RAMAIAH UNIVERSITY OF APPLIED SCIENCES

M S Ramaiah University of Applied Sciences

Program Structure and Course Details

of

M.Tech (Artificial Intelligence and Machine Learning)

Degree Programme

Program Code: 126

Batch: 2020 Onwards

Dean
Faculty of Engineering & Technology
M.S. Ramaiah University of Applied Sciences
Bangalore - 560 058.

Registrar
M.S. Ramaiah University of Applied Sciences
Bangalore - 560 054

Department of Computer Science and Engineering
Faculty of Engineering and Technology
M S Ramaiah University of Applied Sciences

Dean - Academics
M.S. Ramaiah University of Applied Sciences
Bangalore-560054

RAMAIAH UNIVERSITY OF APPLIED SCIENCES

M S Ramaiah University of Applied Sciences

Programme Specifications

M.Tech. (Artificial Intelligence and Machine Learning) Degree Programme

Programme Code: 126

Batch 2020 Onwards

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Faculty of Engineering and Technology

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University's Vision, Mission and Objectives

The M. S. Ramaiah University of Applied Sciences (MSRUAS) will focus on student-centric professional education and motivates its staff and students to contribute significantly to the growth of technology, science, economy and society through their imaginative, creative and innovative pursuits. Hence, the University has articulated the following vision and objectives.

Vision

MSRUAS aspires to be the premier university of choice in Asia for student centric professional education and services with a strong focus on applied research whilst maintaining the highest academic and ethical standards in a creative and innovative environment

Mission

Our purpose is the creation and dissemination of knowledge. We are committed to creativity, innovation and excellence in our teaching and research. We value integrity, quality and teamwork in all our endeavors. We inspire critical thinking, personal development and a passion for lifelong learning. We serve the technical, scientific and economic needs of our Society.

Objectives

1. To disseminate knowledge and skills through instructions, teaching, training, seminars, workshops and symposia in Engineering and Technology, Art and Design, Management and Commerce, Health and Allied Sciences, Physical and Life Sciences, Arts, Humanities and Social Sciences to equip students and scholars to meet the needs of industries, business and society
2. To generate knowledge through research in Engineering and Technology, Art and Design, Management and Commerce, Health and Allied Sciences, Physical and Life Sciences, Arts, Humanities and Social Sciences to meet the challenges that arise in industry, business and society
3. To promote health, human well-being and provide holistic healthcare
4. To provide technical and scientific solutions to real life problems posed by industry, business and society in Engineering and Technology, Art and Design, Management and Commerce, Health and Allied Sciences, Physical and Life Sciences, Arts, Humanities and Social Sciences
5. To instill the spirit of entrepreneurship in our youth to help create more career opportunities in the society by incubating and nurturing technology product ideas and supporting technology backed business
6. To identify and nurture leadership skills in students and help in the development of our future leaders to enrich the society we live in
7. To develop partnership with universities, industries, businesses, research establishments, NGOs, international organizations, governmental organizations in India and abroad to enrich the experiences of faculties and students through research and developmental programmes

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Programme Specifications: M. Tech. (Artificial Intelligence and Machine Learning)

Faculty	Engineering and Technology
Department	Computer Science and Engineering
Programme Code	075
Programme Name	M.Tech. (Artificial Intelligence and Machine Learning)
Dean of the Faculty	Dr. Dilip Kumar Mahanty
Head of the Department	Dr. T P Pushphavathi

1. **Title of the Award:** M.Tech. (Artificial Intelligence and Machine Learning)
2. **Mode of Study:** Full-Time
3. **Awarding Institution /Body:** M. S. Ramaiah University of Applied Sciences, Bengaluru
4. **Joint Award:** Not Applicable
5. **Teaching Institution:** Faculty of Engineering and Technology, M. S. Ramaiah University of Applied Sciences, Bengaluru
6. **Date of Programme Specifications:** July 2022
7. **Date of Programme Approval by the Academic Council of MSRUAS:** 04 July 2022
8. **Next Review Date:** June 2026
9. **Programme Approving Regulating Body and Date of Approval:**
10. **Programme Accredited Body and Date of Accreditation:**
11. **Grade Awarded by the Accreditation Body:**
12. **Programme Accreditation Validity:**
13. **Programme Benchmark:**
14. **Rationale for the Programme**

Artificial Intelligence (AI) as a subject of study has existed since the 1960s and many AI programs were developed using LISP (List Processing Language) decades ago. AI traditionally has been based on planning, logic, and reasoning. Learning an appropriate function or rules from data has been a problem of great interest since decades, however, its importance grew leaps and bounds with the recent advent of Big Data and enormous computing power made available with advancements in computer architecture and networks. Machine learning techniques such as supervised learning and unsupervised learning are so widely used today that it is extremely important that the underlying theory and practice are taught to students to prepare them not only for industrial, R&D jobs but also academia. Artificial Neural Networks and Deep learning are being used on a regular basis to solve challenging problems that are considered hard and that require intelligence. For

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example, identification of genes causing certain diseases such as cancer and Alzheimer's disease is a problem that is actively pursued today applying deep learning. There is hardly any human endeavor left out of the applications being investigated and developed using Machine Learning techniques. There is a strong need for a programme in Machine Learning and Intelligent Systems for a post-graduate student to be able to go in-depth into Machine Learning and Deep Learning algorithms and architectures so as to apply the knowledge in various domains such as Robotics, Computer vision, Healthcare and Education and conduct research to solve challenging problems and improve the state of art. There exists a strong need for a curriculum that while providing required breadth also provides adequate depth in theory and practice of Machine Learning to enable students to innovate in their respective spheres of professional activities augmenting the quality of human life.

15. Programme Mission

The aim of the programme is to produce postgraduates with advanced knowledge and understanding of machine learning and intelligent systems; higher order critical, analytical, problem solving and transferable skills; ability to think rigorously and independently to meet higher level expectations of industries related to machine learning and intelligent systems, academics, research or take up entrepreneurial route

16. Gradate Attributes (GAs)

GA-1. Engineering knowledge: Ability to apply knowledge of mathematics, science, and Engineering fundamentals to solve complex problems in engineering

GA-2. Problem Analysis: Ability to analyse engineering problems, interpret data and arrive at meaningful conclusions involving mathematical inferences

GA-3. Design and Development of Solutions: Ability to design an engineering system, component, or process to meet desired needs considering public health and safety, and the cultural, societal, and environmental considerations

GA-4. Conduct Instigations of Complex Problems: Ability to understand and solve complex engineering problems by conducting experimental investigations

GA-5. Modern Tool Usage: Ability to apply appropriate tools and techniques and understand utilization of resources appropriately to complex engineering activities

GA-6. The Engineer and Society: Ability to understand the effect of engineering solutions on legal, cultural, social, and public health and safety aspects

GA-7. Environment and Sustainability: Ability to develop sustainable solutions and understand their effect on society and environment

GA-8. Ethics: Ability to apply ethical principles to engineering practices and professional responsibilities

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GA-9. **Individual and Teamwork:** Ability to work as a member of a team, to plan and to integrate knowledge of various engineering disciplines and to lead teams in multidisciplinary settings

GA-10. **Communication:** Ability to make effective oral presentations and communicate technical ideas to a broad audience using written and oral means

GA-11. **Project Management and Finance:** Ability to lead and manage multidisciplinary teams by applying engineering and management principles

GA-12. **Life-long learning:** Ability to adapt to the changes and advancements in technology and engage in independent and life-long learning

17. Programme Outcomes (POs)

M.Tech. graduates will be able to:

PO-1. Acquire, comprehensive knowledge and understanding of the methodologies, principles, practices, and technologies of the engineering domain to solve complex problems with technical competence

PO-2. Conceptualize, apply, analyze, synthesize, and evaluate information related to complex engineering problems using principles of mathematics, science, and engineeringto create new and innovative solutions

PO-3. Provide solutions to engineering problems by designing systems, components, or processes to meet the specified needs considering public health, safety, societal and the environmental considerations

PO-4. Review research literature, standards, guidelines, best practices, research methods and laboratory techniques to solve engineering problems through experimental investigations, analysis, and interpretation of results

PO-5. Create, select, and apply appropriate techniques and IT tools to model and solve complex engineering activities and utilize available resources effectively

PO-6. Understand the effect of engineering solutions on legal, cultural, social, public health and safety aspects and the consequent responsibilities

PO-7. Develop sustainable engineering solutions and assess their effect on society and Environment

PO-8. Understand and apply ethical principles to engineering practices and professional Responsibilities

PO-9. Function effectively as an individual or a team player to handle diverse problems in multi-disciplinary settings

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PO-10. Make oral and written presentations to communicate technical ideas effectively to engineering community and society at large

PO-11. Apply the knowledge of engineering and management principles to manage projects in multi- disciplinary environment with consideration to cost and time.

PO-12. Engage in lifelong learning and adapt to changing engineering/technology and societal requirements

18. Programme Goal

The goal of the programme is to produce postgraduates with advanced knowledge and understanding of machine learning and intelligent systems; higher order critical, analytical, problem solving and transferable skills; ability to think rigorously and independently to meet higher level expectations of industries related to machine learning and intelligent systems, academics, research or take up entrepreneurial route.

19. Program Educational Objectives (PEOs)

The objectives of the M.Tech.(Artificial Intelligence and Machine Learning) Programme are to:

PEO-1. To provide in-depth knowledge in the specialized engineering domain to enable them to deliver efficient solutions for complex engineering

PEO-2. To enable students to design and develop sustainable innovative solutions for industry and societal requirements through applied research by conducting engineering investigations through experimentation with usage of modern tools

PEO-3. To inculcate ethics, communication, leadership, soft, managerial and entrepreneurial skills for a successful career in industries and to engage in lifelong learning

20. Programme Specific Outcomes (PSOs)

At the end of the M.Tech.(Artificial Intelligence and Machine Learning) program, the graduate will be able to:

PSO-1. Apply principles of Artificial Intelligence at large and, Machine Learning and Deep Learning to real-life problems employing critical analysis

PSO-2. Design and develop sustainable and intelligent solutions to address industrial and societal requirements by applying concepts and techniques of Machine learning

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Neural Networks, Deep learning, Pattern recognition and Natural Language Processing

PSO-3. Demonstrate leadership qualities, communication, entrepreneurial skills, decision making based on ethics and passion for lifelong learning for improvement of organization, environment and society

21. Programme Structure:

SEMESTER 1							
Sl.No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	19MIC501A	Mathematics for Machine Learning	3	2		4	100
2	19DSC501A	Programming for Data Science	3		2	4	100
3	19DSC502A	Data Mining	3	2		4	100
4	19MIC502A	Artificial Intelligence	3		2	4	100
5	19MIE501A	Professional Elective - 1	3		2	4	100
6	19FET509A	Research Methodology & IPR	2	--	--	2	50
7	19FET510A	Audit Course	1	--	--	0	0
Total			18	4	6	22	550
Total no. of Hours per Week			38				

SEMESTER 2							
Sl.No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	19MIC504A	Artificial Neural Networks	3	2	2	5	100
2	19MIC505A	Pattern Recognition	3	2	2	5	100
4	19MIE502A	Professional Elective - 2	3		2	4	100
5	19MIE503A	Professional Elective - 3	3	2		4	100
6	19MIE504A	Professional Elective 4	3	2		4	100
7	19FET520A	Audit Course	1			0	
Total			16	8	6	22	500
Total no. of Hours per Week							

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SEMESTER 3							
Sl.No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	19MIC521A	Internship			10	4	100
2	19MIC522A	Group project			15	8	200
Total			-	--	25	12	300
Total number of contact hours per week			25 hours				

SEMESTER 4							
Sl.No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	19MIC523A	Dissertation and Publication		--	24	24	400
Total					24	24	400
Total number of contact hours per week			24 hours				

Note: Students are required to select Professional Elective courses in the 1st Semester and 2nd Semester, from Elective list given as follows:

Electives

Stream /Specialization	S.No.	Course Code	Course Title
AI for Healthcare	1	19MIE501A	Computational Intelligence
	2	19MIE502A	Deep Learning
	3	19MIE503A	Probabilistic Graphical Models
	4	19MIE504A	AI for Healthcare
	5	20MIE507A	Advanced Machine Learning
AI for Robots	1	19MIE505A	Computer Vision
	2	19MIE506A	AI for Robots
	3	20MIE508A	Reinforcement Learning
	4	19MIE501A	Computational Intelligence
	5	19MIE502A	Deep Learning

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22. Elective Courses

There are 4 electives (PE1 – PE4) in the programme. The electives are grouped such a way that a student can choose a set of electives to specialize in a chosen field/stream. However, if the student wishes to opt for elective module that spans multiple streams, the case may be considered subject to the affordability of academic logistics and approval by the module leader, HODs and Deans. For every elective offered, there will be a minimum and a maximum number of registrations that is decided by the department.

There is also a provision for the students to choose PE3 and PE4 through on-line mode such as MOOC's, SWAYAM, NPTEL and other equivalent platforms. The guidelines prescribed by the University for such courses to be adhered to. The student can also earn 3 or 4 credits by participating in the international competitions like technical presentation/ conference/ publications in the journal etc and winning the award in that. In that case he/she can be exempted from one of the elective courses of the programme.

23. Course Delivery: As per the Timetable

24. Teaching and Learning Methods

1. Face to Face Lectures using Audio-Visuals
2. Workshops, Group Discussions, Debates, Presentations
3. Demonstrations
4. Guest Lectures
5. Laboratory work/Field work/Workshop
6. Industry Visit
7. Seminars
8. Group Exercises
9. Project Work
10. Project
11. Exhibitions
12. Technical Festivals

25. Assessment and Grading

25.1. Components of Grading

There shall be **two components** of grading in the assessment of each course:

Component 1, Continuous Evaluation (CE): This component involves multiple subcomponents (SC1, SC2, etc.) of learning assessment. The assessment of the subcomponents of CE is conducted during the semester at regular intervals. This subcomponent represents the formative assessment of students' learning.

