with equation c=3x+12
3 Write a program to implement Playfair Cipher with key ldrp
4 Write a program to implement polyalphabetic Cipher
5 Write a program to implement AutoKey Cipher
6 Write a program to implement Hill Cipher. (Use any matrix but find the inverse yourself)
7 Write a program to implement Rail fence technique
8 Write a program to implement Simple Columner Transposition technique
9 Write a program to implement Advanced Columner Transposition technique
10 Write a program to implement Euclidean Algorithm
11 Write a program to implement Advanced Euclidean Algorithm
12 Write a program to implement Simple RSA Algorithm with small number

Assessment Tools:

Experiments in lab
File work/Class Performance
Viva (Question and answers in lab)
End Term Practical Exam

COURSE ARTICULATION MATRIX:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-248.1	1		3		2		1		
MCS-248.2	1	2		1				1	1
MCS-248.3	1					2			
MCS-248.4		1			1		2		1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

NAAC 'A++' Grade University

MCS-232: SECURITY ANALYSIS & RISK ASSESSMENT

Periods/week	Credits	Max. Marks	: 200
L :3 T: 0	3.0	Continuous Evaluation	: 100
Duration of Exam: 3 Hrs		End Sem Examination	: 100

Pre-Requisite: Knowledge of cyber security
Course Type: Program Elective

Course Outcomes: The students will be able to-
MCS-232.1 Understand the principles and concepts of cybersecurity.
MCS-232.2 Apply security techniques to identify and mitigate vulnerabilities in computer systems and networks.
MCS-232.3 Analyze and evaluate the legal and ethical implications of cybersecurity practices.
MCS-232.4 Develop skills in securing computer systems and use risk assessment techniques.

Unit-1: Introduction to Security

1.1 Overview of cybersecurity
1.2 Legal and ethical aspects of security
1.3 Security methodologies
1.4 Introduction to various security tools and their applications

Unit-2:Network Security and Penetration Testing

2.1 Network security fundamentals: firewalls, intrusion detection systems, etc.
2.2 Network mapping and scanning techniques
2.3 Vulnerability assessment and penetration testing methodologies
2.4 Exploiting network vulnerabilities and countermeasure

Unit-3: Web Application Security

3.1 Introduction to web application security and common vulnerabilities
3.2 Injection attacks: SQL injection, XSS, etc.
3.3 Authentication and session management vulnerabilities
3.4 Web application security best practices and secure coding techniques

Unit-4: Wireless Network Security

4.1 Wireless network security concepts: WEP, WPA, WPA2, etc.
4.2 Wireless network reconnaissance and attacks
4.3 Wireless network encryption cracking techniques
4.4 Wireless network security countermeasures and Malware analysis

Unit-5: Cybersecurity Governance and Ethics

5.5 Cybersecurity governance frameworks: ISO 27001, NIST Cybersecurity Framework, etc.
5.2 Legal and regulatory aspects of cybersecurity
5.3 Privacy and data protection considerations
5.4 Ethical considerations cybersecurity practices

Unit-6: Risk Assessment

6.1 Enterprise and organization used risk analysis
6.2 Benefits of risk analysis
6.3 Steps in the risk analysis process
6.4 Types of risk analysis

Text Books/ Reference Books:

1. Nina Godbole and Sunit Belpure, Cyber Security Understanding Cyber Crimes,Computer Forensics and Legal Perspectives, Wiley .
2. B.B.Gupta, D.P.Agrawal, Haoxiang Wang, Computer and Cyber Security: Principle s, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335,2018.
3. "The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws" by Dafydd Stuttard and Marcus Pinto, Publisher: Wiley.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
End Semester Examination

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-232.1	2		1	1	1		2		
MCS-232.2	2	2		1	3		2	1	
MCS-232.3	3			2	3		3	2	2
MCS-232.4	3	1	2	2	3		3	3	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

CS-M-200 : MINI PROJECT WITH SEMINAR

Periods/week	Credits		
L: 2 T: 0	2	Continuous Evaluation	: 100
Duration of Examination: 3 Hrs		End Sem Examination	: 50

Pre-requisites: Nil

Course Outcomes: The students will be able to-
CS-M-200.1. Understand contemporary / emerging technology for various applications.
CS-M-200.2. Share knowledge effectively in oral and written form and formulate documents.

Distribution of Continuous Evaluation:

Synopsis	20%
Relavance	20%
Performance	30%
Report	20%
Attendance	10%

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
CS-M-200.1	3	2	2	2	2	2	3	2	3
CS-M-200.2	3	2	2	1	2	1	2	2	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-222: SECURE SOFTWARE DESIGN & ENTERPRISE COMPUTING

Periods/week	Credits	Max. Marks	: 200
L: 3 T: 0	3	Continuous Evaluation	: 100
Duration of Examination: 3 Hrs		End Sem Examination	: 100

Pre-requisites: The students must have the knowledge of software engineering concepts

Course Outcomes: The students will be able to-

MCS-222.1. Understand software vulnerabilities and software security, their programming practices and quality issues.
MCS-222.2. Design distributed and enterprise software applications
MCS-222.3. Implement components and database at the different tiers in an enterprise system
MCS-222.4. Analyze insecure exceptions and command/SQL injection
MCS-222.5. Evaluate web and mobile applications against attackers
MCS-222.6. Design new software and concepts containing minimum vulnerabilities and flaws.

Unit-1:

1.1. **Secure Software Design :**Identify software vulnerabilities and perform software security analysis,
1.2. Master security programming practices,
1.3. Master fundamental software security design concepts,
1.4. Perform security testing and quality assurance.

Unit-2:

2.1. **Enterprise Application Development:**Describe the nature and scope of enterprise software applications,
2.2. Design distributed N-tier software application,
2.3. Research technologies available for the presentation,
2.4. business and data tiers of an enterprise software application,
2.5. Design and build a database using an enterprise database system,
2.6. Develop components at the different tiers in an enterprise system,
2.7. Design and develop a multi-tier solution to a problem using technologies used in enterprise system, Present software solution.

Unit-3:

3.1. **Enterprise Systems Administration:**Design, implement and maintain a directory-based server infrastructure in a heterogeneous systems environment,
3.2. Monitor server resource utilization for system reliability and availability,
3.3. Install and administer network services (DNS/DHCP/Terminal Services/Clustering/Web/Email).

Unit-4:

4.1. Obtain the ability to manage and troubleshoot a network running multiple services,
4.2. Understand the requirements of an enterprise network and how to go about managing them.

Unit-5:

5.1. Handle insecure exceptions and command/SQL injection,
5.2. Defend web and mobile applications against attackers,
5.3. software containing minimum vulnerabilities and flaws.

Unit-6:

6.1. Case study of DNS server,
6.2. DHCP configuration and SQL injection attack.

Text Books/ Reference Books:

1. Theodor Richardson, Charles N Thies, 2013, Secure Software Design, Jones & Bartlett
2. Kenneth R. van Wyk, Mark G. Graff, Dan S. Peters, Diana L. Burley, 2015,Enterprise Software Security, Addison Wesley.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:

Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-222.1	1	1	1	1	1	1	1	1	2
MCS-222.2	2	1	1	1	1	1	2	2	2
MCS-222.3	3	1	1	1	2	2	2	2	2
MCS-222.4	3	1	1	1	1	1	3	2	2
MCS-222.5	3	1	1	1	1	1	3	2	2
MCS-222.6	3	1	1	1	1	1	3	2	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

MCS-224: HUMAN AND COMPUTER INTERACTION

Periods/week	Credits		Max. Marks	: 200
L: 3	T: 0	3	Continuous Evaluation	: 100
Duration of Examination: 3 Hrs			End Sem Examination	: 100

Pre-requisites:

Course Outcomes: The students will be able to-
MCS-224.1 : Summarize the concept of I/O channels.
MCS-224.2 : Illustrate the HCI in software process.
MCS-224.3 : Apply the concept of navigation.
MCS-224.4 : Summarize the concept of stake holder
MCS-224.5 : Analyze the concept of Designing Web Interfaces

Unit-1:
1.1 Human: I/O channels – Memory – Reasoning and problem solving;
1.2 The computer: Devices – Memory – processing and networks;
1.3 Interaction: Models – frameworks – Ergonomics – styles – elements – interactivity- Paradigms.

Unit-2:
2.1 Interactive Design basics – process – scenarios – navigation – screen design – Iteration and prototyping.
2.2 HCI in software process – software life cycle – usability engineering – Prototyping in practice – design rationale.
2.3 Design rules – principles, standards, guidelines, rules. Evaluation Techniques – Universal Design.

