RAMAIAH UNIVERSITY OF APPLIED SCIENCES

Programme Structure and Course Details of

B.Tech. (Mechanical Engineering) Degree Programme

Programme Code: 005

Faculty of Engineering and Technology

Batch 2023-2027

Approved during the 29th Academic Council Meeting held on 14th July 2023

Head
Department of Mechanical Engineering
Faculty of Engineering and Technology
M.S.Ramaiah University of Applied Sciences
Bengaluru - 560 058.

Associate Dean - Academics
Ramaiah Technology Campus
M. S. Ramaiah University of Applied Sciences
Bangalore - 560 058.

Dean
...ty of Engineering & Technology
...Ramaiah University of Applied Sciences
Bangalore - 560 058.

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

Programme Specifications: B. Tech. (Mechanical Engineering)

Faculty	Engineering and Technology
Department	Mechanical and Manufacturing Engineering
Programme Code	005
Programme Name	B.Tech. (Mechanical Engineering)
Dean of the Faculty	Prof. J V Desai
Head of the Department	Dr. Dayananda B S

1. **Title of the Award:** B.Tech. (Mechanical Engineering)
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:** October 2023
7. **Date of Programme Approval by the Academic Council of MSRUAS:** 08-July-2023
8. **Next Review Date:** May 2027
9. **Programme Approving Regulating Body and Date of Approval:** All India Council for Technical Education, New Delhi, 30-Jun-2020
10. **Programme Accredited Body and Date of Accreditation:** Not Applicable
11. **Grade Awarded by the Accreditation Body:** Not Applicable
12. **Programme Accreditation Validity:** Not Applicable
13. **Programme Benchmark:** Not Applicable
14. **Rationale for the Programme**

Mechanical engineering is one of the oldest disciplines of engineering. Designing and manufacturing of mechanical machinery and equipment have been there world over for many centuries. Mechanical Engineering is a foundational discipline, critical to the success of many enterprises. It plays a key role in energy, transportation, development of infrastructure and manufacturing of consumer durables.

Presently, mechanical engineers are contributing in research and development pertaining to environmental and bio-medical fields. Mechanical engineers are responsible for selection and processing of eco-friendly materials and processes, design and fabrication of medical devices and prostheses to improve quality of life.

The mechanical engineering programme at Faculty of Engineering and Technology at RUAS has been developed by the members of the faculty based on their teaching experience and long standing interactions with various Universities and industries in India and abroad. The curriculum is

outcome based and helps students to develop critical thinking abilities and imbibe relevant practical skills for a smooth transition from academics to real-life work environment. Opportunities are provided for the students to do their internship in India or abroad depending on their preferences.

The alumni of the faculty hold respected positions in industry and business in India and abroad. The faculty interacts with the industry and business offering engineering and consultancy, product design and development services along with training modules to practicing professionals. The faculty interacts with more than 150 companies in public and private sectors including OEMs spread across India. The above mentioned features of the programme and the faculty members' strong footing in industry and business make the programme unique. The student admitted to the programme in mechanical engineering is given a strong foundation in real-life problem solving which is quite rare with many institutions offering similar programme.

15. Programme Mission

The purpose of the programme is creation of innovative problem solvers in multi-disciplinary settings, entrepreneurs and leaders applying the knowledge, understanding, cognitive abilities, practical skills and transferable skills gained through systematic, flexible and rigorous learning in the chosen academic domain.

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

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)

B.Tech. graduates will be able to:

PO-1. Apply knowledge of mathematics, science, basic engineering fundamentals and engineering specialization concerned for the solution of complex engineering problems

PO-2. Identify, formulate and analyze engineering problems using first principles of mathematics, science and engineering to interpret data and reach substantiated conclusions

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. Apply the knowledge of laboratory techniques and research methods to solve complex engineering problems through experimental investigations, analysis and interpretation of results

PO-5. Gain proficiency in modelling complex engineering activities by selecting appropriate techniques and IT Tools 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

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. Recognize and engage in lifelong learning to adapt to changing needs and advancements in technology

18. Programme Goal

The programme goal is to produce graduates with critical, analytical and problem solving skills, and ability to think independently, to pursue a career in Mechanical Engineering.

19. Programme Educational Objectives (PEOs)

The objectives of the B.Tech. (Mechanical Engineering) Programme are:

PEO-1. To provide students with knowledge in mathematics, science and core engineering area to enable them to deliver efficient solutions for complex engineering problems using analytical and cognitive skills

PEO-2. To enable students to design and develop sustainable innovative solutions for industry and societal requirements by conducting engineering investigations through experimentation and 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 B.Tech.(Mechanical Engineering) program, the graduate will be able to:

PSO-1. Apply the knowledge of Mechanical Design, Thermal Engineering and Manufacturing to develop efficient solutions for complex problems in mechanical engineering and allied areas

PSO-2. Design and develop sustainable solutions using Mechanical Engineering principles, concepts, experimentation and appropriate tools to address industry and societal requirements

PSO-3. Demonstrate ethics, leadership qualities, communication, entrepreneurial skills and involvement in lifelong learning for the betterment of organization, environment and society

21. Programme Structure:

Semester 1 (Physics Cycle)							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	MTF101A	Engineering Mathematics-1	3	2	0	4	100
2	PYB102A	Engineering Physics	3	0	2	4	100
3	MEF101A	Introduction to Mechanical Engineering	3	0	2	4	100
4	MEL105A	Workshop Practice	0	0	2	1	50
5	TSM101A	English Communication	1	0	2	2	50
		Total	10	2	8	15	400
		Total number of contact hours per week	**20**				

Semester 1 (Chemistry Cycle)							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	MTF101A	Engineering Mathematics-1	3	2	0	4	100
2	CYB104A	Engineering Chemistry	3	0	2	4	100
3	MEF101A	Introduction to Mechanical Engineering	3	0	2	4	100
4	MEF103B	Engineering Graphics	2	0	2	3	100
5	TSN102A	Kannada Kali	1	0	0	1	50
		Total	12	2	6	16	450
		Total number of contact hours per week	**20**				

Semester 2 (Physics Cycle)							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	MTF111A	Engineering Mathematics - 2	3	2	0	4	100
2	PYB102A	Engineering Physics	3	0	2	4	100
3	MEF106A	Applied Mechanics	3	1	0	4	100
4	CSB102A	Programming in Python	2	0	2	3	100
5	MEL105A	Workshop Practice	0	0	2	1	50
6	BTN101A	Environmental Studies	2	0	0	2	50
7	TSM101A	English Communication	1	0	2	2	50
		Total	16	2	8	20	550
		Total number of contact hours per week	**26**				

Semester 2 (Chemistry Cycle)							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	MTF111A	Engineering Mathematics - 2	3	2	0	4	100
2	CYB104A	Engineering Chemistry	3	0	2	4	100
3	MEF106A	Applied Mechanics	3	1	0	4	100
4	CSF102A	Programming in Python	2	0	2	3	100
5	MEF103B	Engineering Graphics	2	0	2	3	100
6	BTN101A	Environmental Studies	2	0	0	2	50
7	TSN102A	Kannada Kali	1	0	0	1	50
		Total	16	2	8	21	600
		Total number of contact hours per week	**26**				

Semester 3							
Sl. No.	**Code**	**Course Title**	**Theory (h/W/S)**	**Tutorials (h/W/S)**	**Practical (h/W/S)**	**Total Credits**	**Max. Marks**
1.	MTF201A	Engineering Mathematics- 3	3	0	2	4	100
2.	MEC201A	Materials Science	3	0	0	3	100
3.	MEC202A	Mechanics of Deformable Solids	3	0	2	4	100
4.	MEC203A	Manufacturing Processes	3	0	2	4	100
5.	MEC204A	Fluid Mechanics and Machines	3	0	2	4	100
6.	TSN201A	Essence of Indian Knowledge system	1	0	0	1	50
		Total	16	0	8	20	550
Total Number of Contact Hours per week			24				

Semester 4							
Sl. No.	**Code**	**Course Title**	**Theory (h/W/S)**	**Tutorials (h/W/S)**	**Practical (h/W/S)**	**Total Credits**	**Max. Marks**
1.	MTF202A	Engineering Mathematics - 4	3	0	2	4	100
2.	MEL205A	Mechanical dissection and machine drawing	3	0	2	4	100
3.	MEC205A	Machine Dynamics 1	3	0	2	4	100
4.	MEC206A	Engineering Thermodynamics	3	0	0	3	100
5.	MEC207A	Mechanical Measurements and Metrology	2	0	2	3	100
6.	MEC208A	Conventional Machining Processes	3	0	2	4	100
7.	LAN201A	Indian Constitution, Human Rights and Law	2	0	0	2	50
8.	MEI201A	Internship – 1	0	0	4	2	50
9.	BAU210A	Innovation and Entrepreneurship	3	0	0	3	100
		Total	22	0	14	29	800
Total Number of Contact Hours per week			36				

Semester 5							
Sl. No.	**Code**	**Course Title**	**Theory (h/W/S)**	**Tutorials (h/W/S)**	**Practical (h/W/S)**	**Total Credits**	**Max. Marks**
1.	ROC301A	Control Systems and Engineering	2	0	2	3	100
2.	MEC302A	Thermal Engineering	3	0	2	4	100
3.	MEC303A	Design of Machine elements 1	2	2	0	3	100
4.	MEC304A	Machine Dynamics-2	3	0	2	4	100
5.	MEC305A	Automation in Manufacturing and Industry 4.0	3	0	0	3	100
6.	MEC306A	Engineering Economics and Cost Estimation	3	0	0	3	100
7.	MEC307A	AI for mechanical Engineers	3	0	0	3	100
8.	PTU101A. BNE101A	Yoga/Sports	0	0	4	2	50
9.	PTF301A	Aptitude and Analytical Reasoning -1	0	0	2	1	50
		Total	17	4	15	26	800
Total Number of Contact Hours per week					35		

Semester 6							
Sl. No.	**Code**	**Course Title**	**Theory (h/W/S)**	**Tutorials (h/W/S)**	**Practical (h/W/S)**	**Total Credits**	**Max. Marks**
1	MEC308A	Heat Transfer	3	0	2	4	100
2	MEC309A	Finite Element Analysis	3	0	2	4	100
3	MEC310A	Design of Machine Elements - 2	2	2	0	3	100
4	MEC311A	Industrial Engineering and Lean Operations	3	2	0	3	100
5	MEE31XA	Professional Core Elective – 1	4	0	0	4	100
6	OETXXX	Open Elective – 1	3	0	0	3	100
7	PTF302A	Aptitude and Analytical Reasoning -2	0	0	2	1	50
8	MEI301A	Internship – 2	0	0	4	2	50
Total			19	2	8	24	700
Total Number of Contact Hours per week			29				

Semester 7							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1.	MEE41XA	Professional Core Elective - 2	4	0	0	4	100
2.	MEE42XA	Professional Core Elective - 3	4	0	0	4	100
3.	OETXXX	Open Elective - 2	3	0	0	3	100
4.	MEI401A	Internship – 3	0	0	4	2	50
5.	MEP401A	Integrated Design Project	0	0	8	4	100
		Total	11	0	12	17	450
Total Number of Contact Hours per week			23				

Semester 8							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1.	MEP411A	Capstone Project	0	0	24	12	300
		Total	0	0	24	12	300
Total Number of Contact Hours per week			20				

		Professional Core Electives (PCE):						
Stream ▸ Group ▼		Design	Manufacturing	Thermal	Industrial Engineering	Robotics	Data Sciences and Analytics	Artificial intelligence and Machine learning
PCE-1, Sem. 6	Course Code	MEE311A	MEE312A	MEE313A	MEE314A	MEE315A	MTE301A	MTE302A
	Course Title	Advanced Mechanics of Materials	Advanced Manufacturing Technologies	Fluid Power Systems	Operations Research	Mechatronics and Automation	Probability and Statistics	Advanced Machine Learning
PCE-2 Sem. 7	Course Code	MEE411A	MEE412A	MEE413A	MEE414A	MEE425A	CSF411A	MTE401A
	Course Title	Noise Vibration and Harshness	Advanced Materials and Process	Computational Fluid Dynamics	Supply Chain Management	Robot Kinematics and Dynamics	Data Sciences and Foundation	Predictive maintenance using AI
PCE-3 Sem.7	Course Code	MEE421A	MEE422A	MEE423A	MEE424AA	MEE425A	CSE421A	MTE403A
	Course Title	Fatigue and Fracture Mechanics	Digital Manufacturing	Sustainable energy technologies	Quality Management and Six Sigma	Drone Technology	Data Analytics	Computer Vision

22. Open Elective Courses

A number of Open Elective Courses from Faculties of engineering, management and commerce, art and design, hospitality management and catering technology, pharmacy, dental sciences are offered as mentioned in the University's website. Students can choose the Open Electives on their own choice.

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.

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: 60% and SEE: 40%) 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

For a Theory Course:

Theory Course			
SC1	SC2	SC3	SC4
25 Marks	25 Marks	40 Marks	10 Marks

In Option 1, there shall be four subcomponents of CE (SC1, SC2, SC3 and SC4). Each subcomponent is evaluated individually. 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 = (30% of SC1 and SC2, 20% of SC3, 10%of SC4)

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.

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.

25.3. Laboratory Course

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

Laboratory Course	
SC1	SC2
20 Marks	10 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 = (20% of SC1 and 10% of SC2)

25.4. Course Having a Combination of Theory and Laboratory

For a course that contains the combination of theory and laboratory sessions, the 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	40 Marks	10 Marks

There shall be four subcomponents. 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 = (30% of SC1 and SC2, 20% of SC3, 10% of SC4)

26. Minor Programme

The details of the following aspects of the minor programmes are presented in the **Academic Regulations** for the B. Tech. Degree Programme:

1. Programme Structure
2. Eligibility to Minor Programme
3. Registration to Minor Programme
4. Certification for Minor Programme

27. Student Support for Learning

1. Course Notes
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

28. 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)

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.

Head
Department of Mechanical Engineering
Faculty of Engineering and Technology
M.S.Ramaiah University of Applied Sciences
Bengaluru - 560 058.

Associate Dean - Academics
Ramaiah Technology Campus
M. S. Ramaiah University of Applied Sciences
Bangalore - 560 058.

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

Course Specifications: Engineering Mathematics - 1

Course Title	Engineering Mathematics - 1
Course Code	MTF101A
Course Type	Core Theory
Department	Mathematics and Statistics
Faculty	Engineering and Technology

1. Course Summary

The course introduces students to the basic concepts of calculus and matrix algebra. Students are taught the concepts of limits, continuity, differentiation, series expansion for the functions of one and two variable, indefinite and definite integrals of single real variable functions. Basic concepts of vectors with necessary properties and operations are taught. The mathematical operations in matrix theory, eigenvalue and eigenvector, inversion and diagonalization of matrix and matrix solution for linear system of equations are discussed in this course.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:2:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
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.** State definitions and theorems of calculus and linear algebra
- **CO-2.** Explain the basic concepts of calculus and linear algebra
- **CO-3.** Solve simple mathematical problems associated with calculus and linear algebra
- **CO-4.** Apply the techniques of calculus and linear algebra to solve real world problems
- **CO-5.** Formulate mathematical models to complex real-world problems associated with calculus and linear algebra

4. Course Contents

Unit 1 (Single Variable Calculus); Rolle's Theorem and Lagrange's mean value theorem and their applications. Fundamental theorem of integral calculus. Improper integrals - classification and convergence, gamma and beta functions. Sequence of real numbers, Series, Tests for convergence of series: ratio test and root test. Power series, Taylor and Maclaurin series.

Unit 2 (Two Variable Calculus): Functions of two variables, and partial differentiation. Total differential, tangent plane approximation of a surface. Partial differentiation of composite. Unconstrained and constrained extrema.

Unit 3 (Matrix Algebra): Matrix algebra, elementary row operations, row and reduced row

echelon forms. Linear system of equations, existence and uniqueness of solution. Eigenvalues, eigenvectors and diagonalization.

Unit 4 (Analytic functions): Complex valued functions, limits, continuity and differentiability. Analytic functions and Cauchy-Riemann equations. Construction of analytic functions, Harmonic functions.

Unit 5 (First Order Differential Equation): Exact differential equations. Integrating factors and transformations. Applications of first order ordinary differential equations: orthogonal trajectories, and mixture problems.

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			3		1
CO-2	3	3	1							1			3		1
CO-3	3	3	2	3						2			3	3	2
CO-4	3	3	2	2						2			3	2	2
CO-5	3	3	2	2						2			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		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
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		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. (Mechanical 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	×	×			×
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. James Stewart, 2015, Calculus: Early Transcendentals, 8th edition, Boston, Cengage Learning
2. Steven Leon, 2014, Linear Algebra with Application, 9th edition, New Jersey, Pearson

b. Recommended Reading

1. Maurice D. Weir and Joel Hass, 2017, Thomas Calculus, 13th edition, New Jersey, Pearson
2. Gilbert Strang, 2016, Introduction to Linear Algebra, 5th edition, Massachusetts, Cambridge Press
3. Grewal B S, 2021, Higher Engineering Mathematics, 44th edition, Khanna Publication.

c. Magazines and Journals

d. Websites

1. https://www.coursera.org/
2. http://nptel.ac.in/

e. Other Electronic Resources

1. https://ocw.mit.edu/index.htm
2. https://www.khanacademy.org/
3. tutorial.math.lamar.edu/

10. Course Organization

Course Code	MTF101A	
Course Title	Engineering Mathematics - 1	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	080 4906 5555
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May 2027	

Course Specifications: Engineering Physics

Course Title	Engineering Physics
Course Code	PYB102A
Course Type	Core Theory
Department	Physics
Faculty	Engineering and Technology

I.Course Summary

The Engineering Physics course in Bachelor of Technology (B.Tech) program provides students with a comprehensive understanding of the principles of physics and their applications in engineering. The curriculum emphasizes theoretical concepts, practical skills, and their integration into various engineering disciplines.

2.Course Size and Credits:

Number of credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:2
Total hours of interaction	90
Number of Weeks in a Semester	15
Department responsible	Physics
Total Course Marks	100
Pass requirement	As per the Academic Regulations
Attendance requirement	As per the Academic Regulations

3. Course Objectives (CO)

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

CO - 1 State, explain the concepts of mechanics, quantum mechanics and quantum computation, oscillations and waves, laser and fiber optics

CO - 2 Derive standard relationships in mechanics, quantum mechanics, quantum computation, oscillations and waves, laser & fiber optics, and interpret them

CO - 3 Discuss the applications of mechanics, quantum mechanics, quantum computation, oscillations and waves, laser and fiber optics

CO - 4 Solve problems in mechanics, quantum mechanics, oscillations and waves, laser and fiber optics

CO - 5 Plan the experimental set-up, conduct experiments, calculate and plot the graphs to obtain the results and write a laboratory report as per the prescribed format.

4. Course Contents

Unit 1 – Lasers and Optical Fibers

Interaction of radiation with matter - Absorption, spontaneous emission and stimulated emission - Characteristics of laser light - Expression for the energy density of electromagnetic radiation – Requisite conditions for production of a laser beam—Helium-Neon laser—Applications of laser—Lidar and medical application- Eye surgery.

Principle-- Angle of acceptance—Expression for Numerical aperture-- condition for propagation—Refractive index profiles of step index and graded index fibers (GRIN)—Modal propagation in step index and GRIN fibers –Attenuation—Different types of loss mechanisms--Fiber optic communication system

Unit 2 – Elasticity and Rigid body dynamics

Review of Elasticity — Expression for Y, h and K in terms of linear and lateral strains (Deformation of a cube)—Poisson's ratio—Expression for couple per unit twist—Torsion Pendulum -- determination of rigidity modulus of a wire using torsion pendulum—Bending of beams—Single cantilever—Expression for Young's modulus of a cantilever beam.

Review of Rigid body dynamics — Expressions for moments of inertia of a circular disc and rectangular plate about different axes—MI of Flywheel

Unit 3 – Oscillations and waves

Harmonic oscillator in one-dimension and its solutions, Superposition of simple harmonic oscillations, Lissajous figures, Damped oscillations—Set up of the Differential equation, types of damping, Engineering applications (Qualitative discussions) —automatic door closures and automobile suspension system, Theory of forced oscillations—Set up of the Differential equation, Resonance (Qualitative explanation), Sharpness of resonance (without derivation)

Wave equation and its solution, Dispersion of waves, Dispersion relation at different cases, Interference—Newton's rings, Fraunhofer Diffraction.

Unit 4 – Quantum mechanics and Introduction to Quantum computation

Heisenberg's uncertainty principle—Applications of Heisenberg's uncertainty principle. Wave function and its properties, Born interpretation, Expectation values, Eigen value and eigen functions - Schrodinger's one dimensional time independent wave equation—Application of Schrodinger's equation to a particle in an infinite potential well to determine Eigen values and Eigen function.

Computational basis states, difference between classical bit and qubit, Bloch sphere — representation of a qubit, multiple qubits in computational basis states. Single qubit gates — X gate, Z gate, Hadamard gate, Phase gate, action of these gates on a general qubit state, matrix representation of these states.

Quantum circuits – example of quantum teleportation protocol.

Laboratory Experiments: General experiments will be performed based on the concepts: mechanics, Elasticity, Oscillations, waves, Laser, Optical fibre, quantum theory, error analysis etc.

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		2		1								3	1	0
CO-2	2	1	3	3		1	1						3	2	0
CO-3	3	2											3	0	0
CO-4	3	2	2	1									3	1	0
CO-5	3	2		3			2		1	2			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		02
1. Demonstration using Videos	02	
2. Demonstration using Physical Models /		
3. Demonstration on a Computer		
Numeracy		18
1. Solving Numerical Problems	18	
Practical Work		30
1. Course Laboratory	30	
2. Computer Laboratory		
3. Engineering Workshop / Course Workshop / Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		00
1. Case Study Presentation		
2. Guest Lecture		
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions		
6. Discussing Possible Innovations		
Term Tests, Written Examination		10
Total Duration in Hours		90

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment is presented in the Programme Specifications document pertaining to the B.Tech. (Mechanical 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 (TSC1, TSC2, TSC3 or LSC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation						
Course Outcome	CE (Weightage: 60 %)				Component 2: SEE (40% Weightage)	
	SC1	SC2	SC3	SC4	SEE (Weightage : 25 %)	SEE (Weightage: 15 %)
	Term Test	Term Test	Assignment	Lab	Written exam	Lab Exam
	15	15	20	10	50 Marks	25 Marks
CO-1						
CO-2						
CO-3						
CO-4						
CO-5						
The details of TSC1, TSC2, TSC3 or LSC4 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, and demonstrations
3.	Critical Skills	Assignment
4.	Analytical Skills	Classroom, assignment
5.	Problem Solving Skills	Classroom, assignment
6.	Practical Skills	Classroom, assignment
7.	Group Work	Classroom
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	Presentation
11.	Presentation Skills	Presentation
12.	Behavioral Skills	Course
13.	Information Management	Assignment, examination
14.	Personal Management	Assignment, examination
15.	Leadership Skills	Effective management of learning, time management, achieving the learning

9. Course Resources

1. Essential Reading

1. Class Notes
2. Rajendran, V. (2011) Engineering Physics, TMH
3. Srinivasan M. R. (2011) Physics for Engineers, 3rd Ed, New Age International
4. Gyan Prakash, (2012) Experimental Physics,
5. Michael Sayer, Abhai Mansingh, (1999) Measurement, Instrumentation and Experiment Design in Physics and Engineering, PHI
6. An introduction to quantum computing, Noson S Yanofsky
7. Quantum computation and quantum information. Neilsen and Chuang- Cambridge University Press

2. Recommended Reading

1. Srinivasan M.R. (2011) Applied Solid State Physics, 1st Ed, New Age International
2. S.O. Pillai (2011), A Textbook of Solid State Physics, 6th Ed, New Age International
3. Richtmeyer, F. K., Kennard, E.H. and Cooper, J.N (2007) Modern Physics, 6th Ed, TMH
4. Halliday, I.D., Resnick, R and Walker, J (2010) Fundamentals of Physics, 9th Ed, Wiley
5. Beisser, A. (2009) Concepts of Modern Physics, 6th Ed, TMH
6. Giri, P.K., (2005) Physics Laboratory Manual for Engineering Undergraduates, Department of Physics, Indian Institute of Technology Guwahati
7. A Gentle Introduction to Quantum Computing, Elliot Catt Marcus Hutter, The MIT Press

3. Magazines and Journals

4. Websites

1. http://nptel.ac.in/

5. Other Electronic Resources

1. Electronic resources on the subject area are available on MSRUAS library

10. Course Organization

Course Code	PYB102A	
Course Title	Engineering Physics	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.pi.mp@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review	May 2027	

Course Specifications: Introduction to Mechanical Engineering

Course Title	Introduction to Mechanical Engineering
Course Code	MEF101A
Course Type	Core Theory and Laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is aimed at preparing the students to understand the concepts and underlying principles of mechanical engineering. The students are taught various types of energy sources, power generation, energy conversion methods and types of power plants. Students are taught the working of IC engines and power transmission elements. Students are also exposed to basic operations and applications of machine tools.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:2
Total Hours of Interaction	75
Number of Weeks in a Semester	15
Department Responsible	Mechanical 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 energy sources, energy conversion systems, mechanical power transmission systems, machine tools, modern manufacturing tools and their processes and techniques
- **CO-2.** Explain the working principle of energy conversion technologies and machining operations
- **CO-3.** Solving numerical problems on machining and mechanical power transmission systems
- **CO-4.** Apply principles of energy conversion systems, power transmission systems, machining processes to practical applications
- **CO-5.** Operate Lathe, Drilling machine tools, welding and brazing machines and perform operations as per the given drawing

4. Course Contents

Unit 1 Introduction and overview of Mechanical Systems

Role of Mechanical Engineering in Industries and Society- Emerging Trends and Technologies in different sectors such as Energy, Manufacturing, Automotive, Aerospace, and Marine sectors and contribute to the GDP.

Unit 2 Energy Sources and its Conversion Devices

Energy Sources and Power Plants:

Review of energy sources; Construction and working of Hydel power plant, Thermal power plant, Nuclear power plant, Solar power plant, Tidal power plant, Wind power plant.

Steam Formation and Application:

Formation of steam and thermodynamic properties of steam (Simple Problems using Steam Tables), Applications of steam in industries namely, Sugar industry, Dairy industry, Paper industry, Food processing industry for Heating/Sterilization, Propulsion/Drive, Motive, Atomization, Cleaning, Moisturization, Humidification

Unit 3 Fundamentals of IC Engines:

Review of Internal Combustion Engines, 2-Strokes and 4-Strokes engines, Components and working principles, Application of IC Engines in Power Generation, Agriculture, Marine and Aircraft Propulsion, Automobile.

Insight into future mobility technology; Electric and Hybrid Vehicles, Components of Electric and Hybrid Vehicles, Drives and Transmission. Advantages and disadvantages of EVs and Hybrid vehicles.

1. Demonstration of Multi-cylinder Engine and Engine Components through Cut Sections

Unit 4 Mechanical Power Transmission and fundamentals of robots:

Gear Drives: Types - spur, helical, bevel, worm and rack and pinion, velocity ratio,

Gear Trains and their application: simple and compound Gear Trains, Simple numerical problems on Gear trains involving velocity ratios

Belt Drives: Components of belt drive and concept of velocity ratio; Types of belt drives, FlatBelt Drive, V-Belt Drive and Application of Belt Drives.

Simple numerical problems on Belt drives involving velocity ratios,

Concept of Chain, Rope drives and their applications

Introduction to Robotics

Robot anatomy, Joints & links, common Robot configurations. Applications of Robotics in Material Handling, Processing, Assembly, and Inspection

1. Demonstration of the machine consists of Gear Trains.
2. Demonstration of various elementary mechanisms and their motion.
3. Demonstration of any one model of Robot

Unit 5

Fundamentals of Machine Tools and Operations:

Metal Joining Processes:

Soldering, Brazing and Welding: Definitions. Classification and methods of soldering, brazing, and welding. Brief description of arc welding, Oxy-acetylene welding, Introduction to TIG welding and MIG welding.

Fundamentals of Machining and machine tools,

Construction and Working Principle of Lathe, Various Lathe Operations: Turning, Facing, Taper Turning and Knurling.

Construction and working of simple Drilling Machines and applications.

Advancement in machine tools: Introduction to Computer numerically controlled (CNC) machines, components, advantages and applications. Concepts of Additive Manufacturing and Industrial IoT

1. Demonstration of 3-D Printing and CNC Machining.
2. Demonstration of Lathe Tool and Drill Tool Dynamometers

Laboratory exercises to be performed as part of the course		
Exercise No	**Title**	
Machine tools: Introduction		
01	Model-I: To perform Facing, Centering and Plain turning and chamfering operations on a lathe machine as per the given drawing and develop a model	
02	Model –II: To perform Parting/Step turning and Taper turning operations on a lathe machine as per the given drawing and develop a model	
03	Model –III: To perform Knurling and Thread cutting operations on a lathe machine as per the given drawing and develop a model	
04	Model-IV: To perform Drilling, Reaming and Tapping operations on a drilling machine as per the given drawing and develop a model	
Welding, Soldering and Brazing: Introduction		
05	Model-V: To perform pipe welding, resistance welding, spot and seam welding as per the given drawing and develop models	
06	Model-VI: To perform soldering operations as per the given drawing and develop model	
07	Model-VII: To perform brazing operations as per the given drawing and develop model	

1. 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		
CO-2	3												3		
CO-3		3	2										3		
CO-4		2											2		
CO-5				3										3	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

5. Course Teaching and Learning Methods

Teaching and Learning Methods	**Duration in hours**	**Total Duration in Hours**
Face to Face Lectures		45
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		15
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	15	
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**

6. 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. (Mechanical 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 (TSC1, TSC2, TSC3 or TSC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation						
Course Outcome	**CE (Weightage: 60 %)**				**SEE (Weightage: 40 %)**	
	TSC1: (15 %) Term Test I	**TSC2: (15 %) Assignment**	**TSC3: (15 %) Term Test II**	**LSC4: (15 %) Laboratory CE**	**Theory – SEE (25 %)**	**Laboratory - SEE (15 %)**
	25 marks	**25 Marks**	**25 Marks**	**25 Marks**	**50 Marks**	**25 Marks**
CO-1	×		×		×	
CO-2	×	×	×		×	
CO-3	×	×	×		×	
CO-4		×	×		×	
CO-5				×		×
The details of TSC1, TSC2, TSC3, or LSC4 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.

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	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	--

8. Course Resources

a. Essential Reading

1. Class Notes
2. V. K. Manglik, 2013, Elements of Mechanical Engineering, PHI Learning
3. K. R. Gopalakrishna, 2008, Elements of Mechanical Engineering, Subhash Publishers

b. Recommended Reading

1. G.D. Gokak, J.K. Kittur, 2014, Elements of Mechanical Engineering, Wiley publications
2. G. S. Sawhney, 2003, Fundamental of Mechanical Engineering, Prentice Hall of India Publication
3. S. Trymbaka Murthy, 2006, A Text Book of Elements of Mechanical Engineering, 3rd Revised Edition, I .K. International Publishing House Pvt. Ltd.
4. K. P. Roy and S. K. Hajra Chaudhary, 2005, Elements of Mechanical Engineering, Media Promoters and Publishers Pvt. Ltd.

c. Magazines and Journals

1. ASME Mechanical Engineering Magazine
2. Machine Tools

d. Websites

1. https://www.coursera.org/
2. http://nptel.ac.in/
3. www.asme.org

e. Other Electronic Resources

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

9. Course Organization

Course Code	MEF101A	
Course Title	Introduction to Mechanical Engineering	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May 2027	

◂◆▸

Course Specifications: Workshop Practice

Course Title	Workshop Practice
Course Code	MEL105A
Course Type	Laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This laboratory deals with various workshop operations, tools and their applications. The students will be equipped with basic knowledge and understanding of various workshop tools, equipment and measuring instruments used for bench work. The student will be exposed to the practical application of fitting, welding, sheet metal and carpentry operations. In addition, the student will be trained to select and use suitable tools and processes required for metal fabrication.

2. Course Size and Credits:

Number of Credits	01
Credit Structure (Lecture: Tutorial: Practical)	0:0:2
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	Mechanical 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. Perform operations and prepare physical models of metal fitting, carpentry wood model, sheet metal, pipe fitting and metal arc welded joint models as per given drawing

CO-2. Draft the fitting, welding, pipe fitting and carpentry models, and development drawings for sheet metal models

4. Course Contents

Unit 1: Introduction: Marking tools, workshop tools and their usage, safety precautions

Unit 2: Fitting Practice: V-joint, semi-circular joint, pipe fitting

Unit 3: Welding: Practice of welding joints

Unit 4: Sheet metal fabrication: Sheet metal joints, Development and creation of cylinder and cones

Unit 5: Carpentry Practice: – Wood Carving, Cutting, Planning and demonstration of wood turning operations

Unit 6: Plumbing Practice: – Internal and External Threading, Pipe fitting.

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	1	3										1		3
CO-2	3	1	3							1			1		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		**00**
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		**30**
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	30	
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. Brainstorming 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. (Mechanical 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 (TSC1, TSC2, TSC3 or TSC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (60% Weightage)			Component 2: SEE (40% Weightage)
Subcomponent ▶	SC1	SC2	SC3	
Subcomponent Type ▶	Lab exercise	Lab record	Term test	
Maximum Marks ▶	25	15	10	50 Marks
CO-1	X	X		X
CO-2	X	X	X	X
CO-3	X	X	X	X
The details of TSC1,T SC2, TSC3 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. Course notes
2. Hajra Choudhary S. K., Bose S. K., Hajra Choudhary A. K. and Roy Nirjha, (2007) Elements of Workshop Technology Volume No. II: Machine Tools, Media

Promotors and Publishers Pvt. Limited

b. Recommended Reading

1. W. Chapman (2007) Workshop Technology, Part 2, Butterworth-Heinemann

c. Magazines and Journals

Mechanical Engineering Magazine ASME

d. Websites

www.toolstop.co.uk/workshop-toolsenglishwilleasy.com/english-through-pictures/things-english-throughpictures/workshop/

e. Other Electronic Resources

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

10. Course Organization

Course Code	MEL105A	
Course Title	Workshop Practice	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May-2027	

Course Specifications: English Communication

Course Title	English Communication
Course Code	TSM101A
Course Type	Theory
Department	Mechanical Engineering
Faculty	Engineering and Technology

I. Course Summary

1. Aim and Summary

This course aims at equipping students with the skills required for effective communication in professional context. The students will be guided through Lab exercises to develop Listening, Writing and Reading Skills. Students will be sensitized to the nuances of effective speaking skills in a given situation during theory interactions

2. Course Size and Credits:

Number of credits	02
Credit Structure (Lecture: Tutorial: Practical)	1:0:2
Total hours of interaction during the semester	45
Number of semester weeks	16
Department responsible	Directorate of Transferable Skills and Leadership Development
Total Course marks	Total Mark : 50 Component 1(CE) 60% Weight Lab component:30 marks Component 2(SEE) 40% Weight Semester End Examination: 20 marks
Pass requirement	A minimum of 40% marks in component 1 and component 2 put together is required for a pass. Attending Component 1 and Component 2 is mandatory.
Attendance requirement	80%

	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
CO-2										3					3
CO-3									3						3
CO-4									3	3					3
CO-5										3					3
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

II. **Teaching, Learning and Assessment**

3. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No.	Intended Learning Outcome
1	**Demonstrate appropriate Listening Skills**
2	**Develop professional written document**
3	**Demonstrate appropriate Spoken Skills**
4	**Demonstrate appropriate Reading Skills**

4. Course Contents

Course Content
Pronunciation: Introduction, Consonant Sounds , Kinds of Consonant Sounds , Vowel Sounds , Short and Long Vowel Sounds, Kinds of Vowel Sounds, Comparison of Sounds, and Sentence Identification and Stress, Noun-Verb Pronunciation Difference, Pronunciation Rules
Listening Skills : News Article, Narratives, Conversation, Advertisement, News Article
Speaking Skills: Hobbies and Interests , Extempore, Prepared Speech, Presentation Skills Language Enhancers; Order of Words, Question Tags ,Transformation of Sentence
Reading Skills: Skimming and scanning skills
Writing Skills: Formal Letter, Paragraph and Blog Writing, Informal Letter, Email Writing

5. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		15
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		30
1. Course Laboratory	30	
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	
Written Examination, Presentations		0
Total Duration in Hours		45

6. **Method of Assessment**

There are two components for assessment in this course:

	Component 1: CE (60% Weightage)	**Component 2: SEE (40% Weightage)**
Subcomponent Type ▶	**(Lab Assessment)**	**(Demonstrative assessment)**
Maximum Marks ▶	**30**	**20**
CO-1	**X**	
CO-2	**X**	
CO-3		**X**
CO-4	**X**	

Total Marks: 50

Component - 1: 60% weight

Continuous Evaluation during lab hours

Component - 2: 40% weight

A demonstration of spoken skills during theory hours in the classroom

7. **Reassessment**

As per Academic Regulations 2023-24

8. Achieving Learning Outcomes

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

S.No	Curriculum and Capabilities	How imparted during the course
1.	Knowledge	Laboratory sessions
2.	Understanding	Face to face lectures
3.	Critical Skills	--
4.	Analytical Skills	Face to face lectures, activities, , group discussions, assignment
5.	Problem Solving Skills	--
6.	Practical Skills	Laboratory sessions ,Face to face lectures, activities, , group discussions, course work
7.	Group Work	Course work, practice, group discussion
8.	Self-Learning	Laboratory sessions
9.	Written Communication Skills	Face to face lectures, Course work, Laboratory sessions practice, assignment,
10.	Verbal Communication Skills	Face to face lectures, Course work, Laboratory sessions practice, assignment,
11.	Presentation Skills	Face to face lectures
12.	Behavioral Skills	Course work, practice, assignment, Laboratory sessions, group discussion, presentation practice, role plays
13.	Information Management	Laboratory sessions, Face to face letures, Group Discussions , Brain storming
14.	Personal Management	Laboratory sessions, Face to face letures, Group Discussions , Brain storming
15.	Leadership Skills	Face to face letures, Group Discussions , Brain storming

III. Course Resources

a. Essential Reading

1. Class Notes

2. Raman M and Sharma S (2004) Technical Communication: Principles and Practice. New Delhi: Oxford University Press

4. Hory Sankar Mukherjee, (2013), Business Communication, Oxford University Press

5. Kroehnert, Gary (2004), Basic Presentation Skills, Tata McGraw Hill

b. Recommended Reading

1. Sathya Swaroop Debashish and Bhagaban Das, (2014), Business Communication, PHI, New Delhi
2. Young, Dona J (2006) Foundations of Business Communications: An Integrated Approach, Tata McGraw Hill
3. Kaul, Asha (2007) Effective Business Communication, Prentice Hall India
4. Bienvenu, Sherron (2008) The Presentation Skills Workshop, Prentice Hall
5. Kavita Tyagi and Padma Misra (2011) Professional Communication, PHI Learning Private Limited, New Delhi

c. Websites

1. www.myenglishpages.com
2. www.britishcouncil.com
3. www.englishmagazine.com
4. www.justenglishmagazine.com

d. Other Electronic Resources

1. Words worth language laboratory

IV. Course organization

Course Code	TSM101A	
Course Title	English Communication	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	**Phone:**	080 – 4536 6666
	E-mail:	director.tsld@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review	May 2027	

◂◆▸

Course Specifications: Engineering Mathematics - 2

Course Title	Engineering Mathematics – 2
Course Code	MTF111A
Course Type	Core Theory
Department	Mathematics and Statistics
Faculty	Engineering and Technology

1. Course Summary

This course deals with analytical solutions of ordinary differential equations and Laplace transform. Students are taught the concepts of fundamentals of ordinary differential equations and Laplace transform. The solution procedures for certain standard forms of ordinary differential equations are illustrated. The role, relevance of ordinary differential equations in modelling some of the real world problems are emphasized and this course also covers the underlying principles and applications of transform techniques in various engineering disciplines.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:2:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
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 fundamentals of ordinary differential equations and Laplace transform
- **CO-2.** Discuss the standard forms of ordinary differential equations and Laplace transform of standard functions
- **CO-3.** Solve simple problems in ordinary differential equations and Laplace transform
- **CO-4.** Model real world problems using ordinary differential equations and solve complex problems associated with ordinary differential equations using Laplace transform
- **CO-5.** Apply Laplace transform in solving complex real world engineering problems

4. Course Contents

Unit 1 (Higher Order Differential Equation): Introduction, initial and boundary value problems. Linear homogenous/nonhomogeneous differential equations with constant coefficients, method of undetermined coefficients and variation of parameters. Application of second order linear differential equations with constant coefficients, mass-spring-dashpot system.

Unit 2 (Laplace Transform): Definition, properties and theorems, transform of derivatives, integrals, periodic functions, unit step function, Dirac's delta function and time shifting property. Inverse Laplace transform, convolution theorem, solution of initial value problems.

Unit 3 (Fourier Analysis): Periodic functions, Dirichlet's conditions for convergence of Fourier series, Fourier series for a periodic function of period T, half range Fourier series, complex Fourier series, Harmonic Analysis. Fourier Transform - Definition, Fourier transform of elementary functions, properties. Inverse Fourier transform.