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Component 2, Semester-end Examination (SEE): This component represents the summative assessment carried out in the form an examination conducted at the end of the semester.

Marks obtained CE and SEE components have equal weightage (CE: 50% and SEE: 50%) in determining the final marks obtained by a student in a Course.

The complete details of Grading are given in the Academic Regulations.

25.2. Continuous Evaluation Policies

Continuous evaluation depends on the type of the course as discussed below:

25.2.1 Theory Courses

The following **TWO options** are available for each Faculty to perform the CE exercise.

Option 1 for a Theory Course:

Theory Course			
SC1	SC2	SC3	SC4
25 Marks	25 Marks	25 Marks	25 Marks

In Option 1, there shall be four subcomponents of CE (SC1, SC2, SC3 and SC4). Each subcomponent is evaluated individually for 25 marks. It is mandatory that two of the four subcomponents are term-tests. The remaining two subcomponents can be of any of the following types:

a) Online Test
b) Assignments/Problem Solving
c) Field Assignment
d) Open Book Test
e) Portfolio
f) Reports
g) Case Study
h) Group Task
i) Any other

After the four subcomponents are evaluated, the CE component marks are determined as:

CE Component Marks = (Total of the marks obtained in all the four subcomponents) ÷ 2

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An additional subcomponent (SC5) may be used at the discretion of the Faculty/Department. The department can conduct the 5th subcomponent SC5 if this subcomponent gives benefit to students. If the Department/Faculty conducts the SC5 subcomponent of evaluation, and the score obtained by the student in SC5 is greater than the lowest score of the previous four subcomponents SC1 to SC4, then it replaces the lowest of the four scores.

Option 2 for a Theory Course:

Theory Course			
SC1	SC2	SC3	SC4
25 Marks	25 Marks	25 Marks	25 Marks

In Option 2, there shall be four subcomponents, each carrying 25 marks. Out of these, there shall be two assignments and two term-tests. The assignments can be of any of the following types:

a) Online Test
b) Problem Solving
c) Field Assignment
d) Open Book Test
e) Portfolio
f) Reports
g) Case Study
h) Group Task
i) Any other

After the four subcomponents of CE are evaluated, the CE component Marks are determined as:

CE Component Marks = (Best of two Assignment Marks) + (Best of two Term-Test Marks)

Each Faculty Dean, in consultation with the heads of all departments in the Faculty and the Faculty Academic Registrar, decides whether Option 1 or Option 2 is adopted for each programme offered by the Faculty. He/she notifies the students about the option at the beginning of the semester.

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25.2.2 Laboratory Course

For a laboratory course, the scheme for determining the CE marks is as under:

Laboratory Course		
SC1	SC2	SC3 (Optional)
25 Marks	25 Marks	25 Marks

The subcomponents can be of any of the following types:

a) Laboratory / Clinical Work Record
b) Experiments
c) Computer Simulations
d) Creative Submission
e) Virtual Labs
f) Viva / Oral Exam
g) Lab Manual Report
h) Any other (e.g. combinations)

After the subcomponents of CE are evaluated, the CE component Marks are determined as:

CE Component Marks = (Total of the best two subcomponent marks out of the three) ÷ 2

25.2.3 Course Having a Combination of Theory and Laboratory

For a course that contains the combination of theory and laboratory sessions, the

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scheme for determining the CE marks is as under:

For a Course having a Combination of Theory and Laboratory Sessions			
SC1 (Theory)	SC2 (Theory)	SC3 (Theory)	SC4 (Laboratory)
25 Marks	25 Marks	25 Marks	25 Marks

There shall be four subcomponents, each carrying 25 marks. Out of these, there shall be two term-tests and an assignment to evaluate the students' performance in theory. The fourth subcomponent shall be set to evaluate the students' performance in the laboratory.

The theory assignment can be of any of the following types:

a) Online Test
b) Problem Solving
c) Field Assignment
d) Open Book Test
e) Portfolio
f) Reports
g) Case Study
h) Group Task
i) Any other

The laboratory subcomponent can be of any of the following types:

a) Laboratory / Clinical Work Record
b) Experiments
c) Computer Simulations
d) Creative Submission
e) Virtual Labs
f) Viva / Oral Exam
g) Lab Manual Report
h) Any other (e.g. combinations)

After the four subcomponents are evaluated, the CE component marks are determined as:

CE Component Marks = (Total of the marks obtained in all the four subcomponents) ÷ 2

26. Student Support for Learning

1. Course Notes

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2. Reference Books in the Library
3. Magazines and Journals
4. Internet Facility
5. Computing Facility
6. Laboratory Facility
7. Workshop Facility
8. Staff Support
9. Lounges for Discussions
10. Any other support that enhances their learning

27. Quality Control Measures

1. Review of Course Notes
2. Review of Question Papers and Assignment Questions
3. Student Feedback
4. Moderation of Assessed Work
5. Opportunities for students to see their assessed work
6. Review by external examiners and external examiners reports
7. Staff Student Consultative Committee meetings
8. Student exit feedback
9. Subject Assessment Board (SAB)
10. Programme Assessment Board (PAB)

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28. Programme Map (Course-PO-PSO Map)

Sem.	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	Mathematics for Machine Learning	3	2	3	2	3	3	2	3	1	1	1	1	3	3	2
1	Programming for Data Science	3	2	3	2	2	3	2	3	1	1	1	1	3	3	2
1	Data Mining	3	2	3	2	3	3	2	3	1	1	1	1	3	3	2
1	Artificial Intelligence	3	3	3	2	3	3	2	3	1	1	1	1	3	3	
1	Professional Elective - 1	3	2	2	3	2	1	1				2	2	3	3	
1	Research Methodology and IPR				3		3	3	3	2	3	2	2		3	3
1	Professional Communication					2					3					
2	Artificial Neural Networks	3	3	3	2	3	3	2	3	1	1	1	2	3	3	2
2	Pattern Recognition	3	2	2	1	3	3	2	3	1	1	1	1	2	2	2
2	Professional Elective – 2	3	3	2	2	3	3	3	2	1	2	1	2	3	3	2
2	Professional Elective – 3	3	3	3	2	2	2	1	1	1	1		1	3	3	1
2	Professional Elective - 4	3	3	2	3	2	3	3	2	2	2	2	3	3	3	1
2	Value Education							2	3	2			3			
3	Internship	3	3	3	2	3	2	1	2	3	3	1	3	3	3	3
3	Group project	3	3	3	2	2				1	1			3		
4	Dissertation and Publication	3	3	3	2	2				1	1			3		

3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution

29. Co-curricular Activities

Students are encouraged to take part in co-curricular activities like seminars, conferences, symposia, paper writing, attending industry exhibitions, project competitions and related activities for enhancing their knowledge and networking.

30. Cultural and Literary Activities

Annual cultural festivals are held to showcase the creative talents in students. They are involved in planning and organizing the activities.

31. Sports and Athletics

Students are encouraged to take part in sports and athletic events regularly. Annual sports meet will be held to demonstrate sportsmanship and competitive spirit.

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RAMAIAH UNIVERSITY OF APPLIED SCIENCES

Course Specifications

M.Tech. (Artificial Intelligence and Machine Learning) Degree Programme

Programme Code: 126

Faculty of Engineering and Technology

Batch 2020 Onwards

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Course Specifications: Mathematics for Machine Learning

Course Title	Mathematics for Machine Learning
Course Code	19MIC501A
Course Type	Core Theory Course
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

Students shall be taught mathematical concepts and techniques that are a pre-requisite for machine learning and data science. A number of topics such as linear algebra, matrix decompositions, vector calculus, probability and statistics and continuous optimization are covered.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After the successful completion of this course, the student will be able to:

- **CO-1.** To discuss geometric terms such as planes in higher dimensions and perform mathematical operations on them.
- **CO-2.** To apply different methods to analyse patterns in data and use them to predict, understand, and improve results.
- **CO-3.** To design techniques for reducing the number of variables in training data when dealing with high dimensional data.
- **CO-4.** To discuss the methods for accurate data representation in a lower-dimensional space.
- **CO-5.** To apply the techniques for predicting continuous and discrete values.
- **CO-6.** To develop methods for finding optimal parameter configuration for high dimensional functions.

4. Course Contents

Unit 1 (Linear Algebra): Introduction to Linear Algebra, Introduction to Vectors, Row Vector and Column Vector, Dot Product and Angle between two Vectors, Projection and Unit Vector, Line, Hyperplane, Circle, Ellipse, Hyper Cube

Unit 2 (Probability and Statistics): Introduction to Probability and Statistics, Population and Sample, Gaussian/Normal Distribution, Symmetric distribution, Standard normal distribution, Kernel density

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estimation, Sampling, Q–Q plot, Chebyshev's inequality, Uniform distributions, Discrete distributions, Continuous distributions, Power law distribution, Power Transformation, Non-gaussian distributions, Covariance, Correlation, Measuring correlation, Applying correlations, Confidence interval, Hypothesis testing, Kolmogorov–Smirnov test, Proportional Sampling

Unit 3 (Dimensionality reduction): Introduction to Dimensionality reduction, Data set representation, Matrix representation of data set, Data Preprocessing, Feature Normalization, Mean, Column Standardization, Covariance of a Data Matrix

Unit 4 (Principal component analysis (PCA)): Introduction to PCA, Geometric intuition, Mathematical objective function, Distance minimization, Eigen values and Eigen vectors, Dimensionality reduction, PCA Limitations

Unit 5 (Classification And Regression): Introduction to Classification and Regression, Data matrix notation, K-Nearest Neighbours (K-NN), Distance measures, Cosine Distance & Cosine Similarity, Measuring K-NN, Time and space complexity, Decision surface, Overfitting and Underfitting, K-fold cross validation, Time based splitting, K-NN for regression, Weighted k-NN, Building a kd-tree, Find nearest neighbours using kd-tree, Locality Sensitive Hashing, Cosine similarity, Euclidean distance, Probabilistic class label

Unit 6 (Optimization problems): Differentiation, Maxima and Minima, Vector calculus, Gradient descent, Learning rate, Stochastic gradient descent, Constrained Optimization

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	
CO-1	2	1			2								3	3		
CO-2	3	2											3	3	2	
CO-3	2					3		3		1			3	3		
CO-4	1	2				3	2					1	3	3		
CO-5	3		3	2					1		1		3	3		
CO-6					3			2					3	3		
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution																

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		03
1.Demonstration using Videos	01	
2. Demonstration using Physical Models / Systems		
3. Demonstration on a Computer	02	
Numeracy		15

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1. Solving Numerical Problems	15	
Practical Work		10
1. Course Laboratory	00	
2. Computer Laboratory	10	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		02
1. Case Study Presentation	00	
2. Guest Lecture	01	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	01	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Tech. (Artificial Intelligence and Machine Learning) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ►	SC1	SC2	SC3	SC4	
Subcomponent Type ►	Term Test	Assignment	Term Test	Assignment	100 Marks
Maximum Marks ►	25	25	25	25	
CO-1	X	X			X
CO-2	X	X			X
CO-3	X	X			X
CO-4			X	X	X
CO-5			X	X	X
CO-6			X	X	X
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Assignments
4.	Analytical Skills	Assignments
5.	Problem Solving Skills	Assignments, Examination
6.	Practical Skills	Assignments
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignments
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. **Essential Reading**
   1. Marc Peter Deisenroth, A.Aldo Faisal, Cheng Sooon Ong (2019). Mathematics for Machine Learning, Published by Cambridge University Press.
   2. Class Notes.

b. **Recommended Reading**
   1. José Unpingco (2016). Python for Probability, Statistics, and Machine Learning. Published by Springer.
   2. Chris Albon (2018). Machine Learning with Python Cookbook: Practical Solutions from Preprocessing to Deep Learning. Published by O'Reilly.

c. **Magazines and Journals**
   1. Journal of Machine Learning Research, The MIT Press
   2. Machine Learning, Springer
   3. IEEE Transactions on Pattern Analysis and Machine Intelligence, IEEE
   4. International Journal of Machine Learning and Cybernetics, Springer
   5. IEEE Transactions on Neural Networks and Learning Systems, IEEE
   6. Information Sciences, Elsevier

d. **Websites**
   1. https://machinelearningmastery.com/
   2. https://www.kdnuggets.com/
   3. https://towardsdatascience.com/
   4. https://medium.com/analytics-vidhya
   5. https://www.geeksforgeeks.org/machine-learning/

10. Course Organization

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Course Code	19MIC501A		
Course Title	Mathematics for Machine Learning		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		Phone:	+91-804-906-5555
		E-mail:	hod.cs.et@msruas.ac.in
Course Specifications Approval Date		June 2022	
Next Course Specifications Review Date		June 2026	

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Course Specifications: Programming for Data Science

Course Title	Programming for Data Science
Course Code	19DSC501A
Course Type	Core Theory Course
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

Students shall be taught programming concepts and techniques mainly using Python and the concepts are a pre-requisite for machine learning and data science. A number of topics such as data visualization and program development for machine learning and data science from scratch shall be explored in addition to directly using relevant libraries.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:1
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After the successful completion of this course, the student will be able to:

- **CO-1.** To discuss basic Python programming concepts and execution.
- **CO-2.** To develop different ways of organizing data and working with functions.
- **CO-3.** To apply different libraries for multidimensional array objects, data visualization, data manipulation, and data analysis.
- **CO-4.** To apply relational database concepts and foundational knowledge for communicating with and extracting data from databases.
- **CO-5.** To identify obvious errors and understanding patterns within the data, detect outliers, and find interesting relations among the variables.