Unit-3:
3.1 Cognitive models –Socio-Organizational issues and stake holder requirements.
3.2 Communication and collaboration models-Hypertext,
3.3 Multimedia and WWW.

Unit-4:
4.1 Mobile Ecosystem: Platforms, Application frameworks-
4.2 Types of Mobile Applications: Widgets,
4.3 Applications, Games- Mobile Information Architecture,
4.4 Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools.

Unit-5:
5.1 Designing Web Interfaces – Drag & Drop,
5.2 Direct Selection, Contextual Tools,
5.3 Overlays, Inlays and Virtual Pages,
5.4 Process Flow.
5.5 Case Studies.

Unit-6:
6.1 Recent Trends: Speech Recognition and Translation,
6.2 Multimodal System

Text Books/ Reference Books:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, "Human Computer Interaction", 3rd Edition, Pearson Education, 2004 (UNIT I , II & III)
2. Brian Fling, "Mobile Design and Development", First Edition , O Reilly Media Inc., 2009 (UNIT – IV)
3. Bill Scott and Theresa Neil, "Designing Web Interfaces", First Edition, O Reilly, 2009.(UNIT-V)

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:

Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-224.1	-	-	-	-	-	-	3	2	2
MCS-224.2	-	-	-	2	1	-	-	2	2
MCS-224.3	-	1	-	-	-	-	-	2	2
MCS-224.4	3	-	-	-	-	-	-	2	2
MCS-224.5	-	-	2	-	3	-	-	2	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-225: GPU COMPUTING

Periods/week	Credits	Max. Marks	: 200
L: 3 T: 0	3	Continuous Evaluation	: 100
Duration of Examination: 3 Hrs		End Sem Examination	: 100

Pre-requisites: The students must have the knowledge of computer architecture

Course Outcomes: The students will be able to-
MCS-225.1. Understand the basic concepts of Graphic Processing Unit Processing
MCS-225.2. Explain the detailed architecture of GPU computing.
MCS-225.3. Work on different case studies based on GPU Computing.
MCS-225.4. Analyze different programming environment of GPU Computing.
MCS-225.5. Relate the available architectural concepts for synthesizing an efficient GPU.
MCS-225.6. To do some research by studying the advanced topics in GPU computing

Unit-1:
1.1 **Introduction:** History, Graphics Processors, Graphics
1.2 Processing Units, GPGPUs. Clock speeds,
1.3 CPU / GPU comparisons, Heterogeneity, Accelerators,
1.4 Parallel programming, CUDA OpenCL / OpenACC,
1.5 Hello World Computation Kernels, Launch parameters,
1.6 Thread hierarchy, Warps / Wavefronts,
1.7 Thread blocks / Workgroups, Streaming multiprocessors,
1.8 1D / 2D / 3D thread mapping, Device properties,
1.9 Simple Programs

Unit-2:
2.1 **Memory:** Memory hierarchy, DRAM / global, local / shared, private / local, textures,
2.2 Constant Memory, Pointers, Parameter Passing,
2.3 Arrays and dynamic Memory, Multi-dimensional Arrays,
2.4 Memory Allocation, Memory copying across devices,
2.5 Programs with matrices,
2.6 Performance evaluation with different memories

Unit-3:
3.1 **Synchronization:** Memory Consistency, Barriers (local versus global),
3.2 Atomics, Memory fence. Prefix sum, Reduction.
3.3 Programs for concurrent Data Structures such as Worklists,
3.4 Linked-lists. Synchronization across CPU and GPU.
3.5 **Functions:** Device functions, Host functions,
3.6 Kernels functions, Using libraries (such as Thrust), and developing libraries.

Unit-4:
4.1 **Support:** Debugging GPU Programs.
4.2 Profiling, Profile tools, Performance aspects
4.3 **Streams:** Asynchronous processing, tasks,
4.4 Task-dependence, Overlapped data transfers, Default Stream,

4.5 Synchronization with streams. Events, Event-based- Synchronization –
4.6 Overlapping data transfer and kernel execution,
4.7 pitfalls.

Unit-5:
5.1 **Case Studies:** Image Processing,
5.2 Graph algorithms,
5.3 Simulations,
5.4 Deep Learning

Unit-6:
6.1 Advanced topics: Dynamic parallelism,
6.2 Unified Virtual Memory, Multi-GPU processing,
6.3 Peer access, Heterogeneous processing

Text Books/ Reference Books:
1. David Kirk, Wen-meiHwu, 2010, Programming Massively Parallel Processors: A Hands-on Approach, ISBN: 978-0123814722, Morgan Kaufman.
2. Shane Cook,2012, CUDA Programming: A Developer's Guide to Parallel Computing with GPUs, ISBN: 978-0124159334 Newnes.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-225.1	2	1	1	1	1	1	2	2	2
MCS-225.2	2	1	1	1	1	1	2	2	2
MCS-225.3	3	1	2	1	1	1	3	3	2
MCS-225.4	3	1	1	1	1	1	3	3	2
MCS-225.5	3	1	1	1	1	2	3	3	3
MCS-225.6	3	1	2	2	2	2	3	3	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

MCS-226 : DIGITAL FORENSICS

Periods/week	Credits	Max. Marks	: 200
L: 3 T: 0	3	Continuous Evaluation	: 100
Duration of Examination: 3 Hrs		End Sem Examination	: 100

Pre-requisites: Knowledge of cyber security

Course Outcomes: The students will be able to-

MCS-226.1. Understand the basic digital forensics and techniques for conducting the forensic examination on different digital devices.
MCS-226.2. Identify the essential concepts, protocols tools, and methodology of mobile forensics.
MCS-226.3. Illustrate the examination of digital evidences such as the data acquisition, identification analysis.
MCS-226.4. Assess and cite appropriate instances for the application of digital forensics
MCS-226.5. Analyze digital forensic evidence.

Unit-1:

1.1 **Digital Forensics Science:** Forensics science,
1.2 computer forensics, and digital forensics.
1.3 **Computer Crime:** Criminalistics as it relates to the investigative process,
1.4 analysis of cyber-criminalistics area,
1.5 holistic approach to cyber-forensics

Unit-2:

2.1 **Cyber Crime Scene Analysis:** Discuss the various court orders etc.,
2.2 methods to search and seizure electronic evidence,
2.3 retrieved and un-retrieved communications,
2.4 Discuss the importance of understanding what court documents would be required for a criminal investigation.

Unit-3:

3.1 **Evidence Management & Presentation:** Create and manage shared folders using operating system,
3.2 importance of the forensic mindset, define the workload of law enforcement,
3.3 Explain what the normal case would look like,
3.4 Define who should be notified of a crime, parts of gathering evidence,
3.5 Define and apply probable cause.

Unit-4:

4.1 **Computer Forensics:** Prepare a case, Begin an investigation,
4.2 Understand computer forensics workstations and software, Conduct an investigation,
4.3 Complete a case, Critique a case,
4.4 **Network Forensics:** open-source security tools for network forensic analysis,
4.5 requirements for preservation of network data.

Unit-5:

5.1 **Mobile Forensics:** mobile forensics techniques,
5.2 mobile forensics tools.
5.3 **Legal Aspects of Digital Forensics:** IT Act 2000,

5.4 amendment of IT Act 2008.

Unit-6:
6.1 Recent trends in mobile forensic technique and methods to search and seizure electronic evidence.

Text Books/ Reference Books:
1. John Sammons, The Basics of Digital Forensics, Elsevier
2. John Vacca, Computer Forensics: Computer Crime Scene Investigation, Laxmi Publications

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-226.1	2	1	2	1	1	1	1	3	3
MCS-226.2	2	1	1	1	1	1	1	3	3
MCS-226.3	2	1	1	1	2	1	1	3	3
MCS-226.4	2	1	1	1	2	1	1	3	3
MCS-226.5	2	1	1	1	2	1	1	3	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-231: DATA PREPARATION AND ANALYSIS LAB

Periods/week	Credits		
P: 4	2	Continuous Evaluation	: 50
Duration of Examination: 3 Hrs		End Sem Examination	: 50

pre-requisites: NIL

Course Outcomes: The students will be able to-
MCS-231.1. Perform preprocessing of various datasets.
MCS-231.2. Implement various data mining algorithms.
MCS-231.3. Analyze the results and get insights into data.
MCS-231.4. To evaluate data mining techniques and optimize the solution.