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			3		1
CO-2	2	3	2							1			3		1
CO-3	3	3	1							1			3		1
CO-4	3	3	2	2	2					1			3	2	1
CO-5	3	3	2	2	2					1			3	2	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		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
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		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. (Mechanical 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	×	×			×
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. Glyn James, 2016, Advanced Modern Engineering Mathematics, 4th edition, Pearson
2. Dennis Zill, 2012, A First Course in Differential Equations, 10th edition, Massachusetts, Brooks/Cole

b. Recommended Reading

1. George Simmons, 2017, Differential Equations with Applications and Historical Notes, 2nd edition, New Jersey, McGraw Hill
2. Erwin Kreyszig, 2015, Advanced Engineering Mathematics, tenth edition, John Wiley & Sons Inc.
3. Shepley Ross, 2007, Introduction to Ordinary Differential Equations, 4th edition, New York, John Wiley & sons

c. Magazines and Journals

d. Websites

1. http://nptel.ac.in/
2. https://ocw.mit.edu/index.htm

e. Other Electronic Resources

1. https://www.khanacademy.org/
2. tutorial.math.lamar.edu/

10. Course Organization

Course Code	MTF111A	
Course Title	Engineering Mathematics - 2	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May 2027	

Course Specifications: Engineering Chemistry

Course Title	Engineering Chemistry
Course Code	CYB104A
Course Type	Core Theory and Laboratory
Department	Department of Chemistry
Faculty	Engineering and Technology

1. Course Summary

This subject aims at enhancing the basic understanding of chemistry with reference to engineering systems and to train students to perform quantitative analysis related to Engineering Chemistry. This subject deals with topics on electrochemistry, energy stage devices, fuels, chemical kinetics, corrosion science, metal finishing, polymers and nanomaterials. Students are trained to determine physical and chemical properties of a given sample experimentally. They are trained to analyze the results and infer appropriate conclusions based on concepts of Engineering Chemistry.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:2
Total Hours of Interaction	90
Number of Weeks in a Semester	15
Department Responsible	Chemistry
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.** Explain the basic concepts of electrochemistry, conversion of chemical energy into electrical energy, theory of corrosion and principles of metal finishing
- **CO-2.** Differentiate renewable - nonrenewable fuels, primary - secondary electrodes & primary - secondary batteries, batteries - fuel cells, electroplating – electroless plating, thermosetting – thermoplastic polymers and dry corrosion - wet corrosion
- **CO-3.** Discuss the reaction chemistry and stoichiometry of combustion of fuels, remedial measures to control oxides of nitrogen, sulphur and carbon, polymerization – methods, mechanism, preparation, properties and applications of some polymers, concepts of nano science and nanotechnology
- **CO-4.** Identify the types of corrosion and methods to prevent corrosion, suitable polymers and nanocomposite materials for engineering applications
- **CO-5.** Derive kinetic rate equations for various chemical systems and equation for electromotive force
- **CO-6.** Analyze the suitability of polymers & composites for various applications and solve problems related to storage devices, chemical kinetics, electro chemistry, corrosion and metal finishing
- **CO-7.** Plan the experimental set up, conduct experiments, calculate and plot the graphs to

obtain results, and write a laboratory report as per the prescribed format

4. Course Contents

Unit 1 Electrochemistry: Electrochemical cell, Electrode Potential and EMF. Construction of Galvanic cell, Types of Electrodes. Numerical on Electrode Potential of cell using Nernst equation. Construction and working of reference electrodes: calomel and silver-silver chloride electrode. Construction, working and application of Ion-selective electrode: Glass electrode. Determination of pH using glass electrode

Unit 2 Storage and Conversion devices – Batteries: Storage devices – Batteries: Primary batteries, Secondary batteries, reserve batteries and super capacitors. Construction, working and application of dry cell, lead acid, Nickel-Cadmiun, Nickel-Metal hydride, Zinc –Air, Lithium-ion batteries, Lithium polymer batteries.
Conversion devices: Fuel cells, Construction, working and application of: Hydrogen-Oxygen, Methanol-Oxygen cells.

Unit 3 Corrosion and its Control: Types of corrosion. Electrochemical theory of corrosion. Factors affecting, Corrosion control: Metal coating, cathodic protection, organic coating, corrosion-inhibitors.

Unit 4 Metal Finishing: Technological importance of metal finishing, Polarization and factors influencing polarization, Principle of electroplating, factors affecting electrodeposition, Electroplating of Chromium and Gold. Electro-less Plating of Copper and Nickel.

Unit 5 Chemical Kinetics: Order of Reactions, Derivation of second, third, consecutive reactions, rate equations, Steady State Concept, numerical problems with suitable examples of different kinds of reactions.

Unit 6 Combustion Chemistry: Introduction to Fuels, types and classification, Sources of Fuels, Characteristics of a good fuel, Proximate and ultimate analysis, Petroleum cracking, Mechanism of Knocking and its effect, Anti-knocking agents, Octane and Cetane numbers, Functioning of Catalytic converter, Introduction to Biofuels, Flue gases and control measures.

Unit 7 Polymers and polymerization: Introduction & Classification of polymers, Addition, condensation and co- ordination polymerizations, mechanism of free radical addition polymerization with ethylene as example, Techniques of polymerization (Bulk, Solution, suspension, emulsion), Tg, factors affecting Tg, effect of structure on properties of polymers, fundamentals of biodegradable polymers, preparation, properties and technical applications of thermoplastics (PVC, PVA, Teflon), thermosets (PF, UF), elastomers (natural rubber, SBR) & adhesives (epoxy and acrylics) Introduction to polymeric composites.

Unit 8 Introduction to nanoscience and nanotechnology: Basic concepts of Nanoscience and Nanotechnology – Graphene – Carbon nanotubes – Material processing by top down and down top synthesis; chemical vapor deposition and physical vapor deposition– Potential uses of nanomaterials in electronics, robotics, computers, sensors, vehicles and transportation – Medical applications of nanomaterials.

List of Experiments:	
1	Determination of Viscosity Coefficient of a given liquid using Ostwald's Viscometer
2	Conductometric estimation of an acid using standard NaOH solution

3	Determination of pKa of the given weak acid using Glass electrode-Ag/AgCl electrode assembly
4	Potentiometric estimation of FAS using standard $K_2Cr_2O_7$ solution
5	Colorimetric estimation of copper
6	Determination of total hardness of a given water sample
7	Determination of percentage of Cu from the given brass sample
8	Determination of percentage of Fe in the rust solution by external indicator Method
9	Determination of first order reaction constant for acid hydrolysis of ethyl acetate
10	Electroplating of copper*
11	Determination of composition of brass alloy using UV-Vis spectroscope*
12	Measurement of voltage in a hydrogen-oxygen fuel cell*
13	Preparation of printed circuit board*
14	Construction and operation of lead acid battery cell*
15	Determination of empirical formula of a fuel using exhaust gas analyzer*

***** Demo experiments

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		
CO-2						3								3	
CO-3							3							3	
CO-4			3										3		
CO-5							1							1	
CO-6		3		2						3			3	2	3
CO-7	3	2		3			2		1	3			3	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		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		30
1. Course Laboratory	30	
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		**90**

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. (Mechanical 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 (TSC1, TSC2, TSC3, LSC4 or LSC5), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation						
Course Outcome	**CE (Weightage: 60 %)**				**Component 2: SEE (40% Weightage)**	
	SC1	**SC2**	**SC3**	**SC4**	**SEE (Weightage: 25 %)**	**SEE (Weightage: 15 %)**
	Term Test	**Term Test**	**Assignment**	**Lab**	**Written exam**	**Lab Exam**
	15	**15**	**20**	**10**	**50 Marks**	**25 Marks**
CO-1	×		×		×	
CO-2	×		×		×	
CO-3	×		×		×	
CO-4	×	×	×		×	
CO-5	×		×		×	
CO-6		×			×	
CO-7				×		×
The details of TSC1, TSC2, TSC3 or LSC4 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. Gadag, R.V. and Nityananda Shetty A., (2010), Engineering Chemistry, Second Edition, New Delhi, I.K. International Publishing House
3. O.G. Palanna, (2011), Engineering Chemistry, New Delhi, Tata McGraw Hill Education Pvt Ltd.
4. Gurudeep Raj, (2014), Advanced Physical Chemistry, Meerut-Uttar Pradesh, Krishnan Prakashana
5. Pradeep. T, (2012) "A Text Book of Nanoscience and Nanotechnology", New Delhi, Tata McGraw Hill Company Ltd.

b. Recommended Reading

1. Pletcher, D. and Walsh, F.C., (1993), Industrial Electrochemistry, Second edition, UK, Blackie Academic and Professional
2. Kuriacose, J.C. & Rajaram, J., (1998), Chemistry in Engineering & Technology (Vol I & II), Third reprint, New Delhi, Tata McGrahill Company
3. C. N. R. Rao, Achim Muller and A.K. Cheetham, (2004), The Chemistry of Nanomaterials, Vol I & II, Weinheim, Wiley VCH.

c. Magazines and Journals

d. Websites

e. Other Electronic Resources

1. http://nptel.ac.in/
2. Electronic resources on the subject area are available on MSRUAS library

10. Course Organization

Course Code	CYB104A	
Course Title	Engineering Chemistry	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May 2027	

Course Specifications: Applied Mechanics

Course Title	Applied Mechanics
Course Code	MEF106A
Course Type	Core Theory Course
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. **Course Summary**

This course is an introduction to concepts and principles of engineering mechanics and its applications to mechanical engineering problems. Students will be trained on application of engineering mechanics to solve practical problems pertaining to various force systems and static and dynamic equilibrium of rigid bodies.

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	Mechanical 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 Explain concepts of force, moment, representation of force and moment in two and three dimensions and their equilibrium
CO-2 Describe the concepts of Kinematics and Kinetics of rigid bodies in two (2D) and three (3D) Dimensions and their applications
CO-3 Illustrate the equilibrium equations in two (2D) and three (3D) dimensions and solve equivalent system problems
CO-4 Apply the equilibrium equations to analyze real world engineering problems with the aid of Free Body Diagrams
CO-5 Determine centroid/centre of gravity for various plane shapes and calculate moment of inertia for structural members
CO-6 Recognize the existence of friction and its considerations in real world engineering Problems

4. Course Contents

Unit 1

Fundamental Concepts and Principles: Engineering Mechanics, Applications of Engineering Mechanics, Systems of Units; Method of Problem Solution; Numerical Accuracy; Vectors for

mechanics; Forces in plane and Space; Resultant of forces; Resolution of forces into components; Equilibrium of particles; Rigid bodies and Equivalent system of forces; External and Internal Forces; Principle of Transmissibility; Equivalent Forces; Moment of a Force about a Point; Varignon's Theorem; Rectangular Components of the Moment of a Force; Moment of a Force about a given Axis; Moment of a Couple; Equivalent Couples; Addition of Couples; Reduction of a System of Forces to one Force and a couple; Equivalent Systems of Forces; Reduction of a System of Forces to a Wrench.

Unit 2

Equilibrium of Rigid Bodies: Free-Body Diagram; Equilibrium in Two Dimensions; Reactions at Supports and Connections for a Two-Dimensional Structure; Statically Indeterminate Reactions, Partial constraints; Equilibrium in Three Dimensions; Reactions at Supports and Connections for a Three-Dimensional Structure.

Unit 3

Centroid and Moment of Inertia: Distributed Forces, Centroids and Centers of Gravity; Center of Gravity of a Two-Dimensional Body; Centroids of Areas and Lines; First Moments of Areas and Lines; Composite Plates and Wires; Determination of Centroids by Integration; Distributed Loads on Beams; Forces on Submerged Surfaces. Volumes; Center of Gravity of a Three-Dimensional Body; Centroid of a Volume; Composite Bodies; Determination of Centroids of Volumes by Integration, Moments of Inertia of Areas; Determination of the Moment of Inertia of an Area by Integration; Polar Moment of Inertia; Radius of Gyration of an Area; Parallel-Axis Theorem; Moments of Inertia of Composite Areas; Product of Inertia; Principal Axes and Principal Moments of Inertia; Moment of Inertia of a Mass; Moments of Inertia of Thin Plates; Determination of the Moment of Inertia of a Three-Dimensional Body by Integration; Moments of Inertia of Composite Bodies; Moment of Inertia of a Body with Respect to an Arbitrary Axis.

Unit 4

Friction: Introduction; The Laws of Dry Friction; Coefficients of Friction; Angles of Friction; Problems Involving Dry Friction; Wedges; Square-Threaded Screws; Journal Bearings - Axle Friction; Thrust Bearings - Disk Friction; Wheel Friction – Rolling Resistance; Belt Friction.

Unit 5

Kinematics of Rigid Bodies: Introduction, Translation, Rotation about a Fixed Axis, General Plane Motion, Absolute and Relative Velocity in Plane Motion, Instantaneous Center of Rotation in Plane Motion, Absolute and Relative Acceleration in Plane Motion, Rate of Change of a Vector with Respect to a Rotating Frame, Plane Motion of a Particle Relative to a Rotating Frame, Coriolis Acceleration, Three-Dimensional Motion of a Particle Relative to a Rotating Frame, Frame of Reference in General Motion.

Unit 6

Kinetics of Rigid Bodies: Forces and Accelerations, Equations of Motion for a Rigid Body, Angular Momentum of a Rigid Body in Plane Motion, Plane Motion of a Rigid Body , D'Alembert's Principle, Systems of Rigid Bodies, Constrained Plane Motion.

Introduction to Kinetics of Rigid Bodies in Three Dimensions: Angular Momentum of a Rigid Body in Three Dimensions, Application of the Principle of Impulse and Momentum to the Three-Dimensional Motion of a Rigid Body, Kinetic Energy of a Rigid Body in Three Dimensions, Motion of a Rigid Body in Three Dimensions.

Energy and Momentum Methods: Principle of Work and Energy for a Rigid Body, Work of Forces Acting on a Rigid Body, Kinetic Energy of a Rigid Body in Plane Motion, Systems of Rigid Bodies, Conservation of Energy, Power, Principle of Impulse and Momentum for the Plane Motion of a Rigid Body, Systems of Rigid Bodies, Conservation of Angular Momentum.

Method of Virtual Work: Introduction, Work of a Force, Principle of Virtual Work, Applications of the Principle of Virtual Work, Real Machines, Mechanical Efficiency, Work of a Force during a Finite Displacement, Potential Energy, Potential Energy and Equilibrium, Stability of Equilibrium.

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		
CO-2	3												3		
CO-3	3	3											3		
CO-4	3	2	1										2		
CO-5		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		20
Demonstrations		0
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		40
1. Solving Numerical Problems	30	
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 components and subcomponents of course assessment are presented in the Academic Regulations document pertaining to the B. Tech. (Mechanical Engineering) Programme. The procedure to determine the final course marks is also presented in the Academic Regulations document as well.

The assessment questions are set to test the course learning outcomes. In each component or subcomponent, certain Course Outcomes are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (60% Weightage)				**Component 2: SEE (40% Weightage)**
Subcomponent ▶	**SC1**	**SC2**	**SC3**	**SC4**	
Subcomponent Type ▶	**Term Test**	**Term Test**	**Assignment**	**Quiz**	**50 Marks**
Maximum Marks ▶	**15**	**15**	**20**	**10**	
CO-1	X	X	X	X	✕
CO-2	X	X	X	X	✕
CO-3	X	X			✕
CO-4			X	X	✕
CO-5			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 course outcomes in each component assessed in the above template at the beginning of the semester.
Course reassessment policies are also 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, Assignment
2.	Understanding	Classroom lectures, Assignment, Self-study
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Classroom lectures, Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	--

7.	Group Work	--
8.	Self-Learning	Assignment, Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class notes

2. Beer, Johnston, Cornwell and Sanghi, Vector Mechanics for Engineers: Statics and Dynamics, 10th Edition, McGraw-Companies, Inc., New York, 2013.

b. Recommended Reading

1. S. Timoshenko, D.H. Young, J.V. Rao, Sukumarati (2017), Engineering Mechanics, McGraw Hill Education
2. Meriam J.L and Kraige L.G., Engineering Mechanics, Volume I - Statics, Volume II - Dynamics, 7th Edition, John Wiley & Sons, New York, 2012.
3. Russell C Hibbeler and Ashok Gupta, Engineering Mechanics: Statics and Dynamics (11th Edition), Pearson Education Inc., Prentice Hall, 2010.
4. C. Lakshamanarao, J. Lakshinarashiman, Raju Sethuraman, Srinivasan M. Sivakumar (1993), Engineering Mechanics: Statics and Dynamics, PHI, New Delhi
5. R K Rajput (2011), A Text Book of Applied Mechanics, 3rd Edn, Laxmi Publications

c. Magazines and Journals

1. Journal of Engineering Mechanics
2. International Journal for Theoretical and Applied Mechanics

d. Websites

https://asme.org/

e. Other Electronic Resources

1. https://nptel.ac.in/

1. Course Organization

Course Code	MEF106A		
Course Title	Applied Mechanics		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	+91-804-906-5555
		E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date		May 2023	
Next Course Specifications Review Date		May 2027	

Course Specifications: Programming in Python

Course Title	Programming in Python
Course Code	CSF102A
Course Type	Core Theory and laboratory
Department	Dept. of CSE
Faculty	Engineering and Technology

1. Course Summary

This course is intended to teach the students the techniques for solving computing problems and programming in Python. Python programming language constructs, standard data structures and structured problem solving via functional decomposition are taught in detail. Python libraries and their use in the implementation of computer programs are covered. Students learn program development, testing, randomized test input generation and exception handling.

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	2:0:2
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 elements of programming using Python language
CO-2. Explain standard data structures in Python
CO-3. Discuss functional decomposition and structured programming
CO-4. Apply Python libraries and modules for building programs
CO-5. Develop Python programs for simple applications
CO-6. Test and validate Python programs

4. Course Contents

Unit 1 (Introduction): Introduction to computer programming, programming languages, Python programming language, IDEs and Workbooks.

Laboratory Exercises: Basic use of Python IDE

Unit 2 (Elements of Programming in Python): Basic data types, variables and keywords in Python. Arithmetic, logical operations, operators and expressions. Input/Output operations in Python. Conditional statements, chained and nested conditionals. Loop statements and iteration in Python.
Laboratory Exercises on Problem Solving using Python.

Unit 3 (Data Structures in Python): Standard data structures in Python: Lists, Strings, Tuples, Sets and Dictionaries.

Laboratory Exercises on programming using data structures in Python.

Unit 4 (Structured Programming using Python): Built-in and user-defined functions in Python, Function calls, Program structure and decomposition using functions, Variable scope: global and local variables. Recursion and recursive functions. Iteration vs recursion.

Laboratory exercises on structured programming in Python.

Unit 5 (Programming using Python Libraries): Modules and libraries in Python. Introduction to the Python Standard Library. Programming using libraries. Basics of numpy and matplotlib libraries.

Laboratory exercises on programming using Python libraries.

Unit 6 (Program Development using Python): Elements of good programming style, decomposing problems and random number generation. Identifying test cases and test data generation. Exception handling in Python.

Demonstrations and laboratory exercises on program development in Python.

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	3	2	2	2		1			1	2	3	2	2
CO-2	2	1	3	2	2	2		1			1	2	3	2	2
CO-3	2	1	3	2	2	2		1			1	2	3	2	2
CO-4	2	1	3	2	2	2		1			1	2	3	2	2
CO-5	2	1	3	2	2	2		1			1	2	3	2	2
CO-6	2	1	3	2	2	2		1			1	2	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		20
Demonstrations		05
1. Demonstration using Videos	05	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
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		
1. Case Study Presentation	10	
2. Guest Lecture	00	
3. Industry / Field Visit	00	10
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Mid Terms, 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. 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 (CEor SEE) or subcomponent of CE (SC1, SC2 or SC3), COs are assessed as illustrated in the followingTable.

Focus of COs on each Component or Subcomponent of Evaluation						
Course Outcome	**CE (Weightage: 60 %)**				**Component 2: SEE (40% Weightage)**	
	SC1	**SC2**	**SC3**	**SC4**	**SEE (Weightage: 25 %)**	**SEE (Weightage: 15 %)**
	Term Test	**Term Test**	**Assignment**	**Lab**	**Written exam**	**Lab Exam**
	15	**15**	**20**	**10**	**50 Marks**	**25 Marks**
CO-1	X	X			X	
CO-2	X	X			X	
CO-3	X	X			X	
CO-4	X	X	X		X	
CO-5	X	X	X		X	
CO-6			X	X		X
The details of TSC1, TSC2, TSC3 or LSC4 are presented in the Programme Specifications Document.						

The Course Leader assigned to the course, in consultation with the Head of the Department, shallprovide 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 teachingand 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 Readings

1. Class Notes
2. Rao, B. N., 2021, Learning Python, CyberPlus Infotech.

b. Recommended Reading

1. Downey, A. B., 2016, Think Python: How to Think Like a Computer Scientist, O'Rielly.
2. Dromey, R. G., 1982, How to Solve It by Computer, New Delhi: Pearson Education.
3. Schneider, G. M., and Gersting, J. L. (2019) Invitation to Computer Science, 8th edn., Cengage].

c. Magazines and Journals

d. Websites

1. Association of Computing Machinery (ACM), http://www.acm.org/
2. IEEE Computer Society, http://www.computer.org/

e. Other Electronic Resources

1. Electronic resources on the course area available on MSRUAS library
2. Think Python online: http://openbookproject.net/thinkcs/python/english2e/

10. Course Organization

Course Code	CSF102A	
Course Title	Programming in Python	
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	May 2023	
Next Course Specifications Review Date	May 2027	

Course Specifications: Engineering Graphics

Course Title	Engineering Graphics
Course Code	MEF103B
Course Type	Core Theory with Laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with graphical representation of geometrical entities in various views for visualization and communication. The students will be taught orthographic projection of points, lines, planes and solids. The students will be taught sections and development of solids; and isometric projections of simple and combination of solids. The students will be equipped to visualize and apply principles of orthographic projection to a given application. The students will also be trained to use CAD tool to carry out the above geometric projections.

2. Course Size and Credits:

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	2:0:2
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mechanical 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 conventions used in projections of geometric entities and interpret the same
- **CO-2.** Draw orthographic projections for the geometric entities in specified positions
- **CO-3.** Develop lateral surfaces of un-sectioned and sectioned regular solids
- **CO-4.** Develop orthographic projections for given applications
- **CO-5.** Draw isometric projections for the solids and their combinations
- **CO-6.** Demonstrate competency in using CAD tool for drawing projections of geometric entities

4. Course Contents

Unit 1 (Introduction to Engineering Drawing and CAD Tool): Drawing Instruments and their uses, Bureau of Indian Standards (BIS) conventions and specifications, Dimensioning and Significance of Lettering, Graphical User Interface (GUI), Co-ordinate system and reference planes. Definitions of Horizontal Plane (HP), Vertical Plane (VP), Right Profile Plane (RPP) & Left Profile Plane (LPP). Creation of 2D environment. Selection of drawing size and scale. Creation of geometric entities and text. Modification and editing of geometric entities. Dimensioning, line conventions and material conventions.

Unit 2 (Orthographic Projections of Points, Lines and Planes):
Definitions - Planes of projection, reference line and conventions employed.
Projections of points in all the four quadrants
Projections of straight lines (located in First quadrant, first angle of projection), True and apparent lengths.
Definitions–projections of plane Surfaces –triangle, square, rectangle, pentagon, hexagon. Planes in different positions by change of position method only
Computer Aided Drawing:
To develop CAD models for the manual drawings using commands like Polygon, Rectangle, Copy, Move, Rotate, Align and Array

Unit 3 (Orthographic Projections – Solids (First Angle Projection): Definitions – Projections of solids– cube, prisms, cylinder, pyramids, cones in different positions
Computer Aided Drawing:
To develop CAD models for the manual drawings using commands like Polygon, Rectangle, Copy, Move and Rotate Command, Align, Array

Unit 4 (Orthographic Projections – Section of Solids and Development of Surfaces (First Angle Projection): Section planes, Sectional views, apparent shapes of sections of right regular prisms, pyramids, cylinders and cones resting in simple positions
Computer Aided Drawing:
To develop CAD models for the manual drawings using commands like Polygon, Rectangle, Copy, Move and Rotate Command, Align, Arc, Hatching, Pattern

Unit 5 (Isometric Projections using Isometric Scale) : Isometric scale, Isometric projection of simple solids and truncated solids – prisms, pyramid, cylinders, cones and simple combinations of solids
Computer Aided Drawing:
To develop CAD models for the manual drawings using commands like Isometric grid, scaling

Unit 6 Demonstration of a simple team design project that illustrates geometry and topology of engineered components: Creation of engineering models and their presentation in standard 2D form and as 3D solids; geometric dimensioning and tolerance; Use of solid-modelling software for creating associative models at the component and assembly levels.

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		
CO-2	3	2								1			3		1
CO-3	3	2								1			3		1
CO-4	3	2								1			3		1
CO-5	3	2								1			3		1
CO-6					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		26
Demonstrations		04
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	04	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		30
1. Course Laboratory	00	
2. Computer Laboratory	30	
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. (Mechanical 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 (TSC1, TSC2, TSC3 or TSC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (60% Weightage)				**Component 2: SEE (40% Weightage)**
Subcomponent ▶	**SC1**	**SC2**	**SC3**	**SC4**	
Subcomponent Type ▶	**Term Test**	**Term Test**	**Assignment**	**Quiz**	**50 Marks**
Maximum Marks ▶	**15**	**15**	**20**	**10**	
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
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Classroom lectures, Assignments
4.	Analytical Skills	Classroom lectures, Assignments
5.	Problem Solving Skills	Classroom lectures, Assignments
6.	Practical Skills	Assignment
7.	Group Work	Assignments
8.	Self-Learning	Assignments
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	Assignment
12.	Behavioral Skills	--
13.	Information Management	Assignment, Examination
14.	Personal Management	Course Work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. K. R. Gopalakrishna, 2005, Engineering Graphics, 32nd Edition, Shubhash Publishers

b. Recommended Reading

1. W. J. Luzadder, 2006, Fundamentals of Engineering Drawing, 11th Edition, Prentice Hall India
2. N. D. Bhatt and V. M. Panchal, 2006, Engineering Drawing, 49th Edition, Charotar Publishing House
3. CAD Tool Users Manuals

c. Magazines and Journals

d. Websites

1. http://nptel.ac.in

e. Other Electronic Resources

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

10. Course Organization

Course Code	MEF103B	
Course Title	Engineering Graphics	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May 2027	

Course Specifications: Environmental Studies

Course Title	Environmental Studies
Course Code	BTN101A
Course Type	Ability Enhancement Compulsory Course
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim of this course is to invoke awareness among students about the burning global environmental issues. The course exposes the students to various problems associated with abuse of natural resources. The concepts of ecosystems, biodiversity and its conservation and environmental pollution will be discussed. The course emphasizes social issues associated with the environment, and the impact of human population on the environment.

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	Department of Biotechnology
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.** Illustrate the multidisciplinary nature of environmental studies and recognize the need for public awareness
- **CO-2.** Explain the various natural resources and their associated problems, ecosystem, and environmental pollution
- **CO-3.** Analyse the concept of ecosystem and classify various types
- **CO-4.** Compare biodiversity at local, national and global levels
- **CO-5.** Discuss various social issues pertaining to environment including sustainable development and energy issues

4. Course Contents

Unit 1: Natural resources:

Forest resources: Use and over-exploitation, deforestation**, Water resources:** Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems**,** Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies**. Food resources:** World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. **Energy resources:** Growing energy needs, renewable and non-renewable energy

sources, use of alternate energy sources. **Land resources:** Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

Unit 2: Ecosystems:

Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, ocean estuaries).

Unit 3: Biodiversity and its conservation:

Definition: genetic, species and ecosystem diversity, Biogeographical classification of India, Value of biodiversity: consumptive use, productive use, social, ethical aesthetic and option values Biodiversity at global, national and local levels, India as a mega-diversity nation, Hot-spots of biodiversity, Threats to biodiversity: habitat loss, poaching of wildlife, man wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Unit 5: Environmental Pollution:

Definition, causes, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear pollution, Solid waste management: Causes, effects and control measures of urban and industrial wastes, Role of an individual in prevention of pollution. **Disaster management:** floods, earthquake, cyclone and landslides

Unit 6: Social Issues and the Environment:

From unsustainable to sustainable development, Urban problems and related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns.

Unit 7: Environmental ethics:

Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Case studies, Wasteland reclamation, Consumerism and waste products, Environmental Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation, Public awareness. Human Population and the Environment: Population growth, variation among nations, Population explosion

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					3							1	3	
CO-2	1					3							1	3	
CO-3	1					3							1	3	
CO-4	1					3							1	3	
CO-5	1					3							1	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		22
Demonstrations		05
1. Demonstration using Videos	05	
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		03
1. Case Study Presentation	03	
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		**40**

7. Course Assessment and Reassessment

The components and subcomponents of course assessment are presented in the Academic Regulations document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Academic Regulations document as well.

The assessment questions are set to test the course learning outcomes. In each component or subcomponent, certain Course Outcomes are assessed as illustrated in the following Table.

Focus of Course Learning Outcomes in each component assessed		
	CE (60% Weightage)	**SEE (40% Weightage)**
	SC Innovative Assignment	**SEE**
	25 Marks	25 Marks
CO-1	×	×
CO-2	×	×
CO-3	×	×
CO-4		×
CO-5		×

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

Course reassessment policies are also 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. Bharucha, E., 2004, Environmental Studies, New Delhi, University Grants Commission Ahluwalia, V.K., 2013,
3. Environmental Studies: Basic concepts, The Energy and Resources Institute (TERI).

b. Recommended Reading

1. Jadhav, H. and Bhosale, V. M., 1995, Environmental Protection and Laws, New Delhi, Himalaya Publishing House

c. Magazines and Journals

https://www.omicsonline.org/environmental-sciences-journals-impact-factor-ranking.php

d. Websites

https://www.sciencedaily.com/news/earth_climate/environmental_science

e. Other Electronic Resources

http://www.globalissues.org/issue/168/environmental-issues

10. Course Organization

Course Code	BTN101A	
Course Title	Environmental Studies	
Course Leader Name	As per Timetable	
Course Leader Contact Details	**Phone:**	08045366666
	E-mail:	hod.bt.ls@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May 2027	

Course Title: Kannada Kali

Course Title	Kannada Kali
Course Code	TSN102A
Course Type	Theory
Department	Humanities
Faculty/ School	Engineering and Technology

1. Aim and Summary

To enable students to communicate in Kannada at a rudimentary level. To understand basic conversation and to familiarize with basic legal usage.

2. Course Size and Credits:

Number of Credits	01
Credit Structure (Lecture: Tutorial: Practical)	1:0:0
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	Humanities
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes

4. After undergoing this course, students will be able to:

Cos	**Intended Learning Outcome**
CO-1	**Able to read and write basics of Kannada**
CO-2	**Understand and speak the language**
CO-3	**Legal words in Kannada- to read and write**

5. Course contents

Unit 1:

a) ಕನ್ನಡ ಅಕ್ಷರಮಾಲೆ

b) ಸ್ವರಗಳು

ಹ್ರಸ್ವಸ್ವರ

ದೀರ್ಘಸ್ವರ

C) ಸಂಧ್ಯಾಕ್ಷರಗಳು

d) ಯೋಗವಾಹಕಗಳು

e) With respect or Plural (wrp) Kannada word, English word, and simple sentences. – Session 1

Unit 2:

With respect or Plural (wrp) Kannada word, English word, and simple sentences. – Session 2

a) ವ್ಯಂಜನಗಳು
ವರ್ಗೀಯ ವ್ಯಂಜನಗಳು ವಿವರಣೆ
ಅವರ್ಗೀಯ ವ್ಯಂಜನಗಳು ವಿವರಣೆ
b) ಅಲ್ಪಪ್ರಾಣ ಮಹಾಪ್ರಾಣ ಅನುನಾಸಿಕ ಪದಗಳು
c) ಗುಣಿತಾಕ್ಷರಗಳು ವಿವರಣೆ
ಲೇಖನ ಚಿಹ್ನೆಗಳು ವಿವರಣೆ
d) ಕನ್ನಡದ ಅಂಕಿಗಳು ಬರವಣಿಗೆ
ವಾಕ್ಯಗಳಲ್ಲಿ ಪ್ರಯೋಗ ಮಾಡುವುದು

Unit 3:

With respect or Plural (wrp) Kannada word, English word, and simple sentences. – Session 3

- **Words conveying relations**
- **Numbers 1 to 20 and 10 to 100**
- **Commonly required vegetables, fruits and colors name**

Unit 4:

a) ಕಾನೂನು ಪದಕೋಶ
(ಕನ್ನಡ ಟು ಇಂಗ್ಲಿಷ್ ಮತ್ತು ಇಂಗ್ಲಿಷ್ ಟು ಕನ್ನಡ)
b) ನ್ಯಾಯಾಲಯದ ಪರಿಭಾಷೆಯಲ್ಲಿ ಎರವಲು ಪದಗಳು
C) ಕನ್ನಡದಲ್ಲಿ ಪತ್ರ ಬರವಣಿಗೆ
ಸಾಮಾಜಿಕ ಪತ್ರ
ವ್ಯವಹಾರಿಕ ಪತ್ರ
ಉದಾಹರಣೆಗಳ ಸಮೇತ ಬರೆಯುವುದು

1. 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 (Mechanical 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 (60% Weightage)	**Component 2: (40% Weightage)**
Subcomponent▶	**SC1**	**SEE Theory**
Subcomponent Type ▶	**Assignment 1**	**(40% Weightage)**
Maximum Marks▶	**25**	**50 Marks**
CO-1	**×**	**×**

CO-2	×	×
CO-3	×	×
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.

Component-1: 60% weight

It has three sub-components

Part A: Assignment 1 (SC2): 50% Weight of Component-1

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

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

Component-2: 40% weight

Semester End written Examination: 40% of Component 2.

A three-hour duration semester end examination for a maximum of 50 marks will be conducted and reduced to 50% weight.

A student is required to score a minimum of 40% marks in CE and SEE and 40% marks overall.

Reassessment

A student having met attendance requirement and happens to fail in component-2 will be asked to re-sit for examination (Make up examination).

A student fails to attain attendance eligibility is required to re-register in the next opportunity.

The maximum number of such opportunities are limited (as specified in the academic regulations governing this programme)

6. Essential Reading:

1. Lingadevaru Halemane , Kannada Kali, A Language text book for Non Kannada Professional Degree courses
2. N. Gopalkrishna Udupa, Kannada Vyakarna Rachana (Kannada Grammar), 2020
3. U.R. Mediratta & Mehul Mediratta, General English Kannada (for all classes), Kannada Edition, 2016
4. Pramilamma, Sulabha Kannada Vyakarna, Sunstar Publishers, 2022

Suggested Reading:

5. B.S. Rukkamma, Navkarnataka Sachitra Sarala Vyakarna, 2012
6. S.N. Sridhar, Modern Kannada Grammar, Manohar publications, 2007.

7. Wren & Martin, revised by N.D.V Prasada Rao, High School English Grammar & Composition (English-Kannada), S. Chand.

7. Course Organization

Course Code	TSN102A		
Course Title	Kannada Kali		
Course Leaders Name		As per Time table	
Course Leader Contact Details		**Phone:**	080 – 4536 6666
		E-mail:	director.tsld@msruas.ac.in
Course Specifications Approval Date		May 2023	
Next Course Specifications Review Date:		May 2027	

Course Specifications: Engineering Mathematics - 3

Course Title	Engineering Mathematics - 3
Course Code	MTF201A
Course Type	Core Theory
Department	Mathematics and Statistics
Faculty	Engineering and Technology

1. Course Summary

This course deals with vector spaces, vector calculus, probability and statistics. The basic concepts of vector spaces are taught along with the rudimentary principles and important theorems in vector calculus. Students are taught the probability theory and statistical distributions needed to quantify uncertainty and accuracy of information. This course also covers the underlying principles and applications of vector calculus in various engineering disciplines. The students will be able to implement numerical techniques to solve a diverse range of applied mathematical problems using MATLAB.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:2
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
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.** Define and explain the concepts of vector spaces, vector calculus, correlation, regression, random variables and probability distribution.
- **CO-2.** Solve simple problems in vector spaces, vector calculus, probability and statistics.
- **CO-3.** Implement the programs to solve system of linear equations using MATLAB
- **CO-4.** Apply interpolation, curve fitting and numerical integration method in analyzing some real world problems using MATLAB
- **CO-5.** Formulate and solve complex real world engineering problems associated with vector calculus, probability and statistics.

4. Course Contents

Unit 1 (Vector Spaces): Vector spaces, subspaces, linear independence, basis and dimension. Row, column and null space of a matrix. Linear transformations.

Unit 2 (Vector Calculus): Review of vector algebra, vector and scalar fields, derivatives of vector

valued functions, curves, tangents, arc length. Gradient of a scalar field, directional derivatives, divergence and curl of a vector field. Polar, Cylindrical and Spherical coordinates systems. Line integral, double integral and triple integral, Green's theorem, Stokes' theorem, Gauss divergence theorem.

Unit 3 (Probability and Statistics): Review of basics of probability and statistics, conditional probability and Bayes' theorem. Random variables, probability distributions. Probability density function and cumulative density function. Mean and variance of distributions. Binomial, exponential and normal distributions. Contingency, correlation and regression.

Unit 4 (MATLAB – 1): Introduction to MATLAB, Basic algebraic and matrix operations, built-in and command line functions, Plots scripts and functions. Newton-Raphson method and Numerical solution of system of linear equations by Gauss Seidel method.

Unit 5 (MATLAB – 2): Interpolation - Lagrange interpolation, Newton's divided difference interpolation. Linear and non-linear curve fitting, Newton-Cotes' quadrature, trapezoidal, Simpson's 1/3 and Simpson's 3/8 rules, and Gaussian quadrature.

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	2	1
CO-2	3	3											3		
CO-3	3	3											3		
CO-4	3	3	3		2				1	1			3	2	1
CO-5	3	3	3		2				1	1			3	2	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

5. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
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		15
1. Course Laboratory		
2. Computer Laboratory	15	
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**

6. 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. (Mechanical 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						
Course Outcome	**CE (Weightage: 60 %)**				**Component 2: SEE (40% Weightage)**	
	SC1	**SC2**	**SC3**	**SC4**	**SEE (Weightage: 25 %)**	**SEE (Weightage: 15 %)**
	Term Test	**Term Test**	**Assignment**	**Lab**	**Written exam**	**Lab Exam**
	15	**15**	**20**	**10**	**50 Marks**	**25 Marks**
CO-1	×	×			×	×
CO-2	×	×			×	×
CO-3			×	×	×	×
CO-4			×	×	×	×
CO-5	×	×	×	×	×	×
The details of TSC1, TSC2, TSC3 or LSC4 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.

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	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	--

8. Course Resources

a. Essential Reading

1. Glyn James, 2016, Advanced Modern Engineering Mathematics, 4th edition, Pearson
2. Dennis Zill and Warren Wright, 2011, Advanced Engineering Mathematics, 4th edition, Jones and Bartlet
3. Sheldon Ross, 2013, A first course in probability, 9th edition, Pearson education
4. Rudra Pratap, 2010, Getting Started with MATLAB, 1st edition, Oxford University Press

b. Recommended Reading

1. Erwin Kreyszig, 2015, Advanced Engineering Mathematics, tenth edition, John Wiley & Sons Inc
2. Spiegel, M.R., Schiller, J and Srinivasan, R.A., 2000, Probability and Statistics, 2nd Ed., New York: McGraw-Hill.
3. Amos Gilat, 2016, MATLAB An Introduction with Applications, 6th edition, Wiley

c. Magazines and Journals

d. Websites

1. http://nptel.ac.in/
2. https://ocw.mit.edu/index.htm

e. Other Electronic Resources

1. https://www.khanacademy.org/
2. tutorial.math.lamar.edu/

9. Course Organization

Course Code	MTF201A	
Course Title	Engineering Mathematics – 3	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May 2027	

Course Specifications: Materials Science

Course Title	Materials Science
Course Code	MEC201A
Course Type	Core Theory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

The course deals with introduction to engineering materials, their properties and applications. The students will be able to develop an understanding of the structure of metals, ceramics, polymers and composites. Physical and mechanical properties of engineering materials will be discussed. Students will be exposed to application of phase diagrams, TTT diagrams and heat treatment methods. Concepts of strengthening mechanisms, creep, fracture and fatigue in engineering materials will be taught. Students will be able to apply the mechanism of plastic deformation, principle of strengthening methods. Utilize the mechanical behavior of materials and learn about failure analysis. Students will acquire knowledge about properties and applications of advanced engineering materials.

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	Mechanical 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.** Explain different types and classification of metals and non-metals for various engineering applications, different strengthening mechanisms and concepts related to plastic deformation
- **CO-2.** Describe phase diagrams and effect of heat treatment processes on properties of metals
- **CO-3.** Discuss the testing and characterization techniques of engineering materials.
- **CO-4.** Identify various modes of failure and corelate it to material behaviour
- **CO-5.** Select and apply advanced materials for specific applications based on their properties

4. Course Contents

Unit 1 (Phase Diagram and Heat Treatment):
Crystal structure, Imperfection in solids, Solid solutions – Types, factors governing solubility rules. Phase diagram – cooling curve, phase rule, types and interpretation. Iron–Iron carbide

($Fe-Fe_3C$) phase diagram, Microstructural aspects and invariant reactions in $Fe-Fe_3C$ diagram. Effect of alloying elements on $Fe-Fe_3C$ diagram. TTT and CCT diagrams. Various heat treatment and surface hardening process.

Unit 2 (Elastic and Plastic Behaviour of Materials):
Stress-Strain relation in elastic and plastic region Mechanism of plastic deformation – slip and twinning, slip systems, critically resolved shear stress, Shear strength of perfect and real crystals. Dislocation – climb, interaction, multiplication and pile ups. Strengthening mechanisms – Solid solution, Grain boundary, Dispersion, Precipitation, Fiber, Martensite strengthening, Strain aging and Strain hardening.

Unit 3 (Characterization of Materials):
Types of fracture in metals, Griffith's theory of brittle fracture, Stress intensity factor, Fracture toughness, Theory of Ductile to brittle transition. Creep – Creep curve, mechanism of creep deformation. Fatigue - S-N curve, low and high cycle fatigue, stages of fatigue. Sources of failure, Procedure of failure analysis. Hardness: Rockwell, Brinell, Vickers hardness, Nano-Indentation Technique. Introduction to characterization of materials - XRD, SEM and TEM. Demonstration – various material characterization.

Unit 4 (Properties of Advanced Materials):
Properties of plain carbon steel, Tool steel, Stainless steel, Cast iron. Need of microalloying, HSLA steel - Dual phase steel, TRIP steel. Aluminum alloys – classifications, properties, applications, Titanium alloys. Polymers – Types, Properties and applications. Ceramics – Types, Properties and applications. Composites – classification, Reinforcement and matrix material, Rule of Mixture. Properties and applications of MMC, CMC and PMC. Demonstration – Various characterizations of materials.

Unit 5 (Futuristic Materials and Computational Materials Design):
Smart materials – Types, Shape memory alloys. Nanomaterials: Carbon nanotubes, Graphene – properties and applications. Metallic foams, Metallic glasses, Super alloys, High entropy alloys, biomaterials. Multiscale materials modelling, Integrated Computational Materials Engineering with application to Industry 4.0. Materials Informatics, Machine learning for design of materials.