4. Course Contents

Unit 1 (Programming Fundamentals): Introduction to Programming language, Keywords and identifiers, Comments, Indentation and statements, Variables and data types, Standard Input and Output, Operators, Control flow

Unit 2 (Data Structures and Functions): Lists, Tuples, Sets, Dictionary, Strings, Introduction to functions, Types of functions, Function arguments, Recursive functions, Lambda functions, Modules, Packages, File Handling, Exception Handling, Debugging, Time and Space Complexity

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Unit 3 (Basic Data Processing and Visualization): Introduction to Numpy, Scientific computing with Numpy, Data visualization with Matplotlib, Data manipulation and analysis with pandas, Basics of Data Frame, Basic Operations on Data Frames

Unit 4 (Programming with Databases): Introduction to SQL, Applying SQL to huge datasets, Data selection, Data Grouping, Ordering results, Data extraction, Organizing SQL Queries, Combining data sources

Unit 5 (Exploratory Data Analysis): Introduction to dataset, Scatter plot, Pair plots, Probability Density Function, Cumulative Distribution Function, Mean, Variance and Standard Deviation, Median, Percentiles and Quantiles, Inter Quartile Range and Median Absolute Deviation, Plotting data, Univariate, Bivariate and Multivariate analysis, Multivariate Probability Density, Representing a 3-dimensional surface

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	
CO-1	2	1			2								3	3		
CO-2	1	2											3	3		
CO-3	3					3		3		1			3	3	2	
CO-4	3	2				3	2					1	3	3	2	
CO-5			3	2					1		1		3	3	2	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution																

6. Course Teaching and Learning Methods:

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		03
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	03	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		25
1. Course Laboratory	00	
2. Computer Laboratory	25	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		02
1. Case Study Presentation	00	
2. Guest Lecture	01	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	

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6. Discussing Possible Innovations	01	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Tech. (Artificial Intelligence and Machine Learning) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ►	SC1	SC2	SC3	SC4	
Subcomponent Type ►	Term Test	Assignment	Term Test	Assignment	100 Marks
Maximum Marks ►	25	25	25	25	
CO-1	X	X			X
CO-2	X	X			X
CO-3	X	X			X
CO-4			X	X	X
CO-5			X	X	X
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Assignments
4.	Analytical Skills	Assignments
5.	Problem Solving Skills	Assignments, Examination
6.	Practical Skills	Assignments
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignments
14.	Personal Management	--

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15.	Leadership Skills	--

9. Course Resources

e. Essential Reading

1. Jake VanderPlas (2016), Python Data Science Handbook, O'Reilly.
2. Class Notes.

f. Recommended Reading

1. Wes McKinney (2017), Python for Data Analysis, O'Reilly
2. Al Sweigart (2015), Automate The Boring Stuff With Python
3. Andreas C. Müller & Sarah Guido (2016), Introduction to Machine Learning with Python

g. Magazines and Journals

1. International Journal of Data Science and Analytics, Springer
2. Data Mining and Knowledge Discovery, Springer
3. IEEE Transactions on Knowledge and Data Engineering, IEEE
4. Artificial Intelligence, Elsevier
5. Journal of Big Data, Springer

h. Websites

1. https://machinelearningmastery.com/
2. https://elitedatascience.com/
3. https://www.kdnuggets.com/
4. https://www.kaggle.com/
5. https://online.datasciencedojo.com/blog/
6. https://ryanswanstrom.com/blog/
7. https://towardsdatascience.com/

10. Course Organization

Course Code	19DSC501A	
Course Title	Programming for Data Science	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cs.et@msruas.ac.in
Course Specifications Approval Date	June 2022	
Next Course Specifications Review Date	June 2026	

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Course Specifications: Data Mining

Course Title	Data Mining
Course Code	19DSC502A
Course Type	Core Theory Course
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The course aims to teach a broad overview of data science in different areas from statistics, machine learning to data engineering. The course aids students to understand and apply the fundamental concepts essential in data science from data acquisition to insight and impacts of data. The course trains students in data analysis, decision making and is designed to equip them with the ability to derive insights from vast quantities and varieties of data. The emergence of massive datasets containing a lot of observations provides the primary impetus for the field. Students shall be taught to understand the principles, methods and technologies used in data science and data science approach is being used to develop decision making process in various applications.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	70
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After the successful completion of this course, the student will be able to:

CO-1. To be able to understand the fundamental concepts essential in data science, from data acquisition to insight and social impacts of big data.
CO-2. To design data analytics applications using machine learning and data mining techniques for knowledge discovery
CO-3. To develop algorithms, statistical approaches and visualization techniques for explorations of large scale data.
CO-4. To develop prototypes for new data analytics applications.
CO-5. To analyse the data as well as the performance of the data analytics applications
CO-6. To apply appropriate methodologies to selected applications in data science.

4. Course Contents

Unit 1 Introduction:
Introduction to data science and Big Data, Importance of data science, The Current trends, Data Science Jobs, Applications. Introduction to Data mining, knowledge discovery process, data mining issues. Data Analytics and its role in Business Intelligence and Knowledge Discovery. Data Analytics processes:

reparation, Warehousing, Analysis, Mining, Validation and Performance Evaluation. Data Analytics tools and platforms and applications.

Unit 2 (Understanding data): Data objects and attributes, statistical descriptions of data, data visualization, measuring similarity and dissimilarity, knowledge representation general insights.

Unit 3 (Data warehousing and modelling): Traditional Data Base systems for data storage and processing. Big data and Cloud based platforms such as Hadoop. Data warehousing and analysis: Initial data analysis, Statistical data analysis methods, Multidimensional data modeling, data cube, OLAP

Unit 4 (Machine Learning and Knowledge Discovery): unsupervised learning: clustering and categories of clustering, association rule mining. Supervised learning: statistical methods, Bayesian networks. Decision trees, Artificial Neural Networks

Unit 5 (Data mining): Knowledge generation from Data Mining. Relation and contrast with Machine Learning. Classification and different types of classifiers, Predictive data mining.

Unit 6 (Advances in Data analytics): Traditional analytics and Big data analytics, text analytics, web analytics, multimedia analytics, mobile analytics, social network analytics. Research trends.

Unit 7 (Applications): Business analytics, Science informatics, Web science, Social data informatics, Health and Biomedical informatics.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	
CO-1	2	1			2											
CO-2	1	2														
CO-3	3					3		3		1			3			
CO-4	3	2				3	2					1		3		
CO-5			3	2					1		1				2	
CO-6					3			2								
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution																

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		10
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	15	
Numeracy		10

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1. Solving Numerical Problems	10	
Practical Work		
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	00
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	00
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B.Tech. (Computer Science and Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ►	SC1	SC2	SC3	SC4	
Subcomponent Type ►	Term Test	Term Test	Assignment	Assignment	100 Marks
Maximum Marks ►	25	25	25	25	
CO-1	X	X			X
CO-2	X	X			X
CO-3	X	X			X
CO-4			X	X	X
CO-5			X	X	X
CO-6			X	X	
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

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8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Assignments
4.	Analytical Skills	Assignments
5.	Problem Solving Skills	Assignments, Examination
6.	Practical Skills	Assignments
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignments
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

i. **Essential Reading**

1. Class Notes
2. Han, J., Kamber, M., and Pei, J. (2012) *Data Mining: Concepts and Techniques*, 3rd edn. Morgan Kauffman
3. Cios, K. J., Pedrycz, W., Swiniaski, R. W., and Kurgan, L. A. (2007) *Data Mining: A Knowledge Discovery Approach*. Springer

j. **Recommended Reading**

1. Data-Intensive Text Processing with MapReduce, Jimmy Lin and Chris Dyer, 2010.
2. Mining of Massive Dataset. Jure Leskovec, Anand Rajaraman, Jeff Ullman.
3. Han, J., Kamber, M., Pei, J. Data mining concepts and techniques. Morgan Kaufmann, 2011
4. Hastie, T., Tibshirani, R., Friedman, J. The Elements of Statistical Learning, 2nd edition. Springer, 2009.
5. Murphy, K. Machine Learning: A Probabilistic Perspective. - MIT Press, 2012.
6. Data Analytics: Concepts, Techniques, and Applications - Mohiuddin Ahmed, Al-Sakib Khan Pathan, CRC Press, Published October 2, 2018

k. **Magazines and Journals**

1. IEEE Transactions on data and knowledge engineering
2. Data Mining and Knowledge Discovery
3. International Journal of Data Warehousing and Mining

l. Websites

1. https://datascience.berkeley.edu/academics/curriculum/fundamentals-of-data-engineering/
2. https://datascience.berkeley.edu/academics/curriculum/research-design-application-data-analysis/
3. http://cm.dce.harvard.edu/2014/01/14328/publicationListing.shtml

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4. http://cds.iisc.ac.in/courses/ds256/
5. http://cds.iisc.ac.in/academics/mtechcds/#CourDesc

10. Course Organization

Course Code	Data Mining	
Course Title	19DSC502A	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	Phone:	+91-804-906-5555
	E-mail:	hod.cs.et@msruas.ac.in
Course Specifications Approval Date	June 2022	
Next Course Specifications Review Date	June 2026	

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Course Specifications: Artificial Intelligence

Course Title	Artificial Intelligence
Course Code	19MIC502A
Course Type	Core Course
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is aimed at providing theoretical and hands-on exposure to artificial intelligence, intelligent agents and their applications. The principles of knowledge representation, search strategies, learning, reasoning and planning will be covered in detail. Application of the principles of artificial intelligence in machine learning, robotics and perception will be discussed. There will be a special emphasis on the analysis and synthesis of intelligent agent-based applications of artificial intelligence.

2. Course Size and Credits:

Number of Credits	05
Credit Structure (Lecture: Tutorial: Practical)	3:0:2
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After the successful completion of this course, the student will be able to:

CO-1. Describe the concepts of artificial intelligence and intelligent agents
CO-2. Explain the principles of knowledge representation, search strategies, learning, reasoning and planning
CO-3. Apply the principles of knowledge representation, search strategies, learning, reasoning and planning to design intelligent agents
CO-4. Analyze a scenario and identify strategies for knowledge representation, search, learning, reasoning and planning
CO-5. Synthesize an intelligent agent for a given scenario
CO-6. Evaluate the performance of an intelligent agent based on appropriate measures of performance

4. Course Contents

Unit 1 (Introduction): Overview of AI problems and examples, Intelligent behavior, The Turing test, Rational versus non-rational reasoning, AI problem characteristics, Nature of agents: Autonomous versus semi- autonomous, Reflexive, goal-based, and utility-based. Perception and environmental interactions.

Unit 2 (Search Strategies): Problem spaces-states, goals and operators, problem solving by search, Factored representation, Uninformed search, Heuristics and informed search. Game playing and

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minimax search, Constraint satisfaction-backtracking and local search methods. Advanced search: Search trees, stochastic search techniques.

Unit 3 (Knowledge Representation and Reasoning): Propositional and Predicate Logics for logical reasoning. Resolution and theorem proving. Forward and backward chaining. Probabilistic reasoning. Rule-based Expert Systems. Fuzzy Logic. Descriptive Logics. Ontology engineering.

Unit 4 (Machine Learning): Introduction, Supervised and Unsupervised learning: Classification, and Clustering. Theory of learning: PAC learning framework. Artificial Neural Networks, Statistical learning, Decision Trees, Over-fitting problem and generalization.

Unit 5 (Agents): Agent architectures. Agent theory-Rationality and Game Theory. Decision-theoretic agents. Software agents: Information gathering and access, Believable and Learning agents. Multi-agent systems: Collaborating agents, Agent teams, Competitive agents, Swarm systems and biologically inspired models.

Unit 6 (Planning): Partial and totally ordered planning, Plan graphs, Hierarchical planning, Planning and execution-conditional planning and continuous planning, Mobile agent/Multi-agent planning.

Unit 7 (Reasoning Under Uncertainty): Conditional Independence, Knowledge representations-Bayesian Networks, Exact inference, Randomised sampling methods, Markov Networks, Hidden Markov Models. Causality

Unit 8 (Decision Theory): Preferences and utility functions, Maximising expected utility.

Unit 9 (Applications): Natural Language Processing, Robotics, Perception and Computer Vision

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	
CO-1	3	3											3			
CO-2	1	3	3										3			
CO-3	3	3	3			3		3		1			3			
CO-4	3	3	3			3	2					1	3			
CO-5	3	3	3	2					1		1		3	3		
CO-6	3	3	3		3			2					3	3		
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution																

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		03
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	03	
Numeracy		05
1. Solving Numerical Problems	05	
Practical Work		20

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1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		
1. Case Study Presentation	02	02
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B.Tech. (Computer Science and Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ►	SC1	SC2	SC3	SC4	
Subcomponent Type ►	Term Test	Lab Exam	Assignment	Group Task	100 Marks
Maximum Marks ►	25	25	25	25	
CO-1	×	×			×
CO-2	×	×			×
CO-3	×	×			×
CO-4			×	×	×
CO-5			×	×	
CO-6			×	×	
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course

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1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Assignments
4.	Analytical Skills	Assignments
5.	Problem Solving Skills	Assignments, Examination
6.	Practical Skills	Assignments
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignments
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. Russel, S. J., and Norvig, P., 2010, Artificial Intelligence: A Modern Approach, 3rd Edn, Prentice-Hall
3. Amit Konar, 2000, Artificial Intelligence and Soft Computing: Behavioral and Cognitive Modeling of the Human Brain, Taylor & Francis Inc

b. Recommended Reading

1. Rich, E., and Knight, K., 2009, Artificial Intelligence, 3rd Edn, Tata McGraw Hill
2. Nilsson, N. J., 1998, Artificial Intelligence: A New Synthesis, , Morgan Kaufmann
3. Neapolitan, R. E., and Jiang, X., 2012, Contemporary Artificial Intelligence, CRC Press
4. Luger, G., and Stubblefield, W., 2004, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Benjamin/Cummings
5. Sowa, J. F., 2000, Knowledge Representation: Logical, Philosophical, and Computational Foundations, Brooks/Cole
6. Shai, S-S., and Shai, B-D., 2014, Understanding Machine Learning, Cambridge University Press
7. Alpaydın, E., 2014, Introduction to Machine Learning, 3rd Edn, The MIT Press
8. Pearl, J., 1986, Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference, Morgan Kaufmann

c. Magazines and Journals

1. Journal of Artificial Intelligence Research
2. Journals in Artificial Intelligence
3. Applied Artificial Intelligence
4. IEEE Intelligent Systems
5. IEEE Access
6. The International Journal of Robotics Research
7. Journal of the ACM

d. Websites

1. https://www.tutorialspoint.com/artificial_intelligence/
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-034-artificial-intelligence-fall-2010/
3. https://web.stanford.edu/class/cs221/#coursework
4. https://www.technologyreview.com/artificial-intelligence/
5. https://www.javatpoint.com/artificial-intelligence-tutorial
6. https://nptel.ac.in/

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10. Course Organization

Course Code	19MIC502A		
Course Title	Artificial Intelligence		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	+91-804-906-5555
		E-mail:	hod.cs.et@msruas.ac.in
Course Specifications Approval Date		June 2022	
Next Course Specifications Review Date		June 2026	

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Course Specifications: Research Methodology and IPR

Course Title	Research Methodology and IPR
Course Code	20FET508A
Course Type	Mandatory Course
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with the principles of research, research methodology, significant phases of research, Intellectual property, and its rights. Students are taught the realistic guidelines to be followed in the choice of field of research, topic of research and formulation of research problem. Key and careful considerations in the choice of tools for the solution of research problem are covered in this module. The module emphasizes the desirable close-knit relation between innovation and concept of out of the box thinking. The principles of effective research and the need for a Proactive approach in a successful research programme are also explained. The course discusses the significant role of Literature Review in a research cycle and the expectations from good literature review as well as procedure for systematic literature review. This course gives insight of the intellectual property rights and overview of the benefits.