Following are some of the suggested topics for the Lab Practicals:

1. Demonstration of preprocessing on dataset student.arff
2. Demonstration of preprocessing on dataset labor.arff
3. Demonstration of Association rule process on dataset contactlenses.arff using apriori algorithm
4. Demonstration of Association rule process on dataset test.arff using apriori algorithm
5. Demonstration of classification rule process on dataset student.arff using j48 algorithm
6. Demonstration of classification rule process on dataset employee.arff using j48 algorithm
7. Demonstration of classification rule process on dataset employee.arff using id3 algorithm
8. Demonstration of classification rule process on dataset employee.arff using naïve bayes algorithm
9. Demonstration of clustering rule process on dataset iris.arff using simple k-means
10. Demonstration of clustering rule process on dataset student.arff using simple kmeans

Note: At least 5 more exercises to be given by the teacher concerned.

Distribution of Continuous Evaluation:

Viva- I	30%
Viva- II	30%
File/Records	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Experiments in lab
File work/Class Performance
Viva (Question and answers in lab)
End Term Practical Exam

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-231.1	2	2	2	1	2	1	1	2	2
MCS-231.2	2	2	2	2	2	2	1	1	2
MCS-231.3	1	1	2	1	2	1	1	2	1
MCS-231.4	2	2	2	2	2	1	2	2	2

SEMESTER-III

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

CS-M-350: Colloquium

Periods/week	Credits		
L: 0 T: 2	0	Max. Marks	: 50
		Continuous Evaluation	: 50

Pre-requisites: The students must have done mini project with seminar

Course Outcomes: The students will be able to-
CS-M-350.1. Understand contemporary / emerging technology for various applications.
CS-M-350.2. Share knowledge effectively via presentation and formulate documents.

FOR COLLOQUIUM EACH STUDENT WOULD BE REQUIRED TO GIVE AT LEAST THREE SEMINARS UNDER THE SUPERVISION OF SOME OF FACULTY MEMBER ON CURRENT EMERGING AREAS OF COMPUTER SCIENCE AMONG WHICH ATLEAST ONE WOULD BE RESEARCH ORIENTED.

Distribution of Continuous Evaluation:

Synopsis	20%
Relevance	20%
Performance	30%
Report	20%
Attendance	10%

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
CS-M-350.1	3	3	1	1	3	1	3	3	3
CS-M-350.2	3	3	1	1	3	1	3	3	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-300: Dissertation (Phase-I)

Periods/week	Credits	Max. Marks	: 300
P: 20	10	Continuous Evaluation	: 200
Duration of Examination: 4 Hrs		End Sem Examination	: 100

Pre-requisites: The students must have the knowledge of research methodology

Course Outcomes: The students will be able to-
MCS-300.1. Demonstrate knowledge of contemporary issues in their chosen field of research.
MCS-300.2. Consolidate the literature search to identify and formulate the engineering problem.
MCS-300.3. Design engineering solutions to complex problems utilizing a systems approach.
MCS-300.4. Apply knowledge and abilities in practical activities with regards to relevant scientific professional and social judgments.

THE TOPIC OF THE DISSERTATION OF 4TH SEMESTER IS TO BE APPROVED BY THE INTERNAL COMMITTEE IN THE 3RD SEMESTER AS PER ORDINANCE FOR M.TECH PROGRAMME. THE DISSERTATION CAN BE TAKEN UP ON ANY EMERGING AREAS OF COMPUTER SCIENCE OR ON ANY TOPIC OF INDUSTRIAL IMPORTANCE RELATED TO COMPUTER SCIENCE AND SHOULD INCLUDE CRITICAL REVIEW OF THE LITERATURE IN THE AREA.

Distribution of Continuous Evaluation:

Synopsis	20%
Relevance	20%
Performance	30%
Report	20%
Attendance	10%

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PSO 1	PSO 2
MCS-300.1	3	3	1	1	3	1	3	3	3
MCS-300.2	3	3	1	1	3	1	3	3	3
MCS-300.3	3	3	1	1	3	1	3	3	3
MCS-300.4	3	3	1	1	3	1	3	3	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-321: Mobile Applications and Services

Periods/week Credits	Max. Marks : 200
L: 3 T: 0 3	Continuous Evaluation : 100
Duration of Examination: 3 Hrs	End Sem Examination : 100

Pre-requisites: The students must have the knowledge of programming language

Course Outcomes: The students will be able to-
MCS-321.1. Describe different aspects of Android architecture that make it unique from other programming platforms.
MCS-321.2. Critique mobile applications on their design pros and cons.
MCS-321.3. Illustrate wireless communications standards and data transmission standards
MCS-321.4. Conceptualize Mobile App Development Hurdles, Testing and Security issues.
MCS-321.5. Assess vision and State of the Art of IoT

Unit-1: Introduction
1.1. Introduction to Mobile Computing,
1.2. Introduction to Android Development Environment
1.3. Factors in Developing Mobile Applications
1.4. Mobile Software Engineering, Frameworks and Tools
1.5. Generic UI Development Android User

Unit-2: User Interface Design
2.1. VUIs and Mobile Apps,
2.2. Text-to-Speech Techniques,
2.3. Designing the Right UI,
2.4. Multichannel and Multimodal Uis,
2.5. Storing and Retrieving Data,
2.6. Synchronization and Replication of Mobile Data,
2.7. Getting the Model Right,
2.8. Android Storing and Retrieving Data,
2.9. Working with a Content Provider

Unit-3: Communications via Network and the Web
3.1. State Machine,
3.2. CorrectCommunications Model,
3.3. Android Networking and Web,
3.4. TelephonyDeciding Scope of an App,
3.5. Wireless Connectivity and Mobile Apps,
3.6. AndroidTelephony, Notifications and Alarms
3.7. Performance, Performance and Memory Management,
3.8. Android Notifications and Alarms,
3.9. Graphics, Performance and Multithreading, Graphics and UI Performance, Android, Graphics

Unit-4: Mobile Application Deployment
4.1. Packaging and Deploying,
4.2. Performance Best Practices,
4.3. Android Field Service App,

4.4.Location Mobility and Location Based Services
4.5. Android Multimedia: Mobile Agents and Peer-to-Peer Architecture, Android Multimedia

Unit-5: Platforms and Additional Issues
5.1. Development Process,
5.2. Architecture, Design,
5.3. Technology Selection,
5.4. Mobile App Development Hurdles, Testing, Security and Hacking, Active Transactions,
5.5. More on Security, Hacking Android.

Unit-6: Recent Trends in Mobile Applications
6.1. Recent trends in Communication protocols for IOT nodes,
6.2. mobile computing techniques in IOT, agents based communications in IOT

Text Books/ Reference Books:
1. Wei-Meng Lee, 2012, Beginning Android™ 4 Application Development, Ist edition, John Wiley & Sons.
2. Ryan Cohen, Tao Wang, 2014, GUI Design for Android Apps : 1 st Edition, Heinz Weinheimer

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-321.1	1	1	1	1	1	1	1	1	1
MCS-321.2	2	1	1	1	1	1	1	1	2
MCS-321.3	1	1	1	1	1	1	1	1	3
MCS-321.4	2	1	1	1	1	2	3	2	2
MCS-321.5	2	1	2	2	2	2	3	3	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

MCS-322: Compiler for HPC

Periods/week	Credits		Max. Marks	: 200
L: 3	T: 0	3	Continuous Evaluation	: 100
Duration of Examination: 3 Hrs			End Sem Examination	: 100

Pre-requisites: knowledge of Compiler Design

Course Outcomes: The students will be able to-

MCS-322.1 Describe the different phases of the compilation process , different language translators.
MCS-322.2 Understand dependency of data in different domain.
MCS-322.3 Apply appropriate algorithms for various types of machines.
MCS-322.4 Design structures for recent complier trends.
MCS-322.5 Analyze concurrency and array region using different techniques.

Unit-1: High Performance Systems

1.1. Structure of a Compiler
1.3. Programming Language
1.4. Features
1.5. Languages for High Performance

Unit-2: Data Dependence

2.1. Data Dependence in Loops
- 2.1.1. Data Dependence in Conditionals
- 2.1.2 Data Dependence in Parallel Loops
- 2.1.3 Program Dependence Graph

2.2 Scalar Analysis with Factored Use-Def Chains
- 2.2.1 FUD Chains for Arrays
- 2.2.2. Induction Variables Using FUD Chains
- 2.2.3. Constant Propagation with FUD Chains
- 2.2.4. Data Dependence for Scalars
- 2.2.5. Dependence Analysis for Arrays.

Unit-3: Array Region Analysis

3.1. Pointer Analysis
- 3.1.1. I/O Dependence
- 3.1.2. Procedure Calls,
- 3.1.3. Inter-procedural Analysis,

3.2. Loop Restructuring
- 3.2.1. Simple Transformations
- 3.2.2. Loop Fusion
- 3.2.3. Loop Fission
- 3.2.4. Loop Reversal
- 3.2.5. Loop Interchanging
- 3.2.6. Loop Skewing
- 3.2.7. Linear Loop Transformations
- 3.2.8. Strip-Mining, Loop Tiling
- 3.2.9. Other Loop Transformations, and Inter-procedural Transformations.