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	
CO-2	3	3											3		
CO-3	3	3											3		
CO-4	3	3	3		2								3	2	
CO-5	3	3	3		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		30

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		15
1. Course Laboratory	15	
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. (Mechanical 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 (60% Weightage)				**Component 2: SEE (40% Weightage)**
Subcomponent ▶	**SC1**	**SC2**	**SC3**	**SC4**	
Subcomponent Type ▶	**Term Test**	**Term Test**	**Assignment**	**Quiz**	**50 Marks**
Maximum Marks ▶	**15**	**15**	**20**	**10**	
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	--
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment, Examination
14.	Personal Management	Course Work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. W. D. Callister Jr. and D. G. Rethwisch, 2019, Materials Science and Engineering: An Introduction, 10th Edition, Wiley Publications.

b. Recommended Reading

1. H. Van Vlack, 2002, Elements of Materials Science and Engineering, 6th Edition, Addison-Wesley.
2. V. Raghavan, 2015, Materials Science and Engineering: A First Course, 6th Edition, PHI.
3. Donald R. Askeland, 2016, The Science and Engineering of Materials, 8th Edition, Chapman and Hall.
4. Z. L. Wang and Z. C. Kang, 2012, Functional Materials: Structural Evolution and Structure Analysis, Plenum, New York.
5. Flake. C Campbell, Elements of Metallurgy and Engineering Alloys, ASM International, 2008
6. Dieter G.E, Mechanical Metallurgy, McGraw Hill, 2019
7. Budinski.K.G, Budinski.M.K, Engineering Materials Properties and Selection, Pearson Publication, 2010
8. ASM Handbook, Failure analysis and Prevention, Vol: 11, 2021
9. Chaudhary Mustansar Hussain, Smart Materials and New Technologies, Springer, 2022

10. Shubhabrata Datta and J. Paulo Davim, Machine Learning in Industry, Springer, 2021
11. Shubhabrata Datta and J. Paulo Davim, Materials Design Using Computational Intelligence Techniques, CRC Press, 2016

c. Magazines and Journals

1. Materials Science and Engineering: A
2. Materials Science and Engineering: B
3. Materials Science and Engineering: C
4. Materials Science and Engineering: R: Reports
5. Materials Research Bulletin
6. Journal of Materials Science
7. Materials Today Magazine

d. Websites

1. http://www.mrs.org
2. http://www.mrsi.org.in
3. http://www.asminternational.org
4. https://www.coursera.org/
5. http://nptel.ac.in/

e. Other Electronic Resources

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

10. Course Organization

Course Code	MEC201A	
Course Title	Materials Science	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May-2023	
Next Course Specifications Review Date	May-2027	

Course Specifications: Mechanics of Deformable Solids

Course Title	Mechanics of Deformable Solids
Course Code	MEC202A
Course Type	Core Theory and laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with the concepts and principles of strength of materials. Students are taught various types of forces and their reactions on the structures. The concepts of stress, strain, deformation and their applications in solving general engineering problems will be explained. Students are trained to analyse the response of the simple structural components to applied forces and boundary conditions. Students will be able to apply principles of strength of materials to solve problems of practical importance.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:2
Total Hours of Interaction	75
Number of Weeks in a Semester	15
Department Responsible	Mechanical 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 various types of forces , stresses, strains and elastic constants
- **CO-2.** Explain Hooke's law, stress strain behavior of materials, bending of beams, torsion of shafts, shear force and bending moments, thick and thin cylinders, columns and struts
- **CO-3.** Derive standard mathematical relationships for structural elements subjected to different loading and boundary conditions to analyse stresses, strains and deflections
- **CO-4.** Solve numerical problems on stress/strain/deflection analysis for various structural elements
- **CO-5.** Apply principles of strength of materials to solve problems of practical importance
- **CO-6.** Conduct experiment to determine various mechanical properties of engineering materials

4. Course Contents

Unit 1 (Introduction): Importance of strength of materials, basic assumptions, fundamental laws of mechanics, types of loading, Concept of stress; normal stress; shear stress; bearing stress; different states of stress – uniaxial, biaxial, triaxial, plane stress; Equivalent stress, principal stresses and maximum shear stress, Mohr’s circle applied to biaxial state of stress,

Concept of strain; normal strain; shear strain; different states of strain – uniaxial, biaxial, triaxial, plane strain, principal strain, volumetric strain

Unit 2 (Mechanical Behavior of Material): Stress-strain diagram; properties of engineering materials; Hooke's law; Poisson's ratio; elastic modulus, bulk modulus; modulus of rigidity; relationship between different elastic constants, strain energy in axially loaded members, Thermal Effects, Coefficient of thermal expansion, thermal strain, thermal stress, examples of thermal stresses

Unit 3 (Thin and Thick Cylinders): Thick and thin cylinders; Thin cylindrical pressure vessels subjected to internal pressure; Stresses in thin cylinders; Thick cylindrical pressure vessels subjected to internal pressure; Stresses in thick cylinders

Unit 4 (Beams and Stresses due to Bending): Types of loads; types of supports; reactions. Shear Force and Bending Moment, sign conventions, diagrams for simply supported, cantilever and overhang beams with point load, couple, uniformly distributed load, uniformly varying load, point of contra flexure, Beams with uniform cross section; pure bending of beams, assumptions, moment of inertia, neutral axis, bending stress; normal and shear stresses in beams, Deflection and slopes in beams, Deflection and slopes in simply supported and cantilever beams, strain energy in beams.

Unit 5 (Torsion in Shafts and Columns and Struts): Pure torsion; Assumptions, polar moment of inertia, angle of twist, stresses due to torsion; solid and hollow circular shafts; Torsional strain energy, combined torsion and axial loading. Elastic stability of columns; critical load of a slender column; eccentrically loaded columns; Euler's and Rankine Gordon theory of columns

Unit 6 (Laboratory Exercise)

1	Conduct tensile test on Mild steel and Aluminum to determine tensile strength as per ASTM E9 (M)
2	Conduct compression test on ductile (Mild steel and Aluminum) and brittle (Cast iron) materials to determine compressive strength as per ASTM E9 (M)
3	Conduct single and double shear test to determine shear strength of given material
4	Conduct Izod and Charpy impact test to determine the energy absorbed by the test specimen as per ASTM E23(M)
5	Conduct Rockwell hardness test on ferrous and non-ferrous materials to determine Brinell hardness number for the test material as per ASTM standard E18-19
6	Conduct Brinell hardness test on ferrous and non-ferrous materials to determine Brinell hardness number for the test material as per ASTM standard E10-18

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		
CO-2	3												3		
CO-3	3	1											3		
CO-4		3	3	3	3								3		
CO-5		3		3	3			3				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		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		30
1. Course Laboratory	30	
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		**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. (Mechanical 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						
Course Outcome	CE (Weightage: 60 %)				Component 2: SEE (40% Weightage)	
	SC1	SC2	SC3	SC4	SEE (Weightage: 25 %)	SEE (Weightage: 15 %)
	Term Test	Term Test	Assignment	Lab	Written exam	Lab Exam

	15	15	20	10	50 Marks	25 Marks
CO-1	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	
The details of TSC1, TSC2, TSC3 or LSC4 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	Class room lectures, Assignments
2.	Understanding	Class room lectures, Assignments
3.	Critical Skills	Class room lectures, Assignments
4.	Analytical Skills	Class room lectures, Assignments
5.	Problem Solving Skills	Class room lectures, Assignments
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. R. C. Hibbeler, 2013, Mechanics of Materials, 9th Edition, Pearson Education India.
3. S. N. Ramamrutham, 2017, Strength of Materials, 9th Edition, Dhanpat Rai Publishing Company.

b. Recommended Reading

1. B.C. Punmia, Ashok Kumar Jain, Arun Kumar Jain, 2015, Strength of Materials, 10th Edition, Laxmi Publications.
2. Stephen H. Crandall, Norman C. Dahl, Thomas Lardner and M. S. Sivakumar, 2012, An Introduction to Mechanics of Solids, 3rd Edition, Tata McGraw-Hill.
3. S. Timoshenko, 1986, Strength of Materials, Part 1 and 2, 3rd Edition, CBS.
4. Robert L. Mott, Joseph A. Untener, 2017, Applied Strength of Materials, CRC Press.
5. Sadhu Singh, 1978, Strength of Materials, 11th Edition, Khanna Publishers.

c. Other Electronic Resources

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

10. Course Organization

Course Code	MEC202A	
Course Title	Mechanics of Deformable Solids	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May-2027	

Course Specifications: Manufacturing Processes

Course Title	Manufacturing Processes
Course Code	MEC203A
Course Type	Core Theory and laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with primary manufacturing processes like metal casting, metal forging, metal joining and sheet metal forming. Students are introduced to working principles, operations and application of various metal casting, metal forging. Metal joining and sheet metal forming processes. Students will be able to select suitable metal casting, metal forging, metal joining and sheet metal forming processes based on component features and application. Students will be able to identify the casting, welding and forging defects formed during manufacturing process and suggest suitable remedies.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:2
Total Hours of Interaction	75
Number of Weeks in a Semester	15
Department Responsible	Mechanical 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.** Explain the working principles and operations of equipment required for metal casting, metal forging, metal joining and sheet metal forming processes
- **CO-2.** Describe the various metal casting, metal forging, metal joining and sheet metal forming processes, their process parameters, defects along with remedial actions
- **CO-3.** Calculate load and power requirement for forging and sheet metal forming processes
- **CO-4.** Select appropriate manufacturing process for given component based on features and applications
- **CO-5.** Test for moulding sand properties and prepare sand moulds using different patterns
- **CO-6.** Prepare components through forging operation as per drawing

4. Course Contents

Unit 1 (Introduction to Manufacturing Processes): Overview of Manufacturing Processes, Classification, Primary and secondary processes, Characteristics, Classification based on type of energy used and Influence of manufacturing processes on mechanical properties

Unit 2 (Metal Casting Processes): Introduction to casting processes, Classification, Advantages,

Limitations and Applications of Casting Processes Sand Casting and Moulding Practices: Moulding sand characteristics, Core sand properties, Green sand, Baked sand, No bake sand and CO2 processes, Patterns - materials, types, pattern allowances, Shell mould casting, Investment casting, Gravity die casting, Pressure die casting, Centrifugal casting, Squeeze casting, Thixocasting, Rheocasting processes.

Unit 3 (Furnaces and Melting Practices): Furnaces – Oil / gas fired, Electric arc, Resistance and Induction furnaces Degassing, Grain refining, Casting cleaning and Foundry defects
Gating System: Elements of gating system, Function of sprue, Runner, Gates and Risers.

Unit 4 (Metal Forming Processes): Introduction to metal forming processes, Classification, Advantages, Limitations and Applications of forming processes, Hot working and cold working, Plastic deformation of metallic materials
Forging: Working Principle, Types, Characteristics of forged products, Forging load, Forging dies and presses, Forging defects, Numerical problems on calculation of forming load in forging process
Rolling: Working Principle, Types, Characteristics of rolled products, Rolling load, Effect of friction, Rolling of structural shapes and sheets.
Extrusion and Drawing: Working Principle, Types, Extrusion equipment, Wire, rod and tube drawing, Extrusion defects.

Unit 5 (Metal joining techniques): Overview of joining processes, classification, Heat Affected Zone (HAZ). Welding techniques – resistance, arc, friction, laser welding processes and mechanical sheet metal joining processes, welding defects, Applications

Unit 6 (Sheet Metal Operations): Formability and Forming Limit Diagram, Press tool operations, Tooling for press work, Dies and presses, Drawing, Stretch forming, Embossing and coining, Defects in sheet formed components, Numerical problems on calculation of forming load.

Laboratory exercise

1	Determination of compression and shear strength tests on green sand specimen and discuss the results
2	Determination of the percentage of clay content for green sand specimen
3	Determination of the percentage of moisture content for green sand specimen
4	Determination of the permeability number on green sand specimen and discuss the results
5	Conduction of the mouldability and friability test on green sand specimen and discuss the results
6	Determination of the grain fineness number for foundry sand
7	Preparation of green sand moulding using cope and drag for split piece pattern and core mould
8	Demonstration of melting of Aluminum alloys and pouring of castings and NDT techniques
9	Conduct of hot forging operations and to draw conclusions

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		
CO-2	3												3		
CO-3		3											3		
CO-4	3	2											3		
CO-5	3	2								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		05
1. Demonstration using Videos	05	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	0	
Numeracy		10
1. Solving Numerical Problems	10	
Practical Work		20
1. Course Laboratory	20	
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	05	
2. Guest Lecture	00	
3. Industry / Field Visit	05	
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. (Mechanical 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						
Course Outcome	CE (Weightage: 60 %)				Component 2: SEE (40% Weightage)	
	SC1	SC2	SC3	SC4	SEE (Weightage: 25 %)	SEE (Weightage: 15 %)
	Term Test	Term Test	Assignment	Lab	Written exam	Lab Exam
	15	15	20	10	50 Marks	25 Marks
CO-1	×	×			X	
CO-2	×	×			X	
CO-3	×	×			X	
CO-4			×	×	X	×
CO-5			×	×	X	×
The details of TSC1, TSC2, TSC3 or LSC4 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	--
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment, Examination
14.	Personal Management	Course Work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. P. N. Rao, 2003, Manufacturing Technology, Foundry, Forming and Welding, Tata McGraw-Hill
3. Serope Kalpakjian and Steven R. Schmid, 2004, Manufacturing Engineering and Technology, Pearson Education

b. Recommended Reading

1. Paul Degarmo E. and Black Jt., 2004, Materials and Processes In Manufacturing, JWS
2. Peter Beeley, 2001, Foundry Technology, Butterworth-Heinemann
3. Heine, Loper and Rosenthal, 2008, Principles of Metal Casting, McGraw-Hill
4. John G Lenard, 2002, Metal Forming Science and Practice, Elsevier

c. Magazines and Journals

1. Journal of Materials Processing Technology
2. Journal of Manufacturing Processes, Society of Manufacturing Engineers
3. International Journal of Material Forming
4. International Journal of Forming Processes, Computational and Physical Methods, Esaform
5. Indian Foundry Journal, Institute of Indian Foundrymen
6. International Welding Journal, American Welding Society
7. Indian Welding Journal, Indian Institute of Welding

d. Websites

1. http://www.efoundry.iitb.ac.in
2. www.asm.org
3. www.nptel.ac.in
4. https://www.coursera.org/
5. http://nptel.ac.in/

e. Other Electronic Resources

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

10. Course Organization

Course Code	MEC203A	
Course Title	Manufacturing Processes	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May-2023	
Next Course Specifications Review Date	May-2027	

Course Specifications: Fluid Mechanics and Machines

Course Title	Fluid Mechanics and Machines
Course Code	MEC204A
Course Type	Core Theory and Laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

I. Course Summary

This course deals with the principles of fluid mechanics and machines with their application which facilitates students to understand fluid properties and classify fluid flows. Basics of hydrostatics, kinematics and dynamics of fluid flow will be taught. Students are trained to use the principles of dimensional analysis to infer the non- dimensional parameters involved in a flow problem. Students will be able to solve practical fluid flow problems and apply laws of thermodynamics to evaluate fluid machine performance and select the right type of fluid machine for a given application.

2. Course Size and Credits:

Number of credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:2
Total hours of interaction	65
Number of Weeks in a Semester	15
Department responsible	Mechanical Engineering
Total Course Marks	100
Pass requirement	As per the Academic Regulations
Attendance requirement	As per the Academic Regulations

3. Course Objectives (CO)

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

CO-1. Explain various types of fluid flows, fluid kinematics and dynamics, viscous and turbulent flow through pipes, boundary layer phenomenon and dimensional analysis

CO-2. Derive fluid equations based on Hydrostatic law, Pascal's law, Archimedes principle, Conservation laws, Bernoulli's theorem and Solve the problems based on it

CO-3. Explain the types, working principle and applications of fluid machines

CO-4. Apply steady flow energy equation to determine energy exchange across a fluid machine and derive the Euler turbine equation

CO-5. Conduct practical laboratory experiments on fluid mechanics and machines

4. Course Contents

Unit 1 Different types of fluid Properties and Pressure Measurement
Units and dimensions, Properties of fluids, Viscosity, No-slip condition, Newtonian and non-Newtonian fluids, Classification of fluids and flows: internal and external, steady and unsteady, uniform and non-uniform, incompressible and compressible, ideal and real, rotational and irrotational flow, laminar and turbulent flow, numerical problems

Definition of pressure and pressure gradient, Pressure at a point, Pascal's law, hydrostatic pressure, absolute and gauge pressures, Measurement of pressure, simple and differential manometers, numerical problems

Unit 2 Hydrostatics and Kinematics of Fluid Flow: Archimedes principle, buoyancy and stability, Concept of scalar and vector fields, Lagrangian and Eulerian descriptions of fluid flow, Definition of path line, streamline, streak line, stream tube, derivation of continuity equation, acceleration of field of fluid flow, definition of velocity potential, stream function, streamline, equipotential line, relation between velocity potential and stream function, Laplace equation; numerical problems

Unit 3 Dynamics of Fluid Flow and Dimenional Analysis: Derivation of Euler's equation and Bernoulli's equation, assumptions and limitations, Application of Bernoulli's equation - Pitot tube, Venturimeter. Major and Minor losses in pipe derivation of Darcy-Weisbach equation, Chezy's equation, friction factor, Moody chart, numerical problems. Principle of dimensional homogeneity, Buckhingam's π - theorem, Non-dimensional parameters and their importance, Concept of model testing.

Unit 4 Energy Transfer in Fluid Machines: Comparison between fluid machines and positive displacement machines; Static and stagnation states; Application of first and second law of thermodynamics to fluid machines. Euler turbine equation; components of energy transfer, Velocity triangles; Principles of impulse and reaction machines; Degree of reaction; Utilization factor for different types of turbines; Relation between Degree of Reaction and Utilization factor; Conditions for maximum utilization factor

Unit 5 Hydraulic Machines: Classification; Pelton, Francis, Propeller and Kaplan turbines; Hydraulic turbine power utilization; Velocity triangles and work done; Hydraulic, and volumetric efficiencies; Performance characteristics; Runaway speed; Penstock, tailstock, draft tubes; Water hammer and surge tank; Cavitation in hydraulic turbines
. Centrifugal pumps – Classification; Working principle; Advantages over positive displacement pumps; Definition of suction head, delivery head, manometric head, gross head, and static head; NPSH; Priming; Theoretical Head-Capacity relationship; Velocity triangles and work done; Power input and various efficiencies; Operating characteristics; Cavitation in hydraulic pumps; Submersible pumps

List of laboratory experiments

SL No.	Name of Experiment
01	Determination of coefficient of discharge of orifice plate of various diameters
02	Determination of coefficient of discharge of Venturimeter
03	Determination of major losses in fluid flow through pipes
04	Determination of minor losses in fluid flow through pipe fittings and valves

05	Determination of coefficient of impact of jets on different shaped vanes
06	Determination of the performance of a Multi stage Centrifugal pump and plotting operating characteristic curves
07	Determination of the performance of Pelton wheel and plotting main and operating characteristic curves
08	Determination of the performance of Francis turbine and plotting main and operating characteristic curves
09	Determination of the performance of Kaplan turbine and plotting main and operating characteristic curves
Total Marks is 50 Marks, reduced to 25	

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		2		1								3	1	
CO-2	2	1	3	2		1	1						3	2	
CO-3	3	2											3		
CO-4	3	2	2	1									3	1	
CO-5	3	3	2	3									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		02
1. Demonstration using Videos	02	
2. Demonstration using Physical Models /		
3. Demonstration on a Computer		
Numeracy		13
1. Solving Numerical Problems	13	

Practical Work		20
1. Course Laboratory	20	
2. Computer Laboratory		
3. Engineering Workshop / Course Workshop / Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		00
1. Case Study Presentation		
2. Guest Lecture		
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions		
6. Discussing Possible Innovations		
Term Tests, Written Examination		10
Total Duration in Hours		75

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment is presented in the Programme Specifications document pertaining to the B.Tech.(Mechanical 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						
Course Outcome	**CE (Weightage: 60 %)**				**Component 2: SEE (40% Weightage)**	
	SC1	**SC2**	**SC3**	**SC4**	**SEE (Weightage: 25 %)**	**SEE (Weightage: 15 %)**
	Term Test	**Term Test**	**Assignment**	**Lab**	**Written exam**	**Lab Exam**
	15	**15**	**20**	**10**	**50 Marks**	**25 Marks**
CO-1	**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 TSC1, TSC2, TSC3 or LSC4 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	Class room lectures, and demonstrations
3.	Critical Skills	Assignment
4.	Analytical Skills	Class room, assignment
5.	Problem Solving Skills	Class room, assignment
6.	Practical Skills	Class room, assignment
7.	Group Work	Classroom
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	Presentation
11.	Presentation Skills	Presentation
12.	Behavioral Skills	Course
13.	Information Management	Assignment, examination
14.	Personal Management	Assignment, examination
15.	Leadership Skills	Effective management of learning

9. Course Resources

a. Essential Reading

1. Class Notes
2. R. K. Bansal, 2011, A Textbook of Fluid Mechanics and Hydraulic Machines, Lakshmi Publications
3. Y. A. Cengel and J. M. Cimbala, 2010, Fluid Mechanics: Fundamentals and Applications,McGraw Hill Education
4. S.M Yahya, 2002, Turbines, Compressors and Fans, Second Edition, TataMcGraw Hill
5. Vedanth Kadambi and Manohar Prasad, 2011, An Introduction to Energy Conversion Volume III Turbomachinery, Second Edition, New Age International Publishers

b. Recommended Reading

1. F. M. White, 2008, Fluid Mechanics, 6th Edition, Tata McGraw-Hill
2. R. W. Fox, A. T. McDonald and P. J. Pritchard, 2013, Fluid Mechanics, 8th Edition, Wiley Publications
3. P. N. Modi and S. M. Seth, 2015, Hydraulics and Fluid Mechanics including Hydraulics Machines, Standard Book House
4. D. G. Shepherd, 1956, Principles of Turbomachinery, New York, MacMillan Company
5. S. L. Dixon, 1998, Fluid Mechanics and Thermodynamics of Turbo machinery,Reed Educational and Professional Publishing Ltd
6. G. Gopalkrishna and D. Privithiraj, 2002, A Treatise on Turbo machines, Scitech
7. H. I. H. Saravanamuttoo, H. Cohen and G. F. C. Rogers, 1996, Gas Turbine Theory, Longman Publications

c. Magazines and Journals

d. Websites

1. http://nptel.ac.in/

e. Other Electronic Resources

1. Electronic resources on the subject area are available on MSRUAS library

10. **Course Organization**

Course Code	MEC204A	
Course Title	Fluid Mechanics and Machines	
Course Leader/s Name		As per Time - table
Course Leader Contact Details		**Phone:** +91-804-906-5555
		E-mail: hod.me.et@msruas.ac.in
Course Specifications Approval Date		May-2023
Next Course Specifications Review Date		May-2027

Course Specifications: Essence of Indian Knowledge Systems

Course Title	Essence of Indian Knowledge Systems
Course Code	TSN201A
Course Type	Humanities and Social Sciences
Department	Civil Engineering
Faculty	Engineering and Technology

1. Course Summary

The course

2. Course Size and Credits:

Number of Credits	01
Credit Structure (Lecture: Tutorial: Practical)	1:0:0
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	DTSLD
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:

CO1 Sensitize the students about context in which they are embeded i.e. Indian culture and civilisation including its Knowledge System and Tradition.
CO2 Understand the knowledge, art and creative practices, skills andvalues in ancient Indian system.
CO3 Study the enriched scientific Indian heritage.
CO4 Introduce the contribution from Ancient Indian system & tradition to modern science & Technology

4. Course Contents

Introduction to IKS [Duration: 8 Lectures]

(Any eight of total sessions assigned for Literary activity)
Introductory lecture on the any eight topics below:
1. Indian Knowledge System
2. Indian Culture & Civilization
3. Ancient Indian Chemistry
4. Ancient Indian Metallurgy
5. Ancient Indian Mathematics
6. Ancient Indian Astronomy
7. Indian Astronomical Instruments
8. Indian Knowledge System (Upveda: Ayurveda)
9. Indian Knowledge System (Upveda: Gandharveda)
10. Indian Knowledge System (Vedangas: Shiksha, Kalpa, Vyakrana)

11. Indian Knowledge System (Vedangas: Jyotisha, Nirukta, Chandas)
12. Indian Architecture I: Sthapatya-Veda
13. Indian Architecture II: Temples
14. Indian Architecture III: Town & Planning
15. Indian Philosophical System

Module 2: Introduction to Creative Practices [Duration: 20 Lectures]

(Twenty Lectures with at least Five different topics of total session under Creative activity)
Introductory lecture on the topics below:
1. Dhatuvada: art of metallurgy
2. Akara jnana: art of mineralogy
3. Vastuvidya: art of engineering
4. Yantramatrika: art of mechanics
5. Takshana: art of carpentry
6. Chalitakayoga: art of practicing as a builder of shrines
7. Raupyaratnapariksha: art of testing silver and jewels
8. Maniraga jnana: art of tinging jewels
9. Sucivayakarma: art of needleworks and weaving
10. Vadya vidya: art of playing on musical instruments
11. Geet vidya : art of singing
12. Nritya vidya: art of dancing
13. Natya vidya: art of theatricals
14. Alekhya vidya: art of painting
15. Viseshakacchedya vidya: art of painting the face and body with color
16. Udakavadya: art of playing on music in water
17. Manasi kavyakriya: art of composing verse
18. Bhushanayojana: art of applying or setting ornaments
19. Citrasakapupabhakshyavikarakriya: art of preparing varieties of delicious food
20. Dasanavasanangaraga: art of applying preparations for cleansing the teeth, cloths and painting the body
21. Utsadana: art of healing or cleaning a person with perfumes
22. Vastragopana: art of concealment of cloths
23. Balakakridanaka: art of using children's toys
24. Tandulakusumabalivikara: art of preparing offerings from rice and flowers
25. Pushpastarana: art of making a covering of flowers for a bed

5. 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		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		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		**40**

6. Course Assessment and Reassessment

The components and subcomponents of course assessment are presented in the Academic Regulations document pertaining to the B. Tech. (Mechanical Engineering) Programme. The procedure to determine the final course marks is also presented in the Academic Regulations document as well.

The assessment questions are set to test the course learning outcomes. In each component or subcomponent, certain Course Outcomes are assessed as illustrated in the following Table.

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		**Component 2: SEE (40% Weightage)**
Subcomponent Type ▶	**Terms Tests**	**Assignments**	
CO-1	**X**		**X**
CO-2	**X**	**X**	**X**
CO-3	**X**	**X**	**X**
CO-4	**X**	**X**	**X**
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are also presented in the Academic Regulations document.

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

8. Course Resources

a. Essential Reading

1. Class notes

b. References:

1. Textbook on IKS by Prof. B Mahadevan, IIM Bengaluru

2. Kapur K and Singh A.K (Eds) 2005). Indian Knowledge Systems, Vol. 1. Indian Institute of

Advanced Study, Shimla. Tatvabodh of sankaracharya, Central chinmay mission trust,

Bombay, 1995.

3. The Cultural Heritage of India. Vol.I. Kolkata:Ramakrishna Mission Publication, 1972.

4. Nair, Shantha N. Echoes of Ancient Indian Wisdom. New Delhi: Hindology Books, 2008.

5. Dr. R. C. Majumdar, H. C. Raychaudhuri and Kalikinkar Datta: An Advanced History of

India (Second Edition) published by Macmillan & Co., Limited, London, 1953.

6. Rao, N. 1970. The Four Values in Indian Philosophy and Culture. Mysore: University of

Mysore.

7. Avari, B. 2016. India: The Ancient Past: A History of the Indian Subcontinent from c. 7000

c. Magazines and Journals

d. Websites

9. Course Organization

Course Code	TSN201A		
Course Title	Essence of Indian Knowledge System		
Course Leader Name		As per Timetable	
Course Leader Contact Details		**Phone:**	+91-804-906-5555
		E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date		May 2023	
Next Course Specifications Review Date		May 2027	

Course Specifications: Engineering Mathematics - 4

Course Title	Engineering Mathematics - 4
Course Code	MTF202A
Course Type	Core Theory
Department	Mathematics and Statistics
Faculty	Engineering and Technology

1. Course Summary

The course introduces the basic concepts of complex analysis and partial differential equations. The course encompasses the essentials of statistics, probability theory and numerical solution of differential equations. Students are taught the probability theory and statistical distributions needed to quantify uncertainty and accuracy of information. The significance and use of numerical methods for solution of ordinary and partial differential equations are emphasized in this course. The utility of complex analysis to solve complex engineering problems and that of partial differential equations in modeling real world problems are highlighted. The students will be able to implement probabilistic /numerical technique to solve a diverse range of applied mathematical problems using MATLAB.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:2
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
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.** Define and explain the concepts of correlation, regression, random variables, probability distribution, partial differential equations and complex analysis
- **CO-2.** State theorems and solve simple problems in partial differential equations, complex analysis , probability , probability distributions
- **CO-3.** Apply numerical methods to solve ordinary and partial differential equations using MATLAB
- **CO-4.** Solve complex engineering problems associated with numerical methods using MATLAB
- **CO-5.** Analyze real world problems associated with probability, probability distributions, partial differential equations and complex analysis
- **CO-6.** Construct the Bar chart, pie chart, Histogram , Box-plot and fitting of curves using MATLAB

4. Course Contents

Unit I (Partial differential equations): Basic concepts, classification of first order partial differential equations. Solutions by Lagrange's method. Classification of second order linear partial differential equations. Solutions of heat, wave and Laplace's equations by method of separation of variables.

Unit II (Probability and Probability distribution): Review of basics of probability, conditional probability and Bayes' theorem. Random variables, probability distributions. Probability density function and cumulative density function. Mean and variance of distributions. Binomial, exponential and normal distributions.

Unit III (Complex analysis): Complex valued functions, limits, continuity and differentiability. Analytic functions and Cauchy-Riemann equations. Construction of analytic functions, Harmonic functions. Complex line integral, Cauchy's integral theorem and integral formula. Taylor and Laurent series. Singularities and residues, Cauchy's residue theorem.

Unit IV (Correlation and Regression): Review of statistics. Contingency, correlation and regression Curve fitting: Least squares method - polynomial, exponential and power fit.

Unit V (Numerical Methods): Types of errors, numerical solution of ordinary differential equations by single-step methods – Euler's, modified Euler's and Runge-Kutta methods. Multi-step methods – Milne's and Adams' methods. Solution by MATLAB built-in function ode45.

Unit VI (Finite Difference Method): Finite differences, explicit methods for one dimensional heat and wave equations, stability conditions. Implicit method for one dimensional heat equation. Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain.

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	2	2	2										2		
CO-3	3	3	2							1			3		1
CO-4	3	3	2		2				1	1			3	2	1
CO-5	3	3	2		2					1			3	2	1
CO-6	3	3			1				1	1			3	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		45

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		15
1. Course Laboratory	00	
2. Computer Laboratory	15	
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. (Mechanical 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						
Course Outcome	**CE (Weightage: 60 %)**				**Component 2: SEE (40% Weightage)**	
	SC1	**SC2**	**SC3**	**SC4**	**SEE (Weightage: 25 %)**	**SEE (Weightage: 15 %)**
	Term Test	**Term Test**	**Assignment**	**Lab**	**Written exam**	**Lab Exam**
	15	**15**	**20**	**10**	**50 Marks**	**25 Marks**
CO-1	×	×			×	
CO-2	×	×			×	
CO-3	×	×			×	

CO-4			×	×	×	×
CO-5			×	×	×	×
CO-6			×	×	×	×
The details of TSC1, TSC2, TSC3 or LSC4 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. Dennis Zill and Patrick Shanahan, 2013, Complex Analysis, 3rd edition, Jones and Bartlett
2. Richard Burden and Douglas Faires, 2017, Numerical Analysis, 9th edition, Massachusetts, Brooks/Cole
3. Erwin Kreyszig, 2015, Advanced Engineering Mathematics, 10th edition, John Wiley & Sons Inc

b. Recommended Reading

1. Rao V. Dukkipati, 2011, Applied Numerical Methods using MATLAB, 1st edition, New Delhi, New Age
2. M. K. Jain, S.R.K. Iyengar and R.K. Jain, 2008, Numerical Methods, New Delhi, New Age
3. James Brown and Ruel Churchill, 2017, Complex Variables and Applications, 8th

edition, McGraw Hill Education
4. Sheldon Ross, 2013, A first course in probability, 9th edition, Pearson education
5. Richard A. Johnson, 2011, Miller and Freund's – Probability and Statistics for Engineers, 8th edition, Prentice hall India

c. Websites

1. http://nptel.ac.in/
2. https://ocw.mit.edu/index.htm

d. Other Electronic Resources

1. https://www.khanacademy.org/
2. https://tutorial.math.lamar.edu

10. Course Organization

Course Code	MTF202A	
Course Title	Engineering Mathematics - 4	
Course Leader/s Name	As per timetable	
Course Leader Contact Details	Phone:	080 4906 5555
	E-	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	May-2023	
Next Course Specifications Review Date	May-2027	

Course Specifications: Mechanical Dissection and Machine Drawing

Course Title	Mechanical Dissection and Machine Drawing
Course Code	MEL205A
Course Type	Core Theory with Laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course aims at preparing the students to use engineering drawing concepts to visualize machine components/elements, prepare parts, assembly, detailed drawings and BOM of mechanical systems. This will be achieved through teaching the principles of drawings, dimensioning, tolerances and fits used in machine drawing. Students will be trained to produce part, assembly as well as production drawings of various machine elements/components as per the standards using CAD software tool. The students are trained to dis-assemble simple machines and products, identify and document components, their functionality, form, features and material.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:2
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mechanical 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 ISO notations used in machine drawings
- **CO-2.** Create 3-D models of machine elements/components and produce detailed drawings
- **CO-3.** Create 3-D assembly models and draw 2-D detailed drawings with sectional details wherever required and prepare BOM for standard assemblies
- **CO-4.** Create 3-D assembly models and draw 2-D detailed drawings with sectional details wherever required and prepare BOM for standard assemblies
- **CO-5.** Dissect a given machine/product and examine components for form, features, functionality and develop 2D/3D sketches of components

4. Course Contents

1	General Considerations and Procedure for Design of Machinery, Classification of design, Machine component design, geometric modeling, various methods, recent trends in modeling, assembly modeling and their applications
2	Overview of Machine Drawing: Importance and areas of applications – Conventions, abbreviations and symbols, Principles of drawing- Scales, types of lines, title block and BOM, Part drawing, assembly and detail drawing, production drawing
3	Dimensions, Fits and Tolerances: Dimensioning, Principles of dimensioning methods, use of symbols and abbreviations in machine drawing, allowances, tolerance and surface finish, standards and accepted practices
4	Creation of 3-D models, assemblies and detailed drawings of Power transmission elements like Knuckle Joint, Oldham's coupling, Protected type flanged coupling, Screw Jack; Plummer Block, Machine Vice, Non- return valve and Tailstock of lathe
5	Thread forms: Thread terminology, Types of nuts and bolts. (Hexagonal bolt and nut with washer (assembly), square bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut Keys: Types and their applications Riveted Joints and their applications. Representation of standard Mechanical Components in Assemblies
6	Dissection of machine/product: Flanged coupling, machine vice, single cylinder four stroke IC engine, brake assembly and hand drilling machine

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		
CO-2					3					2				3	2
CO-3					3					2				3	2
CO-4					3					2				3	2
CO-5					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		12
Demonstrations		12
1. Demonstration using Videos	00	

2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	12	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		36
1. Course Laboratory	00	
2. Computer Laboratory	36	
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. (Mechanical 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 or SC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (60% Weightage)				**Component 2: SEE (40% Weightage)**
Subcomponent ▶	**SC1**	**SC2**	**SC3**	**SC4**	
Subcomponent Type ▶	**Term Test**	**Term Test**	**Assignment**	**Submission of drawing**	**50 Marks**
Maximum Marks ▶	**15**	**15**	**20**	**10**	
CO-1	×		×		×
CO-2	×		×		×
CO-3			×		×
CO-4		×		×	×
CO-5		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	Laboratory Work
2.	Understanding	Laboratory Work
3.	Critical Skills	Laboratory Work
4.	Analytical Skills	Laboratory Work
5.	Problem Solving Skills	Laboratory Work
6.	Practical Skills	Laboratory Work
7.	Group Work	Laboratory Work
8.	Self-Learning	Laboratory Work
9.	Written Communication Skills	Laboratory Report
10.	Verbal Communication Skills	Viva Voce
11.	Presentation Skills	Laboratory Work
12.	Behavioral Skills	--
13.	Information Management	Laboratory Manual
14.	Personal Management	--
15.	Leadership Skills	Laboratory Work

9. Course Resources

a. Essential Reading

1. Class Notes
2. N. D. Bhatt and V. M. Panchal, 2006, Engineering Drawing, Charotar Publishing House
3. K. R. Gopalakrishna, 2012, Machine Drawing, Subhas Publications

b. Recommended Reading

1. W. J. Luzadder, 2006, Fundamentals of Engineering Drawing, Prentice Hall India
2. M. Siddeshwara, P. Kamaiah, V.S. Sastry, 2007, Machine Drawing, Tata McGraw-Hill
3. K. L. Narayana, P. Kanaiah, K. Venkatat Reddy, 2006, Machine Drawing, New Age International Publication
4. M. B. Shah, B. C. Rana, 2007, Engineering Drawing, Dorling Kindersly (India) Pvt. Ltd.

c. Magazines and Journals

d. Websites

e. Other Electronic Resources

1. RUAS Laboratory Videos
2. Electronics resources on the course area are available in RUAS library

10. Course Organization

Course Code	MEL205A		
Course Title	Mechanical Dissection and Machine Drawing		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	080-49065555
		E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date		May-2023	
Next Course Specifications Review Date		May-2027	

◂◆▸

Course Specifications: Machine Dynamics-1

Course Title	Machine Dynamics-1
Course Code	MEC205A
Course Type	Core Theory and laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to prepare the students to perform kinematic analysis of planar mechanisms and use such mechanisms during design of different types of machinery. Students are taught kinematic analysis of mechanisms to accomplish desired motions of the machinery and their rigid body dynamic behavior during design. Students will be able to perform design/selection of different motion/power transmission mechanisms such as gears and cams.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:2
Total Hours of Interaction	75
Number of Weeks in a Semester	15
Department Responsible	Mechanical 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 basic concepts and principles of kinematics of machines
CO-2. Illustrate kinematic construction and working of commonly used planar mechanisms
CO-3. Determine displacement, velocity and accelerations in planar mechanisms using graphical and analytical methods
CO-4. Construct cam profile for the desired kinematic motion
CO-5. Solve problems on kinematic analysis of planar mechanism, construction of cam profile and gear drive
CO-6. Develop simulation model of planar mechanisms and analyse for position, velocity and accelerations using ADAMS

4. Course Contents

Unit 1 (Introduction): Introduction to kinematics of motion, Types of Motion; Displacement; Velocity, Acceleration; Relation between Linear and Angular Motion, Mechanisms and Machines; Links, Kinematic pairs and Kinematic chains; Planar and Spatial Mechanisms; Degree of Freedom in Planar and Spatial Mechanisms; Kinematic Diagrams, Kutzbach and Gruibler's criterion; Grashof's criterion

Unit 2 (Mechanisms) : Four- bar chain and its inversions; Slider crank chain and its inversions;

Double slider crank chain and its inversions; Quick return motion mechanisms; Straight line motion mechanisms; Intermittent Motion mechanisms; Toggle mechanism; Ackerman steering gear mechanism

Unit 3 (Kinematic Analysis of Planar Mechanisms): Position Analysis of Linkages -Graphical and Analytical Methods; Transmission Angles; Velocity analysis of mechanisms using graphical and analytical methods; Acceleration analysis of mechanisms using graphical and analytical methods; Coriolis component of Acceleration

Unit 4 (Cams): Overview of Cams; Classification of followers; Classification of Cams; Cam nomenclature; Motion of the Follower; Displacement, Velocity and acceleration diagrams when the follower moves with Simple Harmonic Motion, Uniform acceleration and retardation, uniform velocity, cycloidal motion; construction of CAM profiles

Unit 5 (Gears and Gear Trains): Law of gearing; Gear tooth nomenclature; Gear types; Simple gear trains; Compound gear trains; Epicyclic gear trains, reverted gear train; numericals

Unit 6 (Kinematic analysis using ADAMS software):
Overview of ADAMS software, commands and hot keys;
Laboratory exercises to be performed as part of the course

- Modelling of four bar mechanism and six bar mechanism
- Position analysis of four bar mechanism
- Position analysis of slider crank mechanism
- Velocity analysis of four bar mechanism
- Velocity analysis of slider crank mechanism
- velocity analysis of toggle mechanism
- Acceleration analysis of four bar mechanism
- Acceleration analysis of slider crank mechanism

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		
CO-2	3												3		
CO-3		3											3		
CO-4	3			1									3	1	
CO-5		3											3		
CO-6					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		00

1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		12
1. Solving Numerical Problems	12	
Practical Work		30
1. Course Laboratory	00	
2. Computer Laboratory	30	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		03
1. Case Study Presentation	03	
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		**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. (Mechanical 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						
Course Outcome	**CE (Weightage: 60 %)**				**Component 2: SEE (40% Weightage)**	
	SC1	**SC2**	**SC3**	**SC4**	**SEE (Weightage: 25 %)**	**SEE (Weightage: 15 %)**
	Term Test	**Term Test**	**Assignment**	**Lab**	**Written exam**	**Lab Exam**
	15	**15**	**20**	**10**	**50 Marks**	**25 Marks**
CO-1	**X**				**X**	
CO-2	**X**				**X**	
CO-3	**X**		**X**		**X**	
CO-4		**X**			**X**	
CO-5		**X**		**X**	**X**	**X**
CO-6			**X**			
The details of TSC1, TSC2, TSC3 or LSC4 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	Class room lectures, Assignments
2.	Understanding	Class room lectures, Assignments
3.	Critical Skills	Class room lectures, Assignments
4.	Analytical Skills	Class room lectures, Assignments
5.	Problem Solving Skills	Class room lectures, Assignments
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. S. S. Rattan, 2014, Theory of Machines, Tata McGraw-Hill Education

b. Recommended Reading

1. R. L. Norton, 2004, Design of Machinery, McGraw-Hill
2. Thomas Bevan, 1984, Theory of Machines, CBS Publishers and Distributors
3. Charles E. Wilson, J. Peter Sadler, 2003, Kinematics and Dynamics of Machinery, 3rd Edition, Prentice Hall
4. A. K. Mallik, A. Ghosh and G. Dittrich, 1994, Kinematic Analysis and Synthesis of Mechanisms, CRC press
5. A. G. Erdman and G. N. Sandor, 1988, Mechanisms Design, Analysis and Synthesis, Affiliated East West Press

c. Magazines and Journals

1. Journal of Mechanisms
2. Mechanism and Machine Theory
3. JSME International Journal - Series C: Mechanical Systems Machine Elements and Manufacturing

d. Websites

1. http://www.machinedesignonline.com

2. http://www.asminternational.org
3. www.nptel.ac.in

e. Other Electronic Resources

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

10. Course Organization

Course Code	MEC205A	
Course Title	Machine Dynamics-1	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May-2023	
Next Course Specifications Review Date	May-2027	

f◂◆▸

Course Specifications: Engineering Thermodynamics

Course Title	Engineering Thermodynamics
Course Code	MEC206A
Course Type	Core Theory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course intends to impart the knowledge of principles of classical thermodynamics. In this course, students are different approaches to thermodynamic systems and the concept of thermodynamic equilibrium. Zeroth, First, Second and Third Law of Thermodynamics and their application for energy conversion will be discussed. Students will be able to identify different thermodynamic processes and relate their properties to estimate the work and heat interaction.

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	Mechanical 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: Explain the concepts of thermodynamic systems, properties, processes, thermodynamic equilibrium, and entropy.
CO-2: Interpret the Zeroth, First, Second, and Third Laws of Thermodynamics with appropriate applications.
CO-3: Analyze various thermodynamic processes and cycles using P-V, T-s, and h-s diagrams.
CO-4: Derive fundamental equations related to thermodynamic cycles, laws, and processes for different thermodynamic systems.
CO-5: Apply thermodynamic principles to solve numerical problems involving various thermodynamic relations.