2. Course Size and Credits:

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	2:0:0
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	Aerospace Engineering
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After the successful completion of this course, the student will be able to:

CO-1. Describe the value, scope, relevance and mandatory steps of research as well as principles of effective research, Nature of Intellectual Property.

CO-2. Discuss the guidelines to progress from the choice of broad field of research to specific topic of research, patent rights, process of patenting at National and International level, New Developments in IPR.

CO-3. Demonstrate the application and utility of the Systematic approach and out of box thinking concepts for research to be effective.

CO-4. Adapt, analyze and prepare well-structured research proposal and research paper invoking clearly outlined principles.

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4. Course Contents

Unit 1 (Foundations of Research): Definitions of Research, Mandatory Steps in Research, Types of Research, Relevance of Research for Innovation and Technology Development, Effective Research and Self Discipline.

Unit 2 (Formulation of Research Problem): Identification of problems, narrowing down the problem, Factors to be considered for problem selection. History and Evolution of Science & Technology.

Unit 3 (Out of the Box Thinking and Systematic Approach in Research): Transformation to Impossible Thinking, Convergent and Divergent Thinking, Generation, Evaluation and Selection of Ideas, Critical Thinking

Literature Review – Importance of Literature Review, Constituents of Good Literature Review, Strategies for Literature Search, Referencing, Paraphrasing, and Summarizing Academic Standards and Ethics

Research Proposal – Structure of a Good Research Proposal, Getting Started, Tips for Compilation of Good Research Proposal.

Unit 4 (Nature of Intellectual Property): Patents, Designs, Trade and Copyright.
Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit 5: (Patent Rights): Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases, Geographical Indicators.

Unit 6: (New Developments in IPR): Administration of Patent System. New developments in IPR; IPR of Biological Systems, Copy rights for Software. Traditional knowledge Case Studies.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1				3		3		3	2	3	2	1	0	3	3
CO-2				3		3		3		1	1	1	0	3	3
CO-3				3		3	3	3		1		1	0	3	3
CO-4				3				2		3	3	1	0	3	3
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

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6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		20
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		10
1. Case Study Presentation	06	
2. Guest Lecture	04	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**40**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B.Tech. (Electronics and Communication Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ▶	SC1	SC2	SC3	SC4	
Subcomponent Type ▶	Term Test	Term Test	Assignment	Assignment	50 Marks
Maximum Marks ▶	25	25	25	25	
CO-1	×	×	×	×	×
CO-2	×	×	×	×	×
CO-3	×	×	×	×	×
CO-4			×	×	
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. Melville, S. and Goddard, W. (1996) Research Methodology: An Introduction for Science & Engineering Students, Juta
3. Merges, R. P., Menell, P. S. and Lemley, M. A. (2016) Intellectual Property in New Technological Age, Fourth Edition, Wolters Kluwer

b. Recommended Reading

1. Kothari, C. R. and Garg G. (2019) Research Methodology: Methods and Techniques, New Age International Publishers

c. Magazines and Journals

d. Websites

e. Other Electronic Resources

1. NPTEL Videos and Digital Library

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10. Course Organization

Course Code	20FET508A		
Course Title	Research Methodology and IPR		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	+91-80-4906-5555
		E-mail:	hod.aae.et@msruas.ac.in
Course Specifications Approval Date		June 2022	
Next Course Specifications Review Date		June 2026	

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Course Specifications: Professional Communication

Course Title	Professional Communication
Course Code	19FET509A
Program	M.Tech
Course Type	Audit Course
Department	Directorate of Transferable Skills and Leadership Development
Faculty	Engineering and Technology

1. Course Summary

This course aims at sensitising students to the essentials of professional communication. Professional Communication is essential to achieve the objectives of an organisation.

2. Course Size and Credits:

Number of Credits	00
Credit Structure (Lecture: Tutorial: Practical)	2:0:0
Total Hours of Interaction	10
Number of Weeks in a Semester	15
Department Responsible	Directorate of Transferable Skills and Leadership Development
Total Course Marks	25
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After the successful completion of this course, the student will be able to:

CO-1. Compose effective written business communication
CO-2. Practice the techniques of presentation

4. Course Contents

Unit 1 : (Communication - Introduction)
Introduction to Professional Communication, Conversation and Listening

Unit 2 (Communication – Reading Skills)
Reading Skills for Effective Professional Communication: Introduction, SQ3R (Survey, Question, Read, Retrieve, and Review) Technique of Reading

Unit 3 (Communication - Writing Skills):
Written Business Communication: Writing Memos, Letters, Circulars and Notices, Communicating through Email

Unit 4 (Communication - Presentation)
Presentation Skills: Message development, content, projection, inflection, and delivery

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5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Educational Outcomes (PEOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PEO-1	PEO-2	PEO-3
CO-1					2					2					1
CO-2										3					2
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		6
Demonstrations		0
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		0
1. Solving Numerical Problems	00	
Practical Work		
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	04	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		4
1. Case Study Presentation	02	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	02	
5. Group Discussions	02	
6. Discussing Possible Innovations	00	
In-class assessments, Term Tests, Laboratory Examination/Written Examination, Presentations		2
Total Duration in Hours		**12**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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The evaluation questions are set to measure the attainment of the COs. In either component(CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of CO's on each Component or Subcomponent of Evaluation:

	Component 1: CE (100% Weightage)	Component 2: SEE (0% Weightage)
Subcomponent▶	SC1	
Subcomponent Type ▶	In-Class Assessment	0 Marks
Maximum Marks▶	25	
CO-1	X	
CO-2	X	

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Face to face lectures
2.	Understanding	Face to face lectures, group discussions
3.	Critical Skills	--
4.	Analytical Skills	Face to face lectures, activities, , group discussions, assignment
5.	Problem Solving Skills	--
6.	Practical Skills	Face to face lectures, activities, , group discussions, course work
7.	Group Work	Course work, practice, assignment, group discussion
8.	Self-Learning	Course work, practice, assignment, group discussion
9.	Written Communication Skills	Face to face lectures, Course work, practice, assignment, group discussion
10.	Verbal Communication Skills	Face to face lectures, Course work, practice, assignment, group discussion

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11.	Presentation Skills	--
12.	Behavioral Skills	Course work, practice, assignment, group discussion, presentation practice, role plays
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. Dr. C.S.G. Krishnamacharyulu (2016) Business Communication, Himalaya Publishing House

b. Recommended Reading

1. V. Lesikar, John D. Pettit, Jr., Marie E. Flatley. (1999), Basic Business Communication, 8th Edition, Tata McGraw Hill

c. Websites

1. www.myenglishpages.com

d. Other Electronic Resources

1. Electronic resources on the course area are available on RUAS library

10. Course Organization

Course Code	19FET509A	
Course Title	Professional Communication	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-80-453666666
	E-mail:	director.tsld@msruas.ac.in
Course Specifications Approval Date	June 2022	
Next Course Specifications Review Date	June 2026	

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Course Specifications: Artificial Neural Networks

Course Title	Artificial Neural Networks
Course Code	19MIC504A
Course Type	Core Theory Course
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

Artificial Neural Networks (ANNs) represent connectionist models that get their computational capabilities through training from examples. ANNs generalize their processing knowledge into previously unseen situations; and thus, they perform well when the inputs are noisy, incomplete or inaccurate. This attribute of ANNs is well-suited for modelling tasks in challenging engineering problems. This module covers the various neural network architectures and algorithms, adaptive behaviour, associative learning, competitive dynamics and biological mechanisms. Several applications of ANNs including cognitive information processing, control, and signal analysis will be discussed. Special emphasis will be laid on the architecture and learning algorithms of deep neural networks which can model high-level abstractions in data by using multiple processing layers.

2. Course Size and Credits:

Number of Credits	05
Credit Structure (Lecture: Tutorial: Practical)	3:1:1
Total Hours of Interaction	85
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After the successful completion of this course, the student will be able to:

CO-1. Demonstrate an understanding of the various concepts and techniques of ANNs.
CO-2. Determine under which circumstances ANNs are useful in solving real-world problems.
CO-3. Discuss the main factors involved in achieving good learning and generalization performance in neural network systems.
CO-4. Build different kinds of ANNs, train them, evaluate their performance, and use them to solve complex problems.
CO-5. Evaluate whether neural networks are appropriate to a particular application.
CO-6. Analyze the steps needed to improve performance of the selected neural network.

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4. Course Contents

Unit 1 (Supervised Learning): Regression models, Linear regression, Error function, Polynomial regression, Parameters and hyperparameters, Underfitting, Overfitting, Testing, Regularization, Perceptron algorithm, Logistic classifiers.

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Unit 2 (ANN Architecture): Biological inspiration, Models of ANNs, Learning and adaptation, Neural network learning rules, Single layer perceptrons, Training a single-neuron model, Limitations of single-layer ANNs, MultiLayered Perceptron (MLP), Training an MLP, Activation functions, Vanishing Gradient problem, Bias-Variance tradeoff.

Unit 3 (Support Vector Machines and Kernel Methods): Support vector planes, Loss function, Kernel method, Polynomial Kernel, Radial Basis Function (RBF) Kernel, Domain specific Kernels, Train and run time complexities, SVM Regression.

Unit 4 (Attractor Neural Networks): Associative Learning Attractor Associative Memory, Linear Associative memory, Hopfield Network, Application of Hopfield Network, Brain State in a Box neural Network, Simulated Annealing, Boltzmann Machine, Bidirectional Associative Memory.

Unit 5 (Self-organization Feature Map): Maximal Eigenvector Filtering, Extracting Principal Components, Generalized Learning Laws, Vector Quantization, Self- organization Feature Maps, Growing Neural Gas.5. Course Map (CO-PO-PSO Map)

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	
CO-1	2	1			2											
CO-2	2	3														
CO-3	3					3		3		1			3			
CO-4	1	2				3	2					2		3		
CO-5			2	2	2				1		1				2	
CO-6			3		3			2				2				
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution																

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		10
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		05
1. Solving Numerical Problems	05	
Practical Work		20
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	

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3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**85**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Tech. (Data Science and Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ►	SC1	SC2	SC3	SC4	
Subcomponent Type ►	Term Test	Term Test	Assignment	Group Task	100 Marks
Maximum Marks ►	25	25	25	25	
CO-1	X	X			X
CO-2	X	X			X
CO-3	X	X			X
CO-4			X	X	X
CO-5			X	X	X
CO-6			X	X	
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Assignments
4.	Analytical Skills	Assignments
5.	Problem Solving Skills	Assignments, Examination
6.	Practical Skills	Assignments
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Tests,Assignments, Examination
10.	Verbal Communication Skills	Group discussion

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11.	Presentation Skills	Seminars
12.	Behavioral Skills	--
13.	Information Management	Assignments
14.	Personal Management	--
15.	Leadership Skills	Group discussion

9. Course Resources

a. Essential Reading

1. Course notes
2. Zurada J. (1992). Introduction to Artificial Neural Systems. St. Paul, MN, USA. West Publishing Co.
3. Deng L. & Yu D. (2014). Deep Learning: Methods and Applications. Foundations and Trends in Signal Process. 7(3, 4).

b. Recommended Reading

1. Haykin S. (1998). Neural Networks: A Comprehensive Foundation. PTR, Upper Saddle River, NJ, USA, Prentice Hall.
2. Hagan M.T., Demuth H. B., & Beale M. (1997). Neural Network Design. Boston, MA, USA.PWS Pub. Co.
3. Demuth H. & Beale M. (2000). MATLAB neural network toolbox user's guide. Natick, MA, USA. The Math Works.Magazines and Journals

c. Websites

1. http://www.journals.elsevier.com/neural-networks.
2. http://cis.ieee.org/
3. http://lumiverse.io/series/neural-networks-demystified
4. http://www.deeplearningbook.org/
5. http://neuralnetworksanddeeplearning.com/
6. http://deeplearning.net/

10. Course Organization

Course Code	Artificial Neural Networks	
Course Title	19MIC504A	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cs.et@msruas.ac.in
Course Specifications Approval Date	June 2022	
Next Course Specifications Review Date	June 2026	

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Course Specifications: Advanced Machine Learning

Course Title	Advanced Machine Learning
Course Code	20MIE507A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The field of machine learning is concerned with the question of how to construct computer programs that automatically improve with experience. In recent years many successful machine learning applications have been developed, ranging from data-mining programs that learn to detect fraudulent credit card transactions, to information-filtering systems that learn users' reading preferences, to autonomous vehicles that learn to drive on public highways. At the same time, there have been important advances in the theory and algorithms that form the foundations of this field Machine Learning largely models its methods using human ability to distinguish features and create a knowledge base.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After the successful completion of this course, the student will be able to:

CO-1. Discuss the concepts of Neural networks.
CO-2. Discuss the principles of Back propagation Algorithm.
CO-3. Discuss the concepts of Radial Basis Neural networks
CO-4. Discuss the principles of Support Vector Machines.
CO-5. Discuss the Unsupervised Learning Techniques.