3.3. Optimizing for Locality
- 3.3.1. Single Reference to Each Array

3.3.2. Multiple References
3.3.3. General Tiling
3.3.4. Fission and Fusion for Locality.

Unit-4: Concurrency Analysis
4.1. Concurrency from Sequential Loops
4.2. Concurrency from Parallel Loops
4.3. Nested Loops, Round off Error
4.4. Exceptions and Debuggers.
4.5. Vector Analysis
4.5.1. Vector Code
4.5.2. Vector Code from Sequential Loops
4.5.3. Vector Code from For all Loops
4.5.4. Nested Loops
4.5.5. Round off Error
4.5.6. Exceptions, and Debuggers
4.5.7. Multi-vector Computers.

Unit-5: Message-Passing Machines
5.1. SIMD Machines
5.2. MIMD Machines
5.3. Data Layout
5.4. Parallel Code for Array Assignment
5.5. Remote Data Access
5.6. Automatic Data Layout
5.7. Multiple Array Assignments
5.8. Other Topics
5.9. Scalable Shared-Memory Machines:
5.9.1. Global Cache Coherence
5.9.2. Local Cache Coherence
5.9.3. Latency Tolerant Machines.

Unit-6:
6.1. Recent trends in compiler design for high performance computing
6.2. Recent trends in compiler design for message passing machines
6.3. Recent trends in compiler design for scalable shared memory machine.

Text Books/ Reference Books:
1. High-Performance Compilers for Parallel Computing, Michael Wolfe, 1995: Pearson

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials.

Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-322.1	2	1	1	1	1	1	1	2	2
MCS-322.2	2	1	1	1	1	1	1	2	2
MCS-322.3	2	1	1	1	1	1	1	3	3
MCS-322.4	2	1	1	1	1	1	1	2	3
MCS-322.5	2	1	1	1	1	1	2	3	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-223: COMPUTER VISION

Periods/week	Credits		
L: 3 T: 0	3	Continuous Evaluation	: 100
Duration of Examination: 3 Hrs		End Sem Examination	: 100

Pre-requisites: The students must have the knowledge of basics of computer Graphics

Course Outcomes: The students will be able to-
MCS-223.1. Learn basic concept of computer vision, Image formation and preprocessing methods.
MCS-223.2. Understand various Edge detection algorithm and apply them in real applications.
MCS-223.3. Understand the Image Segmentation techniques and analysis them using real applications.
MCS-223.4. Learn and compare various feature extraction techniques with emphasis on applications.
MCS-223.5. Use the concept of Pattern recognition, various learning techniques and apply them in various applications.
MCS-223.6. Implement computer vision systems with emphasis on applications and problem solving

Unit-1:
1.1. Overview, computer imaging systems,
1.2. Lenses, Image formation and sensing, Image analysis,
1.3. pre-processing and Binary image analysis

Unit-2:
2.1. Edge detection, Edge detection performance
2.2. Hough transform, corner detection

Unit-3:
3.1. Segmentation,
3.2. Morphological filtering,
3.3. Fourier transform

Unit-4:
4.1. Feature extraction, shape, histogram,
4.2. color, spectral, texture, using CVIPtools,
4.3. Feature analysis, feature vectors, distance /similarity measures,
4.4. data preprocessing

Unit-5:
5.1. Pattern Analysis:
5.2. Clustering: K-Means, K-Medoids,
5.3. Mixture of Gaussians
5.4. Classification: Discriminant Function, Supervised, Un-supervised, Semisupervised
5.5. Classifiers: Bayes, KNN, ANN models;
5.6. Dimensionality Reduction: PCA, LDA,
5.7. ICA, and Non-parametric methods.

Unit-6:
6.1. Recent trends inActivity Recognition,
6.2. computational photography,
6.3. Biometrics.

Text Books/ Reference Books:

1. Richard Szeliski,2010," Computer Vision: Algorithms and Applications" 1 st edition, Springer.
2. Goodfellow, Bengio, and Courville ,2016," Deep Learning" , 1 st edition ,MIT Press.
3. Fisher et al ,2014," Dictionary of Computer Vision and Image Processing" 2 nd Edition, Wiley.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:

Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-223.1	1	1	3	1	2	1	3	1	1
MCS-223.2	3	1	2	1	1	1	2	1	3
MCS-223.3	3	1	1	1	2	2	1	1	1
MCS-223.4	2	1	1	1	1	1	1	2	2
MCS-223.5	1	1	2	1	2	1	2	1	2
MCS-223.6	2	1	1	1	1	1	1	1	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-323: Optimization Techniques

Periods/week Credits	Max. Marks : 200
L: 3 T: 0 3	Continuous Evaluation : 100
Duration of Examination: 3 Hrs	End Sem Examination : 100

Pre-requisites: The students must have the knowledge of Algorithms

Course Outcomes: The students will be able to-
MCS-323.1. Outline the Optimization Fundamentals
MCS-323.2. Understand General Structure of Optimization Algorithms
MCS-323.3. Identify different Optimization Programming Techniques
MCS-323.4. Categorize Branches of Mathematical Programming
MCS-323.5. Compare and contrast different Genetic Optimization Techniques
MCS-323.6. Formulate Real life Problems and their mathematical formulation

Unit-1: Optimization fundamentals
1.1 Engineering application of Optimization
1.2 Formulation of design problems as mathematical programming problems.

Unit-2: Problem Solving
2.1 General Structure of Optimization Algorithms,
2.2 Constraints,
2.3 The Feasible Region

Unit-3: Optimization Programming Techniques
3.1 Branches of Mathematical Programming
3.2 Optimization using calculus,
3.3 Graphical Optimization,
3.4 Linear Programming,
3.5 Quadratic Programming,
3.6 Integer Programming,
3.7 Semi Definite Programming.

Unit-4: Genetic Optimization
4.1 Optimization Algorithms: Genetic Optimization,
4.2 Particle Swarm Optimization,
4.3 Ant Colony Optimization etc.

Unit-5: Case Study
5.1 Real life Problems and their mathematical formulation as standard programming problems.

Unit-6: Recent trends
6.1 Recent trends: Applications of ant colony optimization,
6.2 Genetics and linear and quadratic programming in real world applications.

Text Books/ Reference Books:
1. Laurence A. Wolsey, 1998, Integer programming, Wiley,ISBN 978-0-471-28366-9.
2. Andreas Antoniou ,Practical Optimization Algorithms and Engineering Applications, Springer.

3. Edwin K., P. Chong & Stanislaw h. Zak, 2017,An Introduction to Optimization, 4th Edition, Wiley-Interscience Publication. JOHN WILEY & SONS, INC.
4. Dimitris Bertsimas; Robert Weismantel , 2005,Optimization over integers.Dynamic Ideas, ISBN 978-0-9759146-2-5.
5. John K. Karlof, 2006, Integer programming: theory and practice, CRC Press. ISBN 978-0-8493- 1914-3.
6. H. Paul Williams ,2009,Logic and Integer Programming, ISBN 978-0-387-92279-9. Springer
7. Michael Jünger; Thomas M. Liebling; Denis Naddef; George Nemhauser; William R. Pulleyblank; Gerhard Reinelt; Giovanni Rinaldi; Laurence A. Wolsey, eds. , 2009,50 Years of Integer Programming 1958-2008: From the Early Years to the State-of-the- Art, Springer.ISBN 978-3- 540-68274-5.
8. Der-San Chen; Robert G. Batson; Yu Dang, 2010, Applied Integer Programming: Modeling and Solution, John Wiley and Sons.ISBN 978-0-470-37306-4.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-323.1	2	3	1	1	3	1	3	3	3
MCS-323.2	2	3	1	1	3	1	3	3	3
MCS-323.3	1	3	1	1	3	1	3	3	3
MCS-323.4	3	3	1	1	3	1	3	3	3
MCS-323.5	2	3	1	1	3	1	3	3	3
MCS-323.6	3	3	1	1	3	1	3	3	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

NAAC 'A' Grade University

MCS-324 :BUSINESS INTELLIGENCE AND DATA VISUALIZATION

Periods/week	Credits	Max. Marks	: 200
L :3 T: 0	3	Continuous Evaluation	: 100
Duration of Exam: 3 Hrs		End Sem Examination	: 100

Pre-Requisite: Understanding of databases, SQL or any programming languages (e.g., Python, R**)**

Course Type: Program Elective

Course Outcomes: The students will be able to-

MCS-324.1 Understand the concepts and principles of Business Intelligence.