4. Course Contents

Unit 1(Fundamental Concept and Definitions): Role of Thermodynamics in Engineering applications, Basic Definitions, Types of thermodynamic Systems, Characteristics of system boundary and control-volume, Thermodynamic properties. Thermodynamic state and processes, Thermodynamic equilibrium; thermal equilibrium, chemical equilibrium, Zeroth law of thermodynamics, Temperature concepts, scales, fixed points and measurements

Unit 2 (Work and Heat): Definition of heat and work and its limitations, units and sign convention; Displacement work and Quasistatic process, functions , Different types of work- Shaft work; Electrical work, Stirring work, Flow work, etc. Comparison between heat and work; Joule's experiments.

Unit 3 (First Law of Thermodynamics): First law of thermodynamics for open and closed system undergoing -cyclic processes and a non-cyclic process/change of state, Energy as a property of a system, Different forms of energy, PMMI -Perpetual Motion Machine I, Extension of the first law to open system/control volume, Mass and energy balance in steady flow process, Steady flow energy equation and its applications.

Unit 4 (Second Law of Thermodynamics): Definitions of heat engines and reversible heat engines, Energy reservoirs, Kelvin Planck and Clausius statements of II Law, Heat engine performance parameters -Refrigerator and Heat pump, Corollaries of II law and PMM II, Reversibility and irreversibility as applied to cyclic and non-cyclic process. Carnot Cycle and Reversible heat engine, Carnot's Theorem, Efficiency of reversible heat engines, Thermodynamic scale of temperature

Unit 5 (Entropy): Clausius theorem, Clausius Inequality, Entropy - A Property of a System, Entropy Change in Reversible Process, Thermodynamic Property Relation, calculation of Change in Entropy, Principle of Increase of Entropy.

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

	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**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	3											3		
CO-2	3											3		
CO-3	3	1										3		
CO-4	3	1										3		
CO-5		3										3		

6. Course Teaching and Learning Methods

Teaching and Learning Methods	**Duration in hours**	**Total Duration in Hours**
Face to Face Lectures		25
Demonstrations		05
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	03	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	25	
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		
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		**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. (Mechanical 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 (60% Weightage)				**Component 2: SEE (40% Weightage)**
Subcomponent ▶	**SC1 15 marks**	**SC2 15 marks**	**SC3 20 marks**	**SC4 10 marks**	
Subcomponent Type ▶	**Term Test**	**Term Test**	**Assignment**	**Quiz**	**50 Marks**
Maximum Marks ▶	**25**	**25**	**20**	**25**	
Weightage (%) ▶	**15**	**15**	**20**	**10**	**40**
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	Class room lectures, Assignments

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

9. Course Resources

a. Essential Reading

1. Class Notes
2. P. K. Nag, 2002, Basic and Applied Thermodynamics, 3rd Edition, Tata McGraw Hill.
3. Y. A. Cengel and M. A. Boles, 2004, Thermodynamics An Engineering Approach, Tata McGraw Hill

b. Recommended Reading

1. G. J. Van Wylen and R. E. Sonntag, 2001, Fundamental of Classical Thermodynamics, 3rd Edition, Wiley Eastern
2. David Burghardt, 1986, Engineering Thermodynamics with Applications, Harper Row International Edition
3. T. D. Eastop and A. McConkey, 2006, Applied Thermodynamics for Engineering Technologies, Pearson
4. K. Mark, 1995, Advanced Thermodynamics for Engineers, Tata McGraw Hill

c. Magazines and Journals

1. Journal of Energy Engineering (IJEE)
2. American Journal of Energy Engineering (AJEE)
3. Journal of Power and Energy Engineering (IJPEE)

d. Websites

1. www.learnthermo.com
2. http://termodinamik.webs.com

e. Other Electronic Resources

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

10. Course Organization

Course Code	MEC206A		
Course Title	Engineering Thermodynamics		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	080-49065555
		E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date		May 2023	
Next Course Specifications Review Date		May-2027	

◂◆▸

Course Specifications: Mechanical Measurements, Metrology and Laboratory

Course Title	Mechanical Measurements and Metrology
Course Code	MEC207A
Course Type	Core Theory and Laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course introduces the principles of measurements and practices of metrology. Students are taught static and dynamic characteristics of measurement system, measurement of displacement, velocity, acceleration, temperature, pressure, force etc. It also deals with the measurement of linear, angular and surface attributes of a component. The students will be trained to use suitable measuring devices based on the parameters and accuracy required for measurements.

2. Course Size and Credits:

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	2:0:2
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mechanical 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. Explain generalized measurement system, errors in measurement systems and need for calibration

CO-2. Describe sensors, transducers, signal conditioning and output devices used in measurement systems

CO-3. Select appropriate measurement systems for measuring displacement, strain, force, torque, pressure and temperature

CO-4. Analyze limits, fits, and measuring techniques to design GO and No-GO gauges using Taylor's principle, considering material conditions.

CO-5. Interpret Geometric Dimensioning & Tolerance for a given engineering drawing

CO-6. Utilize contact and non-contact measurement instruments to measure physical and geometrical parameters for a given part.

4. Course Contents

Unit 1 (Introduction and Mechanical Measurements): Need and Significance of Mechanical Measurements, Standards of Measurement, Generalized Measurement system, First order-Second Order systems.
Linear and angular measurements:
Length standard, line and end standard, Contact and non-contact type measuring techniques, linear measuring instruments-Vernier caliper, Micrometer, Vernier Height Gauge; Measurement of angles and tapers-Bevel protractor, Sine bar, Sine Centre, Slip gauges, Dial indicator; CMM and its applications
Measurement of component geometry using appropriate instruments.

Unit 2 (Sensors and Transducers): Classification of transducers, Linear Variable Differential Transformer (LVDT), Elastic Transducers, Piezoelectric sensors, Piezo resistive sensors, Thermoelectric sensors, Photodetectors, Strain measurement, Strain gauge, load cell, Force and torque measurement, Pressure measurement, Temperature measurement, Resistance Temperature Detectors (RTD), Thermocouple, Thermistors.
Calibration of Linear Variable Differential Transformer (LVDT)
Calibration of strain gauge, load cell and thermocouple.

Unit 3 Limits, Fits and gauges : Engineering tolerance-Unilateral, Bilateral and Compound tolerance; System of limits and fits and their types; hole and shaft basis systems; interchangeability and selective assembly; Numerical.**:** Classification of gauges, Taylors principle, Maximum and Minimum Material conditions, Design of Go and No Go gauges, Numerical; Usage of gauges-Plug gauge, Ring gauge, Bore gauge, Thread plug gauge, Thread ring gauge, Feeler gauge, Screw pitch gauge, Snap gauge and Air gauge

Unit 4 GD & T symbols and their interpretations, feature control frames, datum systems, and various tolerances (form, orientation, location, and runout). It includes advanced topics like positional and composite tolerances, their applications in design, Applications of GD & T techniques for dimension control and case studies.

Unit 5 (Optical and Surface Roughness Measuring instruments): Tool maker's microscope, Profile projector, Autocollimator, Interferometry- optical flats, NPL interferometer Surface roughness measurement:
Roughness, Waviness, Numerical assessment of surface finish-CLA, R.M.S, Rz values, Methods of measurement of surface finish, ISI symbols, Measurement through comparators- Mechanical comparators
Measurement of component geometry using Tool maker's microscope and Profile projector
Assessment of surface roughness parameters using Surface Roughness Tester

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		
CO-2	3												3		
CO-3	3	2											3		
CO-4		3	2										3		
CO-5		3	2										3		
CO-6		3			2								3	2	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

5. 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		10
1. Solving Numerical Problems	10	
Practical Work		30
1. Course Laboratory	30	
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**

6. 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. (Mechanical 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						
Course Outcome	**CE (Weightage: 60 %)**				**Component 2: SEE (40% Weightage)**	
	SC1	**SC2**	**SC3**	**SC4**	**SEE (Weightage: 25 %)**	**SEE (Weightage: 15 %)**
	Term Test	**Term Test**	**Assignment**	**Lab**	**Written exam**	**Lab Exam**
	15	**15**	**20**	**10**	**50 Marks**	**25 Marks**
CO-1	**X**				**X**	
CO-2	**X**		**X**		**X**	
CO-3	**X**		**X**		**X**	
CO-4		**X**	**X**	**X**	**X**	**X**
CO-5		**X**	**X**	**X**	**X**	
CO-6			**X**			
The details of TSC1, TSC2, TSC3 or LSC4 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	Classroom lectures, Assignments
4.	Analytical Skills	Classroom lectures, Assignments
5.	Problem Solving Skills	Classroom lectures, Assignments
6.	Practical Skills	--
7.	Group Work	Assignment

8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. Thomas G. Beckwith, Roy and John H. Lienhard, (2009), Mechanical Measurements, Pearson Education, India
3. Jain R.K (2009) Engineering Metrology, Khanna Publishers, India

b. Recommended Reading

1. Vinay A Kulkarni, Anand K Bewoor (2009) Metrology And Measurement , Tata McGraw Hill Education India
2. N V Raghavendra, L Krishnamurthy(2013) Engineering Metrology and Measurements, Oxford university press
3. Alan S. Morris (1997) The Essence of Measurement, Prentice Hall- Gale
4. Ernest Doebelin's (2007) Doebelin's Measurement Systems, Tata McGraw Hill Education

c. Magazines and Journals

1. International Journal of Metrology and Quality Engineering, Published online by Cambridge University Press
2. Journal of Metrology and Measurement Systems, Published online by Polish academy of sciences, Division IV - Technical Sciences

d. Websites

1. http://www.tolcap.com/
2. http://www.callabmag.com
3. https://nptel.ac.in/courses/112106179/

e. Other Electronic Resources

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

10. Course Organization

Course Code	MEC207A	
Course Title	Mechanical Measurements and Metrology	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May-2027	

◂◆▸

Course Specifications: Conventional Machining Processes

Course Title	Conventional Machining Processes
Course Code	MEC208A
Course Type	Core Theory and Laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with conventional machining processes. The student will be taught mechanics of metal cutting, cutting tools, cutting fluids and tool life. The students will be taught working principle, construction and operations of different types of machines, namely, turning, milling, shaping, grinding and drilling machines. Work holding devices, cutting tools and cutting fluids useful in performing machining operations will be explained. Student will be trained to select machining operations for achieving a given part feature.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:2
Total Hours of Interaction	75
Number of Weeks in a Semester	15
Department Responsible	Mechanical 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 conventional machining processes and their applications
CO-2. Explain working principles and construction details of machine tools, different types of cutting tools and accessories
CO-3. Select appropriate material removal process with process parameters for achieving required dimensions and surface finish based on the part features

CO-4. Select machine tools, cutting tools and cutting fluids based on part features
CO-**5.** Calculate the material removal rate, cutting forces, tool wear and tool life
CO-6. Operate the machine tools and perform machining operations like turning, milling and drilling using software

4. Course Contents

Unit 1 (Overview and Principles of Metal Cutting): Overview of material removal operations and machine tools. Chip formation, Cutting tool geometry, Metal cutting mechanics, Thermal aspects of metal cutting, Cutting force calculation, Tool dynamometer, Cutting tool materials, Cutting tool life and wear, Cutting fluids, Metal cutting economics

Unit 2 (Machine Tools and Turning Machines): Classification of machine tools, Methods of generating surfaces, Basic elements of machine tools
Specifications of lathes, Lathe operations, Machining time and power estimation, Capstan and Turret lathe, Automatic lathes, Numerical problems on material removal rate, cutting forces, tool wear and tool life

Unit 3 (Reciprocating Machine and Milling Machines): Types of milling machines, Milling operations, Milling cutters, Dividing head, Milling fixtures, Machining time estimation, Numerical problems on indexing and gear ratio calculations, material removal rate, cutting forces, tool wear and tool life

Unit 4. Grinding wheel, Grinding operations, Types of grinding machines, Honing, Lapping and super finishing

Unit 5 CNC machine tools: Introduction to numerical control, computer numerical control, direct/distributed numerical control, classification of CNC machines, merits and demerits, features of CNC machine tools, manual part programming methods, and computer aided part programming.

Laboratory exercise

1	Conduction of facing, plain turning, chamfering and step turning operations on component using lathe
2	Conduction of grooving, taper turning and thread cutting operations on component using lathe
3	Conduction of Knurling, Parting, Drilling, Boring, Tapping operations on component using lathe.
4	Conduction of Face milling, End/side milling and Step milling operations on component using vertical milling machine
5	Demonstration of CAPS Mill and Turn software, basic geometries & Simulation
6	Simulation and generation of NC part program for drilling operation
7	Simulation and generation of NC part program for milling operation
8	Simulation and generation of NC part program for plane turning operation
9	Simulation and generation of NC part program for step turning and operation

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		
CO-2	3												3		
CO-3	3	2											3		
CO-4	3	2											3		
CO-5		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		05
1. Demonstration using Videos	05	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	0	
Numeracy		10
1. Solving Numerical Problems	10	
Practical Work		20
1. Course Laboratory	20	
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	05	
2. Guest Lecture	00	
3. Industry / Field Visit	05	
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. (Mechanical 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						
Course Outcome	**CE (Weightage: 60 %)**				**Component 2: SEE (40% Weightage)**	
	SC1	**SC2**	**SC3**	**SC4**	**SEE (Weightage: 25 %)**	**SEE (Weightage: 15 %)**
	Term Test	**Term Test**	**Assignment**	**Lab**	**Written exam**	**Lab Exam**
	15	**15**	**20**	**10**	**50 Marks**	**25 Marks**
CO-1	×▪	×▪			X	
CO-2	×▪	×▪			X	
CO-3	×▪	×▪			X	
CO-4			×	×	X	×▪
CO-5			×▪	×	X	×
CO-6				×		×
The details of TSC1, TSC2, TSC3 or LSC4 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.

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

8. Achieving COs

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

9. Course Resources

a. Essential Reading

1. Course notes
2. P. N. Rao, 2003, Manufacturing Technology, Machine Tools and Machining Operations, Tata McGraw-Hill
3. Serope Kalpakjian and Steven R. Schmid, 2004, Manufacturing Engineering and Technology, Pearson Education

b. Recommended Reading

1. Amitabha Ghosh and Asok Kumar Mallik, 1994, Manufacturing Science, New Delhi, EWP.
2. Production Technology, 1997, HMT, TMH
3. E. Paul DeGarmo, 2005, Materials and Processes in Manufacturing, McMillan Publication, Eastern Economy Edition
4. E. M. Trent and P. K. Wright, 2000, Metal Cutting, Butterworth-Heinemann
5. M. C. Shaw, 2005, Metal Cutting- Principles and Practices, Cambridge University Press

c. Magazines and Journals

1. Efficient Manufacturing, Industrial trade Magazine
2. EDM Today, America's EDM forum Magazine
3. American Machinist Magazine

d. Websites

1. http://americanmachinist.com
2. http://www.edmtodaymagazine.com/
3. http://www.sme.org/
4. http://www.aws.org/
5. http://nptel.ac.in/

e. Other Electronic Resources

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

10. Course Organization

Course Code	MEC208A	
Course Title	Conventional Machining Processes	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May- 2023	
Next Course Specifications Review Date	May-2027	

Course Specifications: Constitution, Human Rights and Law

Course Title	Constitution, Human Rights and Law
Course Code	LAN101A
Course Type	AECC
Department	Law
Faculty	School of Law

1. **Course Summary**

The course introduces students to the basic types of laws. It gives a broad overview of the Constitution of India as the epitome of human rights protection. The rights and duties enshrined in our Constitution and constitutional remedies will be introduced. Students will also be introduced to environment protection law and intellectual property rights.

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	Law
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. Identify the various facets of law and its branches
CO-2. Appreciate the constitutional protection of rights and the duties of citizens
CO-3. Understand the basics of human rights and the need for its protection
CO-4. Apply the principles of environmental law for a sustainable future
CO-5. Know the need to protect the various intellectual property rights and its applicability

4. **Course Contents**

Unit 1

Introduction to law - Meaning of law, types of law like Constitutional law, Family law, Corporate law, Criminal law, Property law, Tort law, Contract law, Banking law, Insurance law, International law, Consumer Protection law, Labour Law

Unit 2

Constitution and Human rights – Preamble, Right to equality, Right to Freedom, Right against exploitation, Freedom of Religion, Cultural and Educational Rights, Right to Constitutional remedies, broad principles of Universal Declaration of Human Rights (UDHR) and its application in the Indian Constitution, fundamental duties.

Unit - 3

Environmental Law - salient features of Environment Protection Act, 1986, need for sustainable development and environmental impact

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

Unit 4

Intellectual Property Rights – Broad overview of IPR and the need for its protection - Patent, Copyright, Trademark, Designs, Semi-conductor and integrated chip and Geographic indications.

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															
CO-2															
CO-3															
CO-4															
CO-5															
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		25
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		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		05
Total Duration in Hours		**30**

Dean - Academics
M.S. Ramaiah University of Applied Sciences
Bangalore - 560 058

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 ..... 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.

There will be no SEE. Only 2 CEs as mentioned below.

Focus of COs on each Component or Subcomponent of Evaluation		
Component 1: CE (100% Weightage)		
Subcomponent ▶	**SC1**	**SC2**
Subcomponent Type ▶	**Mid-Term Test**	**Assignment 1**
Maximum Marks ▶	**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	Assignment
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

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

9. Course Resources

a. Essential Reading

- Constitution of India Bare Act
- P M Bakshi, Constitution of India, 19th Edition, 2023, Lexis Nexis
- Y. V. Rao Laymans Guide to Law Know Your Rights, 2018, Civil Law Books, Asia Law House,
- Avtar Singh Intellectual Property Law1st Edition, 2013, EBC

b. Recommended Reading

- Vijay Kumar SinghLearn the Law 1st Edition, 2022 Eastern Book Company
- Indu Bhan Legal Eagles: Stories of the Top Seven Indian Lawyers, 2015, Random House India
- M. Rama Jois Legal And Constitutional History Of India: Ancient Legal, Judicial And Constitutional System (reprint), 2022, Universal Lexis Nexis

c. Magazines and Journals

- The Journal of Legal Studies
- The Indian Journal of Law and Technology
- The National Law School of India Review
- Socio-Legal Review

d. Websites

- Manupatra
- SCC Online
- Law & Justice-National Portal of India

e. Other Electronic Resources

10. Course Organization

Course Code		
Course Title		
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	
	E-mail:	
Course Specifications Approval Date		
Next Course Specifications Review Date		

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

Course Title	Internship 1
Course Code	MEI201A
Department	Mechanical Engineering
Faculty	Engineering and Technology

Course Summary

Student shall undergo internship in an industry, business organization, research organization or any other university on a topic of relevance during vacation of 1st and 2nd semesters for a duration of 2 weeks. It can be Intra Institutional activity. Lateral entry students can with complete Internship 1 during 2nd year with the prior approval from the department head and faculty dean.

Course Size and Credits:

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	0:0:4
Total Hours of Interaction	90
Number of Weeks in a Semester	15
Department Responsible	Mechanical Engineering
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

Course Outcomes

After undergoing this course students will be able to:

CO 1. Write a report on experiences during internship
CO 2. Make a presentation to a panel of examiners

Course Contents

- Inter/ Intra Institutional Activities (As per AICTE guidelines)
- Training with higher Institutions; Soft skill training organized by Training and Placement Cell of the respective institutions; contribution at incubation/ innovation /entrepreneurship cell of the institute;
- Participation in conferences/ workshops/ competitions etc.;
- Learning at Departmental Lab/ Tinkering
- Laboratory/ Institutional workshop; Working for consultancy/ research project within the institutes and
- Participation in all the activities of Institute's Innovation Council for eg: IPR Workshop/Leadership Talks/ Idea/
- Design/ Innovation/ Business Completion/ Technical Expos etc.

	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											3		3		3
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.															

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. Other Electronic Resources

1. https://nptel.ac.in

Course Code	MEI201A		
Course Title	Internship 1		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	+91-804-906-5555
		E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date		May- 2023	
Next Course Specifications Review Date		May-2027	

Course Specifications: Innovation and Entrepreneurship

Course Title	Innovation and Entrepreneurship
Course Code	**BAU210A**
Course Type	Core Theory Course
Department	Management Studies
Faculty	Management and Commerce

1. Course Summary

This course on Innovation and Entrepreneurship is introduced across all the undergraduate programs with an aim to impart comprehensive knowledge of an entrepreneurial ecosystem. Further, the course enables to develop entrepreneurial skills by building entrepreneurial intentions among students. The students also gain knowledge on competencies to provide with necessary inputs for creation of new ventures and scaling up existing startups. The students are also introduced to design thinking process to nurture entrepreneurial way of thinking.

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	Respective Department of the Faculty
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (CDs)

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

C0-1. Explain the concepts and process of Innovation as well as entrepreneurship
C0-2. Construct and apply the idea generation techniques
C0-3. Discuss the opportunities for launching of new venture and various entry strategies
C0-4. Examine innovative ideas for the creation and management of entrepreneurship
C0-5. Formulate and present a viable business plan to the investors appraisal

Course Contents

Unit 1: Introduction to Entrepreneurship
Introduction to entrepreneurship, Evolution of the concept, Entrepreneurial process, Types of Entrepreneurship - Social entrepreneurship, rural entrepreneurship. Characteristics of an Entrepreneur, Incorporation of a Company, Managing a Family Business, Corporate Intrapreneurship

Unit 2:

Innovation and Creativity: Types of Innovations. Identify Various Sources of Ideas for New Ventures, Methods Available for Generating New Venture Ideas - Creativity, Design Thinking and the Techniques for Creative Problem Solving. Aspects of the Product Planning and Development Process.

Unit3

New Venture:

Creating Opportunities, Resources, Role of **New** Ventures and Small Businesses in the Economy, Types of Entry Strategies, Launch a New Venture and the Generic Strategies

Unit4

Strategies to Sustain and Grow:

Strategies for Expansion, Joint Ventures, Acquisitions, Merges, Franchising, Growth Strategy, Exit Strategy.

Unit 5 Business Plan

Business plan, scope and value of the business plan, step-by-step explanation of the business plan, marketing plan, Organizational plan, financial plan {source of capital), entrepreneurship models

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

	Programme Outcomes (PCs)											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	PSO 1	PSO 2	PSO-3	PSO-4
CO-1	2	2	2									2			3
CO-2	3	2	2	2	3								3	2	
CO-3	3	3	2	2								2		2	
CO-4	3	2	2	2	2	3			3	3			2		3
CO-5	2	3		2							3		2	3	
3: Very Strong Contr1bution, 2: Strong Contribution, 1: Moderate Contribution															

5. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		20
Demonstrations		02
1. Demonstration using Videos	02	
2. Demonstration using Physical Models/ Posters	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	03	03
4. Clinical Laboratory	00	
S. Hospital	00	
6. Model Studio	00	
Others		15
1. Case Study Presentation	**05**	
2. Guest Lecture	**01**	
3. Industry/ Field Visit	02	
4. Brain Storming Sessions	**02**	
5. Group Discussions	04	
6. Discussing Possible Innovations	01	
Mid Terms, Laboratory Examination/Written Examination, Presentations		OS
Total Duration in Hours		**45**

6. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Program Specifications document pertaining to the UG Program. 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 (SCl, SC2), cos are assessed as illustrated in the following Table.

Focus of cos on each Component or Subcomponent of Evaluation			
	Component 1: CE {50% Weightage)		**Componen t2: SEE-Group Task/Activit y(50% Welghtage** }
Subcomponent ►	**SC1**	**SC2**	
Subcomponent Type ►	**Mid Term**	**Assignment/Presentation** Deck of **Innovative Ideas**	**50 Marks**
Maximum Marks►	**25**	**25**	
CO-1	X		X
CO-2	X		X
CO-3		X	X
CO-4		X	X
CO-5		X	X
The details of SCl and SC2 are presented in the Programme Specifications Document.			

The Course Leader assigned to the course, shall provide the focus of COs in each component of assessment in the beginning of the semester to capture the Group Task evaluation parameters such as: field visit, presentation of business plan, case study presentation on success and failure companies. Ideating and running the business for a day inside the campus.

Course reassessment policies are presented in the Academic Regulations document.

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	Class room lectures
2.	Understanding	Class room lectures
3.	Critical Skills	Assignment
4.	Analytical Skills	Class room, assignment, examination
5.	Problem Solving Skills	Assignment, Field visit and presentation
6.	Practical Skills	Assignment
7.	Group Work	Case study Presentation
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	Case study and group discussions
11.	Presentation Skills	Case study and group discussions
12.	Behavioral Skills	Group discussions
13.	Information Management	Assignment
14.	Personal Management	Assignment and Group Discussion
15.	Leadership Skills	Group discussions and Case study

8. Course Resources

a. Essential Reading

1. Course notes
2. Hisrich, R., Peters, M. and Shepherd, D., 2020. *Entrepreneurship.* 11th ed. Noida: McGraw Hill.

b. **Recommended Reading**

1. Charantimath, P., 2018. *Entrepreneurship development and small business enterprises.* 3rd ed. Belgaum, India: Pearson Education.
2. Roy, R., 2020. *Entrepreneurship.* 3rd ed. Neida: Oxford University Press.

c. **Magazines and Journals**

1. Business World: ABP Group
2. Journal of Small Business Management, Blackwell Publishing
3. Business Strategy: PwC Strategy & Inc.

d. Websites

1. India, S., 2022. *Homepage.* [online] Start-up India. Available at: <https://www.startupindia.gov.in£> [Accessed 10 July 20221.
2. Allsharktank, Products., 2022. *Homepage.* [online] All Shark Tank Products. Available at: <https://www.allsharktankproducts.com/> [Accessed 10 July 2022).
3. India, M., 2022. *Make In India.* [online] Makeinindia.com. Available at: <https://www.makeinindia.com/> [Accessed 10July 20221.

e. Other Electronic Resources

NA

9. Course Organization

Course Code	**BAU210A**	
Course Title	Innovation and Entrepreneurship	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-80-4536-6666
	E-mail:	
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May 2027	

Course Specifications: Control Systems and Engineering

Course Title	Control Systems and Engineering
Course Code	ROC301A
Course Type	Core Theory and Laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

I. Course Summary

This course deals with the modeling and analysis of linear control systems. This course aims to impart concepts of mathematical modelling, time response analysis, frequency response analysis and stability theory. Students will be able to model, apply control system techniques for any given application and analyze the response for suitability of design using standard software.

2. Course Size and Credits:

Number of credits	03
Credit Structure (Lecture: Tutorial: Practical)	2:0:2
Total hours of interaction	60
Number of Weeks in a Semester	15
Department responsible	Electrical Department
Total Course Marks	100
Pass requirement	As per the Academic Regulations
Attendance requirement	As per the Academic Regulations

3. Course Objectives (CO)

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

CO-1. Explain the basic concepts of control system and associated terminologies

CO-2. Develop mathematical models of mechanical systems and determine their transfer functions

CO-3. Discuss time response, frequency response analysis and stability aspects of a system

CO-4. Design linear controllers for a system and analyze its performance

CO-5. Apply control system techniques for a given application and analyze the response for suitability of design using standard software

4. Course Contents

Unit 1 (Concepts of Control Systems): Introduction to control systems, Open loop and closed loop systems, Examples, Effects of feedback, Classification, Applications

Unit 2 (Mathematical Model of Physical Systems): Linear differential equations, Order and degree of a system, Overview of Laplace transforms, Transfer functions of various physical systems, Analogous systems, Block diagram and signal flow graph analysis. Simulation of mathematical models using transfer function, block diagram reduction.

Unit 3 (Time Response Analysis): Standard input signals: Step, ramp, parabolic and impulse, analysis of first order system, second order systems and time domain specifications. Simulation of first order and second order systems and perform time response analysis.

Unit 4 (Controller Design): Proportional, Integral, Derivative, Proportional integral, Proportional integral derivative controllers, Transfer function, Applications. Simulation of conventional control techniques.

Unit 5 (Stability Analysis): Characteristic equation, Necessary and sufficient conditions, Routh – Hurwitz criteria of stability. Root locus plots.

Unit 6 (Frequency Response Analysis): Introduction to Bode plots, sketching individual Bode components, Bode plots of complex transfer functions, Gain margin, Phase margin, Stability analysis.

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		
CO-2		3	3										3		
CO-3		3											3		
CO-4		1	3		2								3	2	
CO-5		3	3		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		30
Demonstrations		
1. Demonstration using Videos		
2. Demonstration using Physical Models /		
3. Demonstration on a Computer		
Numeracy		10
1. Solving Numerical Problems	10	
Practical Work		20
1. Course Laboratory	20	
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. Brainstorming Sessions	00	

5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Written Examination		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment is presented in the Programme Specifications document pertaining to the B.Tech. Programmes. 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						
Course Outcome	**CE (Weightage: 60 %)**				**Component 2: SEE (40% Weightage)**	
	SC1	**SC2**	**SC3**	**SC4**	**SEE (Weightage: 25 %)**	**SEE (Weightage: 15 %)**
	Term Test	**Term Test**	**Assignment**	**Lab**	**Written exam**	**Lab Exam**
	15	**15**	**20**	**10**	**50 Marks**	**25 Marks**
CO-1	**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**	
CO-6				**X**		**X**
The details of TSC1, TSC2, TSC3 or LSC4 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, and demonstrations
3.	Critical Skills	Assignment
4.	Analytical Skills	Classroom, assignment
5.	Problem Solving Skills	Classroom, assignment
6.	Practical Skills	Classroom, assignment

7.	Group Work	Classroom
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	Presentation
11.	Presentation Skills	Presentation
12.	Behavioral Skills	Course
13.	Information Management	Assignment, examination
14.	Personal Management	Assignment, examination
15.	Leadership Skills	Effective management of learning

9. Course Resources

1. Essential Reading

1. Class Notes
2. Norman Nise (2015) Control System Engineering, John Wiley & Sons.

2. Recommended Reading

1. C. Dorf Richard and R. H. Bishop (2008), Modern Control Systems, Pearson Education
2. Katsuhiko Ogata (2010), Modern Control Engineering, Prentice Hall

3. Magazines and Journals

1. IEEE Control Systems Magazine
2. IEEE Transactions on Automatic Control
3. IEEE Transactions on Control Systems Technology
4. IEEE Control Systems

4. Websites

1. http://nptel.ac.in/

5. Other Electronic Resources

1. Electronic resources on the subject area are available on MSRUAS library

10. **Course Organization**

Course Code	ROC301A		
Course Title	Control Systems and Engineering		
Course Leader/s Name		As per Time - table	
Course Leader Contact Details		**Phone:**	+91-804-906-5555
		E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date		May - 2023	
Next Course Specifications Review Date		May-2027	

Course Specifications: Thermal Engineering

Course Title	Thermal Engineering
Course Code	MEC302A
Course Type	Core Theory and Laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

I. Course Summary

This course deals with gas and vapor power cycles, air compressors, refrigeration, and air conditioning systems. Students are taught the application of gas power cycles (Otto, Diesel, and Brayton), vapor power cycle (Rankine cycle). Students will be able to estimate the performance parameters like power, efficiency for reciprocating compressors, steam power plants, refrigeration, and air conditioning system. Different types of fuels, air- fuel ratio, rich and lean combustion, flame temperature, heats of formation and reaction for various fuels will be discussed. Students will be able to perform numerical calculations to obtain engineering parameters and the overall performance of vapor power cycles, refrigeration, and air- conditioning systems.

2. Course Size and Credits:

Number of credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:2
Total hours of interaction	75
Number of Weeks in a Semester	15
Department responsible	Mechanical Engineering
Total Course Marks	100
Pass requirement	As per the Academic Regulations
Attendance requirement	As per the Academic Regulations

3. Course Objectives (CO)

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

- **CO-1.** Explain fuels and their properties, combustion process, various air standard and vapor power cycles.
- **CO-2.** Discuss thermal efficiency, work output and performance parameters for steam turbine, IC Engines and reciprocating compressors.
- **CO-3.** Solve numerical on air standard cycles, vapor power cycles and reciprocating compressors.
- **CO-4.** Analyze the cycles for the thermodynamic properties, work and heat interactions and compare actual cycles with air standard and vapor power cycles.
- **CO-5.** Select and evaluate appropriate thermodynamic cycle suitable to various practical applications.

4. Course Contents

Unit 1 (Gas power cycles): Review of thermodynamic relations, properties and Ideal gas mixtures; Air standard cycle parameters; Air standard cycles: Carnot, Otto, Diesel, Dual Combustion, Stirling and Brayton cycles; Comparison of Otto, Diesel and Dual cycles; Fuel- air cycles; p-v and T-s diagrams, efficiencies and mean effective pressures, Chemical equilibrium loss; Comparison between air standard and fuel-air cycles; Thermal efficiency and fuel consumption; Comparison between air standard, fuel-air and real cycles for SI and CI engines; Difference between fuel-air and real cycles

Experiential Learning:

1. Determination of performance of Multi cylinder Petrol IC engine using Morse test
2. Determination of performance of 4 stroke diesel engine
3. Construction of valve timing diagram of a 4 stroke petrol engine

Unit 2 (Fuels and combustion): Fuels for IC engines; Fuel properties; Air fuel ratio; Excess Air; Volumetric and Gravimetric analysis of exhaust gases; Measurement of exhaust gas composition; Laminar and Turbulent flames, flame speed, Adiabatic flame temperature

Experiential Learning:

1. Determination of flash and fire point of liquid fuel using Abel's and Cleveland's apparatus
2. Determination of viscosity of lubricating oils using Redwood and Saybolt viscometers
3. Determination of calorific value of gaseous fuel using Boy's gas calorimeter

Unit 3 (Air compressors): Operation of a single stage reciprocating compressor, work input through p-v diagram; Effect of clearance and volumetric efficiency; Adiabatic, isothermal and mechanical efficiencies; Need of multistage compressor; Constructional details of multistage compressors, saving in work, optimum intermediate pressure, inter- and after cooling, minimum work for compression; Theoretical and actual indicator diagram for multistage compressors, Capacity control of compressors.

Experiential Learning:

1. Determination of performance of a two stage reciprocating compressor

Unit 4 (Vapor power cycles): Carnot cycle; Rankine cycle and its performance; T- s diagram; Comparison of Carnot and Rankine cycles; Effects of pressure and temperature on Rankine cycle performance; Actual vapour power cycles; Ideal and practical regenerative Rankine cycle; Open and closed feed water heaters; Reheat Rankine cycle and Multistage regenerative cycles; Organic Rankine cycles

Types of steam turbines; Compounding of steam turbines; Power efficiency and other related calculations for impulse and reaction turbines using velocity triangles; Reaction turbines and Degree of reactions; Parson's turbines; Internal losses in steam turbines; Reheat Factor; Governing of Steam Turbines and graphical method of solution for numerical problems on steam turbines.

Experiential Learning:

1. Determination of Boiler Efficiency of packaged boiler using indirect method
2. Determination of Dryness Fraction of Steam using separating and throttling calorimeter
3. Determination of Steam turbine efficiency of a two stage steam turbine

Unit 5 (Refrigeartion): Analysis of vapour compression and absorption refrigeration system; Refrigerating effect, capacity and power required; Units of refrigeration; COP; Actual vapour compression cycle; Second law analysis of vapour Compression Cycle; Refrigerants and their desirable properties; Selection of refrigerants; Requirements of refrigerants; Effects of lubricants in refrigerants; Air cycle refrigeration; Reversed Carnot cycle; reversed Brayton cycle; steam jet refrigeration

Vapour compression refrigeration system: Analysis of vapour compression and absorption refrigeration system; Refrigerating effect, capacity and power required; Units of refrigeration; COP; Actual vapour compression cycle; Second law analysis of vapour Compression Cycle; Refrigerants and their desirable properties; Selection of refrigerants; Requirements of refrigerants; Effects of lubricants in refrigerants; Air cycle refrigeration; Reversed Carnot cycle; reversed Brayton cycle; steam jet refrigeration

Unit 6 (Psychrometry and Air conditioning): Atmospheric air and psychometric properties; Dry bulb temperature; Wet bulb temperature; Dew point temperature; Partial pressures, specific and relative humidities and the relation between the two enthalpy and adiabatic saturation temperature; Construction and use of psychometric chart; Analysis of various processes- heating, cooling, dehumidifying and humidifying; Adiabatic mixing of moist air; Summer andwinter air-conditioning; Load calculation; Layout and design principles of air conditioning system

Experiential Learning:

1. Determination of Heating capacity in Sensible heating mode in an air conditioning system
2. Determination of cooling capacity in Sensible cooling mode in an air conditioning system

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		
CO-2	3												3		
CO-3		3											3		
CO-4		3											3		
CO-5			3	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		30
Demonstrations		05
1. Demonstration using Videos	03	
2. Demonstration using Physical Models /	02	
3. Demonstration on a Computer		
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		20
1. Course Laboratory	20	
2. Computer Laboratory		
3. Engineering Workshop / Course Workshop / Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		05
1. Case Study Presentation		
2. Guest Lecture		
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions	05	
6. Discussing Possible Innovations		
Term Tests, Written Examination		10
Total Duration in Hours		85

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment is presented in the Programme Specifications document pertaining to the B.Tech. Programmes. 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						
Course Outcome	**CE (Weightage: 60 %)**				**Component 2: SEE (40% Weightage)**	
	SC1	**SC2**	**SC3**	**SC4**	**SEE (Weightage: 25 %)**	**SEE (Weightage: 15 %)**
	Term Test	**Term Test**	**Assignment**	**Lab**	**Written exam**	**Lab Exam**
	15	**15**	**20**	**10**	**50 Marks**	**25 Marks**

CO-1	**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**	
The details of TSC1, TSC2, TSC3 or LSC4 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	Class room lectures, and demonstrations
3.	Critical Skills	Assignment
4.	Analytical Skills	Class room, assignment
5.	Problem Solving Skills	Class room, assignment
6.	Practical Skills	Class room, assignment
7.	Group Work	Classroom
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	Presentation
11.	Presentation Skills	Presentation
12.	Behavioral Skills	Course
13.	Information Management	Assignment, examination
14.	Personal Management	Assignment, examination
15.	Leadership Skills	Effective management of learning

9 Course Resources

a. Essential Reading/Text books

1. Class Notes
2. I.C. Engines / V. Ganesan / Mc Graw Hill
3. Thermal Engineering / Mahesh M Rathore / Mc Graw Hil

b. Recommended Reading

1. Y.A. Cengel and Boles, 2011, Thermodynamics An Engineering Approach (SI Units), Tata McGraw-Hill Education Pvt. Ltd
2. H. N. Shapiro and Moran, 2010, Fundamentals of Engineering Thermodynamics, Wiley Publication
3. M. L. Mathur and Sharma, 1996, Internal Combustion Engine, Dhanpat Rai Publication

c. Magazines and Journals

1. SAE International Journal of Fuels and Lubricants
2. SAE International Journal of Engines
3. Combustion and Flame
4. The Journal of Chemical Thermodynamics
5. Journal of Thermodynamics, Hindawi Publishing Corporation

d. Websites

1. www.learnengineering.org
2. www.nptel.ac.in
3. www.learnthermo.com

e. Other Electronic Resources

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

10. Course Organization

Course Code	MEC302A	
Course Title	Thermal Engineering	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May-2023	
Next Course Specifications Review Date	May-2027	

Course Specifications: Design of Machine Elements - 1

Course Title	Design of Machine Elements - 1
Course Code	MEC303A
Course Type	Core Theory
Department	Mechanical Engineering
Faculty	Engineering and Technology

I. Course Summary

This course is aimed at preparing the students to carry out design of common machine elements used in different machinery. Students will acquire the knowledge on stress analysis of different machine components subjected to different types of loadings to predict state of stress at critical locations. Students will be taught to design machine components based on predicted stress state and appropriate failure theories. Students will be able to analyse and design machine components like shafts, power screws, couplings and mechanical joints like fastener joints, riveted and welded joints.

2. Course Size and Credits:

Number of credits	03
Credit Structure (Lecture: Tutorial: Practical)	2:2:0
Total hours of interaction	60
Number of Weeks in a Semester	15
Department responsible	Mechanical Engineering
Total Course Marks	100
Pass requirement	As per the Academic Regulations
Attendance requirement	As per the Academic Regulations

3. Course Objectives (CO)

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

CO-1. Describe basic concepts and principles of machine component design

CO-2. Identify the loading conditions on a machine element and predict state of stress at critical locations

CO-3. Calculate design stress based on appropriate failure theory and select suitable material

CO-4. Design machine elements like shafts, keys and couplings, power screws, riveted and welded joints

CO-5. Perform iterative design calculations to achieve induced stress values well within design stress values for various machine elements and verify results using appropriate design software

4. Course Contents

Unit 1 (Introduction and Load Analysis): General considerations, factors affecting machine design, procedure of machine design; Material properties and selection.