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4. Course Contents

Unit 1 (Neural Networks): Neural networks, the perceptron, the learning rate, the bias input, the perceptron learning algorithm, an example of perceptron learning: logic functions, implementation, linear separability, the perceptron convergence theorem, the exclusive or (xor) function, the pima indian dataset, preprocessing: data preparation, linear regression, linear regression.

Unit 2 (Back-propagation): Going backwards: back-propagation of error, the multi-layer perceptron algorithm, initialising the weights, different output activation functions, sequential and batch training ,local minima, picking up momentum, minibatches and stochastic gradient descent, other improvements, the multi-layer perceptron in practice, amount of training data, number of hidden layers, when to stop learning, examples of using the mlp, a regression problem, classification with the mlp, a classification example: the iris dataset, time-series prediction, data compression: the auto-associative network, deriving back-propagation, the network output and the error, the error of the network, requirements of an activation function, back-propagation of error, the output activation functions, an alternative error function.

Unit 4 (Radial Basis Functions): Receptive fields, the Radial basis function (RBF) network, training the RBF network, interpolation and basis functions, bases and basis expansion, the cubic spline, fitting the spline to the data, smoothing splines, higher dimensions, beyond the bounds.

Unit 5 (Support Vector Machines): Support vector machines, optimal separation, the margin and support vectors, a constrained optimisation problem, slack variables for non-linearly separable problems, kernels, and choosing kernels, the support vector machine algorithm, implementation, extensions to the SVM, multi-class classification, SVM regression, and other advances.

Unit 6 (Unsupervised Learning): Unsupervised learning, the k-means algorithm, dealing with noise, the k-means neural network, normalization, a better weight update rule, example: the iris dataset again, using competitive learning for clustering, vector quantization, the self-organizing feature map, neighborhood connections, self-organization, network dimensionality and boundary conditions.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	2	2	3	2		1					1		3	2	2
CO-2	2	2	3	2		1					1		3	2	2
CO-3	2	2	3	2		1					1		3	2	2
CO-4	2	2	3	2		1					1		3	2	2
CO-5	2	2	3	2		1					1		3	2	2

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6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		15
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	15	
Numeracy		05
1. Solving Numerical Problems	05	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B.Tech. (Artificial Intelligence and Machine Learning) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ▶	SC1	SC2	SC3	SC4	

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Subcomponent Type ▶	Term Test	Term Test	Assignment	Assignment	100 Marks
Maximum Marks ▶	25	25	25	25	
CO-1	×	×			×
CO-2	×	×			×
CO-3	×	×	×	×	×
CO-4	×	×	×	×	×
CO-5	×	×	×	×	×
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class notes
2. Bishop, C. M. (2006). Pattern Recognition and Machine Learning, Springer.

b. Recommended Reading

3. Seliski, R. (2010). Computer Vision: Algorithms and Application. New York: Springer-Verlag Inc.

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c. Magazines and Journals

4. http://www.journals.elsevier.com
5. http://ieeexplore.ieee.org

d. Websites

6. https://www.coursera.org/
7. http://nptel.ac.in/
8. Oracle Documentation, docs.oracle.com

10. Course Organization

Course Code	20MIE507A	
Course Title	Advanced Machine Learning	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cs.et@msruas.ac.in
Course Specifications Approval Date	June 2022	
Next Course Specifications Review Date	June 2026	

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Course Specifications: Pattern Recognition

Course Title	Pattern Recognition
Course Code	19MIC505A
Course Type	Core Theory Course
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course focuses on the underlying principles, methods and techniques of pattern recognition used to develop pattern recognition applications in the real world. This course enables the students to build a classifier that can determine the class of an input pattern. The classifier may take a form of a function, an algorithm, a set of rules, etc. This course also covers building and applying the classifiers in various applications such as data mining, image processing and signal processing.

2. Course Size and Credits:

Number of Credits	05
Credit Structure (Lecture: Tutorial: Practical)	3:0:1
Total Hours of Interaction	85
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After the successful completion of this course, the student will be able to:

CO-1. To be able to understand the fundamental concepts essential in data science, from data acquisition to insight and social impacts of big data.
CO-2. To design data analytics applications using machine learning and data mining techniques for knowledge discovery
CO-3. To develop algorithms, statistical approaches and visualization techniques for explorations of large scale data.
CO-4. To develop prototypes for new data analytics applications.
CO-5. To analyse the data as well as the performance of the data analytics applications
CO-6. To apply appropriate methodologies to selected applications in data science.

4. Course Contents

Unit 1 (Introduction): Introduction to pattern recognition, Problems of classification and Regression, Issues of over fitting and under fitting, Applications of pattern recognition; Bayesian inference – Prior, Likelihood and Posterior functions, loss and discriminant functions, Risk functions and Reject options.

Unit 2 (Component analysis and Dimensionality reduction): Principal Component Analysis, Fischer Linear Discriminant, Multidimensional Scaling, Local Linear Embedding.

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Unit 3 (Regression Techniques): Bayesian Regression and relations to Least Squares with regularization, Gaussian Process Regression.

Unit 4 (Introduction to machine learning) : Neural Networks, Kernel methods, Sparse Kernel Machines – Support Vector Machine for classification and regression problems, Relevance Vector Machine for regression

Unit 5 (Mixture models and Expectation Maximization): Gaussian mixtures

Unit 6 (Graphical models): Bayesian networks, Markov Random Fields, Exact and Approximate inference techniques

Unit 7 (Case studies with demonstrations): PCA, LDA, Bayesian Regression, GPR, SVM, GMM Laboratory and Assignment activity, Tutorials: Demonstrations and case studies.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	
CO-1	2	1		1	2											
CO-2	1	2		1												
CO-3	3					2				1			2			
CO-4	3	2				3	2	3				1		2		
CO-5			2	1					1		1				2	
CO-6					3			2								
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution																

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		10
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	15	
Numeracy		05
1. Solving Numerical Problems	00	
Practical Work		20
1. Course Laboratory	00	
2. Computer Laboratory	25	

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3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	00
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**85**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B.Tech. (Computer Science and Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ►	SC1	SC2	SC3	SC4	
Subcomponent Type ►	Term Test	Term Test	Assignment	Assignment	100 Marks
Maximum Marks ►	25	25	25	25	
CO-1	X	X			X
CO-2	X	X			X
CO-3	X	X			X
CO-4			X	X	X
CO-5			x	X	x
CO-6			X	X	
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Assignments
4.	Analytical Skills	Assignments
5.	Problem Solving Skills	Assignments, Examination
6.	Practical Skills	Assignments
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignments
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. Bishop C. M. (2007). Pattern Recognition and Machine Learning. Springer.

b. Recommended Reading

1. Hastie, T., Tibshirani, R., Friedman, J. (2009) The Elements of Statistical Learning, 2nd edition. Springer,.
2. Murphy, K. , (2012) Machine Learning: A Probabilistic Perspective. - MIT Press.

c. Magazines and Journals

1. IEEE Transactions on Pattern Analysis and Machine Intelligence
2. Pattern Recognition Letters
3. Pattern Recognition Journal

d. Websites

1. https://datascience.berkeley.edu/academics/curriculum/fundamentals-of-data-engineering/
2. https://datascience.berkeley.edu/academics/curriculum/research-design-application-data-analysis/

10. Course Organization

Course Code	Pattern Recognition	
Course Title	19MIC505A	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cs.et@msruas.ac.in
Course Specifications Approval Date	June 2022	
Next Course Specifications Review Date	June 2026	

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Course Specifications: Value Communication

Course Title	Value Education
Course Code	19FET510A
Program	.....
Course Type	Ability Enhanced Compulsory Course
Department	Directorate of Transferable Skills and Leadership Development
Faculty	Engineering and Technology

1. Course Summary

This course aims at sensitizing students to learn the importance of value education. It gives an insight about the Universal Brotherhood.

2. Course Size and Credits:

Number of Credits	00
Credit Structure (Lecture: Tutorial: Practical)	2:0:0
Total Hours of Interaction	10
Number of Weeks in a Semester	15
Department Responsible	Directorate of Transferable Skills and Leadership Development
Total Course Marks	25
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After the successful completion of this course, the student will be able to:

CO-1. Discuss the role of Values and Ethics in Self-Development
CO-2. Appreciate the importance of Universal Brotherhood

4. Course Contents

Unit 1 (Communication – Values, Ethics and Judgements)

- Values, Ethics and Self-Development; Awareness of self-destructive habits, Power of faith, Positive Thinking
- Value judgements – Stereotypes, prejudices and biases

Unit 2 (Communication – Sense of Duty)

- Sense of duty, Self-reliance, Confidence, Concentration, Discipline, Honesty, Truthfulness
- National Unity, Patriotism, Love for nature

Unit 3 (Communication – Character Development):

- Universal brotherhood and religious tolerance
- Character and Competence –Rational Thinking vs Blind faith

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5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Educational Outcomes (PEOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PEO-1	PEO-2	PEO-3
CO-1							2	3				2			2
CO-2	2								2			3			2
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		06
Demonstrations		00
2. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	04	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		04
1. Case Study Presentation	02	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	02	
5. Group Discussions	02	
6. Discussing Possible Innovations	00	
In-class assessments, Term Tests, Laboratory Examination/Written Examination, Presentations		02
Total Duration in Hours		**12**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of CO's on each Component or Subcomponent of Evaluation:

	Component 1: CE (100% Weightage)	Component 2: SEE (0% Weightage)
Subcomponent▶	SC1	
Subcomponent Type ▶	In-Class Assessment	0 Marks
Maximum Marks▶	25	
CO-1	X	
CO-2	X	

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Face to face lectures
2.	Understanding	Face to face lectures, group discussions
3.	Critical Skills	--
4.	Analytical Skills	Face to face lectures, activities, , group discussions, assignment
5.	Problem Solving Skills	--
6.	Practical Skills	Face to face lectures, activities, , group discussions, course work
7.	Group Work	Course work, practice, assignment, group discussion
8.	Self-Learning	Course work, practice, assignment, group discussion
9.	Written Communication Skills	Face to face lectures, Course work, practice, assignment, group discussion
10.	Verbal Communication Skills	Face to face lectures, Course work, practice, assignment, group discussion

M.S. Ramaiah University of Applied Sciences Bangalore - 560 054

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11.	Presentation Skills	--
12.	Behavioral Skills	Course work, practice, assignment, group discussion, presentation practice, role plays
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes

b. Recommended Reading

c. Websites

d. Other Electronic Resources

1. Electronic resources on the course area are available on RUAS library

10. Course Organization

Course Code	19FET510A	
Course Title	Value Education	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-80-453666666
	E-mail:	director.tsld@msruas.ac.in
Course Specifications Approval Date	June 2022	
Next Course Specifications Review Date	June 2026	

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Course Specifications: Computational Intelligence

Course Title	Computational Intelligence
Course Code	19MIE501A
Course Type	Professional Elective
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

Computational Intelligence (CI) is the study of the adaptive mechanisms that allow intelligent behavior in complex and changing environments. The objective of this module is to provide theoretical and practical knowledge of CI for building intelligent systems. The module lays major emphasis on the computational modelling of natural intelligent systems: fuzzy logic, evolutionary computation, swarm intelligence and artificial immune systems. In addition to these dominant paradigms, the module includes hybrid intelligent systems that seek to resolve real-world and complex problems within the CI development framework.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:1
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After the successful completion of this course, the student will be able to:

- **CO-1.** Discuss the underlying concepts of fuzzy systems, evolutionary computation, swarm intelligence and artificial immune systems.
- **CO-2.** Analyse whether a specific engineering problem can be dealt with Computational Intelligence
- **CO-3.** Compare and contrast the use of different Computational Intelligence techniques to achieve particular functionalities
- **CO-4.** Recommend the most suitable Computational Intelligence technique to address a specific engineering problem.
- **CO-5.** Specify, implement, customize, and evaluate typical Computational Intelligence algorithms in response to a practical problem
- **CO-6.** Develop variants and hybrids of typical Computational Intelligence algorithms.