MCS-324.2 Learn how to collect, transform, and analyze data for decision-making.

MCS-324.3 Explore different data visualization techniques and tools.

MCS-324.4 Develop skills in designing and creating effective visualizations.

MCS-324.5 Apply business intelligence techniques and data visualization principles to real-world scenarios.

Unit-1: Introduction to Business Intelligence

1.1 Overview of Business Intelligence concepts and applications,
1.2 Role of data in decision-making and business strategies,
1.3 Components of a Business Intelligence system
1.4 Data collection methods and techniques,
1.5 Data integration and data quality issues, Data warehousing concepts and architecture

Unit-2: Data Analysis for Business Intelligence

2.1 Exploratory data analysis techniques,
2.2 Key performance indicators (KPIs) and metrics,
2.3 Predictive analytics, and forecasting
2.4 Introduction to popular BI tools (e.g., Tableau, Power BI, Qlik),
2.5 Data visualization capabilities and features

Unit-3: Data Visualization Principles

3.1 Principles of effective data visualization,
3.2 Understanding data types and visual encoding techniques,
3.3 Colour theory and perception in data visualization
3.4 Types of Data Visualizations: Charts and graphs for quantitative data,
3.5 Maps and geospatial visualization, Network and hierarchical visualizations

Unit-4: Interactive Data Visualization

4.1 Creating interactive dashboards and reports,
4.2 Filtering and drill-down capabilities,

4.3 Storytelling with data visualizations

Unit-5: Advanced Data Visualization Techniques

5.1 Visualizing time-series data
5.2 Visualizing multivariate data,
5.3 Visualizing text and unstructured data;
5.4 Hierarchical and tree map visualization.

Unit-6: Data Visualization Tools and Techniques

6.1Hands-on experience with popular data visualization tool: Matplot Library of python,
6.2 Designing and creating visualizations using selected tools,
6.3 Applying best practices for interactive and engaging visualizations.

Textbooks/ Reference Books:

1. Kieran Healy, 2018, "Data Visualization: A Practical Introduction",Princeton University Press.
2. Alexandru C. Telea, 2014, "Data Visualization: Principles and Practice", CRC Press.
3. Rick Sherman, 2014"Business Intelligence Guidebook: From Data Integration to Analytics", Morgan Kaufmann.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
End Semester Examination

Course Articulation Matrix:

CO Statement (MCS- 324)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-324.1	1			2	3		2		3
MCS-324.2		1					3		
MCS-324.3				1					2
MCS-324.4	1			1		1			
MCS-324.5		1			1		2	1	

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

NAAC 'A' Grade University

MCS-237 :DEEP LEARNING

Periods/week Credits	Max. Marks : 200
L :3 T:0 3.0	Continuous Evaluation : 100
Duration of Exam: 3 Hrs	End Sem Examination : 100

Pre-Requisite: Knowledge of Machine Learning

Course Type: Program Elective

Course Outcomes: The students will be able to-

MCS-237.1 To introduce basics of linear algebra and probability theory

MCS-237.2 To introduce the fundamental techniques and principles of Neural Networks

MCS-237.3 To familiarize different models in Artificial Neural Networks (ANN) and their applications

MCS-237.4 To familiarize deep learning concepts with Convolutional Neural Network case studies

MCS-237.5 To explain functioning of deep neural networks

MCS-237.6 To evaluate model performance and interpret results

Unit-1: Linear Algebra and Probability Theory:

1.1 Linear Algebra :Scalars, Vectors, Matrices and Tensors, Multiplying Matrices and Vectors, Identity and

1.2 Inverse Matrices Calculus: Derivatives and Differentiation, Partial Derivatives,

1.3 Gradients Probability Theory : Basic Probability Theory, Dealing with Multiple Random Variables, Expectation and Variance

Unit-2:Fundamentals of Neural Networks:

2.1 Introduction to Neural Network

2.2 Model of Artificial Neuron

2.3 Learning rules and various activation functions

Unit-3:Neural Network Architecture:

3.1 Single layer Feed-forward networks

3.2 Multi-layer Feed-forward networks

3.3 Recurrent Networks.

Unit-4: Back propagation Networks:

4.1 Back Propagation networks

4.2 Architecture of Back-propagation (BP) Networks

4.3 Back propagation Learning

4.4 Variation of Standard Back propagation algorithms

Unit-5: Deep Neural Networks:

5.1 Introduction to Deep Neural Networks

5.2 Training deep models

5.3 Training Deep Neural Networks using Back Propagation-Setup and initialization issues

5.4 Gradient- Descent Strategies, vanishing and exploding Gradient problems

5.5 Regularizations, dropouts.

Unit-6: Convolutional Neural Networks:

6.1 Basic structure of Convolutional Network

6.2 Convolutions for Images, Padding and Stride

6.3 Multiple Input and Multiple Output Channels

6.4 Pooling

6.5 FCNN Case study: Image classification using CNN

Text Books/ Reference Books:

1. S.Rajasekaran and G.A. Vijayalakshmi Pai, 2003, "Neural Networks,Fuzzy Logic and Genetic Algorithms", PHI Learning Pvt. Ltd., ISBN:978-81-203-2186-1.
2. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, 2021, "Dive into Deep Learning", Amazon Science.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:

Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
End Semester Examination

Course Articulation Matrix:

CO Statement (MCS- 237)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-237.1	1			2	3		2		3
MCS-237.2		1					3		
MCS-237.3				1					2
MCS-237.4	1			1		1			
MCS-237.5		1			1		2	1	
MCS-237.6		2		2		2			3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

NAAC 'A++' Grade University

MCS-325: BLOCKCHAIN

Periods/week Credits	Max. Marks : 200
L :3 T:0 3.0	Continuous Evaluation : 100
Duration of Exam: 3 Hrs	End Sem Examination : 100

Pre-Requisite: Knowledge of Distributed Systems
Course Type: Program Core

Course Outcomes: The students will be able to-

MCS325.1: Students would be able to design & implement any blockchain properly.
MCS325.2: Students would be able to implement any problem by writing their own algorithm in blockchain.
MCS325.3: By analyzing, students would be able to implement public private key combination in security.
MCS325.4: To become an efficient blockchain developer.

Unit-1: Basics of Blockchain technology

1.1 Basic introduction about blockchain in digital world,
1.2 Crypto asset or Digital asset,
1.3 Self Sovereign Identity,
1.4 Smart Contract,
1.5 Decentralized Business Model,
1.6 Device to device communication in blockchain

Unit-2: Security aspects of Blockchain

2.1 Network Security,
2.2 Different type of network attac: Warm hole attack, byzantine attack, network based attack etc,
2.3 Trust based Secure routing schemes.

Unit-3: Bitcoin & Blockchain

3.1 Blockchain Structure,
3.2 Basic Operations,
3.3 Beyond Bitcoin,
3.4 Gas , minor's role in blockchain.

Unit-4: Ethereum Blockchain

4.1 Smart Contracts,
4.2 Ethereum Structure,
4.3 Ethereum Operations,
4.4 Incentive Model in blockchain.

Unit-5: Cryptography and cryptocurrency

5.1 Algorithms & Techniques Public-Key Cryptography,
5.2 Public key and private key combinations in Blockchain security,
5.3 Hashing,
5.4 Transaction Integrity,
5.5 Securing Blockchain.

Unit-6: Decentralized Systems in Blockchain

6.1 Consensus Protocol,
6.2 Practitioner's Perspective
6.3 Decentralized Governance, Robustness, Forks.

Text Books/ Reference Books:

1. EladElrom , The Blockchain Developer: A Practical Guide for Designing, Implementing, Publishing, Testing, and Securing Distributed Blockchain-based Projects, ISBN-13: 978-1484248461, ISBN-10: 1484248465.
2. Alan T. Norman , Blockchain Technology Explained: The Ultimate Beginner's Guide About Blockchain Wallet, Mining, Bitcoin, Ethereum, Litecoin, Zcash, Monero, Ripple, Dash, IOTA and Smart Contracts.

Instructions for paper setting:

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
End Semester Examination

Course Articulation Matrix:

CO Statement (MCS- 237)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-325.1	1			2	3		2		3
MCS-325.2		1					3		
MCS-325.3				1					2
MCS-325.4	1			1		1			

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

NAAC 'A' Grade University

MCS-326: CLOUD SECURITY ESSENTIALS

Periods/week	Credits		Max. Marks	: 200
L :3 T:0	3.0		Continuous Evaluation	: 100
Duration of Exam: 3 Hrs			End Sem Examination	: 100

Pre-Requisite: knowledge of cloud computing
Course Type: Program Core

Course Outcomes: The students will be able to-
MCS-326.1 to get the knowledge on Cloud access management, compute and configuration management.
MCS-326.2 to classify and protect the data in cloud.
MCS-326.3 to get the idea of governance and compliance in cloud
MCS-326.4 to know about networking and logging.