Types of loads - static-axial, bending, torsion, dynamic, Impact Loading and cyclic loadings

Unit 2 (Stress, Strain, Deflection and Stress Concentration): Stress analysis, Simple stress, combined stresses, Principal stress, Maximum shear stress, uniaxial, biaxial and triaxial states of stress; Examples involving different types of machinery components

Stress concentration under static loading, determination of stress concentration factors, designing to avoid stress concentrations; Examples involving different types of machinery components

Unit 3 (Static Failure Theories and Design of Curved Beams): Need of failure theories, Maximum shear stress theory, Distortion energy theory, Maximum principal stress theory, Mohr's theory, design of simple machine elements using failure theories

Analysis of Curved Beams, Stresses in curved beams of standard cross sections used in crane hook, punching presses and clamps

Unit 4 (Design of shafts, keys and coupling): Types of shafts, shaft design on strength and torsional rigidity basis, ASME Code, design of hollow shafts; types of keys, design of flat and square key, design of splines; types of couplings, design procedure for couplings, design of rigid flange coupling and flexible coupling

Unit 5 (Design of Power Screws and Threaded Fasteners): Types of screws, Terminology of power screws, self-locking screw, torque requirement-lifting load and lowering load, design of screw and nut, threaded joints, types of screw fastening, terminology of screw threads, ISO Metric screw threads, torque requirement of bolt tightening, design of turnbuckle, elastic analysis of bolted joints

Unit 6 (Design of welded and riveted Joints): Design of welded joints- welding processes, butt joints, fillet joints, strength of butt welds, parallel fillet welds, transvers fillet welds, welded joints, welded joint subjected to bending moment and torsional moment

Strength of riveted joints, failure mechanisms in riveted joints, efficiency of riveted joints and design of riveted joints, longitudinal butt joint for boiler shell, circumferential lap joint for boiler shells

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		
CO-2	3												3		
CO-3		3											3		
CO-4		3											3		
CO-5			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		33
Demonstrations		05
1. Demonstration using Videos	05	
2. Demonstration using Physical Models /		
3. Demonstration on a Computer		
Numeracy		20
1. Solving Numerical Problems	20	
Practical Work		00
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop / Course Workshop / Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		02
1. Case Study Presentation		
2. Guest Lecture		
3. Industry / Field Visit	02	
4. Brain Storming Sessions		
5. Group Discussions		
6. Discussing Possible Innovations		
Term Tests, Written Examination		10
Total Duration in Hours		70

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment is presented in the Programme Specifications document pertaining to the B.Tech. Programmes. 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.

ocus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (60% Weightage)				**Component 2: SEE (40% Weightage)**
Subcomponent ▶	**SC1**	**SC2**	**SC3**	**SC4**	
Subcomponent Type ▶	**Term Test**	**Term Test**	**Assignment**	**Quiz**	**50 Marks**
Maximum Marks ▶	**15**	**15**	**20**	**10**	
CO-1	**X**		**X**		**X**
CO-2	**X**		**X**		**X**
CO-3	**X**		**X**		**X**
CO-4	**X**	**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	Class room lectures, Assignments
2.	Understanding	Class room lectures, Assignments
3.	Critical Skills	Class room lectures, Assignments
4.	Analytical Skills	Class room lectures, Assignments
5.	Problem Solving Skills	Class room lectures, Assignments
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. Bhandari, V. B. (2020) Design of Machine Elements, 5th ed, McGraw-Hill
3. Shigley'S Mechanical Engineering Design Budynas, R. G., Nisbett, J. K., Tangchaichit, K. (2020) Shigley'S Mechanical Engineering Design, 5th ed, McGraw-Hill
4. Lingaiah, K. (2017) Machine Design Handbook, 2nd ed, McGraw-Hill
5. Mahadevan, K., Balaveera Reddy, K. (2019) Design Data Handbook for Mechanical Engineers, 4th ed, CBS Publishers & Distributors

b. Recommended Reading

1. Juvinall, R. C., Marshek, K. M. (2016) Machine Component Design, 5th ed, John Wiley & Sons Inc (Sea) Pte Ltd
2. Norton, R. L. (2018) Machine Design, 5th ed, Pearson Education
3. Mott, R. L. (2020) Machine Elements in Mechanical Design, 4th ed, Pearson Education
4. Klebanov, B. M., Barlam, D. M., Nystrom, F. E. (2007) Machine Elements: Life and Design, Boca Raton, CRC Press

c. Magazines and Journals

1. Journal of Advanced Mechanical Design, Systems, and Manufacturing
2. Journal of Machine Design

d. Websites

1. http://www.machinedesignonline.com
2. http://www.asminternational.org
3. http://nptel.ac.in/

e. Other Electronic Resources

1. Electronic resources on the subject area are available on MSRUAS library

10. **Course Organization**

Course Code	MEC303A		
Course Title	Design of Machine Elements-1		
Course Leader/s Name		As per Time - table	
Course Leader Contact Details		**Phone:**	+91-804-906-5555
		E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date		May 2023	
Next Course Specifications Review Date		May 2027	

Course Specifications: Machine Dynamics-2

Course Title	Machine Dynamics-2
Course Code	MEC304A
Course Type	Core Theory and Laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

I. Course Summary

The aim of this course is to prepare the students to understand and apply concepts of machine dynamics and dynamic effects and also provide practical knowledge to the students for the design of machines based on dynamic analysis. Students are taught force analysis of mechanisms, effect of unbalanced masses in rotating and reciprocating machinery and methods of balancing. Vibration theory, applications, and benefits of vibration analysis in machinery design will be explained. Students will be able to calculate inertia forces at various joints, balancing force, gyroscopic forces and vibration parameters using graphical and analytical methods. Experiments related to dynamic study using balancing apparatus, cam apparatus and universal vibration apparatus will be carried out. In addition, simulation of mechanisms and evaluation of forces and torque at joints using ADAMS software will be taught.

2. Course Size and Credits:

Number of credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:2
Total hours of interaction	75
Number of Weeks in a Semester	15
Department responsible	Mechanical Engineering
Total Course Marks	100
Pass requirement	As per the Academic Regulations
Attendance requirement	As per the Academic Regulations

3. Course Objectives (CO)

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

CO-1. Explain basic concepts and principles of dynamics of machines, mechanical vibrations, model and analyse simple mechanical systems for vibration behaviour
CO-2. Determine static and dynamic forces in planar mechanism
CO-3. Analyse mechanical systems with rotating masses for static and dynamic balancing and assess the influence of gyroscopic effect due to rotating masses
CO-4. Apply and Solve problems to calculate inertia forces at various joints, balancing force, gyroscopic forces and vibration parameters
CO-5. Conduct experiments of vibration apparatus, gyroscope, balancing of rotating masses to understand the machine dynamic effects and Develop simulation model of spring mass system and planar mechanisms to analyse for damping effects, inertia forces of links using ADAMS.

4. Course Contents

Unit 1 (Introduction to Dynamics of Machinery): Review of fundamentals of dynamics, basic principles of force analysis, D'Alembert's principle and inertia forces

Unit 2 (Force Analysis of Machinery): Static forces in machines, force acting on links, Static force analysis of planar mechanisms, graphical force analysis, friction in mechanisms, Inertia forces in machines, dynamic force analysis of mechanisms, Flywheels

Unit 3 (Balancing of Rotating Masses): Dynamics of Rotating Bodies; Effects of unbalance, balancing of inertia forces for masses revolving in single and multiple planes; Introduction to Balancing Machines

Unit 4 (Gyroscope): Concept of gyroscopic action, gyroscopic effect in ships, airplanes, two-wheeler and four wheeler vehicles, gyroscopic stabilization

Unit 5 (Vibrations in mechanical systems): Basic concepts and principles of mechanical vibration, Basic components of a vibratory systems, Analysis of Single degree of freedom system under free vibration, damped vibration and Forced vibration condition, modeling of mechanical systems as equivalent vibratory systems; Critical speeds of shafts; vibration control techniques

Unit 6 (Experiment and Dynamic Analysis using ADAMS)

Experiment:

Conduct test to determine spring stiffness and natural frequency for different springs-mass systems and discuss results

Conduct experiment to study torsional vibration of a single rotor system

Conduct experiment to study damped vibration in a single degree freedom system

Conduct experiment to achieve static balancing of rotating masses

Conduct experiment to determine reactive gyroscopic couple for a given rotating disc

Simulation:

Perform dynamic analysis on slider crank mechanism to determine inertia forces of links

Perform dynamic analysis on four bar mechanism to determine inertia forces of links

Perform dynamic analysis on quick return mechanism to determine inertia forces of links

Perform dynamic analysis on single degree spring mass system to determine damping response and natural frequency of the system

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		
CO-2	3	2											3		
CO-3		3											3		
CO-4		3											3		
CO-5			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		05
1. Demonstration using Videos	02	
2. Demonstration using Physical Models /	02	
3. Demonstration on a Computer	01	

Numeracy		10
1. Solving Numerical Problems	10	
Practical Work		30
1. Course Laboratory	15	
2. Computer Laboratory	15	
3. Engineering Workshop / Course Workshop / Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		00
1. Case Study Presentation		
2. Guest Lecture		
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions		
6. Discussing Possible Innovations		
Term Tests, Written Examination		10
Total Duration in Hours		85

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment is presented in the Programme Specifications document pertaining to the B.Tech. Programmes. 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						
Course Outcome	**CE (Weightage: 60 %)**				**Component 2: SEE (40% Weightage)**	
	SC1	**SC2**	**SC3**	**SC4**	**SEE (Weightage: 25 %)**	**SEE (Weightage: 15 %)**
	Term Test	**Term Test**	**Assignment**	**Lab**	**Written exam**	**Lab Exam**
	15	**15**	**20**	**10**	**50 Marks**	**25 Marks**
CO-1	**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**	
The details of TSC1, TSC2, TSC3 or LSC4 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. Course notes
2. SS Rathan, (2014) , Theory of Machines, McGraw-Hill Education
3. Singiresu S. Rao, (2011), Mechanical Vibrations, Pearson

b. Recommended Reading

1. J. J. Uicker, G. R. Pennock and J. E. Shigley, 2003, Theory of Mechanisms and Machines, Oxford University Press
2. Charles E. Wilson J. Peter Sadler, 2003, Kinematics and Dynamics of Machinery, Prentice Hall
3. S Graham Kelley, (2012), Mechanical Vibrations: Theory and Application SI, Global Engineering
4. J. S. Rao and K. Gupta, 1999, Introductory Course on Theory and Practice of Mechanical Vibrations, New Age International

c. Magazines and Journals

1. Mechanism and Machine Theory
2. Journal of Vibration and Control, Sage Publications
3. Machine Vibration

d. Websites

1. http://www.machinedesignonline.com
2. http://www.asminternational.org
3. http://www.nptel.com

e. Other Electronic Resources

1. Electronic resources on the subject area are available on MSRUAS library

10. **Course Organization**

Course Code	MEC304A		
Course Title	Machine Dynamics-2		
Course Leader/s Name		As per Time - table	
Course Leader Contact Details		**Phone:**	+91-804-906-5555
		E-mail:	hod.pi.mp@msruas.ac.in
Course Specifications Approval Date		May 2023	
Next Course Specifications Review Date		May 2027	



Course Specifications: Automation in Manufacturing and Industry 4.0

Course Title	Automation in Manufacturing and Industry 4.0
Course Code	MEC305A
Course Type	Core Theory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course provides an understanding of automation in manufacturing and its progression to Industry 4.0. It begins with evolution, principles, and strategies of automation, followed by automated system components; sensors, actuators, controllers, PLCs, and CNC machines with programming. The role of industrial robots and cobots in flexible and intelligent manufacturing is emphasized. Students will explore smart factory concepts, including IoT, cyber-physical systems, cloud, AI, big data, additive manufacturing, and digital twin. The course also addresses sustainability, lean automation, safety, ethics, and the transition toward Industry 5.0, highlighting human-centric and resilient manufacturing systems.

2. Course Size and Credit:

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	Mechanical 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:

CO1: Explain the need and strategies for automation in manufacturing.
CO2: Analyze key components of automated systems such as sensors, actuators, controllers, and PLCs.
CO3: Illustrate the structure, functions, and applications of industrial robots and cobots.
CO4: Develop CNC programs for given components.
CO5: Evaluate Industry 4.0 building blocks with focus on smart, sustainable, safe, and ethical manufacturing

4. Course Contents

Unit 1 (Overview):

Need for automation solution for manufacturing, types of automation; strategies of automation, expectations from manufacturing processes and automation solution .pre-requites for automation solution development, process qualification for automation process; standard and standardization process improvement tools.

Unit 2 (Automated System):

Block diagram of automated systems and functional components; process elements,

actuators, sensors, controllers, and feedback mechanisms; role of actuators in motion control and material handling; sensors for measurement and monitoring; controllers for logic and system integration; interaction of hardware and software in automation; PLC, DCS, and SCADA platforms; CNC systems – structure, drives, feedback, and basic part programming (G-codes and M-codes).

Unit 3 (Robots in Manufacturing):

Introduction to industrial robots and their role in manufacturing systems; anatomy and configuration of robots – joints, links, and end-effectors; types of robots based on degree of freedom, work envelope, and applications; robot actuators, sensors, and control systems; programming methods including online and offline programming; applications of robots in material handling, welding, assembly, painting, and inspection; safety, ergonomics, and human–robot collaboration (Cobots) in manufacturing environments. Flexible and smart manufacturing systems.

Unit 4 (Smart Factories and Building Blocks of Industry 4.0):

Smart factories and digital manufacturing; building blocks of Industry 4.0 – IoT, cyber-physical systems (CPS), cloud computing, big data, AI/ML, robotics, additive manufacturing, AR/VR, and digital twin; integration of Manufacturing Execution Systems (MES) and Enterprise Resource Planning (ERP); data-driven decision-making, predictive maintenance, and real-time monitoring.

Unit 5 (Sustainability, Ethics, and Future Trends):

Green and sustainable manufacturing practices; lean automation; human–robot collaboration and workforce transformation in smart factories; safety, ergonomics, and cybersecurity in digital manufacturing environments; ethical and societal implications of automation; transition from efficiency-driven Industry 4.0 to Industry 5.0 concepts focusing on human-centric, resilient, and sustainable manufacturing systems.

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												3		
CO-2	2										1		3		1
CO-3	3												3		
CO-4		3									2		3		2
CO-5		2				3					2		3	2	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		32
Demonstrations		03
1. Demonstration using Videos	03	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		10
1. Solving Numerical Problems	10	
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**

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. (Mechanical 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 (60% Weightage)				Component 2: SEE (40% Weightage)
Subcomponent ▶	SC1	SC2	SC3	SC4	
Subcomponent Type ▶	Term Test	Term Test	Assignment	Quiz	50 Marks
Maximum Marks ▶	15	15	20	10	
CO-1	X				X
CO-2	X				X
CO-3		X			X
CO-4		X	X		X
CO-5			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	Classroom lectures, Assignments
4.	Analytical Skills	Classroom lectures, Assignments
5.	Problem Solving Skills	Classroom lectures, Assignments
6.	Practical Skills	Classroom lectures, Assignments
7.	Group Work	Assignments
8.	Self-Learning	Assignments
9.	Written Communication Skills	Assignment, Written examinations
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Written examinations
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. Mikell P. Groover, (2015), Automation, Production Systems and Computer Integrated Manufacturing, PHI Learning Private Ltd.
3. Groover, M.P. (2014) Fundamentals of Modern Manufacturing: Materials, Processes, and Systems*, 5th edition. Wiley India, New Delhi.
4. Petruzella, F.D. (2019) Programmable Logic Controllers, 5th edition. McGraw Hill India, New Delhi.
5. Smid, P. (2007) CNC Programming Handbook, 3rd edition. Industrial Press Inc., New York
6. Craig, J.J. (2009) Introduction to Robotics: Mechanics and Control, 3rd edition. Pearson Education India, New Delhi.
7. Gilchrist, Alasdair. Industry 4.0: The Industrial Internet of Things. Berkeley, CA, Apress, 2016,

Recommended Reading

1. Bi, Z.M., Xu, L. and Wang, C. (2021) Smart Manufacturing: Concepts and Applications of Industry 4.0. Singapore: Springer.
2. Raj, B. and Sridhar, R. (2021) Cyber-Physical Systems and Industry 4.0: Basic Principles. Singapore: Springer.
3. Singh, N. (2006) Systems Approach to Computer-Integrated Design and Manufacturing. Hoboken: John Wiley & Sons.

Magazines and Journals

1. Journal of Manufacturing Systems
2. Journal of Intelligent Manufacturing
3. International Journal of Advanced Manufacturing Technology (IJAMT)
4. Robotics and Computer-Integrated Manufacturing
5. International Journal of Computer Integrated Manufacturing (IJCIM)

Websites

1. www.ifr.org
2. www.automationworld.com
3. www.controleng.com
4. www.iiconsortium.org
5. www.automationmag.com

a. Other Electronic Resources

1. Electronic resources on the subject area are available in RUAS library

10. Course Organization

Course Code	MEC305A	
Course Title	Automation in Manufacturing and Industry 4.0	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May-2027	



Course Specifications: Engineering Economics and Cost Estimation

Course Title	Engineering Economics and Cost Estimation
Course Code	MEC306A
Course Type	Core Theory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with the essentials of economics for mechanical engineers. Laws of supply and demand and the basic forces that determine equilibrium in a market economy are discussed. Further, it introduces students to the concepts of depreciation of assets and their types, obsolescence of machines, and replacement policy followed in manufacturing industries. Different types of costing followed in manufacturing industries and the areas where each one of them is applicable are taught. The method of budgeting for any given project and estimation of returns from projects are discussed. The course highlights the importance of economics in manufacturing industries and how it impacts the national economy. Students are taught to interpret financial information and prepare a balance sheet.

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	Mechanical 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 basic aspects of business economics with respect to manufacturing industries, book keeping, depreciation of assets and its types
- **CO-2.** Explain the concepts of cash flow diagram, law of supply and demand, principles of micro-economics, costing and economic analysis for manufacturing industries and industrial robots
- **CO-3.** Discuss the behavior of manufacturing firms in a competitive market for short and long term
- **CO-4.** Estimate the total cost incurred for implementing a manufacturing process and developing an industrial/service robot and evaluate its worthiness by calculating PBP, NPV, ARR, IRR and PI
- **CO-5.** Analyze financial decisions mathematically using a production function and interpret financial information for an organization

4. Course Contents

Unit 1 (Economics and Legal Aspects): Basic economic concepts, Cash Flow Diagram, law of demand, Law of supply, Applications of microeconomics in manufacturing industries, Familiarization with supply and demand diagrams, Use of basic tools to analyze shifts in the economy, Understand shifts in supply and demand and their implications for price and quantity sold, foundation of economic analysis, internal and external economic scales, Role of chambers of commerce and industries

Unit 2 (Depreciation): Definition and Concept, Classification, Methods of Calculation, Obsolescence period for machines in a manufacturing industry; Replacement Policy followed in manufacturing sector: Reasons, Failures and Types, Methods, Development of Schematic Replacement Program

Unit 3 (Business Economics): Costing system, Types of Product cost estimation, Elements of product cost, Evaluation of cost using traditional and ABC Costing, Life cycle cost analysis, Break even analysis, Working capital cycle, profit and loss accounting, Evaluating capital expenditure for manufacturing processes like casting, machining and welding. Cost of developing industrial robots, costs involved in a robot lifecycle – Design and Development, Production, Usage, Disposal; Ownership costs of industrial robots; Cost-Benefit analysis for Industrial robots; Cost estimation for Service robots: Function based structure estimation and Component based cost estimation; Data collection and processing methods for cost estimation of robots: Regression analysis, static code analysis, Modeling estimation uncertainty, Expert opinion elicitation

Unit 4 (Capital Budgeting and Economic Analysis): Concept and need, Financial planning, Profit planning, Objectives of profit planning, Essentials of profit planning, Methods: NPV, IRR, ARR, PBP, and PI, S-Curve, Metrics like ACWS, BCWS, BCWP and ACWP, Benchmarking of Manufacturing Operations

Unit 5 (Cycle of Production and Consumption): Study of firm or producer, behaviour, analysis of firms' decisions mathematically using a production function, calculation of optimal level of production, costs, and profits, interaction of firm in a competitive market in the short-run and the long-run, three approaches to calculate GDP, The Law of once price, nature of business cycles, use of trends to forecast economy, Coping strategies for different stage of the business cycle

Unit 6 (Overview of Statements of Financial Information): Source of financial information, Financial statements, Balance sheet, Profit and Loss account, relation between Balance sheet and Profit and Loss account, Preparation of a balance sheet

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		
CO-2	3						1						3	1	
CO-3	3												3		
CO-4		3									2		3		2
CO-5		3									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		35
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		05
1. Case Study Presentation	05	
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. (Mechanical Engineering) 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 (60% Weightage)				**Component 2: SEE (40% Weightage)**
Subcomponent ▶	**SC1**	**SC2**	**SC3**	**SC4**	
Subcomponent Type ▶	**Term Test**	**Term Test**	**Assignment**	**Quiz**	**50 Marks**
Maximum Marks ▶	**15**	**15**	**20**	**10**	
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, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Classroom lectures, Assignments
4.	Analytical Skills	Classroom lectures, Assignments
5.	Problem Solving Skills	Classroom lectures, Assignments
6.	Practical Skills	Assignments
7.	Group Work	Assignments
8.	Self-Learning	Assignments
9.	Written Communication Skills	Assignments, Written Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course Work
13.	Information Management	Assignments, Written Examination
14.	Personal Management	Course Work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. Chan S. Park, 2013, Fundamentals of Engineering Economics, 3rd Edition, Pearson
3. M. Jeffrey Perloff, 2008, Microeconomics, Theory and Applications, Pearson
4. Quentin W. Fleming, 2010, Earned Value Project Management, 4th Edition, Project Management Institute

b. Recommended Reading

1. T. Froyen Richard, 2005, Macroeconomics, Theory and Applications, 8th Edition, Prentice Hall-Gale
2. N. Mankiw, Gergory, 2012, Principles of Microeconomics, Nashville, South Western Publishers
3. L. Rubinfeld Daniel, L. Mehta Prem, S. Pindyck Robert, 2009, Microeconomics, 7th Edition, Pearson

4. Mankiw Gregory, 2008, Macroeconomics, 6th Edition, Palgrave

c. Magazines and Journals

1. The Economist
2. Business and Economy
3. The Indian Economic Journal
4. The Indian Journal of Economics
5. Arthashastra: Indian Journal of Economics and Research

d. Websites

1. www.economist.com
2. www.ft.com
3. www.economictime.com
4. www.indianeconomicjournal.org
5. www.indianjournalofeconomics.com
6. www.indianjournalofeconomicsandresearch.com

e. Other Electronic Resources

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

10. Course Organization

Course Code	MEC306A	
Course Title	Engineering Economics and Cost Estimation	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May - 2023	
Next Course Specifications Review Date	May-2027	

◂◆▸

Course Specifications: AI for Mechanical Engineers

Course Title	AI for Mechanical Engineers
Course Code	MEC307A
Course Type	Core Theory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course aims to provide principles of artificial intelligence, intelligent agents in mechanical engineering applications. It covers the concepts of sensing, machine learning, decision making, planning of artificial intelligence in robot operations. Applications of artificial intelligence in searching, goal seeking, computer perception for industrial automation are taught. Case studies covers real life applications of artificial intelligence in various domains including defense and space exploration.

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	Mechanical 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. Explain the techniques of solving problems by searching, adversarial search and constraint satisfaction problems
CO-2. Discuss Intelligent agents, knowledge, reasoning and planning as well as uncertain knowledge and reasoning
CO-3. Apply Learning from examples, knowledge in learning, learning from probabilistic models and elementary concepts of reinforcement learning
CO-4. Discuss principles of Robotics; communicating, perceiving and acting
CO-5. Explain principles of localization, tracking and control with a focus on examples from Robotics/Self-driving cars/Aviation

4. Course Contents

Unit 1 (Introduction to Artificial Intelligence): Overview of the role of Artificial Intelligence in mechanical engineering, Self-driving cars and Aviation; Intelligent agents, Agents and environments and the structure of agents

Unit 2 (Problem Solving): Solving problems by searching, local search algorithms and optimization problems, searching with partial observations, Adversarial search, Constraint

Satisfaction Problems

Unit 3 (Knowledge, Reasoning and Planning): Logical agents, Classical planning, Algorithms for planning as state-space search, Planning graphs, Planning and acting in the real-world, Knowledge representation, Uncertain knowledge and reasoning, Quantifying uncertainty, Probabilistic Reasoning, Probabilistic Reasoning over time, Making simple decisions and Making complex decisions

Unit 4 (Machine Learning): Learning from examples: Forms of learning, Supervised learning, Decision trees, Artificial Neural Networks, Support Vector Machines, Ensemble learning; Knowledge in learning: Explanation-Based learning; Learning probabilistic models, elements of Reinforcement learning.

Unit 5 (Communication, Perceiving and Acting): Perception; Industrial Robotics: Robot actuation, Robot Perception, Planning Movements, Robotic Software Architecture,

Unit 6 (Case Studies): Localization, tracking and control with a focus on examples from Industrial robots, Human Machine Interaction, Predictive Maintenance and Health Management, Fault Detection, Image based part classification, Process Optimization, Material Inspection, Tuning of control algorithms

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		
CO-2	3												3		
CO-3		3											3		
CO-4	3	2											3		
CO-5	3	2								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		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	0	
Numeracy		10
1. Solving Numerical Problems	10	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	05	
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. (Mechanical 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 (60% Weightage)				**Component 2: SEE (40% Weightage)**
Subcomponent ▶	**SC1**	**SC2**	**SC3**	**SC4**	
Subcomponent Type ▶	**Term Test**	**Term Test**	**Assignment**	**Quiz**	**50 Marks**
Maximum Marks ▶	**15**	**15**	**20**	**10**	
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	--
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment, Examination
14.	Personal Management	Course Work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. Arkapravo Bhaumik, From AI to Robotics, CRC press, Taylor and Francis publication, 2018
3. Francis X. Grovers, Artificial Intelligence for Robotics: Build Intelligent Robots that Perform Human Tasks Using AI Techniques, Packt publishing 2018

b. Recommended Reading

1. Huimin Lu, Artificial Intelligence and Robotics, Springer publishing

c. Magazines and Journals

1. https://spectrum.ieee.org/topic/robotics/
2. https://aimagazine.com/
3. https://www.servomagazine.com/magazine

d. Websites

1. https://www.intel.com/content/www/us/en/robotics/artificial-intelligence-robotics.html

e. Other Electronic Resources

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

10. Course Organization

Course Code	MEC307A	
Course Title	AI for Mechanical Engineers	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May-2027	

◂◆▸

Course Specifications: Yoga for Health and Wellness

Course Title	**Yoga for Health and Wellness**
Course Code	**BNE101A**
Course Type	**SEC (Value Based)**
Programme	**UG programmes under NEP- 2020**

1. Course Summary

This elective course on yoga is designed to encourage students to incorporate yoga in their daily routine to manage stress and lead a healthy life.

2. Course Size and Credits

Number of Credits	**2**
Total Hours	**45 hrs**
L:T:P	**1:0:2**
Course Marks	**50**
Pass Requirement	**40% marks in Continuous Assessment**
Attendance Requirement	**75% of attendance is mandatory**

3. Course Outcomes

At the end of the course the students will be able to:

1. Practice basic yoga postures.
2. Manage stress and anxiety through the practice of specific yoga techniques.
3. Be equipped to improve general health and immunity.
4. Create a balance between strength, flexibility and body weight.
5. Enhance ability to improve their memory and concentration.

NAGENDRA-B-N

Dean - Academics

4. Course Content

SL No	TIME (Hrs.)		Learning Objectives	Content	Teaching/ Learning Activities	Assessment method
	T	P				
I	2	1	Students will be motivated to practice basic yoga postures	Introduction to yoga • History of yoga • Concept of yoga • Benefits of yoga • Need of yoga practice in modern times	•Discussion • Sookshma Vyayama	MCQ
II	2	3	Students will be able to better manage stress and anxiety through the practice of specific yoga techniques.	Yoga techniques: • Asana • Relaxation Technique • Pranayama	• Discussion • Practice sessions • Ananda balasana • Balasana • Sukhasana • Badhhakonasana • Yoga nidra (Guided Relaxation) • Vibhagiya Pranayama • Bhramari Pranayama • Sheethali/Shitkari Pranayama	MCQ Class Assessment
III	2	4	Students will be equipped to improve general health and immunity.	Yoga techniques: • Asana • Relaxation Technique • Pranayama	✓ Discussion ✓ Practice sessions • Surya Namaskara • Dhanurasana • Bhujangasana • Paschimottanasana • Setubandhasana • Guided relaxation techniques like DRT & QRT	MCQ Class Assessment
IV	2	6	Students will be able to create a balance between strength, flexibility and body weight.	Yoga techniques: • Asana • Relaxation Technique • Pranayama	✓ Discussion ✓ Practice sessions • Suryanamaskara • Sarvanganasana • Trikonasana • Marjarasana • Savasana • Virabhadrasana • Kapalabhati • Nadi Shodhana Pranayama • Yoga Nidra • Samavrritti Pranayama	MCQ Class Assessment

NALENDRA-B-N

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

V	2	6	Students will have an enhanced ability to improve their memory and concentration.	Yoga techniques: • Asana • Relaxation Technique • Pranayama	• Discussion • Practice sessions • Padahastana • Tadasana • Vrukshasana • Padmasana • Vakrasana • Ardhamatsyendra sana • Sarvangasana • Nadi Shodhana Pranayama • Bramhari Pranayama	MCQ Class Assessment

5. Eligibility for Examination

75 % attendance in sessions

6. Method of Assessment (Continuous)

- Internal Test paper (MCQ) - **20 marks**
- Assignments - **10 marks**
- Assessment of skills (Regular Class)- **10 marks**
- Attendance Marks-**10 Marks**

  75% - 80% - 2 Marks
  >80% - 85% - 4 Marks
  >85 - 90% - 6 marks
  >90 - 95% - 8 marks
  >95 - 100% - 10 marks

7. Standard of Passing

For successful completion of the course the candidate needs to secure a minimum of 40% marks in the Continuous Assessment.

8. Reference Books

1. Karmananda S. Yogic management of common diseases. Bihar: Yoga publications trust; 2021.
2. Patanjali. Yoga Sutras. New Delhi: Srishti publishers and distributors; 2021.
3. Purameri S. Psychology of yoga an introduction to ancient Indian psychology. India: Sarovaram books; 2021.

NATESHORA B N

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

Course Specifications: Sports

Course Title	Sports
Course Code	PTU101A
Course Type	Skill Enhancement Course (Value based)
Programmes	UG Programmes under the NEP 2020 guidelines

1. Course Summary

The course aims to familiarize students with fundamental concepts of sports and Health and Wellness through healthy lifestyle. In addition, it provides training and develops essential skills to enhance the performance capacity in different sports activities. The course emphasizes on physical fitness, management of sports injuries, rules of common sports, ethical practices and practice activities.

2. Course Size and Credits:

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	1:0:2
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Total Course Marks	50
Pass Criterion	40%
Attendance Requirement	75%

Teaching, Learning and Assessment

3. Course Outcomes (COs)

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

CO.1 Explain the benefits of sports and fitness
CO.2 Demonstrate skills in management of sports injuries
CO.3 Apply suitable training techniques to enhance physical fitness
CO.4.Organize sports events to promote physical fitness, teamwork, ethical practices and a competitive spirit
CO.5 Develop skills to play common games and the spirit of sportsmanship

4. Course Contents

Unit 1 (Introduction to Sports): Aim, Objectives and Importance of Sports in Institutions, Ethics in Sports

Unit 2 (Fitness): Meaning, Definition, Components of Physical Fitness - Endurance, Speed, Flexibility, Strength and Agility, Physical Fitness, Health Related Fitness, Importance and Benefits, Daily Regime for Sportspersons, Hygiene, Nutrition, **Warm Up Exercises, Fitness Exercises, Cool Down or Limbering Down Exercises**

Unit 3 (Sports Injuries and Management**):** Definition, Causes and Types, Prevention, Management Techniques, **First Aid**

[Kumar G M]

for Director 10/8/24
Directorate of Student Affairs
M.S. Ramaiah University of Applied Sciences
Bangalore-560054

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

Continuous Evaluation				
Course Outcomes	**Sessional Work 1 Theory Assignment**	**Sessional Work 2 Practical Assignment**	**Sessional Work 3 Group activity (Intramural activity-organizing-participation)**	**Attendance**
Maximum Marks	**10**	**10**	**20**	**10**
CO-1	X			
CO-2	X			
CO-3	X	X		
CO-4			X	
CO-5		X		

- **Group Activity – 20 Marks:**
  Group activity will be assessed based on
  Skills in planning and organizing the tournament – 5 Marks.
  Team Work – 5 Marks.
  Ethics displayed – 5 Marks.
  Performance in the tournament – 5 Marks.

- **Attendance Marks-10 Marks:**

  75% - 80% - 2 Marks.
  80% - 85% - 4 Marks.
  85% - 90% - 6 Marks.
  90% - 95% - 8 Marks.
  95% - 100% -10 Marks.

7. Achieving Course Learning Outcomes

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

Sl.No	Curriculum and Capabilities Skills	How imparted during the course
1	Knowledge	Face to Face Lectures, Demonstrations
2	Understanding	Face to Face Lectures, Demonstrations
3	Critical Skills	-
4	Analytical Skills	-
5	Problem Solving Skills	Practical activities
6	Practical Skills	Practical activities
7	Group Work	Practical activities
8	Self-Learning	Assignments
9	Written Communication Skills	-
10	Verbal Communication Skills	-
11	Presentation Skills	-
12	Behavioral Skills	Practical activities
13	Information Management	Assignment
14	Personal Management	Practical activities
15	Leadership Skills	Practical activities- organizing activities

Director
Directorate of Student Affairs
M.S. Ramaiah University of Applied Sciences
Bangalore-560054

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

8. Course Resources

a. Essential Reading

1. Class Notes
2. Singh Ajmer, Rachhpal Bains Jagdish, Brar Singh, Gill Singh Jatar,(2016), Essentials of Physical Education, 5th Ed, India, Kalyani Publishers

b. Recommended Reading

1. Srivastava A.K., (2010), Book of Rules of Games and Sports, 1st Ed, India, Sports Publication
2. Peterson Lars,Renstrom A.F.H. Per,(2017), Sports Injuries- Prevention, Treatment and Rehabilitation, 4th Ed, Oxfordshire, Routlede

3. William J. Morgan, (2018), Ethics in Sport, 3rd Ed,United Kingdom, Human Kinetic

4. Bean Anitha, (2017), the Complete Guide to Sports Nutrition, 8th Ed, London, Bloomsbury

c. Magazines and Journals.

1. Sportstar, The Hindu, India
2. ESPN the Magazine, SPN Sports Network, Connecticut

c. Websites

1. https://www.fiba.basketball/documents
2. https://www.throwballfederationofindia.in/throwball-rules.htm
3. https://www.fivb.com/en/volleyball/thegame_glossary/officialrulesofthegames
4. https://www.ihf.info/sites/default/files/2022-03/09A%20-%20Rules%20of%20the%20Game_Indoor%20Handball_E.pdf
5. https://documents.ittf.sport/sites/default/files/public/2021-04/2021ITTFHandbook.pdf
6. http://khokho.co.in/kho-kho-game-rules
7. https://www.indiankabaddi.org/rules-of-kabaddi.html

a. Other Electronic Resources

1. DELNET
2. EBSCO

9. Course Organization

Course Code	PTU101A	
Course Title	Sports	
Course Leader/s Name	Kumar G M	
Course Leader Contact Details	**Phone:**	9844583455
	E-mail:	manager1.sports@msruas.ac.in
Course Specifications Approval Date		
Next Course Specifications Review Date:		

[Kumar G.M]

10/8/24

for Director
Directorate of Student Affairs
M.S. Ramaiah University of Applied Sciences
Bangalore-560054

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

Unit 4 (Common Games any one): Basketball/ Volleyball / Throw Ball/ TT/ Handball/ Kabaddi/ Kho-Kho- Rules and Regulations, **Skills Development Exercises, Training, Intra-Murals competitions,** Ethical Practices

5. Course Teaching and Learning Methods:

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		10
Demonstrations		03
1. Demonstration using Videos	03	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration using Computers	00	
Numeracy		
1. Solving Numerical Problems		
Practical Work		30
1. Course Laboratory/ Playground	30	
2. Computer Laboratory		
3. Engineering Workshop / Course/Workshop / Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model studio		
Others		02
1. Case Study Presentation		
2. Guest Lecture	02	
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions		
6. Discussing Possible Innovations		
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

6. Method of Assessment

The components and subcomponents of course assessment are presented in the Academic Regulations document pertaining to the Programme. The procedure to determine the final course marks is also presented in the Academic Regulations document as well.

The assessment questions are set to test the course learning outcomes. In each component or subcomponent, certain Course Outcomes are assessed as illustrated in the following Table.

[Kumar G.M.]

10/8/24
for Director
Directorate of Student Affairs
M.S. Ramaiah University of Applied Sciences
Bangalore-560054

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

Course Specifications: Aptitude & Analytical Reasoning

Course Title	Aptitude & Analytical Reasoning-1
Course Code	PTF301A
Course Type	Skill Enhancement Course (SEC)
Department	All Departments
Faculty	Engineering and Technology

1. Course Summary

This course is designed to enhance the employability of students by learning critical thinking problem-solving skills, logical thinking, and quantitative abilities. It covers key concepts in numerical aptitude, logical reasoning, and data interpretation, which are essential for competitive exams, job assessments, and decision-making in professional settings.

2. Course Size and Credits:

Number of Credits	01
Credit Structure (Lecture: Tutorial: Practical)	0:0:2
Total Hours of Interaction	36
Number of Weeks in a Semester	15
Department Responsible	Directorate of Placements, Training & Career Services
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

- **CO1** **Recall** fundamental concepts of logical reasoning, data interpretation & quantitative aptitude
- **CO2** **Summarize** problem solving approaches in verbal, logical and quantitative reasoning
- **CO3** A**pply** logical and analytical reasoning techniques to solve real world computational problems.
- **CO4** **Differentiate** between various problem-solving strategies and select the best approach for numerical and logical problems
- **CO5** **Assess** different problem-solving approaches and optimize the solutions

4. Course Contents

Unit 1
Quantitative Aptitude

Number Systems
Concept explanation of Classification of Numbers, Divisibility Tests, Power Cycles & reminders, factors and multiples – Multiples, Highest Common factor (HCF), Least common multiple (LCM), Applications of HCF & LCM. Solving problems related to the topics.

Ratio, Proportion, Variation, Linear Equations and Problems on Ages
Introduction to ratio & proportions, formulas on ratios and proportions. Explanation of variation &

linear equations. Solving problems using these concepts.

Simple interest and Compound interest `
Simple Interest, Compound Interest, basic formulas, Difference between simple interest & interest, Successive percentages in SI & CI. Relation Between Simple and Compound Interests Shortcut methods and Solving problems on these concepts

Profit & Loss, Partnerships, Mixtures and Allegations
Basic terminology in Profit and loss, Concept Explanation - Profit, Loss, Cost Price, Selling Price, & Marked Price. Solving problems to review the concepts. Mixtures and alligation & Rule of alligation. Alligation cross, Alligation line, Successive replacement, practicing problems to review the concepts.

Unit 2

Time Speed and Distance
Basic formulas and concept review on Time, Speed & Distance.
Application of relative speed in train problems, boats & streams problems, Solving problems on these concepts.

Time and Work
Concept explanation of Working with Different Efficiencies, Pipes and Cisterns, work equivalence (man days) & Division of Wages. Solving problems related to these concepts.

Set theory and functions
Concept of Set Formulas, Power Set, Subset, Domain & Range. Solving problems related to these topics.

Permutation, Combination and Probability
Fundamental Counting Principle, Permutation and Combination, Computation of Permutation, & basic concept of Probability. Solving problems to review the concepts.

Logarithms, Progressions, Geometry and Quadratic equations
Concept explanation of Logarithms, Arithmetic Progression (A.P), Geometric Progression (G.P), Geometry, Mensuration & Quadratic Equations. Solving problems relevant to these topics.

Unit 3
Logical Reasoning

Logical connectives, Syllogisms and Venn diagram
Concept explanation of Logical connectives, Syllogisms, Venn diagrams – Interpretation & Venn diagrams. Solving problems to review the concept.

Number Series
Explanation of patterns of number series –Explanation on Alphanumeric series & solving problems

Analogies in Reasoning & Judgement Reasoning
Explanation of Numerical analogy, Letter/Word analogy & Image based analogy. Solving questions on these concepts.

Attention to details

Concept explanation of String Matching, Text and Image- based Questions. Practice of problems related to the topic

Data Arrangements and Blood Relations
Concept explanation of data arrangements - Linear Arrangement, Circular Arrangement, distribution and blood relations. Solving problems related to these topics.

Coding and decoding, series, analogy, odd man out and visual reasoning
Concept explanation of Coding and Decoding, Number and Alphabet Series, Analogy, Odd Man Out and visual reasoning. Practicing problems to familiarize the concepts.

Unit 4

Critical Reasoning
Concept explanation of Arguments, Explaining Statements & Course of actions, Statement & Conclusion concepts, solving problems related to these concepts.

Image Interpretation
Concept explanation of Rebus Puzzles & Forming Words Based on Images. Practice exercise to familiarize the concepts.

Data Interpretation and Data Sufficiency
Concept of Data Interpretation – Tables, pie charts, Bar graphs & Data sufficiency.

Clocks, Calendars & Direction Sense
Conceptual review of Clocks, Calendars, Direction Sense and Cubes & practicing related problems**.**

Unit 5
Verbal Ability
Reading Comprehension
Speed Reading Strategies, reading comprehension types and tackling Solving problems related to these concepts.

Sentence correction
Review of basics on Subject – Verb agreement, Modifiers, Parallelism, Pronoun – Antecedent Agreement, Verb-Time Sequence, Comparisons, Prepositions & Determiners. Practicing problems to familiarize the concepts.

Vocabulary
Vocabulary Demystified, Synonyms and Antonyms, Word Analogy, Patterns of questions on word analogy, Idioms, Phrasal Verbs & commonly confused words.

Sentence completion and Para- jumbles
Strategies to solve sentence completion problems and practicing the sentence completion problems. Para Jumbles – Types of paragraph structure – strategies for solving jumbled paragraphs

Voices & Speech
Review of basics on Active vs Passive Voice, Direct vs Indirect Speech. Practice problems related to the topics for familiarizing the concept.

Articles, Prepositions and Interrogatives

Definite and Indefinite Articles, Omission of Articles, Prepositions, Prepositions of Place, Time, & direction. Compound Prepositions and Prepositional Phrases, Interrogatives. Practicing problems to review the concepts.

5. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		10
Demonstrations		0
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		26
1. Problem solving – Concept application	00	
Practical Work		
1. Course Laboratory	00	
2. Computer Laboratory		
3. Engineering Workshop / Course/Workshop / Kitchen	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brainstorming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Quizzes, Self-Practice		4
Total Duration in Hours		**40**

6. Course Assessment and Reassessment

The components and subcomponents of course assessment is presented in the Academic Regulations document pertaining to the B. Tech.(Mechanical Engineering) Programme. The procedure to determine the final course marks is also presented in the Academic Regulations document as well.

The assessment questions are set to test the course learning outcomes. In each component or subcomponent, certain Course Outcomes are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type	Terms Tests	Quizzes	
CO-1	x	X	X
CO-2	x	X	X
CO-3	X	X	X

CO-4	**X**	**X**	**X**
CO-5		**X**	**X**
The details of the number of tests and Quizzes to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

Mode of Evaluation

- One Term test (40%)
- One Quiz (20%)
- Semester End Exam (SEE) – 40%

Evaluation & Assessment Breakdown

To ensure structured learning and measurable progress, the evaluation will consist of Continuous Assessment Tests (Term Test), Quiz, and Semester End Exam.

Continuous Assessment Test – Term Test – 40%

Objective: To evaluate **ongoing progress** and ensure that students retain key concepts.

Frequency: One Term Test will be conducted during the course

Format:

- **Multiple-Choice Questions (MCQs) – 40 marks**

Quizzes – 20%

Objective: Reinforce **problem-solving skills** through **practice-based learning**.

Frequency: One quiz will be given during the course

Format:

- **MCQs on the topics covered**

Semester End Examination (SEE) – 40%

Objective: To ensure students gain the necessary knowledge, skills, and competencies that are needed to perform well in their professional career.

Format:

MCQs covering the entire course curriculum – 50 marks (50 MCQs) normalized to 40 for final computation with a weightage of following topics

- **Section 1 – Quantitative Aptitude (QA) – 20 Marks**
  - **20 MCS**
- **Section 2 – Logical Reasoning (LR) – 20 Marks**
  - **20 MCQs**
- **Section 3 – Verbal Ability (VA) – 10 Marks**
  - **10 MCQs**

Final Evaluation of the course				
	Term Test 1	**Quiz 1**	**SEE**	**Final Marks**
Maximum marks	40	20	50	
Test format	MCQs	MCQs	MCQs	
No of MCQs	40	20	50	
Weightage	40%	20%	80%	
Marks assigned for each component	**40**	**20**	**40**	**100**

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.
Course reassessment policies are also presented in the Academic Regulations document.