4. Course Contents

Unit 1 (Introduction): Pitfalls of traditional artificial intelligence, Definitions and nomenclature, Fundamental elements of Computational Intelligence (CI), A brief review of CI paradigms, Synergism in CI

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Unit 2 (Evolutionary Computation): Genetic algorithms, genetic programming, evolutionary programming, evolution strategies, differential evolution, coevolution, recent trends, implementation considerations and applications

Unit 3 (Fuzzy Systems): Fuzzy sets and logic, fuzzification, fuzzy inferencing, fuzzy controllers and rough sets, recent trends, implementation considerations and applications

Unit 4 (Swarm intelligence (SI)): Particle swarm optimization algorithm, bacterial foraging algorithm, artificial honeybee algorithm, ant colony optimization algorithm, recent trends in SI, variants and hybrids of SI algorithms, implementation considerations and applications

Unit 5 (Artificial Immune Systems (AIS)): Negative and clonal selection, multi layered AIS, danger theory, implementation considerations and applications

Unit 6 (CI Algorithm Functionalities): Performance issues of CI algorithms and suitability of CI algorithms for desired functionalities

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	
CO-1	3	3	2	3	2	1	1	1	1		2		2	2		
CO-2	3	3	3	3	2	2	2	2	1		2		3	3	1	
CO-3	3	3	2	2	1	1	1	0	1	0	3	1	3	3	1	
CO-4	3	3	2	3	2	1	2	1	1	0	3	0	3	3	1	
CO-5	3	3	1	3	3	1	1	2	2	2	2	0	2	2		
CO-6	3	3	2	3	3	1	2	2	2	2	2	1	1	1		
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution																

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		03
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems		
3. Demonstration on a Computer	03	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		10
1. Course Laboratory	00	
2. Computer Laboratory	10	

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3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		
1. Case Study Presentation	03	
2. Guest Lecture	01	
3. Industry / Field Visit	00	02
4. Brain Storming Sessions	00	
5. Group Discussions	01	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Tech. (Artificial Intelligence and Machine Learning) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				**Component 2: SEE (50% Weightage)**
Subcomponent ►	**SC1**	**SC2**	**SC3**	**SC4**	
Subcomponent Type ►	**Term Test**	**Term Test**	**Assignment**	**Assignment**	**100 Marks**
Maximum Marks ►	**25**	**25**	**25**	**25**	
CO-1	X	X			X
CO-2	X	X			X
CO-3	X	X			X
CO-4			X	X	X
CO-5			X	X	X
CO-6			X	X	
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

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S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Assignments
4.	Analytical Skills	Assignments
5.	Problem Solving Skills	Assignments, Examination
6.	Practical Skills	Assignments
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignments
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Engelbrecht, A. P. (2007). Computational intelligence: An introduction. Chichester, England, John Wiley & Sons.
2. Eberhart, R. C. (2007). Computational Intelligence: Concepts to Implementations. San Francisco, CA, USA, Morgan Kaufmann Publishers Inc.
3. Konar, A. (2005). Computational Intelligence: Principles, Techniques and Applications. Secaucus, NJ, USA, Springer-Verlag New York, Inc.

b. Recommended Reading

1. Kennedy, J. & Eberhart, R. C. (2001). Swarm Intelligence. San Francisco, CA, USA, Morgan Kaufmann Publishers Inc.
2. De Jong, K. A. (2012). Evolutionary Computation: A Unified Approach. New York, USA, Bradford Books.
3. Ross, T. J. (2004). Fuzzy Logic with Engineering Applications. John Wiley & Sons.
4. de Castro L. R. & Timmis, J. (2002). Artificial Immune Systems: A New Computational Intelligence Paradigm. Secaucus, NJ, USA, Springer-Verlag New York, Inc

c. Magazines and Journals

1. Journal of Machine Learning Research, The MIT Press
2. Machine Learning, Springer
3. IEEE Transactions on Pattern Analysis and Machine Intelligence, IEEE
4. International Journal of Machine Learning and Cybernetics, Springer
5. IEEE Transactions on Neural Networks and Learning Systems, IEEE
6. Information Sciences, Elsevier

d. Websites

1. http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=10207
2. http://cis.ieee.org/ieee-transactions-on-neural-networks-and-learning-systems.html
3. http://cis.ieee.org/ieee-transactions-on-fuzzy-systems.html
4. http://cis.ieee.org/ieee-transactions-on-evolutionary-computation.html

10. Course Organization

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Course Code	19MIE501A		
Course Title	Computational Intelligence		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	+91-804-906-5555
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Course Specifications Approval Date		June 2022	
Next Course Specifications Review Date		June 2026	

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Course Specifications: Deep Learning

Course Title	Deep Learning
Course Code	19MIE502A
Course Type	Professional Elective Theory Course
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

Deep learning has become an extremely active area of research. It is paving the way for modern machine learning. Students will be taught both theory and practical applications of deep learning including topics such as Convolutional Neural Networks, Representation learning, Models for Sequence analysis and deep reinforcement learning.

2. Course Size and Credits:

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	55
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After the successful completion of this course, the student will be able to:

- **CO-7.** To discuss traditional machine learning techniques that have had an influence on deep learning algorithms
- **CO-8.** To use Tensor Flow to implement neural networks; to manage problems that arise as networks are made deeper.
- **CO-9.** To perform effective dimensionality reduction using auto encoders
- **CO-10.** To discuss convolution operator and the building blocks for convolutional network architectures; to build neural networks that analyze complex images.
- **CO-11.** To discuss and apply practical design process for deep learning applications; to perform sequence analysis to examine language.
- **CO-12.** To apply deep reinforcement learning techniques.
- **CO-13.** To discuss and apply Generative Networks.

4. Course Contents

Unit 1 (Introduction): Introduction for Deep Learning, Motivation for Deep Learning, Deep Artificial Neural Networks, Regularization for Deep Learning, Introduction to TensorFlow, Neural networks in TensorFlow.

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Unit 2 (Optimization for training models): Gradient Descent optimization technique, Back propagation Optimizing technique, Analysis of Backpropogation technique in weight space. Challenges and next steps.

Unit 3 (Representation learning): Principal Component Analysis, Autoencoders, The word2vec frame work, The Skip-Gram Architecture.

Unit 4 (Convolutional Neural network): Filters and Feature Maps, Full Description of the Convolutional Layer, Pooling layers, Full Architectural Description of Convolution Networks, Accelerating Training with Batch Normalization.

Unit 5 (Sequence Analysis): Analyzing Variable Length Inputs, Tackling seq2seq with Neural N-Grams, Parts of Speech tagger, Recurrent Neural networks, The challenges with vanishing Gradients, Long Short Term Memory (LSTM) Units. Sentiment analysis model, Recurrent and Recursive nets.

Unit 6 (Deep Reinforcement Learning): Introduction to Deep Reinforcement Learning, Markov Decision Process, policy, Future Return, Discounted Future Return, Policy verses value learning, Q-Learning and Deep Q-networks, The Bellman Equation.

Unit 7 (Generative models): Introduction to Generative models, Deep Generative Models, Generative Adversial Networks, Training the GAN, GAN Challenges.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	
CO-1	1	1			2											
CO-2	2	3														
CO-3	2					2		2		2			3			
CO-4	3	2				3	3					2		3		
CO-5			2	2					1		1				2	
CO-6					3			2								
CO-7			2	2					1		1					
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution																

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		05
1. Solving Numerical Problems	05	
Practical Work		00

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1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B.Tech. (Computer Science and Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ►	SC1	SC2	SC3	SC4	
Subcomponent Type ►	Term Test	Term Test	Assignment	Group Task	100 Marks
Maximum Marks ►	25	25	25	25	
CO-1	X		X	X	X
CO-2	X		X	X	X
CO-3	X		X	X	X
CO-4		X	X	X	X
CO-5		X	X	X	X
CO-6		X	X	X	X
CO-7		X	X	X	
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

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S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Assignments
4.	Analytical Skills	Assignments
5.	Problem Solving Skills	Assignments, Examination
6.	Practical Skills	Assignments
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignments
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. Nikhil Buduma (2017), Fundamentals of Deep Learning-Designing Next Generation Machine Intelligence Algorithms, O'Reilly.
3. Ian GoodFellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press.
4. David Foster (2019), Generative Deep Learning- Teaching Machines to Paint, Write, Compose, and Play, O'Reilly

b. Recommended Reading

1. Jeremy Howard, Sylvain Gugger (2020) "Deep Learning for Coders with Fastai and PyTorch", O'Reilly .

c. Magazines and Journals

1. TheScientist

d. Websites

1. https://www.kernel.org
2. http://www.sigops.org

10. Course Organization

Course Code	19MIE502A	
Course Title	Deep Learning	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cs.et@msruas.ac.in
Course Specifications Approval Date	June 2022	
Next Course Specifications Review Date	June 2026	

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Course Specifications: Probabilistic Graphical Models

Course Title	Probabilistic Graphical Models
Course Code	19MIE503A
Course Type	Professional Elective
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

Probabilistic Graphical Models (PGMs) enable learning and inference about systems based on their representations using graphs. The course aims to impart strong foundation in all the three components of PGM: representation, inference and learning. Bayesian Networks and Markov Network models along with algorithms for drawing inferences from them and their construction via learning from data are discussed in detail. The theoretical basis of the algorithms and their implementation is emphasized. Students are taught to apply PGMs for various applications through case-studies and evaluate the performance of different methods.

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After the successful completion of this course, the student will be able to:

- **CO-1.** Discuss the principles of representation, inference, and learning in the context of Probabilistic Graphical Models (PGMs)
- **CO-2.** Discuss the application of Bayesian and Gaussian network models
- **CO-3.** Apply graphical inference methods and learning algorithms for a given representation
- **CO-4.** Develop a representation scheme and an inference framework for a given application
- **CO-5.** Develop algorithms for construction/learning network models from data
- **CO-6.** Evaluate different representations, inference and learning algorithms for a given application

4. Course Contents

Unit 1 Conditional Probabilities over Sets

Sets of random variables, joint and marginal probability distributions over sets of random variables, conditional Probability between sets of random variables, independent and conditional independence of sets of random variables, conditional probabilistic queries, MAP and MMAP queries.

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Unit 2 Representation of Probabilistic Graphical Models

Bayesian Network Models
Directed graphical models, Bayesian network representation of joint distribution via Conditional Probabilities on directed acyclic graph, Conditional dependence and independencies in Bayesian Networks

Markov Network Models
Gibbs distribution, Markov networks, over-parameterization, From Bayesian networks to Markov networks and vice versa, Conditional random fields.

Dynamic Bayesian Networks
Temporal, plate, and probabilistic relational models; Basic assumptions, Dynamic Bayesian networks, State observation models.

Gaussian Network Models
Multivariate Gaussians, Gaussian Bayesian networks, Gaussian Markov random fields.

Unit 3 Inference
Basic ideas, dealing with evidence, MAP and MMAP queries

Exact inference in graphical models: Factors, Variable Elimination and Clique Trees

Approximate Inference algorithms
Inference as optimization-energy functional, fixed point characterization, message passing algorithms
Sampling/particle based approaches: Likelihood weighting, Importance sampling, Gibbs sampling, Markov Chain Monte Carlo (MCMC) methods

MAP inference in graphical models: Extension of exact and approximate algorithms for MAP and MMAP queries

Unit 4 Construction via Learning from Data

Overview: Learning parameters and structure from data.

Parameter estimation: Maximum Likelihood Estimation (MLE), Bayesian Parameter Estimation and MAP estimation in graphical models, learning models with shared parameters

Structure learning in Bayesian Networks: Overview, constraint based methods, Structure scores based methods, Structure Search techniques

Learning Undirected Graphs: Parameter estimation and structure learning methods

Unit 5 Action and Decisions

Action: Causality, Causal inference on graphical networks
Decision: Utilities and decisions, Structured decision problems and applications

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5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	
CO-1	3	3	1	2									1			
CO-2	3	3	3	1	2	1						1	2	1	1	
CO-3	3	3	3	2	2	1			1			1	3	3		
CO-4	3	3	3	2	2	1			1				2	2		
CO-5	3	3	3	2	2	1			1				2	2		
CO-6	3	3	3	2	2	2	1	1	1	1		1	3	3	1	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution																

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		03
1. Demonstration using Videos	01	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	01	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		12
1. Assignment Discussion / Related Activities	10	
2. Case Study Presentation	10	
3. Guest Lecture	02	
4. Industry / Field Visit	00	
5. Brain Storming Sessions	00	
6. Group Discussions	00	
7. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

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7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Tech. (Artificial Intelligence and Machine Learning) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ►	SC1	SC2	SC3	SC4	
Subcomponent Type ►	Term Test	Term Test	Assignment	Assignment	100 Marks
Maximum Marks ►	25	25	25	25	
CO-1	X	X			X
CO-2	X	X			X
CO-3	X	X	X	X	X
CO-4			X	X	X
CO-5			X	X	X
CO-6			X	X	X
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Assignments
4.	Analytical Skills	Assignments
5.	Problem Solving Skills	Assignments, Examination
6.	Practical Skills	Assignments
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignments

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14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. Koller, D., and Friedman, N. (2009) *Probabilistic Graphical Models: Principles and Techniques*, MIT Press.

b. Recommended Reading

1. Darwiche, A. (2009) *Modeling and Reasoning with Bayesian Networks*, Cambridge University Press.
2. Whittaker J. (2009) *Graphical Models in Applied Multivariate Statistics*, Wiley.
3. Pearl, J. (1986) *Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference*, Morgan Kaufmann.
4. Pearl, J., and Mackenzie, D. (2018) *The Book of Why: The New Science of Cause and Effect*, Basic Books.

10. Course Organization

Course Code	19MIE503A	
Course Title	Probabilistic Graphical Models	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
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Course Specifications Approval Date	June 2022	
Next Course Specifications Review Date	June 2026	

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Course Specifications AI for Healthcare

Course Title	AI for Healthcare
Course Code	19MIE504A
Course Type	Professional Elective
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

Students shall be taught the role of Artificial intelligence in various Healthcare specialities, role of text mining and NLP in extracting information from medical records, application of deep learning in diagnosis and ethical aspects.

2. Course Size and Credits:

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After the successful completion of this course, the student will be able to:

- **CO-1.** To discuss the role and assess the benefits and risks of Artificial Intelligence in Healthcare; to discuss the present state and future of AI in major Healthcare specialties
- **CO-2.** To apply text mining and Natural Language Processing methods to extract information from Electronic Health Records
- **CO-3.** To predict the outcome of interventions: causal inference from observational data.
- **CO-4.** To discuss the role of deep learning in diagnosis and drug discovery and apply deep learning to problems in healthcare.
- **CO-5.** To discuss ethics of machine learning and apply bias and fairness criteria

4. Course Contents

Unit 1 (Introduction): Role of Artificial Intelligence in Healthcare, benefits and risks.

Unit 2 (AI in major healthcare specialties): AI in major healthcare specialties such as Radiology, Pathology, Surgery, Cardiology, Pharmacy and Orthopaedics.