Unit-1: Cloud Access Management(Identity and Access Management)
1.1 Cloud Account
1.2 Policies and Permissions
1.3 Groups and Roles
1.4 Temporary Credentials
1.5 Secrets Management
1.6 Customer Account Management and External Access

Unit-2: Compute and Configuration Management
2.1 Secure Instance/ Virtual Machine Deployment
2.2 Host Configuration Management
2.3 Image Management
2.4 Application Security
2.5 Threat Modeling
2.6 Platform As a service (PaaS) and Software as a Service (SaaS) Challenges
2.7 Container Services
2.8 Cloud Storage

Unit-3: Data Protection and Automation
3.1 Data Classification
3.2 Data at Rest Encryption
3.3 Data in Transit Encryption
3.4 Lifecycle Management
3.5 Infrastructure as Code
3.6 Cloud Access Security Brokers(CASB)

Unit-4: Networking and Logging
4.1 Restricting Network Access
4.2 Web Application Firewall (WAF)
4.3 Cloud Services Logging
4.4 IAAS Logging

4.5 Public Cloud Networking
4.6 Cloud Detection Services

Unit-5: Compliance, Incident Response, and Peneration Testing
5.1 Security Assurance
5.2 Cloud Auditing
5.3 Privacy
5.4 Risk Management
5.5 Server less of Defenders
5.6 Penetration Testing
5.7 Legal and Contractual Requirements
5.8 Incident Response and Forensics

Unit-6: Secure Cloud Applications
6.1 Cloud Development Environment for Coding
6.2 Configure Secure Deployment and Access Mechanisms
6.3 Configure Monitoring Services

Text Books/ Reference Books:

1. Zeal Vora, Enterprise Cloud Security and Governance: Efficiently Set Data Protection and Privacy Principles, ISBN-13, 978-1788299558.
2. Chris Dotson, Practical Cloud Security: A Guide for Secure Design and Deployment 1st Edition, ISBN-13 978-1492037514, O' Reilly Media.

Instructions for paper setting:

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
End Semester Examination

Course Articulation Matrix:

CO Statement (MCS- 326)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
MCS-326.1	3				3		3		
MCS-326.2	3					3	3		
MCS-326.3					2	2			2
MCS-326.4	2							3	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

M-ID-001: BUSINESS ANALYTICS

Periods/week	Credits		
L: 3 T: 0	3	Continuous Evaluation	: 100
Duration of Examination: 3 Hrs		End Sem Examination	: 100

Pre-requisites: The students must have the knowledge of statistics

Course Outcomes: The students will be able to-
M-ID-001.1. Understand the concepts of business analytics, statistical notations, and develop reasoning for various methods of statistical analysis.
M-ID-001.2. Design data preprocessing methods based on different types of dataset.
M-ID-001.3. Implement linear and regression techniques, visualizing data and relationships among data variables, forecasting on time series data.
M-ID-001.4. Analyze business performance and opportunities
M-ID-001.5. Evaluate the appropriate use of tools and techniques to inference optimal results.
M-ID-001.6. Design new heights and statistical methods based on performances.

Unit-1: Introduction to Business Analytics
1.1 Overview and scope of business analytics
1.2 Step by step process of business analytics
1.3 Relationship of business analytics and organizations
1.4 Important considerations to Support Business Analytics
1.5 Statistical tools: statistical notation
1.6 Descriptive statistical methods
1.7 Predictive Analytics methods

Unit-2: Trendiness and Regression Analysis
2.1 Types of Data and its importance
2.2 Methods of data preprocessing
2.3 Challenges associated with data preprocessing
2.4 Modeling relationships in data
2.5 Regression techniques
2.6 Models for business analytics
2.7 visualizing and exploring data
2.8 Technologies support business analytics

Unit-3: Organization Structures and types of Analytics
3.1 Organization structures and business analytics
3.2 Team management and management issues
3.3 Designing information policy
3.4 Outsourcing
3.5 Ensuring data quality
3.6 Measuring business analytics contribution
3.7 Data mining methodologies

Unit-4: Forecasting Techniques
4.1 Qualitative and judgmental forecasting
4.2 Statistical forecasting models

4.3 Forecasting models for stationary time series
4.4 Forecasting models for time series with a linear trend
4.5 Forecasting time series with seasonality
4.6 Regression forecasting with casual variables
4.7 Selecting appropriate forecasting models

Unit-5: Decision Analysis
5.1 Formulating decision problems
5.2 Decision strategies with the without outcome probabilities
5.3 Decision trees
5.4 The value of information for decision making
5.5 Utility and decision making

Unit-6: Recent Trends
6.1 Embedded and collaborative business intelligence
6.2 Visual data recovery
6.3 Data storytelling
6.4 Data journalism

Text Books/ Reference Books:

1. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, 2014,Business analytics Principles, Concepts, and Applications, Pearson FT Press.
2. James Evans, 2016 Business Analytics, 2nd edition, persons Education.
3. S. Christian Albright, Wayne L. Winston, Business Analytics: Data Analysis & Decision Making , Cengage Learning,
4. Galit Shmueli, Peter C. Bruce, Inbal Yahav, Nitin R. Patel, Kenneth C. Lichtendahl, Data Mining for Business Analytics: Concepts, Techniques, and Applications in R, WILEY

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-ID-001.1	2	3	1	1	2	1	3	3	3
M-ID-001.2	2	3	1	1	3	1	3	3	3
M-ID-001.3	1	2	1	1	2	1	3	3	3
M-ID-001.4	3	3	1	1	3	1	3	3	3
M-ID-001.5	2	2	1	1	3	1	3	3	3
M-ID-001.6	3	3	1	1	3	1	3	3	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

M-ID-002: INDUSTRIAL SAFETY

Periods/week	Credits		Max. Marks	: 200
L: 3 T: 0	3		Continuous Evaluation	: 100
Duration of Examination: 3 Hrs			End Sem Examination	: 100

Pre-requisites: Nil

Course Outcomes: The students will be able to-

M-ID-002.1. Apply standard safety procedures in an industrial environment.
M-ID-002.2. Be familiar with standard workplace hazard/warning signs and labels.
M-ID-002.3. Be familiar with standard categories of hazardous materials.
M-ID-002.4. Identify hazard and potential hazard areas.
M-ID-002.5. Develop safety programs to prevent or mitigate damage or losses.
M-ID-002.6. Assess safety practices and programs.
M-ID-002.7. Conduct safety audits and improve safety practices.

Unit-1: Industrial safety:

1.1 Accident, causes, types, results and control,
1.2 Mechanical and electrical hazards,
1.3 Types, causes and preventive steps/procedure,
1.4 Describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes.
1.5 Fire prevention and firefighting, equipment and methods.

Unit-2: Fundamentals of maintenance engineering:

2.1 Definition and aim of maintenance engineering
2.2 Primary and secondary functions and responsibility of maintenance department,
2.3 Types of maintenance,
2.4 Types and applications of tools used for maintenance,
2.5 Maintenance cost & its relation with replacement economy,
2.6 Service life of equipment.

Unit-3: Wear and Corrosion and their prevention:

3.1 : Wear- types, causes, effects, wear reduction methods,
3.2 lubricants-types and applications,
3.3 Lubrication methods, general sketch, working and applications,
3.4 Screw down grease cup,
3.5 Pressure grease gun,
3.6 Splash lubrication,
3.7 Gravity lubrication,
3.8 Wick feed lubrication
3.9 Side feed lubrication,
3.10 Ring lubrication, Definition, principle and factors affecting the corrosion.
3.11Types of corrosion, corrosion prevention methods.

Unit-4: Fault tracing:

4.1 Fault tracing-concept and importance,
4.2 Decision tree concept, need and applications

4.3 Sequence of fault finding activities,
4.4 Show as decision tree, draw decision tree for problems in machine tools,
4.5 Hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I.
4.6 i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors,
4.7 Types of faults in machine tools and their general causes.