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	Classroom lectures, Quiz
2.	Understanding	Classroom lectures cum practice sessions, Quiz, Self-study
3.	Critical thinking Skills	Classroom lectures cum practice sessions, Quiz, self-study, examination
4.	Analytical Skills	Classroom lectures cum practice sessions, Quiz, Examination
5.	Problem Solving Skills	Practice in the computer lab, Quiz, Examination
6.	Logical thinking skills	Classroom lectures, Quiz, Examination
7.	Group Work	--
8.	Self-Learning	Quiz, Self-study
9.	Written Communication Skills	Classroom lectures, practice sessions, Quiz, Examination
10.	Verbal Communication Skills	Quiz, Self-study
11.	Presentation Skills	--
12.	Behavioral Skills	
13.	Information Management	Quiz, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

8. Course Resources

Books for Quantitative Aptitude & Logical Reasoning

1. Quantitative Aptitude

"Quantitative Aptitude for Competitive Examinations" – *R.S. Aggarwal*

"Fast Track Objective Arithmetic" – *Rajesh Verma*

"Quantitative Aptitude Quantum CAT" – *Sarvesh Kumar Verma (for advanced problem-*

solving techniques)

2. **Logical & Analytical Reasoning**

   "A Modern Approach to Logical Reasoning" – *R.S. Aggarwal*

   "Logical Reasoning and Data Interpretation for CAT" – *Nishit K. Sinha*

   "How to Prepare for Logical Reasoning for CAT" – *Arun Sharma*

3. **Data Interpretation & Data Sufficiency**

   "How to Prepare for Data Interpretation" – *Arun Sharma*

   "Data Interpretation & Data Sufficiency" – *RS Aggarwal*

📖 **Books for Verbal Ability & Communication Skills**

1. **Verbal Ability & Reading Comprehension**

   "Objective General English" – *SP Bakshi (Arihant Publications)*

   "Word Power Made Easy" – *Norman Lewis (For vocabulary enhancement)*

   "High School English Grammar & Composition" – *Wren & Martin (For strong grammar foundation)*

   "How to Prepare for Verbal Ability and Reading Comprehension" – *Arun Sharma & Meenakshi Upadhyay*

Online Platforms for Placement Preparation

1. **Aptitude Practice & Mock Tests**

   IndiaBix – Free questions for **Quant, LR, DI, Verbal, and Puzzles**.

   PrepInsta – Placement papers & company-specific mock tests.

2. **Coding & Logical Thinking *(For Logical Puzzles & Advanced Aptitude Challenges)***

   HackerRank – Logical reasoning & puzzles.

   GeeksforGeeks – IT recruitment test preparation (Logical & Verbal).

   LeetCode – IT aptitude & coding practice.

3. **Vocabulary & Grammar Practice**

   Merriam-Webster Vocabulary Quizzes – Word games to improve vocabulary.

   Grammarly Blog – Grammar & sentence structure lessons.

9. Course Organization

Course Code	PTF301A	
Course Title	Aptitude & Analytical Reasoning Training	
Course Leader Name	As per Timetable	
Course Leader Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May 2027	

Course Specifications: Heat Transfer

Course Title	Heat Transfer
Course Code	MEC308A
Course Type	Core Theory And Laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course intends to impart knowledge about principles of heat and mass transfer applicable to design of thermal systems. Students are taught the modes of heat transfer and their governing laws, thermal properties of materials, principles of boiling and condensation and various types of heat exchangers. Students will be able to apply the principles of heat and mass transfer for a given application

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:2
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mechanical 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.** State the laws of heat and mass transfer
- **CO-2.** Explain the principles of conduction, convection, radiation, boiling, condensation and diffusion
- **CO-3.** Develop finite difference equations of heat transfer for various conditions
- **CO-4.** Design heat exchangers using LMTD and NTU methods
- **CO-5.** Solve conduction, convection, radiation heat transfer and mass transfer problems

4. Course Contents

Unit 1 (Introduction): Heat Transfer: Modes of heat transfer; Fourier's law; Conductivity. Newton's law of convection and Stefan Boltzmann law of radiation.
Heat Conduction: General heat conduction equation; Boundary and initial conditions; Heat generation; Thermal conductivity; Steady heat conduction: Conduction in plane wall, cylinder, sphere and composite walls; Resistance network analysis; Heat losses and insulation; Critical radius of insulation; Heat transfer from fins; Numerical problems

Unit 2 (Transient heat transfer): Transient Heat Conduction: Lumped system analysis; Transient heat conduction in large plane walls, long cylinders and spheres with spatial effect; Heisler and Grober charts; Numerical methods of heat conduction; Numerical problems

Unit 3 (Convection Heat Transfer): Principles of convection heat transfer; Velocity and thermal boundary layer; laminar and turbulent flows; Conservation equations for mass, momentum and energy; Solution of boundary layer equations; Analogy between heat and momentum transfer; Non-dimensional numbers

External Convection Heat Transfer: Laminar boundary layers; Similarity and integral solutions; Drag and heat transfer, Flow over flat plates, cylinders and spheres

Internal Convection Heat Transfer: Mean velocity and mean temperature; Entrance region; Constant heat flux and temperature condition in pipe flow; Hagen–Poiseuille flow; Heat transfer in laminar developed and developing duct flows; Heat transfer in turbulent boundary layers and turbulent duct flows

Natural/Free Convection: Grashoff number; Natural convection over surfaces and inside enclosures; Laminar and turbulent free convection; Numerical problems

Unit 4 (Boiling and Condensation and Heat Exchangers): Boiling and Condensation: Boiling heat transfer; Bubble nucleation; Pool boiling; Subcooled and saturated flow boiling; Flow boiling; Heat transfer coefficients; Critical heat flux; Effect of sub-cooling; Flow boiling- onset of nucleation; Post-boiling-crisis heat transfer; Condensation heat transfer; Film and drop-wise condensation; Condensation heat transfer correlations; Numerical problems

Heat Exchangers: Types of heat exchangers; Overall heat transfer coefficient; Analysis of heat exchangers; Log Mean Temperature (LMTD) method; Effectiveness (ε)-NTU method; Double pipe heat exchangers: Thermal and Hydraulic design; Shell and Tube heat exchangers: basic design procedure; Heat Exchanger Network (HEN) and process integration; Compact heat exchangers

Unit 5 (Radiation Heat Transfer): Radiation: Fundamentals, Radiative properties of opaque surfaces; Intensity, emissive power and radiosity; Planck's law and Wien's displacement law; Black and Gray surfaces; Emissivity and absorptivity; Spectral and directional variations; Stephan Boltzmann and Kirchhoff's law; Radiative properties of molecular gases and particulate media; Exact solutions of one dimensional gray media

View Factors: Definitions and relations; radiation heat transfer between two black surfaces, diffuse gray surfaces; Network methods; Re-radiating surface; Radiation shield; Radiation effects on temperature measurements; Radiative properties of surfaces; Radiant exchange between surfaces; Radiative heat transfer in participating media; Radiative exchange between gray and diffuse surfaces; Radiation combined with conduction and convection

List of experiments to be conducted along with the theory

1	Determination of steady state heat transfer and thermal conductivity of a metal rod
2	Determination of steady state temperature distribution through a composite wall
3	Determination of critical insulation thickness using lagged pipe apparatus
4	Determination of effectiveness of a rectangular fin using natural and forced convection heat transfer
5	Determination of heat transfer coefficient for natural and forced convection
6	Determination of emissivity of a surface/test plate using Stefan Boltzmann apparatus
7	Determination of Stefan-Boltzmann constant using graphical method

8	Determination of Log Mean Temperature Difference (LMDT) and effectiveness in a counter flow and parallel flow heat exchangers
9	Determination of effectiveness of cross-flow heat exchanger
10	Demonstration of boiling heat transfer
11	Demonstration of droplet and film condensation heat transfer for studying the condensation regime

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		
CO-2	3												3		
CO-3	3		2										3		
CO-4		3											3		
CO-5		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		25
Demonstrations		05
1. Demonstration using Videos	01	
2. Demonstration using Physical Models / Systems	02	
3. Demonstration on a Computer	02	
Numeracy		30
1. Solving Numerical Problems	30	
Practical Work		00
1. Course Laboratory	30	
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. (Mechanical 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						
Course Outcome	CE (Weightage: 60 %)				Component 2: SEE (40% Weightage)	
	SC1	SC2	SC3	SC4	SEE (Weightage: 25 %)	SEE (Weightage: 15 %)
	Term Test	Term Test	Assignment	Lab	Written exam	Lab Exam
	15	15	20	10	50 Marks	25 Marks
CO-1	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
The details of TSC1, TSC2, TSC3 or LSC4 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. Course notes
2. J. P. Holman, 2008, Heat Transfer, McGraw-Hill Inc.
3. F. P. Incropera and D. P. Dewitt, 2007, Fundamentals of Heat and Mass Transfer, Wiley India Pvt. Ltd.

b. Recommended Reading

1. Y. A. Cengel, 2006, Heat and Mass Transfer: A Practical Approach, McGraw-Hill Higher Education
2. S. M. Ghiaasiaan, 2007, Two-Phase Flow, Boiling and Condensation, Cambridge University Press
3. M. Tirumaleshwar, 2008, Fundamentals of Heat and Mass Transfer, Pearson Education
4. K. Nag, 2011, Heat and Mass Transfer, Tata McGraw-Hill

c. Magazines and Journals

1. International Journal of Heat and Mass Transfer
2. International Communications in Heat and Mass Transfer
3. Journal of Heat Transfer
4. Journal of Thermo-physics and Heat Transfer

d. Websites

1. www.machinedesignonline.com
2. www.nptel.ac.in
3. ocw.mit.edu
4. www.class-central.com

e. Other Electronic Resources

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

10. Course Organization

Course Code	MEC308A	
Course Title	Heat Transfer	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May-2023	
Next Course Specifications Review Date	May-2027	

Course Specifications: Finite Element Analysis

Course Title	Finite Element Analysis
Course Code	MEC309A
Course Type	Core Theory and Laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

I. Course Summary

This course is aimed to prepare students to solve structural problems using finite element methods. Students are taught variational principles in solid mechanics, formulations of finite elements and finite element analysis technique. Application of finite element method to solve linear, dynamic and thermal problems will be trained to use FEA tools to solve complex Problems

2. Course Size and Credits:

Number of credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:2
Total hours of interaction	75
Number of Weeks in a Semester	15
Department responsible	Mechanical Engineering
Total Course Marks	100
Pass requirement	As per the Academic Regulations
Attendance requirement	As per the Academic Regulations

3. Course Objectives (CO)

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

CO-1. Explain the basic concepts of finite element method and its role in engineering analysis

CO-2. Outline the general procedure of finite element analysis and element formulation

CO-3. Develop element equations for simple one dimensional, two dimensional elements for structural and thermal analysis

CO-4. Solve simple structural static, dynamic and thermal analysis problems

CO-5. Model and analyse simple linear static, dynamic and thermal problems using ANSYS

4. Course Contents

Unit 1 (Introduction): Engineering analysis, types of engineering analysis problems, methods to solve engineering problems- analytical, numerical and experimental methods, FEA in design and analysis of a component, Principle of Minimum Potential Energy, Origin of FEM, Principle of FEM, Classification of FEM, Types of Analysis-Linear, Dynamic, Harmonic, Thermal, Computation Fluid Flow analysis.

General procedure of FEM. Review of Solid Mechanics: Degrees of Freedom, Rigid Body Motion, Discrete Structures, Continuous Structures, Material Properties, Stress and Strain at a Point, Equilibrium Equations, Generalised Hooke's law, Stress –Strain relations for plane stress and plan strain conditions, Strong form and weak form solutions, General Variational methods in elasticity

problems, variational formulation in FEA, Rayleigh-Ritz Method, and Galerkin Method-Significance and Examples.

Unit 2 (Element formulation of 1D Element): Element stiffness, Different approaches for element formulation, Use of energy approach for element formulation, Shape functions and natural coordinates, Gauss Quadrature, convergence requirements of shape functions , shape functions by Lagrange method.
Derivation of stiffness and equivalent load vector for a two node bar element, two node truss element, and two node beam element, methods of handling boundary conditions-elimination approach and penalty method, Solution of bar, stepped bar and tapered bar problems using two node bar element, plane truss problems using two node truss element and problems on beams.

Unit 3 (Element formulation of 2D, 3D and Higher order Elements): Formulation of 2D Constant Strain Triangular element, Quadrilateral element and solution of simple problems, Formulation of 3D tetrahedral element, Formulations of 1D, 2D and 3D higher order elements

Unit 4 (Dynamic Analysis): Static versus Dynamic analysis – loads and response, Dynamics and Vibration, Types of problems in dynamic analysis – Modal, Transient, Harmonic, Inclusion of dynamic forces in finite element methodology, Solution methodologies for dynamic problems. Problems on dynamic analysis of bars to determine natural frequencies and mode shapes.

Unit 5 (Thermal Analysis): Physics of heat transfer, Governing equations for heat transfer, Extension of FE methodology for structures to thermal problems, Loads and boundary conditions for thermal problems. 1D problems on thermal analysis to determine temperature distribution.

Unit 6 (Modelling and analysis using ANSYS software):

Analysis: Stress analysis of stepped bar and tapered bar; Stress analysis of different types of beams; Stress analysis of plane truss structures; Stress analysis of plane frame structures; Stress analysis of Plane stress and Plane strain examples; Stress analysis of a rectangular plate with a Circular Hole; Stress analysis of corner angle bracket; Thermal analysis of fin; Thermal analysis of composite wall; Modal analysis of stepped bar and cantilever beam; Harmonic analysis of cantilever beam; Dynamic analysis of bar subjected to forcing function.

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		
CO-2	3												3		
CO-3		2			3								2	3	
CO-4		2			3								2	3	
CO-5		2			3								2	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		00
1. Demonstration using Videos		
2. Demonstration using Physical Models /		
3. Demonstration on a Computer		
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		30
1. Course Laboratory		
2. Computer Laboratory	30	
3. Engineering Workshop / Course Workshop / Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		00
1. Case Study Presentation		
2. Guest Lecture		
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions		
6. Discussing Possible Innovations		
Term Tests, Written Examination		10
Total Duration in Hours		85

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment is presented in the Programme Specifications document pertaining to the B.Tech.(Mechanical 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						
Course Outcome	**CE (Weightage: 60 %)**				**Component 2: SEE (40% Weightage)**	
	SC1	**SC2**	**SC3**	**SC4**	**SEE (Weightage: 25 %)**	**SEE (Weightage: 15 %)**
	Term Test	**Term Test**	**Assignment**	**Lab**	**Written exam**	**Lab Exam**
	15	**15**	**20**	**10**	**50 Marks**	**25 Marks**
CO-1	**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**

The details of TSC1, TSC2, TSC3 or LSC4 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. Chandrupatle, T. R., Belegundu, A. D. (2015) Introduction to Finite Elements in Engineering, 4th ed, Pearson Education India
3. Reddy, J. N. (2020) Introduction to Finite Element Method, 4th ed, McGraw-Hill

b. Recommended Reading

1. Zienkiewicz, O. C. (2005) The Finite Element Method, Tata McGraw-Hill Publishing Co. Ltd.
2. Fagan, M. J. (1992) Finite Element Analysis: Theory and Practice, Pearson Education Ltd
3. Bathe, K.-J. (1997) Finite Element Procedures, Prentice Hall India
4. Adams, V., Askenazi, A. (1998) Building Better Products with Finite Element Analysis, Onward Press

c. Magazines and Journals

1. Finite Elements in Analysis and Design

2. Computers and Structures
3. Journal of Computational and Applied Mathematics
4. International Journal of Computational Methods

d. Websites

1. http://www. nptel.ac.in
2. http://www. machinedesignonline.com
3. http://www.asminternational.org

e. Other Electronic Resources

1. www.mece.ualberta.ca
2. www.ansys.com
3. Electronic resources on the subject area are available in RUAS library

10. **Course Organization**

Course Code	MEC309A	
Course Title	Finite Elements Analysis	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	**Pho**	+91-804-906-5555
	E-	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May 2027	

Course Specifications: Advanced Mechanics of Materials

Course Title	Advanced Mechanics of Materials
Course Code	MEE311A
Department	Mechanical Engineering
Faculty	Engineering and Technology

I. Course Summary

1. Aim and Summary

This course deals with principles of mechanics of materials and apply these principles in designing structural components. Students are taught the concepts of elasticity, plasticity and their application in machinery design. Failure criteria and creep concepts will be discussed. Students will be able to analyse the response of the material and structural components to applied forces with boundary conditions.

2. Course Size and Credits:

Number of credits	04
Total hours of class room interaction during the semester	60
Number of tutorial hours	--
Number of semester weeks	16
Department responsible	Mechanical Engineering
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

1. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No.	Intended Learning Outcome
1	Explain material behaviour under various loading conditions
2	Perform stress analysis for given loading and boundary condition from the first principles
3	Identify the critical region of the structure and use appropriate failure model to analyse the failure
4	Develop mathematical models to predict material behaviour under various loading conditions
5	Apply principles of mechanics of materials and solve problems to predict material behavior under different loading conditions like elastic loading, plastic loading and time dependent loading

2. Course Contents

Course Content
General consideration in mechanics of material; types of forces, types of materials; stress-strain behaviour for ductile and brittle material
Analysis of linear elastic materials: Introduction to tensor, stress as a tensor, components of stress, types of stresses, stress at a point, stresses under different co-ordinate systems (Cartesian, cylindrical and polar Co-ordinates), stress transformation, principal stresses and its invariants; Strain as a tensor, types of strain, strain displacement relationship, strain transformation and strain invariants; elastic constants, constitutive, equilibrium equations and compatibility conditions; generalized Hooke`s law; elastic strain energy; effect of temperature on stressstrain relation, thermal stresses; combined loading, failure theories
2D Approximation: Plane stress, plane strain and axisymmetric
Plasticity: True stress and strain; flow curves, yield criteria, yield locus, flow rules; plastic stress-strain relations; hardening behaviour
Creep: Time dependent mechanical behaviour, the creep curve, structural changes during creep, fracture at elevated temperature

3. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		03
1. Demonstration using Videos	01	
2. Demonstration using Physical Models / Systems	02	
3. Demonstration on a Computer	00	
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		02
1. Case Study Presentation	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

4. Method of Assessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification.

5. Reassessment

Course assessment will be followed as per Specification.

6. Achieving Learning Outcomes

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	Class room lectures, Assignments
2.	Understanding	Class room lectures, Assignments
3.	Critical Skills	Class room lectures, Assignments
4.	Analytical Skills	Class room lectures, Assignments
5.	Problem Solving Skills	Class room lectures, Assignments
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, examination
14.	Personal Management	Course work
15.	Leadership Skills	--

III. Course Resources

k. Essential Reading

1. Class Notes
2. G. E. Dieter , 1988, Mechanical Metallurgy: SI Metric Edition, McGraw-Hill
3. L. S. Srinath , 2003, Advanced Mechanics of Solids, 2nd Edition, Tata McGraw-Hill

l. Recommended Reading

4. A. P. Boresi and R. J. Schmidt , 2009, Advanced Mechanics of Materials, John Willey and Sons
5. J. M. Gere and S. P. Timoshenko, 2002, Mechanics of Materials, CBS

m. Magazines and Journals

1. Mechanics of Materials
2. International Journal of Solids and Structures
3. Journal of the Mechanics and Physics of Solids
4. International Journal of Mechanics and Materials in Design

n. Websites

1. http://www.machinedesignonline.com
2. http://www.asminternational.org

o. Other Electronic Resources

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

V.Course Organization

Course Code	MEE311A	
Course Title	Advanced Mechanics of Materials	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	080-49065555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May 2027	

Course Specifications: Advanced Manufacturing Technologies

Course Title	Advanced Manufacturing Technologies
Course Code	MEE312A
Department	Mechanical Engineering
Faculty	Engineering and Technology

I. Course Summary

1. Aim and Summary

This course deals with non-traditional machining and additive manufacturing processes. Students will be taught the working principles, merits and demerits of the above processes along with their applications. Students will be able to compare alternative processes and select appropriate process for manufacturing a given component and criteria.

2. Course Size and Credits:

Number of credits	04
Total hours of class room interaction during the semester	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Mechanical Engineering
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

1. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No.	Intended Learning Outcome
1	Explain the working principles, operations, merits and demerits of non-traditional machining and additive manufacturing processes
2	Describe the types of non-traditional machining and additive manufacturing processes and the effect process parameters
3	Compare the suitability of non-traditional machining and additive manufacturing technologies for various applications
4	Develop CAD model, slicing and tool path generation for additive manufacturing processes
5	Select appropriate process for manufacturing a given component and criteria

2. Course Contents

Course Content
Non-Traditional Machining Processes: Need and importance of Non-traditional machining process, comparison between traditional and non- traditional machining process, advantages and disadvantages
Mechanical energy based non-traditional process: Working principles, equipment, Material Removal Rate (MRR), surface finish, process characteristics and applications of Ultrasonic Machining (USM), Abrasive Jet Machining (AJM) and Water Jet Machining (WJM)
Electrical energy based non-traditional process: Working principles, equipment, MRR, surface finish, process characteristics and applications of Electric Discharge Machining (EDM), Die-Sinker EDM and Wire Cut EDM
Chemical and Electro chemical energy based non-traditional process: Working principles, equipment, MRR, surface finish, process characteristics and applications of Electrochemical Machining (ECM), Chemical Machining (CHM) and Electrochemical Grinding (ECG)
Thermal energy based non-traditional process: Working principles, equipment, MRR, surface finish, process characteristics and applications of Plasma Arc Machining (PAM), Laser Beam Machining (LBM), Electron Beam Machining (EBM) and Ion Beam Machining (IBM)

Additive Manufacturing: Overview, need, importance, applications and challenges of additive manufacturing process in product development, materials for additive manufacturing technology
Steps involved in designing for additive manufacturing: CAD model preparation, part orientation and support generation, model slicing and tool path generation
Liquid based and solid based additive manufacturing systems: Working principle, process characteristics, surface finish, compatibility, advantages and applications of Stereolithographic Apparatus (SLA), Fused Deposition Modeling (FDM) and Laminated Object Manufacturing
Powder based additive manufacturing systems: Working principle, process characteristics, surface finish, compatibility, advantages and applications of three dimensional printing, Laser Engineered Net Shaping (LENS), Electron Beam Melting (EBM)

3. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		50
Demonstrations		05
1. Demonstration using Videos	05	
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		70

4. Method of Assessment

5. Reassessment

6. Achieving Learning Outcomes

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

III. Course Resources

a. Essential Reading

1. Class Notes
2. P. N. Rao, 2003, Manufacturing Technology, Machine Tools and Machining Operations, Tata McGraw-Hill
3. Pandey P.C and Shah H.S, 2014, Modern Machining Process, Tata McGraw-Hill Publications
4. Ian Gibson, David W. Rosen, Brent Stucker, (2015), Additive Manufacturing
   Technologies, Rapid Prototyping to Direct Digital Manufacturing, Springer

b. Recommended Reading

1. V K Jain, 2011, Advanced Manufacturing Processes, , India, Allied Publishers Pvt. Ltd,
2. Hassan Abdel-Gawad El-Hofy, 2005, Advanced Machining Processes, India, The Mcgraw Hill publications
3. Andreas Gebhardt, Jan-Steffen Hotter, 2014, Additive Manufacturing Technologies, Hanser Publishers
4. Mikell P. Groover, (1994), CAD/CAM, India, Pearson Education
5. Serope Kalpakjian and S.R. Schmid, (2004), Manufacturing Engineering and Technology, India, Prentice Hall

c. Magazines and Journals

1. Additive manufacturing journal
2. International journal of additive manufacturing and Subtractive Materials Manufacturing 3. International journal of machine tools and manufacturing

d. Websites

1. www.advancedmachining.com
2. www.progea.com
3. www.nptel.com

e. Other Electronic Resources

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

IV. Course Organization

Course Code	MEE312A	
Course Title	Advanced Manufacturing Technologies	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	49065555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May 2027	

Course Specifications: Fluid Power Systems

Course Title	Fluid Power Systems
Course Code	MEE313A
Department	Mechanical Engineering
Faculty	Engineering and Technology

I. Course Summary

1. Aim and Summary

This course deals with the working of hydraulic and pneumatic actuators. Students will be taught basic principles of hydraulics and pneumatics and their application to fluid power drive systems. Knowledge will be imparted on types of hydraulic and pneumatic drives available for use in various applications and their selection procedures. Students will be able to simulate the working of simple hydraulic and pneumatic systems for better understanding of various components of fluid power systems.

2. Course Size and Credits:

Number of credits	04
Total hours of class room interaction during the semester	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Mechanical Engineering
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

2. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No.	Intended Learning Outcome
1	Explain the principles and components of fluid power systems
2	Describe the working of fluid power systems
3	Select cylinders, actuators and control valves for given application
4	Develop hydraulic or pneumatic systems with circuit diagrams
5	Design and analyze hydraulic/pneumatic circuit for a given application

2. Course Contents

Course Content
Fluid Power: Review of fundamental properties of fluids; fundamental laws and equations of fluid mechanics applicable to pneumatic and oil hydraulic systems; History, applications, advantages and limitations of fluid power systems; General components of a basic fluid power systems
Energy and Power in Hydraulic Systems: Pascal's law and its applications; Conservation of energy, Continuity equation, Bernoulli's equation, Torricelli's equation, Siphon effect, Hydraulic power, Hydraulic circuit analysis
Hydraulic pumps in Fluid Power: Pump classification, pumping theory, pressure regulation, Pump performance and its ratings; Pump noise; pump selection
Hydraulic Actuators: Hydraulic cylinders, operating features and types; cylinder mountings and cushioning in hydraulic cylinders; Gear, vane and piston motors; hydraulic motor theoretical torque, power, flow rate and its performance characteristics
Control Valves: Non return valves, flow control valves, direction control valves, proportional valves
Pneumatic System: Review of properties of air, perfect gas laws; types of compressors and its specifications in pneumatics; working of pneumatic system; comparison of hydraulic and pneumatic system; different types of actuators and control valves used in pneumatic system
Hydraulic and Pneumatic Circuits: Circuit symbols, simple hydraulic and pneumatic circuits to accomplish push-pull, fail-safe, quick-return mechanisms
Design and analysis of simple hydraulic and pneumatic circuits for better understanding of relationships and interactions of various fluid power system components

3. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		03
1. Demonstration using Videos	03	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		10
1. Solving Numerical Problems	10	
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		02
1. Case Study Presentation	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

4. Method of Assessment

Course assessment will be followed as per section 23 "Assessment and Grading" of program specification

Reassessment

5. Course assessment will be followed as per section 23 "Assessment and Grading" of program specification

6. Achieving Learning Outcomes

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	Class room lectures, Assignments
2.	Understanding	Class room lectures, Assignments, Laboratory
3.	Critical Skills	Class room lectures, Assignments
4.	Analytical Skills	Class room lectures, Assignments
5.	Problem Solving Skills	Class room lectures, Assignments
6.	Practical Skills	Laboratory, Assignment
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, examination
14.	Personal Management	Course work
15.	Leadership Skills	--

III. Course Resources

p. Essential Reading

4. Class notes
5. Anthony Esposito, 2000, Fluid Power with Applications, Pearson Education
6. Andrew Par, 2005, Hydraulics and Pneumatics, Jaico Publishing House

q. Recommended Reading

6. Ilango Sivaraman, Introduction to Hydraulics and Pneumatics, PHI, 3rd Edition
7. James L. Johnson, Introduction to Fluid Power, Delmar - A Thomson learning Inc.
8. G. E. Totten, 1999, Handbook of Hydraulic Fluid Technology, CRC Press

r. Magazines and Journals

5. International Journal of Fluid Power
6. International Journal of Fluid Power System
7. Hydraulics and Pneumatics Magazine
8. Drives and controls by Bosch Rexroth

s. Websites

3. www.hydraulicspneumatics.com
4. www.hpmag.co.uk
5. www.nptel.ac.in
6. www.coursera.org

t. Other Electronic Resources

3. Electronic resources on the course area are available on RUAS library
4. EBook on Hydraulics and Pneumatics by Elsevier

IV. Course Organization

Course Code	MEE313A	
Course Title	Fluid Power Systems	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	080-49065555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	July 2023	
Next Course Specifications Review Date	July 2027	

Course Specifications: Operations Research

Course Title	Operations Research
Course Code	MEE314A
Department	Mechanical Engineering
Faculty	Engineering and Technology

I. Course Summary

1. Aim and Summary

The course aims to provide knowledge of optimal design and operation of man - machine systems usually requiring the allocations of scarce resources. Different approaches in balancing conflicting objectives, in the light of alternative courses of actions, will be taught. The students will be introduced to constructing mathematical, economic or statistical models of the problem and analyse the relationships among different variables associated with the problem to determine consequences of decision alternatives. In addition, students will be trained to suggest suitable measures to evaluate the merit of decision alternatives.

2. Course Size and Credits:

Number of credits	04
Total hours of class room interaction during the semester	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Mechanical and Manufacturing Engineering
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

1. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No.	Intended Learning Outcome
1	Describe different problem solving methods for optimal utilization of resources
2	Formulate appropriate mathematical models in order to obtain the optimal solution and analyze their sensitivity
3	Solve numerical problems for obtaining optimal solution by considering the objectives and constraints of a system and draw conclusions
4	Compute normal and standard time of an activity and estimated times for completion of a project
5	Optimize a given system by adhering to the constraints and achieving the desired objectives

2. Course Contents

Course Content
Quantitative Approach to Decision Making: History, Nature and Significance of OR, Features of OR, Models and Modelling in OR, Methods of Solution in OR, OR as a tool for Research Study, Applications of OR and basic OR Models
Linear Programming: LP and allocation of resources, LP definition, Linearity requirement Maximization, Minimization problems, Graphical LP Minimization solution, Simplex method definition, formulating the Simplex model, Simplex Method for similar and mixed limitations, Example containing mixed constraints, Minimization example for similar limitations, Revised Simplex Method and Dual Simplex Method Sensitivity Analysis: Changes in Objective Function, Changes in RHS, Big M Method
Game Theory: Fundamentals, Two-Person Zero-Sum Games, The Maximin-Minimax Principle, Games without saddle points Mixed Strategies, Dominance Property, Algebraic method of solving rectangular games, Minimax and Saddle point theorems
Sequencing Problems: Problems with 'n' jobs and two machines, Problems with 'n' jobs and three machines, Problems with 'n' jobs and 'm' machines, Graphical solutions

Transportation Model: Basic Assumptions Solution Methods: Feasible Solution: The Northwest Method, The Lowest Cost Method; Optimal Solution: The Stepping Stone Method, Modified Distribution (MODI) Method, Degeneracy in Transportation Problems, Assignment Problem, Travelling Salesman Problem
PERT / CPM: Project management, network modeling-probabilistic model, various types of activity times estimation- programme evaluation review techniques- Critical Path-probability of completing the project, deterministic model, critical path method (CPM)-critical path calculation
Queueing Theory: Queuing Theory Essential Features of a Queuing System; Performance Measures of a Queuing System; Probability Distributions in Queuing Systems; Queuing Models and their Solutions: Single Server Queuing Model, Multi Server Queuing Model; Application to Engineering and Business Problems
Simulation: Elements of a simulation model, Event-type simulation, Generation of random phenomena, Steps in simulation, Simulation technique applied to inventory problems and queueing problems

3. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		23
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		35
1. Solving Numerical Problems	35	
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		
1. Case Study Presentation	02	
2. Guest Lecture	00	

3. Industry / Field Visit	00	02
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

4. Method of Assessment

5. Reassessment

6. Achieving Learning Outcomes

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	Classroom lectures, Assignments
4.	Analytical Skills	Classroom lectures, Assignments
5.	Problem Solving Skills	Classroom lectures, Assignments
6.	Practical Skills	Assignments
7.	Group Work	Assignments
8.	Self-Learning	Assignments
9.	Written Communication Skills	Assignments, Written examinations
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work

13.	Information Management	Assignments, Written examinations
14.	Personal Management	Course work
15.	Leadership Skills	--

III. Course Resources

a. Essential Reading

1. Class Notes
2. J. K. Sharma, 2004, Operations Research: Theory and Applications, 5th Edition, Macmillan Publishers
3. Frederick S. Hillier, Gerald J. Lieberman, Bodhibrata Nag and Preetam Basu, 2017, Introduction to Operations Research, 10th Edition , McGraw-Hill Publications

b. Recommended Reading

1. A. Ravindran, Don .T Philips, James J. Solberg, 1987, Operations Research: Principles and Practice, 2nd Edition, Wiley & Sons
2. Harvir Singh Kasana and Krishna Dev Kumar, 2010, Introductory Operations Research: Theory and Applications, Springer
3. Hamdy A. Taha, 2010, Operations Research: An Introduction, Pearson
4. Wayne L. Winston, 2004, Operations Research: Applications and Algorithms, 4th Edition, Indian University

c. Magazines and Journals

1. Journal of Operations Research Society, The OR Society Publications
2. Interfaces: An International Journal of the Institute of Operations Research and Management Sciences (INFORMS) Publications
3. International Journal of Operations and Production Management, Emerald Group Publications

d. Websites

1. www.theorsociety.com
2. www.phpsimplex.com
3. www.orsi.in

e. Other Electronic Resources

1. Electronic resources on the subject area are available in RUAS library

IV. Course Organization

Course Code	MEE314A	
Course Title	Operations Research	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	080-49065555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	July 2023	
Next Course Specifications Review Date	July 2027	

Course Specifications: Mechatronics and Automation

Course Title	Mechatronics and Automation
Course Code	MEE315A
Department	Mechanical Engineering
Faculty	Engineering and Technology

I. Course Summary

1. Aim and Summary

The course deals with evolution of robot and its application in varied fields. Anatomy of robots will be taught along with applications and limitations of using robotic solutions. Different types of end effectors and their design considerations will be taught. Concepts of automation and significance of automation in manufacturing will be discussed. The students are taught the principles of automation systems, automation system components and usefulness of robots in manufacturing automation.

2. Course Size and Credits:

Number of credits	04
Total hours of class room interaction during the semester	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Mechanical and Manufacturing Engineering
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

3. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No.	Intended Learning Outcome
1	Explain the evolution and future of robotic systems and applications
2	Describe the anatomy of given robotic system
3	Discuss the need, significance and types of automation in manufacturing
4	Select appropriate end effector for the robotic application
5	Determine various robot configurations and robot cell features in automation

2. Course Contents

Course Content
Overview of Robotic Systems: Definition of robotic systems, Evolution of robotic systems and future of robotic systems; Global robotic industry; Robot applications in manufacturing sectors, health care, defence, agriculture, production, waste management, hazardous environments, domestic applications, etc.; Relevance of robotic systems and solutions for current and future social needs; socioeconomic impact; Biologically inspired robots
Anatomy of Robotic Systems: Robot physical configurations; Basic robot motions; Different parts and functions in a robotic systems, sensors, manipulator, actuators, power sources, terminologies in robotics
End-Effectors: Types of end effectors, grippers, applications; drives and actuator system for end effectors and grippers; design considerations and guidelines for end effectors
Automation in Manufacturing: Overview, Principles of automation, need for automation, historical overview of automation, overview of control and automation system components, system specification and cost benefit analysis for making decisions, methods for justification of automation systems in terms of cost, performance and general parameters
Automation Technology and Sub-Systems: Sensors generic and sensors for motion control (force, torque, ac celeration, encoders), Actuators, PLC's, CNC, Motors, Drives, Motion controllers, Vision systems and inspection, PC-based control technology, Flexible Manufacturing Systems
Automation of Manufacturing Process using Robots: Robot technology for Manufacturing, Control systems, Accuracy and repeatability, end effectors, Sensors and actuators in robots, Robotic cell and work cell design
Industry 4.0: Introduction to concepts and framework of Industry 4.0 and its developments

3. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		05
1. Demonstration using Videos	05	
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		15
1. Case Study Presentation	05	
2. Guest Lecture	03	
3. Industry / Field Visit	05	
4. Brain Storming Sessions	00	
5. Group Discussions	02	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination / Written Examination, Presentations		10
Total Duration in Hours		70

4. Achieving Learning Outcomes

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	Classroom Lectures, Assignments
4.	Analytical Skills	Classroom Lectures, Assignments
5.	Problem Solving Skills	Classroom Lectures, Assignments
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Coursework
15.	Leadership Skills	--

III. Course Resources

u. Essential Reading

7. Class Notes
8. Harry H. Poole, 1989, Fundamentals of Robotics Engineering, 1st Edition, New York, Van Nostrand Reinhold
9. Mikell P. Groover, 2008, Automation, Production Systems and Computer-Integrated Manufacturing, PHI Learning Private Ltd.

v. Recommended Reading

9. Mikell P. Groover, 2012, Specifications of Industrial Robotics: Technology, Programming, and Applications, 2nd Edition, Mcgraw Hill Education
10. Siciliano Bruno and Oussama Khatib, 2008, Handbook of Robotics, Springer
11. Asai K. and Takshima S., 1994, Manufacturing Automation Systems and Computer Integrated Manufacturing Factories, Chapman

w. Magazines and Journals

9. Journal of Robotics
10. Journal of Robotics and Autonomous Systems
11. Journal of Robotics and Computer-Integrated Manufacturing
12. http://www.botmag.com
13. http://www.roboticmagazine.com

x. Websites

7. http://www.robotics.org
8. http://www.ieee-ras.org/agricultural-robotics
9. http://robohub.org
10. http://spectrum.ieee.org/robotics/medical-robots

y. Other Electronic Resources

i. Electronic resources on the course area are available at RUAS library

IV. Course Organization

Course Code	MEE315A	
Course Title	Mechatronics and Automation	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	080-49065555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	June 2023	
Next Course Specifications Review Date	July 2027	

Course Specifications: Probability and Statistics

Course Title	Probability and Statistics
Course Code	MTE301A
Department	Mathematics and Statistics
Faculty	Mechanical Engineering

I. Course Summary

1. Aim and Summary

The aim of the course is to provide an understanding of probability and statistics.

Students are taught the concepts of mean, median and standard deviation in discrete and continuous probability distribution. The course introduces students to the basic definitions and concepts of inferential statistics. Students are taught the concepts of confidence intervals for mean, variance and standard deviation. This course discusses the hypothesis testing for mean, variance and standard deviation

2. Course Size and Credits:

Number of credits	4
Total hours of class room interaction during the semester	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Mathematics
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

1. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No.	Intended Learning Outcome

1	Explain the concepts of random variables, probability distribution, joint probability distribution and sampling distribution
2	Explain the principles of convex optimization, regression, confidence interval and hypothesis testing
3	Solve simple problems associated with probability distribution, regression, confidence interval and hypothesis testing
4	Model real word problems by using probability distribution and regression
5	Solve complex problems associated with probability distribution, regression, confidence interval and hypothesis testing

2. Course Contents

Course Content
Random variables: Discrete and continuous. Definitions, illustrations and properties of random variables, univariate transformations with illustrations. Probability density function, cumulative distribution function, expected values, variance and their properties. Discrete Probability Distributions: Mean, variance, standard deviation of Binomial, Poisson, Uniform and Negative Binomial along with their characteristic properties and limiting/approximation cases. Continuous probability distributions: Probability density function, cumulative distribution function, mean, Variance, Standard Deviation of Uniform, Normal and Exponential distributions. The Normal Approximation to Binomial Distribution. Limiting/approximation cases. Joint probability distribution: Introduction, Joint Probability density function, marginal probability density function, independent random variables, mathematical expectation Sampling distribution: The sampling distribution of sample mean, sample proportions and sample variance. Central limit theorem.
Convex Optimization Algorithms: Steepest descent and conjugate gradient. Regression: Multivariate linear and non-linear regression. Correlation and covariance.
Estimation: Point estimation and interval estimation. Point Estimation: Unbiased estimation, consistent estimators and simple problems. Method of moments and maximum likelihood estimation. Confidence intervals for the mean for small and large samples. Confidence intervals for population proportions.
Hypothesis Testing: Tests concerning means: Single population, two population and bivariate population. Tests concerning proportion: Single population, two population. Tests concerning variance: Single population, two population.

χ^2 -test for goodness of fit and test for independence of attributes.

3. 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		30
1. Solving Numerical Problems	30	
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

4. Method of Assessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification.

5. Reassessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification

6. Achieving Learning Outcomes

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	Class room lectures, tutor i al s , Assignments
2.	Understanding	Class room lectures, tutor i al s Assignments
3.	Critical Skills	Class room lectures, Assignments
4.	Analytical Skills	Class room lectures, tutor i al s , Assignments
5.	Problem Solving Skills	Class room lectures, tutor i al s , Assignments
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, examination
14.	Personal Management	Course work
15.	Leadership Skills	--

III. Course Resources

a. Essential Reading

1. Class Notes
2. R Johnson, 2010, Miller and Fruend's Probability and Statics for Engineers, 8th edition, Pearson
3. Sheldon Ross, 2010, A First Course in Probability, 8th edition, Pearson
4. Jack Carl Kiefer, 2018, Introduction to Statistical Inference. Springer International Publishing A .G
5. C. Radhakrishna Rao, 1965, Linear Statistical Inference and Its Applications, John Wiley and Sons, INC.

b. Recommended Reading

1. Vijay K. Rohatgi, A. K. Md. Ehsanes Saleh, An Introduction to Probability and Statistics, Wiley
2. Harold J. Larson, Introduction to Probability Theory and Statistical Inference, John Wiley & Sons
3. Hogg, Tannis,Rao,1997,Probability and Statistical Inference, 7h Edition Pearson Publication
4. Pradeep Kumar Sahu. Santi Ranjan Pal, Ajit Kumar Das, 2015, Estimation and inferential Statistics, Springer International Publishing A.G.
5. A. Agresti and C. Franklin, 2012, Statistics: The Art and Science of Learning from Data, 3rd edition, Prentice Hall

c. Magazines and Journals

d. Websites

e. Other Electronic Resources

IV. Course Organization

Course Code	MTE301A	
Course Title	Probability and Statistics	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	49065555
	E-mail:	hod.ph.et@msruas.ac.in
Course Specifications Approval Date	July 2023	
Next Course Specifications Review Date	July 2027	

Course Specifications: Industrial Engineering and Lean Operations

Course Title	Industrial Engineering and Lean Operations
Course Code	MEC311A
Course Type	Core Theory and laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with key concepts of Industrial Engineering with a focus on improving productivity through BPR and TPM. It covers Work Study techniques, including method study, time study, and work sampling for setting standard times. Students explore Ergonomics to understand human factors, risk reduction, and workplace safety. The course also examines Materials Management, including inventory control, EOQ models, and material handling systems. Lastly, it provides an in-depth overview of Lean Thinking, waste elimination, 5S, VSM, JIT, and lean implementation challenges in industrial environments.