Unit 3 (Electronic Health records): Electronic Health records and application of text mining and NLP to extract information, causal inference.

Unit 4 (Machine learning and Deep learning): Application of machine learning and deep learning in healthcare. machine learning in radiology.

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Unit 5 (Computational Pathology): AI for computational pathology, ethical considerations in using AI in Healthcare.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	
CO-1	2	1			2											
CO-2	3	3														
CO-3	2					2		2		2			3			
CO-4	2	3				3	3					3		3		
CO-5			2	3					2		2				2	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution																

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		05
1. Solving Numerical Problems	05	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

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7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B.Tech. (Computer Science and Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ►	SC1	SC2	SC3	SC4	
Subcomponent Type ►	Term Test	Term Test	Assignment	Group Task	100 Marks
Maximum Marks ►	25	25	25	25	
CO-1	X		X	X	X
CO-2	X		X	X	X
CO-3	X		X	X	X
CO-4		X	X	X	X
CO-5		X	X	X	X
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Assignments
4.	Analytical Skills	Assignments
5.	Problem Solving Skills	Assignments, Examination
6.	Practical Skills	Assignments
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignments
14.	Personal Management	--
15.	Leadership Skills	--

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9. Course Resources

a. **Essential Reading**
   1. Course notes
   2. Mahajan MD, Parag Suresh (2018) Artificial Intelligence in Healthcare, Paperback.
   3. Panesar, Arjun(2019), Machine learning and AI for Healthcare-Big Data for Improved Health Outcomes, APress.
   4. Recommended Journal Papers.
   5. Class Notes

b. **Recommended Reading**
   1. TheScientist

c. Websites
   2. https://www.kernel.org
   3. http://www.sigops.org

10. Course Organization

Course Code	19MIE504A	
Course Title	AI for Healthcare	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cs.et@msruas.ac.in
Course Specifications Approval Date	June 2022	
Next Course Specifications Review Date	June 2026	

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Course Specifications: Computer Vision

Course Title	Computer Vision
Course Code	19MIE505A
Course Type	Professional Elective
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course focuses on study of algorithms and techniques to analyze and interpret the visible world around us. This includes understanding of the fundamental concepts related to multi-dimensional signal processing, feature extraction, pattern analysis, visual geometric modelling, stochastic optimization etc. Knowledge of these concepts will enable students to understand and develop applications using existing tools in the field of computer vision. Applications range from biometrics, medical diagnosis, document processing, mining of visual content, to surveillance, advanced rendering etc.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:1
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After the successful completion of this course, the student will be able to:

CO-1. Discuss fundamentals of Digital Images with Image Formation and processing.
CO-2. Discuss Image processing Techniques.
CO-3. Analyse and apply Image processing algorithms to solve recent computer vision problems
CO-4. Gather a basic understanding about the geo-metric relationships between 2D images and the 3D world. Apply classification, clustering, and tracking algorithms for a given computer vision application.
CO-5. Apply classification, clustering, and tracking algorithms for a given computer vision application.
CO-6. Implement machine learning algorithms for computer vision applications

4. Course Contents

Unit 1 (Digital Image Formation and processing):
Overview, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing, Mrphological operations

Unit 2 (Feature Extraction):

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Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters.

Unit 3 (Image Segmentation):
Region Growing, Region Merging, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Object detection.

Unit 4 (Texture Analysis)
Overview, Textures Features, Texture Representation, Texture based matching – classification, Texture segmentation, Feature extraction from varying textures, Gabor Filters, Law's Texture Energy Measures, Wavelet Analysis, CWT, DWT, Steerable Pyramids, Region Based Texture Segmentation, Change in scale and orientation, image stitching.

Unit 5 (Pattern Analysis):
Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods.

Unit 6 (Motion Analysis):
Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.

Unit 7 (Applications):
Inspection(Factory monitoring: Analyze components for deviations,
Biometrics (face recognition, facial biometrics and object/feature detection etc.), Surveillance,
Robot vision– Obstacle avoidance, object recognition– Motion compensation/image stabilization

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	
CO-1	2	1			2											
CO-2	1	2														
CO-3	3					3		3		1			3			
CO-4	3	2				3	2					1		3		
CO-5			3	2					1		1				2	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution																

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30

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Demonstrations		03
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	03	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		25
1. Course Laboratory	00	
2. Computer Laboratory	25	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		02
1. Case Study Presentation	00	
2. Guest Lecture	02	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	03	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Tech. (Artificial Intelligence and Machine Learning) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ►	SC1	SC2	SC3	SC4	
Subcomponent Type ►	Term Test	Term Test	Assignment	Group Task	100 Marks
Maximum Marks ►	25	25	25	25	
CO-1	X	X			X
CO-2	X	X			X
CO-3	X	X			X
CO-4			X	X	X
CO-5			X	X	X
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Assignments
4.	Analytical Skills	Assignments
5.	Problem Solving Skills	Assignments, Examination
6.	Practical Skills	Assignments
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignments
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. R.C. Gonzalez and R.E. Woods, 1992, Digital Image Processing, Addison- Wesley
2. M. C. Bishop, 2006, Pattern Recognition and Machine Learning, Springer
3. S. Theodoridis, K. Koutroumbas, 2008, Pattern Recognition, Academic Press..
4. Class Notes.

b. Recommended Reading

1. R. Szeliski, 2010, Computer Vision: Algorithms and Application, Springer-Verlag Inc.
2. D. A. Forsyth, J. Ponce, 2003, Computer Vision: A Modern Approach, Pearson Education

Magazines and Journals

1. IEEE-T-PAMI (IEEE Transactions on Pattern Analysis and Machine Intelligence).
2. IJCV (International Journal of Computer Vision) - Springer.
3. https://www.cs.cmu.edu/~aarti/Class/10701/
4. Segmentation and Registration Toolkit (ITK): https://itk.org/
5. Visualization Toolkit: https://vtk.org/

c. Websites

1. https://machinelearningmastery.com/

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2. https://elitedatascience.com/
3. https://www.kdnuggets.com/
4. https://www.kaggle.com/
5. https://online.datasciencedojo.com/blog/
6. https://ryanswanstrom.com/blog/
7. https://towardsdatascience.com/

10. Course Organization

Course Code	19MIE505A	
Course Title	Computer Vision	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cs.et@msruas.ac.in
Course Specifications Approval Date	June 2022	
Next Course Specifications Review Date	June 2026	

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Course Specifications: AI for Robots

Course Title	AI for Robots
Course Code	19MIE506A
Course Type	AI for Robots
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The topic of planning is important in Artificial intelligence and Robotics. Students shall be taught planning algorithms with an emphasis on discrete planning. An overview of planning in a continuous space shall be discussed. Applications in the context of robots shall be discussed.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:1
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After the successful completion of this course, the student will be able to:

- **CO-1.** To discuss and apply concepts of discrete planning, decision-theoretic planning.
- **CO-2.** To discuss and apply concepts of sequential decision theory; to apply reinforcement learning to robots.
- **CO-3.** To discuss and apply the concepts of sensors and information spaces.
- **CO-4.** To perform planning under sensing uncertainty
- **CO-5.** To discuss planning in a continuous space

4. Course Contents

Unit 1 (Motivation and Introduction:):
Overview of Artificial Intelligence, Robotics and Planning.

Unit 2 (Discrete Planning:):
Introduction to discrete feasible planning, searching for feasible plans, discrete optimal planning, application of logic in discrete planning, logic-based planning methods, concepts of decision theory, two-player zero sum games, nonzero-sum games;, introduction to sequential decision theory, algorithms for computing feedback plans, infinite-horizon plans, reinforcement learning, sequential game theory, sensors and information spaces, discrete state spaces, derived information spaces, planning under sensing uncertainty, general methods, localization, environment uncertainty and mapping.

Unit 3 (Planning in a continuous state space:):
Introduction to planning in a continuous state space; overview of topics such as sampling-based motion planning and feedback motion planning.

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5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	
CO-1	2	1			2											
CO-2	1	2														
CO-3	3					3		3		1			3			
CO-4	3	2				3	2					1		3		
CO-5			3	2					1		1				2	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution																

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		03
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	05	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		25
1. Course Laboratory	00	
2. Computer Laboratory	25	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		02
1. Case Study Presentation	00	
2. Guest Lecture	02	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	03	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

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The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Tech. (Artificial Intelligence and Machine Learning) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ►	SC1	SC2	SC3	SC4	
Subcomponent Type ►	Term Test	Term Test	Assignment	Group Task	100 Marks
Maximum Marks ►	25	25	25	25	
CO-1	X	X			X
CO-2	X	X			X
CO-3	X	X			X
CO-4			X	X	X
CO-5			X	X	X
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Assignments
4.	Analytical Skills	Assignments
5.	Problem Solving Skills	Assignments, Examination
6.	Practical Skills	Assignments
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignments
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

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a. **Essential Reading**

1. Steven M.LaValle, Planning Algorithms, Cambridge University Press.
2. Available at: http://msl.cs.uiuc.edu/planning/bookbig.pdf
3. Reading material, Journal and Conference papers suggested in class
4. Class Notes

Magazines and Journals

1. IEEE-T-PAMI (IEEE Transactions on Pattern Analysis and Machine Intelligence).
2. IJCV (International Journal of Computer Vision) - Springer.
3. https://www.cs.cmu.edu/~aarti/Class/10701/
4. Segmentation and Registration Toolkit (ITK): https://itk.org/
5. Visualization Toolkit: https://vtk.org/

b. **Websites**

1. https://machinelearningmastery.com/
2. https://elitedatascience.com/
3. https://www.kdnuggets.com/
4. https://www.kaggle.com/
5. https://online.datasciencedojo.com/blog/
6. https://ryanswanstrom.com/blog/
7. https://towardsdatascience.com/

10. Course Organization

Course Code	19MIE506A	
Course Title	AI for Robots	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cs.et@msruas.ac.in
Course Specifications Approval Date	June 2022	
Next Course Specifications Review Date	June 2026	

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Course Specifications: Information Theory and Coding

Course Title	Information Theory and Coding
Course Code	19MIE507A
Course Type	Professional Elective
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with the concepts of information theory and coding. Students are taught various encoding techniques for digital data representation and processing, performance limits and Shannon theorems. The course also emphasizes entropy, information measures and various error detection and correction techniques as applied to data storage, retrieval and processing.

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After the successful completion of this course, the student will be able to:

CO-1. Discuss types of information sources, Shannon entropy, encoding techniques, mutual information, channels, and channels capacity.
CO-2. Discuss the basic concepts of Information Theory and fundamental limits to information transmission via Shannon's theorems.
CO-3. Apply information theory to compute the entropy of sources and channel capacities.
CO-4. Design encoders and decoders for error control coding techniques
CO-5. Evaluate information measures and various codes for a given application.

4. Course Contents

Unit 1 Information Theory: Introduction, Measure of information, Average information content of symbols in long independent sequences, Average information content of symbols in long dependent sequences. Markov model for information source, Entropy and information rate of Markov source.

Unit 2 Source Coding: Encoding of the source output, Shannon's encoding algorithm. Communication Channels, Discrete communication channels, Continuous channels. Source encoding: Encoding of the source output, Shannon's encoding theorem and algorithm. Shannon-Fano codes, Huffman coding, Arithmetic coding, The Lempel–Ziv coding, Run length encoding.

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Unit 3 Fundamental Limits on Performance: Source coding theorem, Huffman coding, Discrete memory less Channels, Mutual information, Channel Capacity. Channel coding theorem, Differential entropy and mutual information for continuous ensembles, Channel capacity theorem.

Unit 4 Discrete communication channel: Models, Mutual information, Channel coding theorem, Channel capacity theorem. Continuous channel: Differential entropy, Mutual information, Channel capacity.

Unit 5 Error Control Coding: Introduction, Types of errors, examples, Types of codes Linear Block Codes: Matrix description, Error detection and correction, Standard arrays and table look up for decoding. Finite fields, Binary Cycle Codes, Algebraic structures of cyclic codes, Encoding using an (n-k) bit shift register, Syndrome calculation. BCH codes. RS codes, Golay codes, Shortened cyclic codes, Burst error correcting codes. Burst and Random Error correcting codes.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
CO-1	3	3	1	2									1			
CO-2	3	3	3	1	2	1						1	2	1	1	
CO-3	3	3	3	2	2	1			1			1	3	3		
CO-4	3	3	3	2	2	1			1				2	2		
CO-5	3	3	3	2	2	2	1	1	1	1		1	3	3	1	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution																

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		20
1. Solving Numerical Problems	20	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	

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Others		10
1. Assignment Discussion / Related Activities	05	
2. Case Study Presentation	03	
3. Guest Lecture	02	
4. Industry / Field Visit	00	
5. Brain Storming Sessions	00	
6. Group Discussions	00	
7. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Tech. (Artificial Intelligence and Machine Learning) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ►	SC1	SC2	SC3	SC4	
Subcomponent Type ►	Term Test	Term Test	Assignment	Assignment	100 Marks
Maximum Marks ►	25	25	25	25	
CO-1	X	X			X
CO-2	X	X			X
CO-3	X	X	X	X	X
CO-4			X	X	X
CO-5			X	X	X
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

Sr No	Curriculum and Capabilities Skills	How imparted during the course

1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Assignments
4.	Analytical Skills	Assignments
5.	Problem Solving Skills	Assignments, Examination
6.	Practical Skills	Assignments
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignments
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. Shanmugam, K. S. (1996) *Digital and Analog Communication Systems,* John Wiley & Sons.

b. Recommended Reading

5. Cover, T. M., and Thomas, J. A. (2006) *Elements of Information Theory,* 2nd edn., John Wiley & Sons.
6. Neubauer, A., Freudenberger, J., and Kuhn, V. (2007) *Coding Theory: Algorithms, Architectures and Applications,* John Wiley & Sons.
7. Haykin, S. (2008) *Digital Communication,* John Wiley India Pvt. Ltd.
8. Gallagar, R. G. (2008) *Principles of Digital Communication,* Cambridge University Press.