Unit-5: Periodic maintenance:
5.1 Periodic inspection-concept and need,
5.2 Degreasing, cleaning and repairing schemes,
5.3 Overhauling of mechanical components,
5.4 Overhauling of electrical motor, common troubles and remedies of electric motor,

Unit-6: Preventive maintenance:
6.1 Repair complexities and its use, definition, need, steps and advantages of preventive maintenance.
6.2 Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets,
6.3 Program and schedule of preventive maintenance of mechanical and electrical equipment,
6.4 Advantages of preventive maintenance.
6.5 Repair cycle concept and importance

Text Books/ Reference Books:
1. Higgins & Morrow , Maintenance Engineering Handbook, , Da Information Services.
2. H. P. Garg , Maintenance Engineering,S. Chand and Company.
3. Audels , Pump-hydraulic Compressors, Mcgraw Hill Publication.
4. Winterkorn, Hans, Chapman & Hall London , Foundation Engineering Handbook.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-ID-002.1	1	1	-	2	2	3	1	-	-
M-ID-002.2	2	2	2	-	2	-	2	-	-
M-ID-002.3	1	2	3	-	2	-	3	-	-
M-ID-002.4	2	1	2	-	1	2	2	-	-
M-ID-002.5	2	2	3	1	2	2	2	-	-
M-ID-002.6	2	2	1	-	3	1	2	-	-
M-ID-002.7	1	3	3	-	2	1	2	-	-

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

M-ID-003: OPERATIONS RESEARCH

Periods/week	Credits		Max. Marks	: 200
L: 3 T: 0	3		Continuous Evaluation	: 100
Duration of Examination: 3 Hrs			End Sem Examination	: 100

Pre-requisites: The students must have the knowledge of mathematics

Course Outcomes: The students will be able to-
M-ID-003.1. Apply the dynamic programming to solve problems of discrete and continuous variables.
M-ID-003.2. Employ the concept of non-linear programming to address complex optimization problem
M-ID-003.3. Evaluate decision-making processes using skills to perform sensitivity analysis,
M-ID-003.4. Model and Simulate Real-world Problems

Unit 1:
1.1 Optimization Techniques, Model Formulation,
1.2 Models, General LP Formulation,
1.3 Simplex Techniques and basics of Sensitivity Analysis,
1.4 Inventory Control Models.

Unit 2:
2.1 Formulation of an LPP - Graphical solution revised simplex method
2.2 Duality theory - Dual simplex method
2.3 Sensitivity analysis - parametric programming.

Unit 3:
3.1 Nonlinear programming problem - Kuhn-Tucker conditions
3.2 min cost flow problem - max flow problem - CPM/PERT.

Unit 4:
4.1 Scheduling and sequencing - single server and multiple server models
4.2 Deterministic inventory models
4.3 Probabilistic inventory control models
4.4 Geometric Programming.

Unit 5:
5.1 Competitive Models,Single and Multi-channel Problems,
5.2 Sequencing Models, Dynamic Programming,
5.3 Flow in Networks, Elementary Graph Theory,
5.4 Game Theory Simulation.

Text Books/ Reference Books:
1 H.A. Taha, 2008, Operations Research, An Introduction, PHI.
2. H.M. Wagner, 1982, Principles of Operations Research, PHI, Delhi.
3. J.C. Pant, 2008, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi.
4. Hitler Libermann, 2009, Operations Research: McGraw Hill Pub.
5. Pannerselvam, 2010, Operations Research: Prentice Hall of India.

6. Harvey M Wagner, 2010, Principles of Operations Research: Prentice Hall of India.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PS O 1	PS O 2
M-ID-003.1	3	1	2	-	1	-	3	-	-
M-ID-003.2	3	1	2	-	1	-	2	-	-
M-ID-003.3	3	1	1	-	1	-	1	-	-
M-ID-003.4	2	1	3	1	1	-	2	-	-

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

M-ID-004: Cost Management of Engineering Projects

Periods/week	Credits		Max. Marks	: 200
L: 3 T: 0	3		Continuous Evaluation	: 100
Duration of Examination: 3 Hrs			End Sem Examination	: 100

Pre-requisites: Nil

Course Outcomes: The students will be able to-
M-ID-004.1. Demonstrate an understanding of, and apply, the fundamentals of project planning and project management.
M-ID-004.2. Prepare and evaluate cost estimates, tender documentation and contract documentation.
M-ID-004.3. Administer and supervise contracts in accordance with the relevant Standards and/or Codes of Practice.
M-ID-004.4. Critically evaluate professional practice principles and their application to an engineering environment.

Unit-1: Introduction
- 1.1 Overview of Class and Team Project
- 1.2 Review Operational Effectiveness
- 1.3 SE Process and Costing
- 1.4 Engineering Cost Estimation
- 1.5 Colors of Money/Costing:
- 1.6 Acquisition, Procurement, SystemsLife Cycle Cost Estimation (SLCC),
- 1.7 Design/Development
- 1.8 Colors of Money
- 1.9 Various names, and need to understand as the SE what can pay for what
- 1.10 Cost Estimation

Unit-2: Review of Engineering Economics
- 2.1 Choice Among Alternatives
- 2.2 Cash Flows
- 2.3 Time Value of Money
- 2.4 Equivalence
- 2.5 Economic Worth
- 2.6 Figures of Merit
- 2.7 Lease Versus Buy
- 2.8 Some Case Studies

Unit-3: LCC
- 3.1 What is LCC
- 3.2 Four Ways of LCC
- 3.3 Simulation Based Costing
  - 3.3.1 Introduction to Simulation Based Acquisition
  - 3.3.2 Simulation Overview
  - 3.3.3 Process Generators
  - 3.3.4 Simulation Using Spreadsheets
  - 3.3.5 Using Crystal Ball

Unit-4: Systems Engineering Scoping and Cost Estimation

4.1 Design to Cost (DTC)
4.2 Trade Studies
4.3 Baseline and Standards Management
4.4 Requirements
4.5 Make sure that the stakeholders understand the differences and consciously choose from:
  4.5.1 Design to Value
  4.5.2 Design to Cost
  4.5.3 Design to Affordability
  4.5.4 Design to Schedule
  4.5.6 Design to Performance
4.6 WBS Development
4.7 Systems Estimating Techniques
4.8 Hardware and Software
4.9 COSYSMO/COSYMOR
4.10 Parametric Cost Estimating-Cost Estimating Relationships

Unit-5: Software

5.1 Sizing
5.2 Cost Estimation
5.3 COCOMO
5.4 Other tools: Price S/H, Galorath's SEER-SEM, etc.
5.5 Handling the various code types:Developed, reused, modified, purchased COTS, tailored COTS, open source, etc.

Unit-6: Management

6.1 Cost as An Independent Variable (CAIV)
  6.1.1 Definitions
  6.1.2 Tradeoffs
6.2 COTS and Open Source
  6.2.1 COTS, GOTS, MOTS
  6.2.2 Technology Refreshment
  6.2.3 Open System Standards
  6.2.4 Cost of Software Reuse
6.3 Cost of Quality
6.4 Project Management

Text Books/ Reference Books:

1. Systems Life Cycle Costing: Economic Analysis, Estimation, and Management, John V. Farr, Draft Textbook, Version 1.0.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-ID-004.1	2	2	2	-	1	-	2	-	-
M-ID-004.2	1	3	2	1	-	1	1	-	-
M-ID-004.3	1	3	2	-	2	-	2	-	-
M-ID-004.4	3	2	1	-	2	-	2	-	-

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

M-ID-005: Composite Materials

Periods/week	Credits		Max. Marks	: 200
L: 3 T: 0	3		Continuous Evaluation	: 100
Duration of Examination: 3 Hrs			End Sem Examination	: 100

Pre-requisites: Nil

Course Outcomes: The students will be able to-
M-ID-005.1. Identify, describe and evaluate the properties of fibre reinforcements, polymer matrix materials and commercial composites.
M-ID-005.2. Develop competency in one or more common composite manufacturing techniques, and be able to select the appropriate technique for manufacture of fibre-reinforced composite products.
M-ID-005.3. Analyse the elastic properties and simulate the mechanical performance of composite laminates; and understand and predict the failure behaviour of fibre-reinforced composites
M-ID-005.4. Apply knowledge of composite mechanical performance and manufacturing methods to a composite design project
M-ID-005.5. Critique and synthesize literature and apply the knowledge gained from the course in the design and application of fibre-reinforced composites.

Unit-1: Introduction
1.1 Classification and characteristics of Composite materials.
1.2 Advantages and application of composites.
1.3 Functional requirements of reinforcement and matrix.
1.4 Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance

Unit-2: Reinforcements Preparation
2.1 Reinforcements Preparation-layup, curing.
2.2 Properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers.
2.3 Properties and applications of whiskers, particle reinforcements.