2. Course Size and Credits:

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:2:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Mechanical 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 productivity and its types, the methods of measuring productivity and measures for improving productivity
CO-2. Explain concepts of industrial engineering, materials management, facility location decisions, and quality control techniques with their applications
CO-3. Discuss human factors and ergonomics in industries
CO-4. Utilize lean tools for waste elimination and process improvement
CO-5. Develop value stream map for given product

4. Course Contents

Unit 1 (Concepts of Industrial Engineering): Concepts of industrial engineering, productivity, types of productivity, productivity measurement, productivity analysis, productivity improvement through BPR, TPM.
Unit 2 (Work Study): Definition, objectives, method study - definition, objectives, steps involved various types of associated charts-difference between micromotion and memomotion studies. Work measurement- definition, time study, steps involved-equipment, different methods of performance rating- allowances, standard time calculation. Work Sampling definition, steps involved, standard time calculations, and differences with time study.

Unit 3 (Ergonomics): Explanations of Human factors and ergonomics, manufacturing ergonomics and risk process, training and involvement of employees, ergonomic evaluation tools for analyzing work, ergonomic controls, safety and proper working conditions, specific cost of manufacturing ergonomic problems and benefits.

Unit 4 (Materials Management): Objectives, Inventory functions, types, EOQ for purchase and manufacturing models and associated costs, inventory classification techniques-ABC and VED analysis. Inventory Control Systems- Continuous review system-periodical review system. Principles of material handling, material handling equipment.

Unit 5: **(Lean Thinking and Waste Elimination)**: Lean Philosophy and Principles: Value, value stream, flow, pull, and perfection. Types of Waste (TIMWOODS): Identification and classification of eight wastes.5S System: Lean Metrics: Takt time, cycle time, lead time, and OEE. Pull Systems and Kanban. Cellular Manufacturing and SMED, Just-in-Time (JIT). Value Stream Mapping (VSM): Current and future state analysis. Implementation Challenges: Cultural and organizational aspects.

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		
CO-2	3										1		3		1
CO-3	3												3		
CO-4		3									2		3		2
CO-5		3				2					1		3	2	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		32
Demonstrations		03
1. Demonstration using Videos	03	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		10
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		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. (Mechanical 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.

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		**Component 2: SEE (40% Weightage)**
Subcomponent Type ▶	**Terms Tests**	**Assignments**	
CO-1	**X**		**X**
CO-2	**X**		**X**
CO-3	**X**		**X**
CO-4		**X**	**X**
CO-5		**X**	**X**
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and 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	Classroom lectures, Assignments
4.	Analytical Skills	Classroom lectures, Assignments
5.	Problem Solving Skills	Classroom lectures, Assignments
6.	Practical Skills	Classroom lectures, Assignments
7.	Group Work	Assignments
8.	Self-Learning	Assignments
9.	Written Communication Skills	Assignment, Written examinations
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Written examinations
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. Adeji B. Badiru, 2006, Industrial and Systems Engineering, Florida, CRC Press Taylor and Francis Group
3. Philip E.Hicks, 1994,Industrial Engineering and Management A New Perspective, New York City, McGraw-Hill Publication
4. Ralph M. Barnes, 2004, Motion and Time Studies, New Jersey, John Wiley andSons
5. Masaaki Imai, 2012 Gemba Kaizen : A Common-sense Approach to a Continuous
6. Improvement Strategy 2nd Edition (Hardcover), Tata McGraw - Hill Education
7. Pascal Dennis, 2007 Lean Production Simplified: A Plain Language Guide to the World's Most Powerful Production System 2nd Edition, Productivity Press

a. Recommended Reading

1. International Labour Organization, 2008, Introduction to Work Study, New Delhi, Oxford & IBH Publishing
2. 2. O.P. Khanna, 2010, Industrial Engineering and Management, New Delhi, Dhanpat Rai Publishing Company
3. 3. C. Nandha Muni Reddy, 2002, Industrial Engineering and Management, New Delhi, New Age International Publishers
4. 4. James R. Evans and William M. Lindsay, 2010, Managing for Quality and Performance Excellence, California, South-Western College
5. Kjell B. Zandin, 2004, Industrial Engineering Past, Present and Future, New York City, McGraw-Hill Publications.
6. T. Amrine Harold, 2007, Manufacturing Organization and Management, London, Pearson
7. Panner Selvam, 2012, Production and Operations Management, New Delhi, PHI
8. Womack, J.P. and Jones, D.T., 2003. *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*. Updated and Revised ed. New York: Simon & Schuster.

9. Liker, J.K., 2004. *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer*. New York: McGraw-Hill.

a. Magazines and Journals

1. International Journal of Industrial Management & Data Systems, Emerald Publishing Group Limited
2. International Journal of Operation and Production Management, Emerald Group Publications
3. Journal of Manufacturing Technology Management, Emerald Publishing Group Limited

a. Websites

1. www.apics.org
2. www.tandfonline.com
3. www.bluespringsoftware.com
4. www.pmi.org
5. www. gembaacademy.com
6. www. lssacademy.co
7. www. lean.org

a. Other Electronic Resources

1. Electronic resources on the subject area are available in RUAS library

Course Specifications: Advanced Mechanics of Materials

Course Title	Advanced Mechanics of Materials
Course Code	MEE311A
Department	Mechanical Engineering
Faculty	Engineering and Technology

I. Course Summary

1. Aim and Summary

This course deals with principles of mechanics of materials and apply these principles in designing structural components. Students are taught the concepts of elasticity, plasticity and their application in machinery design. Failure criteria and creep concepts will be discussed. Students will be able to analyse the response of the material and structural components to applied forces with boundary conditions.

2. Course Size and Credits:

Number of credits	04
Total hours of class room interaction during the semester	60
Number of tutorial hours	--
Number of semester weeks	16
Department responsible	Mechanical Engineering
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

1. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No.	Intended Learning Outcome
1	Explain material behaviour under various loading conditions
2	Perform stress analysis for given loading and boundary condition from the first principles
3	Identify the critical region of the structure and use appropriate failure model to analyse the failure
4	Develop mathematical models to predict material behaviour under various loading conditions
5	Apply principles of mechanics of materials and solve problems to predict material behavior under different loading conditions like elastic loading, plastic loading and time dependent loading

2. Course Contents

Course Content
General consideration in mechanics of material; types of forces, types of materials; stress-strain behaviour for ductile and brittle material
Analysis of linear elastic materials: Introduction to tensor, stress as a tensor, components of stress, types of stresses, stress at a point, stresses under different co-ordinate systems (Cartesian, cylindrical and polar Co-ordinates), stress transformation, principal stresses and its invariants; Strain as a tensor, types of strain, strain displacement relationship, strain transformation and strain invariants; elastic constants, constitutive, equilibrium equations and compatibility conditions; generalized Hooke`s law; elastic strain energy; effect of temperature on stressstrain relation, thermal stresses; combined loading, failure theories
2D Approximation: Plane stress, plane strain and axisymmetric
Plasticity: True stress and strain; flow curves, yield criteria, yield locus, flow rules; plastic stress-strain relations; hardening behaviour
Creep: Time dependent mechanical behaviour, the creep curve, structural changes during creep, fracture at elevated temperature

3. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		03
1. Demonstration using Videos	01	
2. Demonstration using Physical Models / Systems	02	
3. Demonstration on a Computer	00	
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		02
1. Case Study Presentation	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

4. Method of Assessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification.

5. Reassessment

Course assessment will be followed as per Specification.

6. Achieving Learning Outcomes

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	Class room lectures, Assignments
2.	Understanding	Class room lectures, Assignments
3.	Critical Skills	Class room lectures, Assignments
4.	Analytical Skills	Class room lectures, Assignments
5.	Problem Solving Skills	Class room lectures, Assignments
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, examination
14.	Personal Management	Course work
15.	Leadership Skills	--

III. Course Resources

k. Essential Reading

1. Class Notes
2. G. E. Dieter , 1988, Mechanical Metallurgy: SI Metric Edition, McGraw-Hill
3. L. S. Srinath , 2003, Advanced Mechanics of Solids, 2nd Edition, Tata McGraw-Hill

l. Recommended Reading

4. A. P. Boresi and R. J. Schmidt , 2009, Advanced Mechanics of Materials, John Willey and Sons
5. J. M. Gere and S. P. Timoshenko, 2002, Mechanics of Materials, CBS

m. Magazines and Journals

1. Mechanics of Materials
2. International Journal of Solids and Structures
3. Journal of the Mechanics and Physics of Solids
4. International Journal of Mechanics and Materials in Design

n. Websites

1. http://www.machinedesignonline.com
2. http://www.asminternational.org

o. Other Electronic Resources

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

V.Course Organization

Course Code	MEE311A	
Course Title	Advanced Mechanics of Materials	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	080-49065555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May 2027	

Course Specifications: Advanced Manufacturing Technologies

Course Title	Advanced Manufacturing Technologies
Course Code	MEE312A
Department	Mechanical Engineering
Faculty	Engineering and Technology

I. Course Summary

1. Aim and Summary

This course deals with non-traditional machining and additive manufacturing processes. Students will be taught the working principles, merits and demerits of the above processes along with their applications. Students will be able to compare alternative processes and select appropriate process for manufacturing a given component and criteria.

2. Course Size and Credits:

Number of credits	04
Total hours of class room interaction during the semester	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Mechanical Engineering
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

1. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No.	Intended Learning Outcome
1	Explain the working principles, operations, merits and demerits of non-traditional machining and additive manufacturing processes
2	Describe the types of non-traditional machining and additive manufacturing processes and the effect process parameters
3	Compare the suitability of non-traditional machining and additive manufacturing technologies for various applications
4	Develop CAD model, slicing and tool path generation for additive manufacturing processes
5	Select appropriate process for manufacturing a given component and criteria

2. Course Contents

Course Content
Non-Traditional Machining Processes: Need and importance of Non-traditional machining process, comparison between traditional and non- traditional machining process, advantages and disadvantages
Mechanical energy based non-traditional process: Working principles, equipment, Material Removal Rate (MRR), surface finish, process characteristics and applications of Ultrasonic Machining (USM), Abrasive Jet Machining (AJM) and Water Jet Machining (WJM)
Electrical energy based non-traditional process: Working principles, equipment, MRR, surface finish, process characteristics and applications of Electric Discharge Machining (EDM), Die-Sinker EDM and Wire Cut EDM
Chemical and Electro chemical energy based non-traditional process: Working principles, equipment, MRR, surface finish, process characteristics and applications of Electrochemical Machining (ECM), Chemical Machining (CHM) and Electrochemical Grinding (ECG)
Thermal energy based non-traditional process: Working principles, equipment, MRR, surface finish, process characteristics and applications of Plasma Arc Machining (PAM), Laser Beam Machining (LBM), Electron Beam Machining (EBM) and Ion Beam Machining (IBM)

Additive Manufacturing: Overview, need, importance, applications and challenges of additive manufacturing process in product development, materials for additive manufacturing technology
Steps involved in designing for additive manufacturing: CAD model preparation, part orientation and support generation, model slicing and tool path generation
Liquid based and solid based additive manufacturing systems: Working principle, process characteristics, surface finish, compatibility, advantages and applications of Stereolithographic Apparatus (SLA), Fused Deposition Modeling (FDM) and Laminated Object Manufacturing
Powder based additive manufacturing systems: Working principle, process characteristics, surface finish, compatibility, advantages and applications of three dimensional printing, Laser Engineered Net Shaping (LENS), Electron Beam Melting (EBM)

3. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		50
Demonstrations		05
1. Demonstration using Videos	05	
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		70

4. Method of Assessment

5. Reassessment

6. Achieving Learning Outcomes

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

III. Course Resources

a. Essential Reading

1. Class Notes
2. P. N. Rao, 2003, Manufacturing Technology, Machine Tools and Machining Operations, Tata McGraw-Hill
3. Pandey P.C and Shah H.S, 2014, Modern Machining Process, Tata McGraw-Hill Publications
4. Ian Gibson, David W. Rosen, Brent Stucker, (2015), Additive Manufacturing
   Technologies, Rapid Prototyping to Direct Digital Manufacturing, Springer

b. Recommended Reading

1. V K Jain, 2011, Advanced Manufacturing Processes, , India, Allied Publishers Pvt. Ltd,
2. Hassan Abdel-Gawad El-Hofy, 2005, Advanced Machining Processes, India, The Mcgraw Hill publications
3. Andreas Gebhardt, Jan-Steffen Hotter, 2014, Additive Manufacturing Technologies, Hanser Publishers
4. Mikell P. Groover, (1994), CAD/CAM, India, Pearson Education
5. Serope Kalpakjian and S.R. Schmid, (2004), Manufacturing Engineering and Technology, India, Prentice Hall

c. Magazines and Journals

1. Additive manufacturing journal
2. International journal of additive manufacturing and Subtractive Materials Manufacturing 3. International journal of machine tools and manufacturing

d. Websites

1. www.advancedmachining.com
2. www.progea.com
3. www.nptel.com

e. Other Electronic Resources

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

IV. Course Organization

Course Code	MEE312A		
Course Title	Advanced Manufacturing Technologies		
Course Leader/s Name		As per Time - table	
Course Leader Contact Details		Phone:	49065555
		E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date		May 2023	
Next Course Specifications Review Date		May 2027	

Course Specifications: Fluid Power Systems

Course Title	Fluid Power Systems
Course Code	MEE313A
Department	Mechanical Engineering
Faculty	Engineering and Technology

I. Course Summary

1. Aim and Summary

This course deals with the working of hydraulic and pneumatic actuators. Students will be taught basic principles of hydraulics and pneumatics and their application to fluid power drive systems. Knowledge will be imparted on types of hydraulic and pneumatic drives available for use in various applications and their selection procedures. Students will be able to simulate the working of simple hydraulic and pneumatic systems for better understanding of various components of fluid power systems.

2. Course Size and Credits:

Number of credits	04
Total hours of class room interaction during the semester	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Mechanical Engineering
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

2. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No.	Intended Learning Outcome
1	Explain the principles and components of fluid power systems
2	Describe the working of fluid power systems
3	Select cylinders, actuators and control valves for given application
4	Develop hydraulic or pneumatic systems with circuit diagrams
5	Design and analyze hydraulic/pneumatic circuit for a given application

2. Course Contents

Course Content
Fluid Power: Review of fundamental properties of fluids; fundamental laws and equations of fluid mechanics applicable to pneumatic and oil hydraulic systems; History, applications, advantages and limitations of fluid power systems; General components of a basic fluid power systems
Energy and Power in Hydraulic Systems: Pascal's law and its applications; Conservation of energy, Continuity equation, Bernoulli's equation, Torricelli's equation, Siphon effect, Hydraulic power, Hydraulic circuit analysis
Hydraulic pumps in Fluid Power: Pump classification, pumping theory, pressure regulation, Pump performance and its ratings; Pump noise; pump selection
Hydraulic Actuators: Hydraulic cylinders, operating features and types; cylinder mountings and cushioning in hydraulic cylinders; Gear, vane and piston motors; hydraulic motor theoretical torque, power, flow rate and its performance characteristics
Control Valves: Non return valves, flow control valves, direction control valves, proportional valves
Pneumatic System: Review of properties of air, perfect gas laws; types of compressors and its specifications in pneumatics; working of pneumatic system; comparison of hydraulic and pneumatic system; different types of actuators and control valves used in pneumatic system
Hydraulic and Pneumatic Circuits: Circuit symbols, simple hydraulic and pneumatic circuits to accomplish push-pull, fail-safe, quick-return mechanisms
Design and analysis of simple hydraulic and pneumatic circuits for better understanding of relationships and interactions of various fluid power system components

3. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		03
1. Demonstration using Videos	03	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		10
1. Solving Numerical Problems	10	
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		02
1. Case Study Presentation	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

4. Method of Assessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification

Reassessment

5. Course assessment will be followed as per section 23 “Assessment and Grading” of program specification

6. Achieving Learning Outcomes

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	Class room lectures, Assignments
2.	Understanding	Class room lectures, Assignments, Laboratory
3.	Critical Skills	Class room lectures, Assignments
4.	Analytical Skills	Class room lectures, Assignments
5.	Problem Solving Skills	Class room lectures, Assignments
6.	Practical Skills	Laboratory, Assignment
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, examination
14.	Personal Management	Course work
15.	Leadership Skills	--

III. Course Resources

p. Essential Reading

4. Class notes
5. Anthony Esposito, 2000, Fluid Power with Applications, Pearson Education
6. Andrew Par, 2005, Hydraulics and Pneumatics, Jaico Publishing House

q. Recommended Reading

6. Ilango Sivaraman, Introduction to Hydraulics and Pneumatics, PHI, 3rd Edition
7. James L. Johnson, Introduction to Fluid Power, Delmar - A Thomson learning Inc.
8. G. E. Totten, 1999, Handbook of Hydraulic Fluid Technology, CRC Press

r. Magazines and Journals

5. International Journal of Fluid Power
6. International Journal of Fluid Power System
7. Hydraulics and Pneumatics Magazine
8. Drives and controls by Bosch Rexroth

s. Websites

3. www.hydraulicspneumatics.com
4. www.hpmag.co.uk
5. www.nptel.ac.in
6. www.coursera.org

t. Other Electronic Resources

3. Electronic resources on the course area are available on RUAS library
4. EBook on Hydraulics and Pneumatics by Elsevier

IV. Course Organization

Course Code	MEE313A	
Course Title	Fluid Power Systems	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	080-49065555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	July 2023	
Next Course Specifications Review Date	July 2027	

Course Specifications: Operations Research

Course Title	Operations Research
Course Code	MEE314A
Department	Mechanical Engineering
Faculty	Engineering and Technology

I. Course Summary

1. Aim and Summary

The course aims to provide knowledge of optimal design and operation of man - machine systems usually requiring the allocations of scarce resources. Different approaches in balancing conflicting objectives, in the light of alternative courses of actions, will be taught. The students will be introduced to constructing mathematical, economic or statistical models of the problem and analyse the relationships among different variables associated with the problem to determine consequences of decision alternatives. In addition, students will be trained to suggest suitable measures to evaluate the merit of decision alternatives.

2. Course Size and Credits:

Number of credits	04
Total hours of class room interaction during the semester	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Mechanical and Manufacturing Engineering
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

1. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No.	Intended Learning Outcome
1	Describe different problem solving methods for optimal utilization of resources
2	Formulate appropriate mathematical models in order to obtain the optimal solution and analyze their sensitivity
3	Solve numerical problems for obtaining optimal solution by considering the objectives and constraints of a system and draw conclusions
4	Compute normal and standard time of an activity and estimated times for completion of a project
5	Optimize a given system by adhering to the constraints and achieving the desired objectives

2. Course Contents

Course Content
Quantitative Approach to Decision Making: History, Nature and Significance of OR, Features of OR, Models and Modelling in OR, Methods of Solution in OR, OR as a tool for Research Study, Applications of OR and basic OR Models
Linear Programming: LP and allocation of resources, LP definition, Linearity requirement Maximization, Minimization problems, Graphical LP Minimization solution, Simplex method definition, formulating the Simplex model, Simplex Method for similar and mixed limitations, Example containing mixed constraints, Minimization example for similar limitations, Revised Simplex Method and Dual Simplex Method Sensitivity Analysis: Changes in Objective Function, Changes in RHS, Big M Method
Game Theory: Fundamentals, Two-Person Zero-Sum Games, The Maximin-Minimax Principle, Games without saddle points Mixed Strategies, Dominance Property, Algebraic method of solving rectangular games, Minimax and Saddle point theorems
Sequencing Problems: Problems with 'n' jobs and two machines, Problems with 'n' jobs and three machines, Problems with 'n' jobs and 'm' machines, Graphical solutions

Transportation Model: Basic Assumptions Solution Methods: Feasible Solution: The Northwest Method, The Lowest Cost Method; Optimal Solution: The Stepping Stone Method, Modified Distribution (MODI) Method, Degeneracy in Transportation Problems, Assignment Problem, Travelling Salesman Problem
PERT / CPM: Project management, network modeling-probabilistic model, various types of activity times estimation- programme evaluation review techniques- Critical Path-probability of completing the project, deterministic model, critical path method (CPM)-critical path calculation
Queueing Theory: Queuing Theory Essential Features of a Queuing System; Performance Measures of a Queuing System; Probability Distributions in Queuing Systems; Queuing Models and their Solutions: Single Server Queuing Model, Multi Server Queuing Model; Application to Engineering and Business Problems
Simulation: Elements of a simulation model, Event-type simulation, Generation of random phenomena, Steps in simulation, Simulation technique applied to inventory problems and queueing problems

3. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		23
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		35
1. Solving Numerical Problems	35	
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		
1. Case Study Presentation	02	
2. Guest Lecture	00	

3. Industry / Field Visit	00	02
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

4. Method of Assessment

5. Reassessment

6. Achieving Learning Outcomes

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	Classroom lectures, Assignments
4.	Analytical Skills	Classroom lectures, Assignments
5.	Problem Solving Skills	Classroom lectures, Assignments
6.	Practical Skills	Assignments
7.	Group Work	Assignments
8.	Self-Learning	Assignments
9.	Written Communication Skills	Assignments, Written examinations
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work

13.	Information Management	Assignments, Written examinations
14.	Personal Management	Course work
15.	Leadership Skills	--

III. Course Resources

a. Essential Reading

1. Class Notes
2. J. K. Sharma, 2004, Operations Research: Theory and Applications, 5th Edition, Macmillan Publishers
3. Frederick S. Hillier, Gerald J. Lieberman, Bodhibrata Nag and Preetam Basu, 2017, Introduction to Operations Research, 10th Edition , McGraw-Hill Publications

b. Recommended Reading

1. A. Ravindran, Don .T Philips, James J. Solberg, 1987, Operations Research: Principles and Practice, 2nd Edition, Wiley & Sons
2. Harvir Singh Kasana and Krishna Dev Kumar, 2010, Introductory Operations Research: Theory and Applications, Springer
3. Hamdy A. Taha, 2010, Operations Research: An Introduction, Pearson
4. Wayne L. Winston, 2004, Operations Research: Applications and Algorithms, 4th Edition, Indian University

c. Magazines and Journals

1. Journal of Operations Research Society, The OR Society Publications
2. Interfaces: An International Journal of the Institute of Operations Research and Management Sciences (INFORMS) Publications
3. International Journal of Operations and Production Management, Emerald Group Publications

d. Websites

1. www.theorsociety.com
2. www.phpsimplex.com
3. www.orsi.in

e. Other Electronic Resources

1. Electronic resources on the subject area are available in RUAS library

IV. Course Organization

Course Code	MEE314A	
Course Title	Operations Research	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	080-49065555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	July 2023	
Next Course Specifications Review Date	July 2027	

Course Specifications: Mechatronics and Automation

Course Title	Mechatronics and Automation
Course Code	MEE315A
Department	Mechanical Engineering
Faculty	Engineering and Technology

I. Course Summary

1. Aim and Summary

The course deals with evolution of robot and its application in varied fields. Anatomy of robots will be taught along with applications and limitations of using robotic solutions. Different types of end effectors and their design considerations will be taught. Concepts of automation and significance of automation in manufacturing will be discussed. The students are taught the principles of automation systems, automation system components and usefulness of robots in manufacturing automation.

2. Course Size and Credits:

Number of credits	04
Total hours of class room interaction during the semester	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Mechanical and Manufacturing Engineering
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

3. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No.	Intended Learning Outcome
1	Explain the evolution and future of robotic systems and applications
2	Describe the anatomy of given robotic system
3	Discuss the need, significance and types of automation in manufacturing
4	Select appropriate end effector for the robotic application
5	Determine various robot configurations and robot cell features in automation

2. Course Contents

Course Content
Overview of Robotic Systems: Definition of robotic systems, Evolution of robotic systems and future of robotic systems; Global robotic industry; Robot applications in manufacturing sectors, health care, defence, agriculture, production, waste management, hazardous environments, domestic applications, etc.; Relevance of robotic systems and solutions for current and future social needs; socioeconomic impact; Biologically inspired robots
Anatomy of Robotic Systems: Robot physical configurations; Basic robot motions; Different parts and functions in a robotic systems, sensors, manipulator, actuators, power sources, terminologies in robotics
End-Effectors: Types of end effectors, grippers, applications; drives and actuator system for end effectors and grippers; design considerations and guidelines for end effectors
Automation in Manufacturing: Overview, Principles of automation, need for automation, historical overview of automation, overview of control and automation system components, system specification and cost benefit analysis for making decisions, methods for justification of automation systems in terms of cost, performance and general parameters
Automation Technology and Sub-Systems: Sensors generic and sensors for motion control (force, torque, ac celeration, encoders), Actuators, PLC's, CNC, Motors, Drives, Motion controllers, Vision systems and inspection, PC-based control technology, Flexible Manufacturing Systems
Automation of Manufacturing Process using Robots: Robot technology for Manufacturing, Control systems, Accuracy and repeatability, end effectors, Sensors and actuators in robots, Robotic cell and work cell design
Industry 4.0: Introduction to concepts and framework of Industry 4.0 and its developments

3. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		05
1. Demonstration using Videos	05	
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		15
1. Case Study Presentation	05	
2. Guest Lecture	03	
3. Industry / Field Visit	05	
4. Brain Storming Sessions	00	
5. Group Discussions	02	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination / Written Examination, Presentations		10
Total Duration in Hours		70

4. Achieving Learning Outcomes

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	Classroom Lectures, Assignments
4.	Analytical Skills	Classroom Lectures, Assignments
5.	Problem Solving Skills	Classroom Lectures, Assignments
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Coursework
15.	Leadership Skills	--

III. Course Resources

u. Essential Reading

7. Class Notes
8. Harry H. Poole, 1989, Fundamentals of Robotics Engineering, 1st Edition, New York, Van Nostrand Reinhold
9. Mikell P. Groover, 2008, Automation, Production Systems and Computer-Integrated Manufacturing, PHI Learning Private Ltd.

v. Recommended Reading

9. Mikell P. Groover, 2012, Specifications of Industrial Robotics: Technology, Programming, and Applications, 2nd Edition, Mcgraw Hill Education
10. Siciliano Bruno and Oussama Khatib, 2008, Handbook of Robotics, Springer
11. Asai K. and Takshima S., 1994, Manufacturing Automation Systems and Computer Integrated Manufacturing Factories, Chapman

w. Magazines and Journals

9. Journal of Robotics
10. Journal of Robotics and Autonomous Systems
11. Journal of Robotics and Computer-Integrated Manufacturing
12. http://www.botmag.com
13. http://www.roboticmagazine.com

x. Websites

7. http://www.robotics.org
8. http://www.ieee-ras.org/agricultural-robotics
9. http://robohub.org
10. http://spectrum.ieee.org/robotics/medical-robots

y. Other Electronic Resources

i. Electronic resources on the course area are available at RUAS library

IV. Course Organization

Course Code	MEE315A	
Course Title	Mechatronics and Automation	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	080-49065555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	June 2023	
Next Course Specifications Review Date	July 2027	

Course Specifications: Probability and Statistics

Course Title	Probability and Statistics
Course Code	MTE301A
Department	Mathematics and Statistics
Faculty	Mechanical Engineering

I. Course Summary

1. Aim and Summary

The aim of the course is to provide an understanding of probability and statistics.

Students are taught the concepts of mean, median and standard deviation in discrete and continuous probability distribution. The course introduces students to the basic definitions and concepts of inferential statistics. Students are taught the concepts of confidence intervals for mean, variance and standard deviation. This course discusses the hypothesis testing for mean, variance and standard deviation

2. Course Size and Credits:

Number of credits	4
Total hours of class room interaction during the semester	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Mathematics
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

1. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No.	Intended Learning Outcome

1	Explain the concepts of random variables, probability distribution, joint probability distribution and sampling distribution
2	Explain the principles of convex optimization, regression, confidence interval and hypothesis testing
3	Solve simple problems associated with probability distribution, regression, confidence interval and hypothesis testing
4	Model real word problems by using probability distribution and regression
5	Solve complex problems associated with probability distribution, regression, confidence interval and hypothesis testing

2. Course Contents

Course Content
Random variables: Discrete and continuous. Definitions, illustrations and properties of random variables, univariate transformations with illustrations. Probability density function, cumulative distribution function, expected values, variance and their properties. Discrete Probability Distributions: Mean, variance, standard deviation of Binomial, Poisson, Uniform and Negative Binomial along with their characteristic properties and limiting/approximation cases. Continuous probability distributions: Probability density function, cumulative distribution function, mean, Variance, Standard Deviation of Uniform, Normal and Exponential distributions. The Normal Approximation to Binomial Distribution. Limiting/approximation cases. Joint probability distribution: Introduction, Joint Probability density function, marginal probability density function, independent random variables, mathematical expectation Sampling distribution: The sampling distribution of sample mean, sample proportions and sample variance. Central limit theorem.
Convex Optimization Algorithms: Steepest descent and conjugate gradient. Regression: Multivariate linear and non-linear regression. Correlation and covariance.
Estimation: Point estimation and interval estimation. Point Estimation: Unbiased estimation, consistent estimators and simple problems. Method of moments and maximum likelihood estimation. Confidence intervals for the mean for small and large samples. Confidence intervals for population proportions.
Hypothesis Testing: Tests concerning means: Single population, two population and bivariate population. Tests concerning proportion: Single population, two population. Tests concerning variance: Single population, two population.

χ^2 -test for goodness of fit and test for independence of attributes.

3. 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		30
1. Solving Numerical Problems	30	
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

4. Method of Assessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification.

5. Reassessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification

6. Achieving Learning Outcomes

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	Class room lectures, tutor i al s , Assignments
2.	Understanding	Class room lectures, tutor i al s Assignments
3.	Critical Skills	Class room lectures, Assignments
4.	Analytical Skills	Class room lectures, tutor i al s , Assignments
5.	Problem Solving Skills	Class room lectures, tutor i al s , Assignments
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, examination
14.	Personal Management	Course work
15.	Leadership Skills	--

III. Course Resources

a. Essential Reading

1. Class Notes
2. R Johnson, 2010, Miller and Fruend's Probability and Statics for Engineers, 8th edition, Pearson
3. Sheldon Ross, 2010, A First Course in Probability, 8th edition, Pearson
4. Jack Carl Kiefer, 2018, Introduction to Statistical Inference. Springer International Publishing A .G
5. C. Radhakrishna Rao, 1965, Linear Statistical Inference and Its Applications, John Wiley and Sons, INC.

b. Recommended Reading

1. Vijay K. Rohatgi, A. K. Md. Ehsanes Saleh, An Introduction to Probability and Statistics, Wiley
2. Harold J. Larson, Introduction to Probability Theory and Statistical Inference, John Wiley & Sons
3. Hogg, Tannis,Rao,1997,Probability and Statistical Inference, 7h Edition Pearson Publication
4. Pradeep Kumar Sahu. Santi Ranjan Pal, Ajit Kumar Das, 2015, Estimation and inferential Statistics, Springer International Publishing A.G.
5. A. Agresti and C. Franklin, 2012, Statistics: The Art and Science of Learning from Data, 3rd edition, Prentice Hall

c. Magazines and Journals

d. Websites

e. Other Electronic Resources

IV. Course Organization

Course Code	MTE301A	
Course Title	Probability and Statistics	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	49065555
	E-mail:	hod.ph.et@msruas.ac.in
Course Specifications Approval Date	July 2023	
Next Course Specifications Review Date	July 2027	

Course Specifications: Aptitude & Analytical Reasoning

Course Title	Aptitude & Analytical Reasoning-1
Course Code	PTF302A
Course Type	Skill Enhancement Course (SEC)
Department	All Departments
Faculty	Engineering and Technology

1. Course Summary

This course is designed to enhance the employability of students by learning critical thinking problem-solving skills, logical thinking, and quantitative abilities. It covers key concepts in numerical aptitude, logical reasoning, and data interpretation, which are essential for competitive exams, job assessments, and decision-making in professional settings.

2. Course Size and Credits:

Number of Credits	01
Credit Structure (Lecture: Tutorial: Practical)	0:0:2
Total Hours of Interaction	36
Number of Weeks in a Semester	15
Department Responsible	Directorate of Placements, Training & Career Services
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

- **CO1** **Recall** fundamental concepts of logical reasoning, data interpretation & quantitative aptitude
- **CO2** **Summarize** problem solving approaches in verbal, logical and quantitative reasoning
- **CO3** A**pply** logical and analytical reasoning techniques to solve real world computational problems.
- **CO4** **Differentiate** between various problem-solving strategies and select the best approach for numerical and logical problems
- **CO5** **Assess** different problem-solving approaches and optimize the solutions

4. Course Contents

Unit 1
Quantitative Aptitude

Number Systems
Concept explanation of Classification of Numbers, Divisibility Tests, Power Cycles & reminders, factors and multiples – Multiples, Highest Common factor (HCF), Least common multiple (LCM), Applications of HCF & LCM. Solving problems related to the topics.

Ratio, Proportion, Variation, Linear Equations and Problems on Ages
Introduction to ratio & proportions, formulas on ratios and proportions. Explanation of variation &

linear equations. Solving problems using these concepts.

Simple interest and Compound interest `
Simple Interest, Compound Interest, basic formulas, Difference between simple interest & interest, Successive percentages in SI & CI. Relation Between Simple and Compound Interests Shortcut methods and Solving problems on these concepts

Profit & Loss, Partnerships, Mixtures and Allegations
Basic terminology in Profit and loss, Concept Explanation - Profit, Loss, Cost Price, Selling Price, & Marked Price. Solving problems to review the concepts. Mixtures and alligation & Rule of alligation. Alligation cross, Alligation line, Successive replacement, practicing problems to review the concepts.

Unit 2

Time Speed and Distance
Basic formulas and concept review on Time, Speed & Distance.
Application of relative speed in train problems, boats & streams problems, Solving problems on these concepts.

Time and Work
Concept explanation of Working with Different Efficiencies, Pipes and Cisterns, work equivalence (man days) & Division of Wages. Solving problems related to these concepts.

Set theory and functions
Concept of Set Formulas, Power Set, Subset, Domain & Range. Solving problems related to these topics.

Permutation, Combination and Probability
Fundamental Counting Principle, Permutation and Combination, Computation of Permutation, & basic concept of Probability. Solving problems to review the concepts.

Logarithms, Progressions, Geometry and Quadratic equations
Concept explanation of Logarithms, Arithmetic Progression (A.P), Geometric Progression (G.P), Geometry, Mensuration & Quadratic Equations. Solving problems relevant to these topics.

Unit 3
Logical Reasoning

Logical connectives, Syllogisms and Venn diagram
Concept explanation of Logical connectives, Syllogisms, Venn diagrams – Interpretation & Venn diagrams. Solving problems to review the concept.

Number Series
Explanation of patterns of number series –Explanation on Alphanumeric series & solving problems

Analogies in Reasoning & Judgement Reasoning
Explanation of Numerical analogy, Letter/Word analogy & Image based analogy. Solving questions on these concepts.

Attention to details

Concept explanation of String Matching, Text and Image- based Questions. Practice of problems related to the topic

Data Arrangements and Blood Relations
Concept explanation of data arrangements - Linear Arrangement, Circular Arrangement, distribution and blood relations. Solving problems related to these topics.

Coding and decoding, series, analogy, odd man out and visual reasoning
Concept explanation of Coding and Decoding, Number and Alphabet Series, Analogy, Odd Man Out and visual reasoning. Practicing problems to familiarize the concepts.

Unit 4

Critical Reasoning
Concept explanation of Arguments, Explaining Statements & Course of actions, Statement & Conclusion concepts, solving problems related to these concepts.

Image Interpretation
Concept explanation of Rebus Puzzles & Forming Words Based on Images. Practice exercise to familiarize the concepts.

Data Interpretation and Data Sufficiency
Concept of Data Interpretation – Tables, pie charts, Bar graphs & Data sufficiency.

Clocks, Calendars & Direction Sense
Conceptual review of Clocks, Calendars, Direction Sense and Cubes & practicing related problems**.**

Unit 5
Verbal Ability
Reading Comprehension
Speed Reading Strategies, reading comprehension types and tackling Solving problems related to these concepts.

Sentence correction
Review of basics on Subject – Verb agreement, Modifiers, Parallelism, Pronoun – Antecedent Agreement, Verb-Time Sequence, Comparisons, Prepositions & Determiners. Practicing problems to familiarize the concepts.

Vocabulary
Vocabulary Demystified, Synonyms and Antonyms, Word Analogy, Patterns of questions on word analogy, Idioms, Phrasal Verbs & commonly confused words.

Sentence completion and Para- jumbles
Strategies to solve sentence completion problems and practicing the sentence completion problems. Para Jumbles – Types of paragraph structure – strategies for solving jumbled paragraphs

Voices & Speech
Review of basics on Active vs Passive Voice, Direct vs Indirect Speech. Practice problems related to the topics for familiarizing the concept.

Articles, Prepositions and Interrogatives
Definite and Indefinite Articles, Omission of Articles, Prepositions, Prepositions of Place, Time, & direction. Compound Prepositions and Prepositional Phrases, Interrogatives. Practicing problems to review the concepts.

5. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		10
Demonstrations		0
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		26
1. Problem solving – Concept application	00	
Practical Work		
1. Course Laboratory	00	
2. Computer Laboratory		
3. Engineering Workshop / Course/Workshop / Kitchen	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brainstorming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Quizzes, Self-Practice		4
Total Duration in Hours		**40**

6. Course Assessment and Reassessment

The components and subcomponents of course assessment is presented in the Academic Regulations document pertaining to the B. Tech. (Mechanical Engineering) Programme. The procedure to determine the final course marks is also presented in the Academic Regulations document as well.

The assessment questions are set to test the course learning outcomes. In each component or subcomponent, certain Course Outcomes are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type	Terms Tests	Quizzes	
CO-1	x	X	X
CO-2	x	X	X
CO-3	X	X	X

CO-4	**X**	**X**	**X**
CO-5		**X**	**X**
The details of the number of tests and Quizzes to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

Mode of Evaluation

- One Term test (40%)
- One Quiz (20%)
- Semester End Exam (SEE) – 40%

Evaluation & Assessment Breakdown

To ensure structured learning and measurable progress, the evaluation will consist of Continuous Assessment Tests (Term Test), Quiz, and Semester End Exam.

Continuous Assessment Test – Term Test – 40%

Objective: To evaluate **ongoing progress** and ensure that students retain key concepts.

Frequency: One Term Test will be conducted during the course

Format:

- **Multiple-Choice Questions (MCQs) – 40 marks**

Quizzes – 20%

Objective: Reinforce **problem-solving skills** through **practice-based learning**.

Frequency: One quiz will be given during the course

Format:

- **MCQs on the topics covered**

Semester End Examination (SEE) – 40%

Objective: To ensure students gain the necessary knowledge, skills, and competencies that are needed to perform well in their professional career.

Format:

MCQs covering the entire course curriculum – 50 marks (50 MCQs) normalized to 40 for final computation with a weightage of following topics

- **Section 1 – Quantitative Aptitude (QA) – 20 Marks**
  - **20 MCS**
- **Section 2 – Logical Reasoning (LR) – 20 Marks**
  - **20 MCQs**
- **Section 3 – Verbal Ability (VA) – 10 Marks**
  - **10 MCQs**

Final Evaluation of the course				
	Term Test 1	**Quiz 1**	**SEE**	**Final Marks**
Maximum marks	40	20	50	
Test format	MCQs	MCQs	MCQs	
No of MCQs	40	20	50	
Weightage	40%	20%	80%	
Marks assigned for each component	**40**	**20**	**40**	**100**

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.
Course reassessment policies are also presented in the Academic Regulations document.

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	Classroom lectures, Quiz
2.	Understanding	Classroom lectures cum practice sessions, Quiz, Self-study
3.	Critical thinking Skills	Classroom lectures cum practice sessions, Quiz, self-study, examination
4.	Analytical Skills	Classroom lectures cum practice sessions, Quiz, Examination
5.	Problem Solving Skills	Practice in the computer lab, Quiz, Examination
6.	Logical thinking skills	Classroom lectures, Quiz, Examination
7.	Group Work	--
8.	Self-Learning	Quiz, Self-study
9.	Written Communication Skills	Classroom lectures, practice sessions, Quiz, Examination
10.	Verbal Communication Skills	Quiz, Self-study
11.	Presentation Skills	--
12.	Behavioral Skills	
13.	Information Management	Quiz, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

8. Course Resources

Books for Quantitative Aptitude & Logical Reasoning

1. Quantitative Aptitude

"Quantitative Aptitude for Competitive Examinations" – *R.S. Aggarwal*

"Fast Track Objective Arithmetic" – *Rajesh Verma*

"Quantitative Aptitude Quantum CAT" – *Sarvesh Kumar Verma (for advanced problem-*

solving techniques)

2. **Logical & Analytical Reasoning**

   "A Modern Approach to Logical Reasoning" – *R.S. Aggarwal*

   "Logical Reasoning and Data Interpretation for CAT" – *Nishit K. Sinha*

   "How to Prepare for Logical Reasoning for CAT" – *Arun Sharma*

3. **Data Interpretation & Data Sufficiency**

   "How to Prepare for Data Interpretation" – *Arun Sharma*

   "Data Interpretation & Data Sufficiency" – *RS Aggarwal*

📖 **Books for Verbal Ability & Communication Skills**

1. **Verbal Ability & Reading Comprehension**

   "Objective General English" – *SP Bakshi (Arihant Publications)*

   "Word Power Made Easy" – *Norman Lewis (For vocabulary enhancement)*

   "High School English Grammar & Composition" – *Wren & Martin (For strong grammar foundation)*

   "How to Prepare for Verbal Ability and Reading Comprehension" – *Arun Sharma & Meenakshi Upadhyay*

Online Platforms for Placement Preparation

1. **Aptitude Practice & Mock Tests**

   IndiaBix – Free questions for **Quant, LR, DI, Verbal, and Puzzles**.

   PrepInsta – Placement papers & company-specific mock tests.

2. **Coding & Logical Thinking *(For Logical Puzzles & Advanced Aptitude Challenges)***

   HackerRank – Logical reasoning & puzzles.

   GeeksforGeeks – IT recruitment test preparation (Logical & Verbal).

   LeetCode – IT aptitude & coding practice.

3. **Vocabulary & Grammar Practice**

   Merriam-Webster Vocabulary Quizzes – Word games to improve vocabulary.

   Grammarly Blog – Grammar & sentence structure lessons.

9. Course Organization

Course Code	PTF302A	
Course Title	Aptitude & Analytical Reasoning Training	
Course Leader Name	As per Timetable	
Course Leader Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May 2027	

Course Title	Internship 2
Course Code	MEI301A
Department	Mechanical Engineering
Faculty	Engineering and Technology

Course Summary

Student shall undergo internship in an industry, business organization, research organization or any other university on a topic of relevance during vacation of 1st and 2nd semesters for a duration of 2 weeks. It can be Intra Institutional activity. Lateral entry students can with complete Internship 1 during 2nd year with the prior approval from the department head and faculty dean.