10. Course Organization

Course Code	21MIEXXXA	
Course Title	Information Theory and Coding	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cs.et@msruas.ac.in
Course Specifications Approval Date	June 2022	
Next Course Specifications Review Date	June 2026	

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Course Specifications: Internship

Course Title	Internship
Course Code	19MIC521A
Course Type	Core
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to give students an experience of identifying an engineering problem, conceptualise a solution, perform basic design calculations, model, solve, analyse and demonstrate its performance in a virtual environment. The students are expected to work in a team of not more than 4 members and are required to develop an appropriate solution by identifying a problem for which a better or new engineering solution is required. The team need to demonstrate the working of the solution and write a technical report. Students are required to choose a project from students projects database available. Alternatively, Student can undergo internship in an industry, business organization, research organization or any other university on a topic of relevance during vacation after 6th semester with prior approval from the department head and faculty dean.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	0:0:4
Total Hours of Interaction	120
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After the successful completion of this course, the student will be able to:

- **CO-1.** Recognise the need for developing a new or improving an existing engineering product/system through an organised survey of literature
- **CO-2.** Define engineering design specifications
- **CO-3.** Design, model, solve, analyse the product/system to meet the design specifications
- **CO-4.** Evaluate the performance of the modelled system and justify its performance
- **CO-5.** Demonstrate the system working in a virtual environment and make a presentation
- **CO-6.** Write a technical report Alternatively,
- **CO-7.** Write a report on experiences during internship
- **CO-8.** Make a presentation to a panel of examiners

4. Course Contents

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Unit 1: Collection of relevant literature and review of literature

Unit 2: Interaction with the users and collection of data

Unit 3: Data Analysis, Formulation of a problem of suitable size

Unit 4: Product development planning, cost calculations

Unit 5: Detail design calculations

Unit 6: Choosing a modeling environment, learning the appropriate tools and techniques

Unit 7: Modelling, simulation and analysis of design

Unit 8: Defining performance parameters, Evaluation of performance, presentation performance characteristics, Verification of results

Unit 9: Developing a working model, testing the model and evaluating its performance Demonstration to the defined audience and making a presentation to the assessing team making a Technical presentation

Unit 10: Writing project report

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	3	2	3	2	1	2	3		1	3	3	3	3
CO-2	2	2	2				1	2	3		1	3	3	2	3
CO-3	2	1	2	2	2	2		2	3		1	2	3	2	3
CO-4	2		2		2	2			2			3	2	2	3
CO-5	2	1	1		2	2			3	3		3	1	2	3
CO-6	1							2	2	3		3	1		3
CO-7	2							2	3	3		2	1		3
CO-8	1							2	3	3		3	1		3
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

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6. Course Teaching and Learning Methods

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Teaching and Learning Methods	Approximate Duration in Hours
Literature collection, Review of literature, Deciding the sample, for data collection, Developing a questionnaire, Data collection, Analysis of data, Problem formulation and Defining specifications	20
Development of design concept, Basic design calculations	40
Selection of tools, techniques and learning on how to use them	20
Modelling, Simulation, Analysis	40
Evaluation, Verification of results	20
Demonstration, Presentation and Technical Report Writing	20
Total Duration in Hours	160

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B.Tech. (Electronics and Communication Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

	Component 1: Presentation (50% Weightage)	Component 2: Dissertation (50% Weightage)
Subcomponent ▶	SC1	
Subcomponent Type ▶	Mid-term	50 Marks
Maximum Marks ▶	50 Marks	
CO-1	X	X
CO-2	X	X
CO-3	X	X
CO-4	X	X
CO-5	X	X
CO-6	X	X
CO-7	X	X
CO-8	X	X

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Project Work
2.	Understanding	Project Work

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3.	Critical Skills	Project Work
4.	Analytical Skills	Project Work
5.	Problem Solving Skills	Project Work
6.	Practical Skills	Project Work
7.	Group Work	Project Work
8.	Self-Learning	Project Work
9.	Written Communication Skills	Project Work
10.	Verbal Communication Skills	Project Presentation, Viva Voice
11.	Presentation Skills	Project Presentation
12.	Behavioral Skills	Project Work
13.	Information Management	Project Report
14.	Personal Management	Project Work
15.	Leadership Skills	Project Work

9. Course Resources

a. **Essential Reading**

1. Presentations made by the Head of the Department on "Importance of Project work and The Methodology to be followed for successful Completion of Project work"

b. **Recommended Reading**

1. Course Notes, Manuals of Tools and Techniques Chosen to Solve the Design Problem

c. **Magazines and Journals**

d. **Websites**

e. **Other Electronic Resources**

10. Course Organization

Course Code	19MIC521A	
Course Title	Internship1	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cs.et@msruas.ac.in
Course Specifications Approval Date	June 2022	
Next Course Specifications Review Date	June 2026	

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Course Specifications: Group Project

Course Title	Group Project
Course Code	19MIC522A
Course Type	Core Course
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is intended to provide student an opportunity to synergies their learning from the earlier courses through working in a team, sharing responsibilities, to conceiving, designing and fabricating a working prototype of a system related to an automotive application. The students will learn skills related to project identification, planning, management and execution, working in teams and verbal and written communication. During design, analysis and synthesis stage, they will get an opportunity to apply theoretical knowledge to develop real life product and prototyping stage will provide them experience of converting a design into a working system through use of various fabrication techniques available.

2. Course Size and Credits:

Number of Credits	8
Credit Structure (Lecture: Tutorial: Practical)	0
Total Hours of Interaction	330
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	200
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After the successful completion of this course, the student will be able to:

- **CO-1.** To Work in a team and undertake a project in their area of specialization
- **CO-2.** To Apply their knowledge of general and automotive engineering and application, develop a system for automotive application.
- **CO-3.** To apply appropriate research methodology while formulating a project
- **CO-4.** To Prepare specifications, design, analyse, synthesize, prototype and assess the system
- **CO-5.** To Prepare and present appropriate forms of audio-visual and verbal presentations, and written document, to describe the project, its execution and outcome

4. Course Contents

Unit 1 Team building, Team work and Leadership skills

Unit 2 Preparing design specifications, design, analysis and synthesis, design evaluation calculations

Unit 3 Costing, Finance Management, Project management
Unit 4 Procurement, prototype building and related manufacturing methods

Unit 5 Preparing and presenting audio-visual and verbal presentations and preparing written documents

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5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	
CO-1	3	3		2					1	1			3			
CO-2	3	3											3			
CO-3	3	3											3			
CO-4	3	3	3		2				1	1			3			
CO-5	3	3	3		2				1	1			3			
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution																

6. Course Teaching and Learning Methods

Topics	Teaching methods	Hours
Critical Review, Problem Formulation and stating Objectives	Reading Journal papers , books and other relevant materials and problem formulation	20.00
	Presentation to Reviewers	5.00
System Design	Group work with supervisors guidance	30.00
System Modelling, Simulation and Analysis	Group work with supervisors guidance	60.00
Model Building, Instrumentation, Testing and Evaluation	Group work with supervisors guidance	100.00
Verification/Validation	Group work with supervisors guidance	50.00
Drawing Conclusions	Group work with supervisors guidance	10.00
Video creation, Presentation ,Thesis/Report Writing and Viva Voce	Presentation and Viva voce - Group	5.00
	Thesis/Report writing - Group	30.00
	Project Exhibition and Video creation - Group	10.00
	Tests/Examinations/Presentations	10.00
	Total	330.00

6. Course Assessment and Reassessment

Course Assessment will be followed as per section 23. Assessment and Grading of Programme Specifications. The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

Note: The above time calculation is for each student and a group can consists of 4 students and total hours can be computed accordingly.

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	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)	
Subcomponent ►	SC1	SC2	SC3	SC4
Subcomponent Type ►	Mid Term presentation	Final Presentation	Exhibition	Project Report
Maximum Marks ►	50	50	50	50
CO-1	X			X
CO-2	X			X
CO-3	X	X		X
CO-4		X		X
CO-5			X	X
CO-6			X	X

7. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Project work
2.	Understanding	Project work
3.	Critical Skills	Project work
4.	Analytical Skills	Project work
5.	Problem Solving Skills	Project work
6.	Practical Skills	Project work
7.	Group Work	Project work
8.	Self-Learning	Project work
9.	Written Communication Skills	Project work
10.	Verbal Communication Skills	Project work
11.	Presentation Skills	Project work
12.	Behavioral Skills	Project work
13.	Information Management	Project work
14.	Personal Management	Project work
15.	Leadership Skills	Project work

8. Course Resources

a. Essential Reading

1. Presentations made by the Head of the Department on "Importance of Project work and The Methodology to be followed for successful Completion of Project work"
2. Assigned reading relevant to the group project

b. Recommended Reading

c. Magazines and Journals

1. https://link.springer.com/journals/a/1
2. https://ieeexplore.ieee.org/Xplore/home.jsp
3. https://dl.acm.org/

d. Websites

www.ieee.org

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2. http://nptel.ac.in/

e. **Other Electronic Resources**

1. https://ocw.mit.edu/index.htm

9. Course Organization

Course Code	19MIC522A		
Course Title	Group Project		
Course Leader's Name	As per Timetable		
Course Leader's Contact Details	**Phone:**	+91-804-906-5555	
	E-mail:	hod.cs.et@msruas.ac.in	
Course Specifications Approval Date	June 2022		
Next Course Specifications Review Date	June 2026		

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Course Specifications: Dissertation and Publication

Course Title	Dissertation and Publication
Course Code	19MIC523A
Course Type	Core Course
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is intended to give an insight to the students on application of principles of research methodology, preparation of research project proposal, research project management, execution of research project and effective technical communication and presentation. It also emphasizes the need and the relevance of a structured approach to identify a research topic and undertake research. This course provides an opportunity for students to apply theories and techniques learnt during programme work. It involves in-depth work in the chosen area of study.

2. Course Size and Credits:

Number of Credits	10
Credit Structure (Lecture: Tutorial: Practical)	-
Total Hours of Interaction	600
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	400
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After the successful completion of this course, the student will be able to:

- **CO-1.** Critically review scholarly literature collected from various sources for the project purpose and formulate a research problem
- **CO-2.** Prepare and present a research proposal
- **CO-3.** Conduct research to achieve research objectives
- **CO-4.** Propose new ideas/methodologies or procedures for further improvement of the research undertaken
- **CO-5.** Create research document and write research papers for publications
- **CO-6.** Defend the research findings in front of scholarly audience

4. Course Contents

Unit 1 Research Methodology
Unit 2 Information search, retrieval and review
Unit 3 Project definition and project planning
Unit 4 Use of conceptual models and frameworks Problem
Unit 5 solving and Evaluation Interpretations and drawing
Unit 6 Conclusions Proposing ideas or methods for further work
Unit 7 Thesis writing
Unit 8 Oral presentation
Unit 9 Authoring Research paper

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5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
CO-1	3	3		2					1	1			3			
CO-2	3	3											3			
CO-3	3	3											3			
CO-4	3	3	3		2				1	1			3			
CO-5	3	3	3		2				1	1			3			
CO-6	3	3	3		2				1	1			3			
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution																

6. Course Teaching and Learning Methods

Topics	Teaching methods	Hours
Information search, retrieval and review, Project definition and project planning	Reading Journal papers, books and other relevant materials and problem formulation	50.00
	Presentation to Reviewers	20.00
Use of conceptual models and frameworks	Individual work with supervisors guidance	60.00
Problem solving and Evaluation	Individual work with supervisors guidance	120.00
Interpretations and drawing conclusions	Individual work with supervisors guidance	100.00
Proposing ideas or methods for further work	Individual work with supervisors guidance	40.00
Presentation ,Thesis/Report Writing and Viva Voce, Authoring Research paper	Presentation and Viva voce	30.00
	Thesis/Report writing, Authoring research paper	150.00
	Video creation	15.00
	Tests/Examinations/Presentations	15.00
	Total	600.00

6. Course Assessment and Reassessment

Course Assessment will be followed as per section 23. Assessment and Grading of Programme Specifications. The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

Note: The above time calculation is for each student and total hours can be computed accordingly.

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	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)	
Subcomponent ►	SC1	SC2	SC3	SC4
Subcomponent Type ►	Mid Term presentation	Final Presentation	Research Paper	Project Report
Maximum Marks ►	100	100	100	100
CO-1	X			X
CO-2	X			X
CO-3	X	X		X
CO-4		X		X
CO-5			X	X
CO-6			X	X

7. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Project work
2.	Understanding	Project work
3.	Critical Skills	Project work
4.	Analytical Skills	Project work
5.	Problem Solving Skills	Project work
6.	Practical Skills	Project work
7.	Group Work	Project work
8.	Self-Learning	Project work
9.	Written Communication Skills	Project work
10.	Verbal Communication Skills	Project work
11.	Presentation Skills	Project work
12.	Behavioral Skills	Project work
13.	Information Management	Project work
14.	Personal Management	Project work
15.	Leadership Skills	Project work

8. Course Resources

a. **Essential Reading**

1. Presentations made by the Head of the Department on "Importance of Project work and The Methodology to be followed for successful Completion of individual Project work"
2. Assigned reading relevant to the individual project

b. **Recommended Reading**

c. **Magazines and Journals**

1. https://link.springer.com/journals/a/1
2. https://ieeexplore.ieee.org/Xplore/home.jsp
3. https://dl.acm.org/

d. **Websites**

1. www.ieee.org
2. http://nptel.ac.in/

e. **Other Electronic Resources**

1. https://ocw.mit.edu/index.htm

9. Course Organization

Course Code	19MIC523A		
Course Title	Dissertation and Publication		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	+91-804-906-5555
		E-mail:	hod.cs.et@msruas.ac.in
Course Specifications Approval Date		June 2022	
Next Course Specifications Review Date		June 2026	

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