Unit-3: Mechanical Behavior of composites
3.1 Rule of mixtures
3.2 Inverse rule of mixtures
3.3 Isostrain and Isostress conditions

Unit-4: Manufacturing of Metal Matrix Composites Casting
4.1 Solid State diffusion technique.
4.2 Cladding – Hot iso static pressing.
4.3 Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering.
4.4 Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications

Unit-5: Manufacturing of Polymer Matrix Composites
5.1 Preparation of Molding compounds.
5.2 Prepregs – hand layup method, Autoclave method , Filament winding method.
5.3 Reaction injection molding and its properties and applications

Unit-6: Strength Laminar Failure Criteria
6.1 Strength ratio, maximum stress criteria, maximum strain criteria.
6.2 Interacting failure criteria, hydrothermal failure.
6.3 Laminate first play failure-insight strength.
6.4 Laminate strength-ply discount truncated maximum strain criterion.
6.5 strength design using caplet plots; stress concentrations

Text Books/ Reference Books:
1. Material Science and Technology Composites, R.W.Cahn, VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R.Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007
3. Hand Book of Composite Materials-ed-Lubin. 2. Composite Materials – K.K.Chawla. 3. Composite Materials Science and Applications – Deborah D.L. Chung. 4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PS O 1	PS O 2
M-ID-005.1	2	2	2	-	1	-	2	-	-
M-ID-005.2	1	2	3	1	1	1	3	-	-
M-ID-005.3	3	3	2	-	2	-	2	-	-
M-ID-005.4	2	2	1	-	-	-	2	-	-
M-ID-005.5	2	2	-	-	-	-	1	-	-

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

M-ID-006: Waste to Energy

Periods/week	Credits		Max. Marks	: 200
L: 3 T: 0	3		Continuous Evaluation	: 100
Duration of Examination: 3 Hrs			End Sem Examination	: 100

Pre-requisites: Nil

Course Outcomes: The students will be able to-
M-ID-006.1. To enable students to understand of the concept of Waste to Energy.
M-ID-006.2. To link legal, technical and management principles for production of energy from waste.
M-ID-006.3. To learn about the best available technologies for waste to energy.
M-ID-006.4. To analyze case studies for understanding success and failures.
M-ID-006.5. To facilitate the students in developing skills in the decision making process.

Unit-1: Introduction to Energy from Waste
1.1 Classification of waste as fuel
1.2 Agro based, Forest residue
1.3 Industrial waste – MSW
1.4 Conversion devices – Incinerators, gasifiers, digestors

Unit-2: Biomass Pyrolysis
2.1 Pyrolysis – Types, slow fast
2.2 Manufacture of charcoal – Methods, Yields and application
2.4 Manufacture of pyrolytic oils and gases- yields and applications.

Unit-3: Biomass Gasification
3.1 Gasifiers – Fixed bed system
3.2 Downdraft and updraft gasifiers
3.3 Fluidized bed gasifiers – Design,
3.4 construction and operation
3.5 Gasifier burner arrangement for thermal heating
3.6 Gasifier engine arrangement and electrical power
3.7 Equilibrium and kinetic consideration in gasifier operation.

Unit-4: Biomass Combustion
4.1 Biomass stoves – Improved chullahs,
4.2 Types, some exotic designs
4.3 Fixed bed combustors, Types
4.4 inclined grate combustors
4.5 Fluidized bed combustors, Design
4.6 construction and operation
4.7 Operation of all the above biomass combustors

Unit-5: Biogas: Properties of biogas
5.1 Biogas plant technology and status
5.2 Bio energy system
5.3 Design and constructional features
5.4 Biomass resources and their classification

5.5 Types of biogas Plants
5.6 Applications

Unit-6: Biogas Conversion
6.1 Biomass conversion processes
6.2 Thermo chemical conversion
6.3 Direct combustion
6.4 Biomass gasification
6.5 Pyrolysis and liquefaction
6.6 Biochemical conversion - anaerobic digestion
6.7 Alcohol production from biomass
6.8 Bio diesel production
6.9 Urban waste to energy conversion
6.10 Biomass energy programme in India

Text Books/ Reference Books:
1. Non Conventional Energy, Desai, Ashok V., Ist edition., 1995: pearson.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, 1983: Tata McGraw Hill Publishing Co. Ltd.
3. Food, Feed and Fuel from Biomass, Challal, D. S., 1991: IBH Publishing Co. Pvt. Ltd.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan,1 997, John Wiley & Sons

Instructions for paper setting: Eight questions will be set in all by the examiners taking at least one question from each unit. Students will be required to attempt five questions in all.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Evaluation Tools:
Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Sem Examination.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-ID-006.1	1	2	2	-	-	-	2	-	-
M-ID-006.2	1	2	-	-	1	-	2	-	-
M-ID-006.3	1	2	2	-	-	-	2	-	-
M-ID-006.4	2	2	1	-	-	-	1	-	-
M-ID-006.5	2	3	2	-	-	-	2	-	-

SEMESTER-IV

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

MCS-400: DISSERTATION PHASE – II

Periods/week	Credit	Max marks	: 600
P: 32	16	Continuous Evaluation	: 400
Duration of Examination: 3 Hrs		End Sem Examination	: 200

Pre-requisites: The students must have the knowledge Dissertation Phase-I

Course Outcomes: The students will be able to-
MCS-400.1. Select the engineering tools/components for solving the identified engineering problem.
MCS-400.2. Apply the identified concepts and engineering tools to arrive at design solution(s) for the identified engineering problem
MCS-400.3. Analyze and interpret results of experiments conducted on the designed solution(s) to arrive at valid conclusions
MCS-400.4 Demonstrate the knowledge, skills and attitudes of a professional engineer.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO3	PO 4	PO 5	PO6	PO 7	PSO 1	PSO 2
MCS-400.1	3	3	1	1	3	1	3	3	3
MCS-400.2	3	3	1	1	3	1	3	3	3
MCS-400.3	3	3	1	1	3	1	3	3	3
MCS-400.4	3	3	1	1	3	1	3	3	3

Appendix- A : List of courses having Relevance to the Local/Regional, National and Global Development needs

Course Code	Course Name	Regional	National	Global
MCS-101	Mathematical foundations of Computer Science	√		
MCS-102	Advanced Data Structures		√	
M-MC-100	Research Methodology and IPR			√
MCS-112	Advanced Data Structures Lab		√	
MCS-121	Machine Learning			√
MCS-122	Wireless Sensor Networks		√	
MCS-124	Data Science			√
MCS-126	Advanced Wireless and Mobile Networks		√	
MCS-134	Data Science Lab			√
MCS-131	Machine Learning Lab			√
MCS-201	Advance Algorithms			√
MCS-202	Soft Computing			√
MCS-211	Advance Algorithms Lab			√
CS-M-200	Mini Project with Seminar		√	√
MCS-221A	Data Preparation and Analysis			√
MCS-222	Secure Software Design & Enterprise Computing			√
MCS-223	Computer Vision		√	
MCS-224	Human and Computer Interaction			√
MCS-225	GPU Computing			√
MCS-226	Digital Forensics			√
MCS-227	Adhoc Networks		√	
MCS-231	Data Preparation and Analysis Lab			√
CS-M-350	Colloquium		√	√
MCS-300	Dissertation (Phase-I)		√	√
MCS-321	Mobile Applications and Services			√
MCS-322	Compiler for HPC			√
MCS-323	Optimization Techniques			√
MCS-400	Dissertation(Phase-II)*		√	√

Appendix- B : List of courses having focus on Employability, Entrepreneurship and Skill Development

Course Code	Course Name	Employability	Entrepreneurship	Skill Development
MCS-102	Advanced Data Structures			√
M-MC-100	Research Methodology and IPR			√
MCS-112	Advanced Data Structures Lab	√		
MCS-124	Data Science	√		
MCS-134	Data Science Lab	√		
MCS-201	Advance Algorithms			√
MCS-202	Soft Computing			√
MCS-211	Advance Algorithms Lab	√		
CS-M-200	Mini Project with Seminar			√
MCS-221A	Data Preparation and Analysis			√
MCS-231	Data Preparation and Analysis Lab	√		
CS-M-350	Colloquium			√
MCS-300	Dissertation (Phase-I)	√		√
MCS-323	Optimization Techniques			√
MCS-400	Dissertation(Phase-II)*	√		√

Appendix- C: List of courses and proposed activities relevant to Professional Ethics, Gender, Human Values, Environment and Sustainability

		Environment and Sustainability	Professional Ethics	Human Values	Gender Equality
M-MC-100	Research Methodology and IPR		√		
M-MC-001	Stress Management by Yoga	√			
M-MC-002	English for Research Paper Writing		√		
M-MC-003	Disaster Management		√		
M-MC-005	Value Education		√		
M-MC-006	Constitution of India			√	
M-MC-007	Pedagogy Studies			√	
M-MC-008	Personality Development through Life Enlightenment Skills.		√		