Course Size and Credits:

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	0:0:4
Total Hours of Interaction	90
Number of Weeks in a Semester	15
Department Responsible	Mechanical Engineering
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

Course Outcomes

After undergoing this course students will be able to:

CO 1. Write a report on experiences during internship
CO 2. Make a presentation to a panel of examiners

Course Contents

- Inter/ Intra Institutional Activities (As per AICTE guidelines)
- Training with higher Institutions; Soft skill training organized by Training and Placement Cell of the respective institutions; contribution at incubation/ innovation /entrepreneurship cell of the institute;
- Participation in conferences/ workshops/ competitions etc.;
- Learning at Departmental Lab/ Tinkering
- Laboratory/ Institutional workshop; Working for consultancy/ research project within the institutes and
- Participation in all the activities of Institute's Innovation Council for eg: IPR Workshop/Leadership Talks/ Idea/
- Design/ Innovation/ Business Completion/ Technical Expos etc.

	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											3		3		3
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.															

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. Other Electronic Resources

1. https://nptel.ac.in

Course Code	MEI301A		
Course Title	Internship 2		
Course Leader/s Name		As per Time - table	
Course Leader Contact Details		**Pho**	+91-804-906-5555
		E-	hod.me.et@msruas.ac.in
Course Specifications Approval Date		May 2023	
Next Course Specifications Review Date		May 2027	

Course Specifications: Noise Vibration and Harshness

Course Title	Noise Vibration and Harshness
Course Code	MEE411A
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

I. Course Summary

1. Aim and Summary

The aim of this course is to prepare the students to model dynamic mechanical systems and analyse noise and vibration. Students are taught modeling of mechanical systems, and solutions of governing equations for analysis of vibrations. They are also taught various techniques of measurement and control of noise and vibrations in mechanical systems. Students are exposed to MATLAB and SIMULINK software for vibration analysis.

2. Course Size and Credits:

Number of credits	04
Total hours of class room interaction during the semester	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Mechanical and Manufacturing Engineering
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

1. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No.	Intended Learning Outcome

1	Explain the phenomena of noise, vibration, harshness and their sources in machines.
2	Determine vibration parameters of multi degree freedom of system and interpret results.
3	Discuss models of sound waves, sound sources and solid structure interaction with sound waves.
4	Outline techniques of measurement and control of noise and vibration.
5	Identify and analyse sources of noise in mechanical machinery.
6	Solve noise and vibration problems in mechanical components like gears, rotors and shaft, bearing, fans, etc.

2. Course Contents

Course Content

Introduction to Noise, Vibration and Harshness: NVH and need for NVH considerations in design, Terminology used in NVH domain, Need for study of vibration/noise.

Fundamental of Mechanical vibrations: Key elements of vibratory system; free vibration of undamped and damped SDOF; forced vibratory system-forced vibration with periodic, transient and random excitation; vibration analysis of two degree freedom system; vibration analysis of multi degree freedom system.

Fundamentals of sound waves: Introduction to sound waves; conservation of mass and momentum; acoustic wave equation; acoustic velocity potential; sound wave propagation; acoustic parameters and its definition; fundamental acoustic source models.

Sound waves and solid structure interaction: Introduction; fundamentals of fluid structure interaction; sound radiation from infinite plate; sound transmission through panels and partitions; sound transmission through single panels and double leaf panel; effect of fluid loading on vibrating structures.

Noise and vibration measurement and control techniques: Introduction to measurement and control techniques of noise and vibration; noise and vibration measurement instrumentation; sound power measurement- free field technique, reverberant technique, semi-reverberant technique and sound intensity technique; acoustic enclosures and barriers; sound absorbing materials; vibration control techniques; analysis of noise and vibration signals.

NVH in machinery: Introduction; noise and vibration as a diagnostic tool; sources and fault detection of noise and vibration in gears, rotors and shaft, bearing, fans and blowers furnace, burners, punch press and pumps; case studies on noise and vibration in machineries.

3. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		
1. Demonstration using Videos	02	

2. Demonstration using Physical Models / Systems	00	03
3. Demonstration on a Computer	01	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop / Course Workshop / Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		02
1. Case Study Presentation	02	
2. Guest Lecture		
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions		
6. Discussing Possible Innovations		
Term Tests, Laboratory Examination / Written Examination, Presentations		10
Total Duration in Hours		70

4. Method of Assessment

Course assessment will be followed as per Section 23 “Assessment and Grading” of programme specification

5. Reassessment

Course assessment will be followed as per Section 23 “Assessment and Grading” of programme specification

6. Achieving Learning Outcomes

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	Class room lectures, Assignments
2.	Understanding	Class room lectures, Assignments
3.	Critical Skills	Class room lectures, Assignments

4.	Analytical Skills	Class room lectures, Assignments
5.	Problem Solving Skills	Class room lectures, Assignments
6.	Practical Skills	
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	
11.	Presentation Skills	
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, examination
14.	Personal Management	Course work
15.	Leadership Skills	

III. Course Resources

a. Essential Reading

1. Class Notes
2. S.S. Rao, (1995), Mechanical Vibrations, 3rd edition, Addison Wesley
3. M.P. Norton , (1994) , Fundamentals of Noise and Vibrations Analysis for Engineers, Cambridge University Press

b. Recommended Reading

1. W.T. Thomson, (1997) , Mechanical Vibration, 5th edition, Prentice- Hall
2. S.P. Parker , (1987) , Acoustics Source Book,McGraw-H
3. Clarence W. de Silva , (2007), Vibration Monitoring, Testing, and Instrumentation, CRC Press
4. S. Graham Kelly, (2000), Fundamentals of Mechanical Vibrations, McGraw Hills

c. Magazines and Journals

1. The Journal of Sound and Vibration, Elsevier
2. International Journal of Vehicle Noise and Vibration, Inderscience Publishers

d. Websites

1. http://admin.audionlinetraining.com/Upload/SSP/448_SSP_Audi_Noise_Vibration_ Hars
2. http://vw.nate-online.com/techdocs/Noise,%20Vibration,%20and%20Harshness.pdf e. Other Electronic Resources

1. Rice Resonance, http://www.youtube.com/watch?v=Zkox6niJ1Wc
2. Wheel Hop, http://www.youtube.com/watch?v=DOVtnAZYBgM
3. Electronic resources on the course area are available on MSRUAS library

IV. Course Organization

Course Code	MEE411A	
Course Title	Noise Vibration and Harshness	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	080 4906 5555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May 2027	

Course Specifications: Advanced Materials and Processes

Course Title	Advanced Materials and Processes
Course Code	MEE412A
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

I. Course Summary

1. Aim and Summary

This course deals with advanced materials and their processes for potential applications in various industrial sectors. Students will gain knowledge on concepts, properties, selection and fabrication of advanced materials in energy, communications, biological, transport and other industrial sectors. Students will get an exposure to smart materials, nano materials, biomaterials and energy storage materials. Students will be exposed to surface engineering processes for modifying the surface of a material/component for required application. Students will be able to select suitable materials for the given functional requirement. Fabrication and testing of advanced materials will be demonstrated.

2. Course Size and Credits:

Number of credits	04
Total hours of class room interaction during the semester	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Mechanical and Manufacturing Engineering
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

4. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No.	Intended Learning Outcome
1	Explain the importance, properties and applications of advanced materials and surface engineering processes
2	Describe the principles, properties and usage of advanced alloys, polymers and ceramics for different applications
3	Discuss the various advanced materials and surface engineering techniques used in various applications
4	Identify an appropriate advanced materials and surface modification technique for applications based on sustainable technology
5	Select an appropriate processing methods for ceramics, polymers and composites to achieve required functionality

2. Course Contents

Course Content

Need for advanced materials, Classification of advanced materials

Alloys:
Properties, processing and applications of Advanced High Strength Steels, TRIP steels, Maraging steel, Aluminium alloys, Magnesium alloys, Titanium alloys and Super alloys

Ceramics:
Properties and applications of Ceramics Glass, Refractories, Abrasives, Advanced Ceramics, Processing of ceramics Powder Metallurgy

Polymers and Elastomers:
Properties, classification and applications of polymers and elastomers; Processing of Polymers and elastomers - Injection moulding process, Extrusion process, Blow moulding process, Compression moulding process, Foam moulding, Calendaring and Thermoforming process

Composites:
Properties, classification and applications of Metal Matrix composites (MMCs), Ceramic Matrix Composites (CMCs) and Polymer Matrix Composites (PMCs); Processing of PMCs Hand layup, Vacuum bagging, Autoclave moulding process and Resin infusion process

Surface Engineering:
Importance, Benefits, Surface cleaning processes, Coating and Deposition: Plating, Conversion coating,
Physical Vapour Deposition, Chemical Vapour Deposition, Ceramic coatings, Thermal coating

Nanomaterials:
Introduction, importance and classification of carbon based nanomaterials; Synthesis of fullerene, carbon nanotubes and graphene

Advances in Materials:
Overview on Functional Materials like piezoelectric materials, dielectric materials, Shape memory alloys
Overview on Energy Materials like Photovoltaics, Batteries, Fuel Cells, Hydrogen storage technology, Solar Cells and Power technologies

Overview on Bio Materials like Orthopaedic materials, Cadiovascular materials, Dental materials, Tissue engineering

3. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		08
1. Demonstration using Videos	03	
2. Demonstration using Physical Models / Systems	05	
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		02
1. Case Study Presentation	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

4. Method of Assessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification

Reassessment

5. Course assessment will be followed as per section 23 “Assessment and Grading” of program specification

6. Achieving Learning Outcomes

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

III. Course Resources

ee.

Essential Reading

1. Class Notes
2. W. D. Callister, 2005, Materials Science and Engineering an Introduction, John Wiley & Sons
3. Michael F. Ashby, 2011, Materials Selection in Mechanical Design, Processing and Design, Elsevier

ff. Recommended Reading

17. C. Barry Carter and Grant M. Norton, 2013, Ceramic Materials: Science and Engineering, Springer
18. Sanjay Mazumdar, 2001, Composites Manufacturing: Materials, Product, and Process Engineering, CRC Press
19. J. A. Brydson, 1999, Plastic Materials, Butterworth-Heinmann

20. Z. L. Wang and Z. C. Kang, 2012, Functional Materials: Structural Evolution and Structure Analysis, Plenum, New York

21. Bharat Bhushan, 2004, Handbook of Nanotechnology, Springer

22. Peter Martin, 2011, Introduction to Surface Engineering and Functionally Engineered Materials, John Wiley & Sons Publications

23. ASM Handbook, 1994, Volume 5, Surface Engineering, ASM International gg.

Magazines and Journals

14. Advanced Functional Materials, Wiley Publications
15. Functional Materials Letters, World Scientific Publications
16. Advanced Materials, Wiley Publications
17. Materials Today
18. Reinforced Plastics hh. Websites

11. http://www.mrs.org/home/
12. http://www.iom3.org/content/electronics-division
13. http://ceramics.org/ ii. Other Electronic Resources

5.Electronic resources on the subject area are available on RUAS library

IV. Course Organization

Course Code	MEE412A	
Course Title	Advanced Materials and Processes	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	080-49065555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	June 2023	
Next Course Specifications Review Date	July 2027	

Course Specifications: Computational Fluid Dynamics

Course Title	Computational Fluid Dynamics
Course Code	MEE413A
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

I. Course Summary

1. Aim and Summary

This course deals with concepts of fluid mechanics and the use of CFD techniques to solve practical engineering problems. The students are taught the basics of CFD, modeling and analysis of heat and fluid flow systems. Students are also taught to model a flow problem and derive discretised equations. Students will be able to apply CFD techniques to solve practical problems on heat and fluid flow and evaluate the results.

2. Course Size and Credits:

Number of credits	04
Total hours of class room interaction during the semester	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Mechanical and Manufacturing Engineering
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

1. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No. Intended Learning Outcome

1	Explain different models of fluid flow, boundary conditions, discretization schemes, viscous and turbulence models
2	Discuss the importance, applications of CFD and stability of a discretization scheme
3	Formulate fluid flow equations for different models
4	Apply appropriate model and discretization scheme for solution of fluid flow problems
5	Solve fluid flow problems using CFD methods and software

2. Course Contents

Course Content

Overview of Computational Fluid Dynamics:
Need and Importance of CFD in solving fluid flow problems, Applications of CFD, Concept of gradient, divergence and curl

Governing Equations of Fluid Flows:
Different Models of Flow, Substantial Derivative, Derivation of fluid flow equations - continuity, momentum, energy, Types of flows External and internal flows, laminar, turbulent and boundary layer flows

Partial Differential Equations:
Classification of the PDEs, Choice of boundary conditions. Discretisation of PDEs Finite Difference Method, Finite Element Method, Finite Volume Method, Properties of the discretisation schemes, Stability and error analysis

Finite-Difference Methods:
Taylor's Series, Explicit and Implicit Methods, Semi, Crank-Nicholson scheme, ADI scheme

Finite-Volume Methods:
Pure Diffusion, Convection Diffusion, upwind differencing schemes, QUICK scheme, fundamental properties of FVM, solution algorithms

Application of Boundary Conditions for Practical Fluid Flow Problems:
Various boundary and initial conditions for governing equations in practical applications, internal flows, external flows, symmetric and cyclic boundary conditions

Turbulence Modelling:
Turbulent flows, time-averaging, need for turbulence modelling, overview of different turbulence models, selection of appropriate turbulence model for practical fluid flow problems

Demonstration of solution of fluid flow problems using software: Laminar and Turbulent flow over a flat plate, cylinders, fins, airfoils, flow through a pump, laminar and turbulent flow through pipes and heat exchangers
Grid generation, Grid independence studies

3. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		37
Demonstrations		

1. Demonstration using Videos	00	05
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	05	
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		03
1. Case Study Presentation	03	
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

4. Method of Assessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification

5. Reassessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification

6. Achieving Learning Outcomes

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	Class room lectures, Assignments

2.	Understanding	Class room lectures, Assignments
3.	Critical Skills	Class room lectures, Assignments
4.	Analytical Skills	Class room lectures, Assignments
5.	Problem Solving Skills	Class room lectures, Assignments
6.	Practical Skills	Class room lectures, Assignments
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, examination
14.	Personal Management	Course work
15.	Leadership Skills	--

III. Course Resources

a. Essential Reading

1. Class Notes
2. J. D. Anderson, 2012, Computational Fluid Dynamics: The Basics with Applications, McGraw Hill Education
3. H. K. Versteeg and W. Malalasekara, 2008, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, 2nd Edition, Prentice Hall India

b. Recommended Reading

1. S. V. Patankar, 1980, Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing
2. J. C. Tannehill, D. A. Anderson and R. H. Pletcher, 1997, Computational Fluid Mechanics Heat Transfer, Taylor & Francis
3. P. Moin, 2010, Fundamentals of Engineering Numerical Analysis, 2nd Edition, Cambridge University Press
4. G. K. Batchelor, 2000, An Introduction to Fluid Dynamics, Cambridge University Press
5. C. T. Shaw, 1992, Using Computational Fluid Dynamics, Prentice Hall

c. Magazines and Journals

1. Journal of Fluid Mechanics
2. Physics of Fluids
3. ASME Journal of Fluids Engineering
4. AIAA Journal
5. Computers and Fluids
6. Journal of Heat and Fluid Flow

d. Websites

1. www.cfd-online.com
2. www.simscale.com
3. www.learncax.com
4. lorenabarba.com/blog/cfd-python-12-steps-to-navier-stokes

e. Other Electronic Resources

1. ANSYS Workbench
2. Fluent
3. COMSOL
4. Electronic resources on the course area are available on MSRUAS library IV. Course Organization

Course Code	MEE413A	
Course Title	Computational Fluid Dynamics	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	080-49065555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	July 2023	
Next Course Specifications Review Date	July 2027	

Course Specifications: Supply Chain Management

Course Title	Supply Chain Management
Course Code	MEE414A
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

I. Course Summary

1. Aim and Summary

The course is intended to prepare the students to establish supply chain in a business enterprise. The nature, role, contribution and application of supply chain to industry will be discussed. Students will be able to learn the strategic importance of good supply chain design, planning and operation for a firm. Student will be able to develop an understanding about key areas of drivers of supply chain performance, analytical methodologies for supply chain analysis and their interrelationships. The usefulness of the drivers on conceptual and practical levels during supply chain design, planning and operation to improve performance will be taught. Students will also be introduced to the concept of logistics and some of the emerging logistics services like 4PL, 5PL, sustainable supply chains and other newer concepts.

2. Course Size and Credits:

Number of credits	04
Total hours of class room interaction during the semester	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Mechanical and Manufacturing Engineering
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

1. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No.	Intended Learning Outcome
1	Describe the concepts of logistics and supply chain management
2	Explain the role of supply chain drivers in achieving competitive advantage at various decision phases
3	Determine capacity and inventory requirements for optimality and interpret results
4	Select factors to design distribution and supply chain network for achieving feasibility in managing supply and demand
5	Apply principles and concepts of logistics and supply chain in manufacturing and service based organizations for performance improvement

2. Course Contents

Course Content

Fundamentals of Logistics and Supply Chain Management:
History and development of the SCM theme. Evolution from a predominantly manufacturing scenario to one of a value chain from supplier to customer. Objectives and importance of SCM. Process and Push/Pull Views of Supply Chain. Decision phases in Supply Chain Links to strategy and contribution to business performance & Competitive advantage.

Supply Chain Sourcing Decisions:
Types of supply management strategies: Strategic sourcing, Role of sourcing, supplier selection and contracts, scoring and assessment. Vertical integration and Outsourcing: Related issues and impact on supply chain, core competency, Primary Drivers of Make or Buy: Cost, Technology, Obsolescence, Environmental factors, Laws of the land. Short time comfort and long- time benefits. Numerical problems on Make or Buy.

Achieving Supply Chain Strategic Fit, Drivers and Metrics:
Achieving strategic fit and expanding scope of the supply chain, Challenges to achieving and maintaining strategic fit. Drivers of supply chain for competitive performance: Framework, Role, components of decision making and related metrics, Pursuit of responsiveness and efficiency.

Designing the Supply Chain Network:
Distribution Networking Role, Influencing factors, Design options. Supply Chain Network (SCN) Design _ Role, Factors, Framework for Network Design Decisions. Impact of uncertainty on SCN _ overview of discounted cash flow analysis and evaluating network design decisions using decision trees. Importance of demand forecasting and aggregate planning in a supply chain.

Planning and coordinating Demand and Supply:
Role and Evolution of Purchasing, Enablers of Purchasing, Purchasing objectives and process. Cycle Inventory- Role, Related Costs, Estimation, Lot sizing, and Quantity Discounts. Safety Inventory- Role, Factors affecting the level of inventory, Impact of supply and lead time uncertainty on safety inventory, importance of Aggregation. Role of IT in inventory Management, Inbound and Outbound Logistics. Factors affecting transportation and warehousing, Third party logistics.

Supply Chain Coordination:
Co-ordination in a supply chain: Bullwhip effect. Obstacles to coordination. Managerial levers to achieve co-ordination, Building strategic partnerships, Supply Chain Performance Measurement- need, categories and development of measurement and evaluation system. The role of IT supply Chain, The Supply Chain IT framework, ERP. The role of E-business in a supply chain, The E-business framework, E-business in practice.

Advanced Concepts:
Overview of 4PL and 5PL Logistics, Global Logistics, Reverse Logistics, Risk Management in the supply chain, Lean supply Chains, Sustainable and Green supply Chains

3. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		05
1. Demonstration using Videos	03	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	02	
Numeracy		10
1. Solving Numerical Problems	10	
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		05
1. Case Study Presentation	05	
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

4. Method of Assessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification

5. Reassessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification

6. Achieving Learning Outcomes

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	Classroom lectures, Assignments
4.	Analytical Skills	Classroom lectures, Assignments
5.	Problem Solving Skills	Classroom lectures, Assignments
6.	Practical Skills	Assignments
7.	Group Work	Assignments
8.	Self-Learning	Assignments
9.	Written Communication Skills	Assignments, Written examinations
10.	Verbal Communication Skills	---
11.	Presentation Skills	---
12.	Behavioral Skills	Course work
13.	Information Management	Assignments, Written examinations
14.	Personal Management	Course work
15.	Leadership Skills	---

III. Course Resources

1. Essential Reading

1. Class Notes
2. Sunil Chopra, Peter Meindl and Dharam Vir Kalra, 2016, Supply Chain Management: Strategy, Planning and Operation, Pearson
3. Robert B. Handfield, Robert M. Monczka, Larry C. Giunipero and James L. Patterson,
   2011, Sourcing and Supply Chain Management, Cengage

2. Recommended Reading

1. Shapiro and Jeremy F., 2002, Modelling Supply Chain, Thomson

2. Poirer C. C. and Bauer M. J., 2002, E- Supply Chain, Using the Internet to Revolutionize your Business, Viva Books
3. Martin Christopher, 2006, Logistics and Supply Chain Management, Strategies for Reducing Cost and Improving Service, Pearson
4. Stanley Fawcett E., Lisa Ellram M., 2007, Supply Chain Management, From Vision to Implementation, Prentice Hall

3. Magazines and Journals

1. Supply Chain Management: An International Journal, Emerald Publishing Group Ltd.
2. International Journal of Physical Distribution and Logistics Management, Emerald Publishing Group Ltd.
3. International Journal of Production and Operations Management, Emerald Publishing Group Ltd.

4. Websites

1. www.supplychainmanagement.in
2. www.scmr.com

5. Other Electronic Resources

1.Electronic resources on the subject area are available in RUAS library

IV. Course Organization

Course Code	MEE414A	
Course Title	Supply Chain Management	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	080-49065555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	July 2023	
Next Course Specifications Review Date	July 2027	

Course Specifications: Robot Kinematics and Dynamics

Course Title	Robot Kinematics and Dynamics
Course Code	MEE415A
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

I. Course Summary

1. Aim and Summary

The course deals with kinematic and dynamic analysis of robots. Students are taught basics of kinematics and dynamics of robotic manipulators. They are able to describe rigid body motion and carry out forward and inverse kinematics of articulated arms. Students will be able to perform dynamic analysis and estimate the forces and torque required for manipulator motion.

2. Course Size and Credits:

Number of credits	04
Total hours of class room interaction during the semester	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Mechanical and Manufacturing Engineering
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

1. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No.	Intended Learning Outcome
1	Explain basics of planar and spatial description, transformation, kinematics, dynamics and their importance in robotics
2	Describe D-H convention and its application in robotic system
3	Develop kinematics equations and analyze for forward and inverse kinematics
4	Solve for time varying position and orientation of robotic manipulator
5	Analyze for joint forces and torque required to operate manipulators

2. Course Contents

Course Content

Overview of Robot Kinematics:

Principles of spatial mechanisms; Kutzbach's equation; Robotic manipulators; Robotic systems; Common robotic arrangements

Spatial Description and Transformation:

Position, orientation and frames; mappings; operators; translation, rotation and transformation; Composition of transformation, Compound transformation, Inverting a transform, transform equations; Euler angle representation

Manipulator Kinematics:

Link description, link connection description; frames to link fixing conventions; Denavit-Hartenberg parameters; Forward kinematics, Transformation between two adjacent coordinate frames, Forward position kinematics of robots, spherical wrist, assembling kinematics; workspace; Inverse kinematics, solvability, algebraic solution methods, decoupling technique, inverse transformation technique

Velocity and Acceleration Analysis:

Time varying position and orientation; linear and rotational velocity, angular velocity, angular velocity vector and matrix; rigid body velocity, Motion of a link; Forward velocity kinematics, velocity propagation; Jacobians, Jacobian generating vectors; singularities; Angular acceleration vector and matrix, acceleration of a rigid body; acceleration kinematics

Static and Dynamic Analysis:

D'Alembert's principle; Rigid body kinetics, Mass moment of inertia matrix, Static forces in manipulators; static force/torque relationships, Newton's and Euler's equations, Iterative Newton dynamic equations, Lagrange's form of Newton's equations, Lagrangian -Euler Dynamic Formulation, Closed form mechanics, robot Lagrange dynamics, robot statics

3. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		
1. Demonstration using Videos	00	

2. Demonstration using Physical Models / Systems	00	02
3. Demonstration on a Computer	02	
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		03
1. Case Study Presentation	03	
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

4. Method of Assessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification

5. Reassessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification

6. Achieving Learning Outcomes

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	Classroom Lectures, Assignments
4.	Analytical Skills	Classroom Lectures, Assignments
5.	Problem Solving Skills	Classroom Lectures, Assignments
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Coursework
15.	Leadership Skills	--

III. Course Resources

1. Essential Reading

1. Class Notes
2. J. J. Craig, 2005, Introduction to Robotics: Mechanics and Controls, 3rd Edition, Harlow, Pearson Education Inc.
3. R. L. Norton, 2004, Design of Machinery, 3rd Edition, McGraw-Hill

2. Recommended Reading

1. K. S. Fu, R. C. Gonzalez and C. S. Lee, 1987, Robotics: Control, Sensing, Vision and Intelligence, McGraw-Hill
2. Mark W. Spong, Seth Hutchinson and M. Vidyasagar, 2005, Robotic modeling and control, First edition, John Wiley and Sons
3. Robert J. Schilling, 2003, Fundamentals of Robotics: Analysis and Control, New Delhi, Prentice-Hall Inc.
4. J. M. Selig, 1992, Introductory Robotics, New York, Prentice Hall
5. Ashitava Ghosal, 2006, Robotics: Fundamental Concepts and Analysis, Oxford University Press

3. Magazines and Journals
    1. ASME Journal of Mechanisms and Robotics
    2. IEEE Robotics and Automation Magazine
    3. International Journal of Dynamics and Control
    4. The International Journal of Robotics Research, SAGE Journals
4. Websites
    1. http://www.botmag.com/
    2. http://www.roboticmagazine.com/
    3. http://www.robotshop.com/blog/en/a-first-look-at-robot-magazine-4132
    4. http://www.engineersedge.com/
    5. http://www.technologystudent.com
    6. https://nptel.ac.in/
5. Other Electronic Resources
    1. Electronic resources on the module area are available at RUAS library

IV. Course Organization

Course Code	MEE415A	
Course Title	Robot Kinematics and Dynamics	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	080-49065555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May 2027	

Course Specifications: Data Sciences and Foundation

Course Title	Data Sciences and Foundation
Course Code	CSF411A
Department	Mechanical Engineering
Faculty	Engineering and Technology

I. Course Summary

1. Aim and Summary

This course is designed to introduce a range of topics and concepts related to data science. This course will cover fundamental topics such as principles, design and applications of data base systems including the data manipulation and visualization techniques. Data warehousing concepts such as multidimensional data cube and its architecture are thought. Exploratory Data Analysis using R, Four pillars of data mining clustering, classification, association rule mining and prediction are discussed. Students are trained to understand the role and application of data science in various application domains.

2. Course Size and Credits:

Number of credits	04
Total hours of class room interaction during the semester	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Computer Science and Engineering
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

1. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No.	Intended Learning Outcome
1	Describe the principles, design, manipulation and application of database systems

2	Discuss data science application development using machine learning and data warehousing and mining techniques
3	Apply principles of database systems to model, manipulate and visualize the data
4.	Recommend appropriate techniques of machine learning and data mining for knowledge discovery
5	Design data science applications using machine learning and data mining techniques for knowledge discovery
6	Synthesize data science applications using machine learning and data mining techniques and data warehouse

2. Course Contents

Course Content

Data Science concepts:
The abundance of data, data science and data scientist

Basic Concepts:
Database systems-purpose and components, Data, Data modeling- Entity relationship model, Relational data model, Network, Hierarchical model, object-oriented models, Instances Entity Relationship model: E- R diagrams, entity sets and attributes, relationships, roles and constraints

Data Base Operations:
Normal forms, Overview of database languages, SQL -data definition, query formulation, update sublanguage, database stored procedures

Data Warehousing and Analysis:
Data warehouse Concepts, Multidimensional data Modelling Architecture, OLAP, Data Cleaning, Data
Quality, Data Quality measurement, Initial transformations, Handling outliers and missing data

R and Exploratory Data Analysis
Introduction to R, programming in R, EDA using R: Pie chart, bar charts, histograms, box plots, scatter plots, QQ plots, correlation analysis, regression analysis

Data Mining Concepts:
Data types, data sets, attributes, purpose of data mining, Data mining, type of data that can be mined, types of patterns that can be mined, technologies used, Types of applications are targeted, major issues in data mining

Data Mining Trends and Research Frontiers:
Mining complex data types, other methodologies of data mining, data mining applications, data mining and society, data mining trends

3. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		05
1. Demonstration using Videos	03	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	02	
Numeracy		10
1. Solving Numerical Problems	10	
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

4. Method of Assessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification

5. Reassessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program Specification

6. Achieving Learning Outcomes

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	Class room Lectures, Demonstrations, Assignments
2.	Understanding	Class room Lectures, Assignments
3.	Critical Skills	Class room Lectures, Assignments
4.	Analytical Skills	Class room Lectures, Assignments, Tutorials
5.	Problem Solving Skills	Class room Lectures, Assignments, Tutorials
6.	Practical Skills	Assignments
7.	Group Work	Assignments
8.	Self-Learning	Assignments
9.	Written Communication Skills	Tests, Assignments, Examinations
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Interaction with peers, instructors and tutors
13.	Information Management	Assignment, Examination and Presentation
14.	Personal Management	Interaction and requirements of discipline
15.	Leadership Skills	--

III. Course Resources

a. Essential Reading

1. Class Notes
2. Elmasri, R., and Navathe, S. B., 2008 Fundamentals of Database Systems, 4th edn., Pearson Education.
3. Han, J., Kamber, M., Pei, J., 2011, Data mining concepts and techniques, Simon Fraser University, Morgan Kaufmann.
4. Grus, J., 2015, Data Science from Scratch, O'Reilly Media.
5. Gardener, M., 2016, Beginning R: The Statistical Programming Language, John Wiley and Sons.

b. Recommended Reading

1. Simson, G., and Witt, G., 2005, Data Modelling Essentials, 3rd edn., Morgan Kaufmann.
2. Thomsen, E., 2002, OLAP Solutions, Building Multidimensional Information Systems, Wiley.
3. Cios, K. J., Pedrycz,W., Swiniaski, R.W., and Kurgan, L. A., 2007, Data Mining: A Knowledge Discovery Approach. Springer.
4. Hastie, T., Tibshirani, R., and Fiedman, J., 2001, The Elements of Statistical Learning: DataMining, Inference, and Prediction, 2nd edn., Springer.
5. Thomsen, E., 2002, OLAP Solutions: Building Multidimensional Information Systems, 2nd edn., John Wiley & Sons.

c. Magazines and Journals

1. IEEE Transactions on Knowledge and Data Engineering

d. Websites

1. http://www.kdnuggets.com/

e. Other Electronic Resources

1. http://videolectures.net

IV. Course Organization

Course Code	CSF411A	
Course Title	Data Sciences and Foundation	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	49065555
	E-mail:	hod.cs.et@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	Mayy 2027	

Course Title	Fatigue and Fracture Mechanics
Course Code	MEE421A
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

I. Course Summary

1. Aim and Summary

This course deals with fatigue loading and its effect on mechanical components. Students will be taught about types of fatigue loading, fatigue design criteria and fatigue testing. Basic concepts of fracture mechanics, Laws governing crack growth rate under cyclic loading will be discussed. Students will be able to apply theory of fracture mechanics to carry out stress analysis of cracked components and structures.

2. Course Size and Credits:

Number of credits	04
Total hours of class room interaction during the semester	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Mechanical and Manufacturing Engineering
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

1. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No. Intended Learning Outcome

1 Describe basic concepts of metal fatigue and fracture mechanics

2 Explain different types fatigue loading, fatigue design methods and fracture mechanics principles

3 Discuss fatigue and fracture phenomena and governing laws applied to machinery design

4 Solve problems of metal fatigue analysis involving simple mechanical components

5 Apply theory of fracture mechanics to carry out stress analysis of cracked components and structures

2. Course Contents

Course Content

Overview of Fatigue:
Fatigue phenomenon; loading patterns and characteristics; Low cycle fatigue, High cycle fatigue, overview on strategies in fatigue based design; Discussion on fatigue design criteria; Fatigue testing methodology and life prediction

Stress-Life Approach:
Analysis of fatigue data in the finite life region; Estimation of S N curve of a component based on ultimate tensile strength; Effect of modification factors on fatigue strength; Effect of mean stress on fatigue life estimation mathematical models

Strain-life approach:
Analysis of monotonic and cyclic stress–strain behavior of materials; Cyclic stress-strain relationship and Strain-life behaviour under steady, transient and constant amplitude conditions; Strain-life equation and mean stress correction methods

Fracture Mechanics:
Difference between strength of material based approach and Fracture mechanics based approach, Significance of fracture mechanics design, displacement modes; Fracture parameters based on Linear Elastic Fracture Mechanics (LEFM) approach: Energy balance based approach and Stress (SIF, CSIF) based approach; Discussion on plane stress and plane strain conditions, thick plate and thin plate based on fracture mechanics point of view; ASTM E-399 Standard method for plane strain fracture toughness testing on various specimens for varied applications; Governing parameters in EPFM: use of R curve, J integral, COD, CMOD, CTOD concepts; Effect of size of plastic zone and size factors using Irwin's and Dugdale approach

Fatigue Crack Propagation:
Fatigue crack propagation laws, Paris law, Forman law, Walker law; Fatigue life analysis for combined load cases; Variable amplitude loading and cycle counting techniques

3. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		
1. Demonstration using Videos	02	

2. Demonstration using Physical Models / Systems	00	03
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		02
1. Case Study Presentation	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

4. Method of Assessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification

5. Reassessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program Specification

6. Achieving Learning Outcomes

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	Class room lectures, Assignments

2.	Understanding	Class room lectures, Assignments
3.	Critical Skills	Class room lectures, Assignments
4.	Analytical Skills	Class room lectures, Assignments
5.	Problem Solving Skills	Class room lectures, Assignments
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, examination
14.	Personal Management	Course work
15.	Leadership Skills	--

III. Course Resources

a. Essential Reading

1. Class Notes
2. R. I. Stephens, H. O. Fuchs, A. F. Robert, R. Stephens, 2000, Metal Fatigue in Engineering, 2nd Edition, Wiley-IEEE
3. T. L. Anderson, 2005, Fracture Mechanics: Fundamentals and Applications, 3rd Edition, CRC Press

b. Recommended Reading

1. J. Schijve, 2001, Fatigue of Structures and Materials, Springer
2. K. R. Y. Simha, 2001, Fracture Mechanics for Modern Engineering Design, Orient Blackswan
3. K. Y. Dang Van, I. V. Paradopoulos, (1999), High-Cycle Metal Fatigue: From Theory to Applications, Springer Verlag
4. Julie A. Bannantine, Jess J. Comer, James L. Handrock (1990) Fundamentals of Metal Fatigue Analysis, Prentice Hall
5. Yung-Li Lee, Jwo Pan, Richard Hathaway (2011) Fatigue Testing and Analysis:

Theory and Practice, Elsevier

c. Magazines and Journals

1. International Journal of Fatigue
2. International Journal of Fracture
3. Engineering Fracture Mechanics: An International Journal
4. Fatigue and Fracture of Engineering Materials and Structures
5. International Journal of Shock and Vibration, IOS Press
6. Advances in Fracture Mechanics Series, WIT Press

d. Websites

1. http://www.machinedesignonline.com
2. http://www.asminternational.org

e. Other Electronic Resources

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

IV. Course Organization

Course Code	MEE421A	
Course Title	Fatigue and Fracture Mechanics	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	080-49065555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May 2027	

Course Specifications: Quality by Design

Course Title	Quality by Design
Course Code	20MEE432A
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

I. Course Summary

1. Aim and Summary

This course aims to introduce students to the approach of quality by design for building robust product/process. Design of experiments and its importance to deduce vital input parameters will be taught. Single factor, multi factor, factorial experimentation techniques and interpretation of results will be taught. Students will be equipped to conduct experiments using Taguchi techniques. Appropriate software will be used to solve cases. Students will be introduced to multi-level factor designs, multi-response optimization and other techniques such as response surface methodology, Shainin DOE and related cases.

2. Course Size and Credits:

Number of credits	04
Total hours of class room interaction during the semester	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Mechanical and Manufacturing Engineering
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

5. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No.	Intended Learning Outcome
1	Describe the various principles and concepts of statistically designed experiment
2	Explain the guiding principles of designing experiments and their applications for building robustness in product/process
3	Discuss the process of experimentation adopting suitable designs namely, single factor, factorial, special and Taguchi techniques
4	Formulate problems to conduct experiments for arriving at optimal solutions
5	Determine optimal process parameters for a given problem and interpret results
6	Apply experimental design techniques to given situation and analyze results for optimal criteria

2. Course Contents

Course Content
Need for Experiments: Need, Strategy of Experimentation, Basic Principles and process of design of experiments, Guidelines for Designing Experiments, Basic Statistical Concepts, Sampling and Sampling Distributions, Inferences about differences in means and variance, Linear regression-simple and multiple linear regression
Analysis of Variance: ANOVA, Chi-Square distribution, T distribution, F distribution, confidence intervals, one-way ANOVA, twoway ANOVA, Multivariant ANOVA, Model Adequacy Checking, Regression Approach to ANOVA
Deriving the Critical Input Parameters Using Simple Experiments: Single Factor Experiments - Completely randomized design, Randomized block design, effect of coding the observations, Latin Square design, orthogonal contrasts, comparison of treatment means
Orthogonal Array Selection and Utilization: Types of Orthogonal Arrays, selection of standard orthogonal arrays, Linear graphs and Interaction assignment, Dummy level Technique, Compound factor method, Modification of linear graphs. Illustration through Numerical examples
Factorial Experimentation: Basic definitions and principles, advantages of factorials, the two-factor factorial design, the general factorial design, fitting response curves and surfaces 2k designs with two and three factors, Yate's algorithm, practical applications
Special Experimental Designs: Blocking and confounding in 2k factorial design, Two-level fractional factorial designs, exercises
Taguchi Methodology for Quality improvement : Taguchi's quality philosophy, Loss function, Smaller-the- better type, Nominal-the better-type, Largerthe-better type. Illustration through Numerical examples. Robust design-Parameter and tolerance design c - concepts, Steps in experimentation, Orthogonal Taguchi's inner and outer arrays selection and utilisation; Data Analysis using ANOVA and Response Graph methods, Signal to Noise ratios, parameter design strategy, Illustration through Numerical examples
Emerging Concepts: Multi-level Factor Designs, Multi-response optimization, Response Surface Methodology, Shainin DOE and their applications, Case studies on DOE applications

3. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		02
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
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		03
1. Case Study Presentation	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

4.

4. Method of Assessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification

5. Reassessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program Specification

6. Achieving Learning Outcomes

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	Class room lectures
2.	Understanding	Class room lectures
3.	Critical Skills	Class room lectures
4.	Analytical Skills	Class room lectures
5.	Problem Solving Skills	Class room lectures
6.	Practical Skills	---
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	---
11.	Presentation Skills	Assignment
12.	Behavioral Skills	Class room lectures
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	---

III. Course Resources

jj. Essential Reading

1. Class Notes
2. Douglas C. Montgomery, 2013, Design and Analysis of Experiments, John Wiley & Sons
3. Philip J. Ross, 1989, Taguchi Techniques for Quality Engineering, Prentice Hall

kk. Recommended Reading

1. Ajit C. Tamhane, 2009, Statistical Analysis of Designed Experiments: Theory and Applications, John Wiley & Sons
2. K. Krishnaiah and P. Shahabudeen, 2013, Applied Design of Experiments and Taguchi Methods, PHI Learning Pvt. Ltd.
3. Angela M.Dean and Daniel Voss, 2000, Design and Analysis of Experiments, Springer

4. Nicolo Belavendram, 1999, Quality by Design - Taguchi Techniques for Industrial Experimentation, Prentice Hall
5. Jiju Antony, 2003, Design of Experiments for Engineers and Scientists, Butterworth- Heinemann

ll. Magazines and Journals

1. International Journal of Quality & Reliability Management, Emerald Group Publishing Limited
2. International Journal of Productivity and Performance Management, Emerald Group Publishing Limited

mm. Websites

a. http://www.statease.com
b. http://www.stats.gla.ac.uk

nn. Other Electronic Resources

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

IV. Course Organization

Course Code	20MEE432A	
Course Title	Quality by Design	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	080-49065555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	July 2020	
Next Course Specifications Review Date	July 2024	

Course Specifications: Power Plant Engineering

Course Title	Power Plant Engineering
Course Code	MEE433A
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

I. Course Summary

1. Aim and Summary

The course deals with electrical power plants such as steam, gas turbine, diesel, hydraulic, nuclear and solar. Students are taught site selection, construction, operation and generation of electric power and economics of power generation. Students are also imparted knowledge of harnessing solar energy and its potential. Students will be able to

2. Course Size and Credits:

Number of credits	4
Total hours of class room interaction during the semester	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Mechanical and Manufacturing Engineering
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

1. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

Sl. No.	Intended Learning Outcome
1	Explain plant layout, working and various sub components of conventional and renewable power plants
2	Discuss energy scenario, maintenance, small scale power generation and selection of site for power plant
3	Solve simple numerical problems on power plant performance
4	Select appropriate power plant for a specified power generation capacity
5	Analyze the potential of various energy sources suitable for power generation

2. Course Contents

Course Content

Fundamentals of Power Plant:
Classification of power plant, Energy and its types for power generation, load duration curves; selection of plant site, resource availability, cost, power plant economics; present and future energy scenario in India, strategies for efficient management of demand forecast in India, review of thermodynamic cycles related to power generation

Steam Power Plant:
Plant Layout, site selection requirements, working of steam power plant, Rankine cycle and its application in steam cycle, steam power plant performance, cogeneration, Coal handling systems, types of burners,
Ash handling and disposal, environmental impacts, Organic Rankine cycle power plant, Maintenance of Steam power plant, Demonstration of Rankine cycle simulation in MatLab

Gas Turbine Power Plant:
Plant Layout, classification and elements of gas turbine power plants, cogeneration, auxiliary systems, gas turbine efficiency, combined cycle power plants, Maintenance of Gas Turbine power plant

Nuclear Power Plant:
Nuclear energy concepts and terminologies involved, nuclear fusion and fission chain reactions, radioactive decay, nuclear reactor and its classification, nuclear flux, conservation ratio, plant layout, site selection requirements, construction and working, environmental impact and safety concerns in nuclear power generation, maintenance of nuclear plants

Diesel Power Plant:
Layout, choice and characteristics, plant layout and maintenance

Hydro-Electric Power Plant:
Classification, plant layout and site selection requirements of power plant, Run-off, Hydrograph and flow duration curves, mass curves, Micro hydel power plants

Solar Power Plants:
Fundamentals of solar radiation, solar energy availability analyses
Solar Thermal power plant - various solar collectors used in power generation plants, working of solar thermal power plants, Plant layout, and maintenance, Factors considered for site selection and site location
Solar PV power plant - photovoltaic materials and its electrical characteristics, recent photovoltaic technologies for solar power generation, detailed study of solar photovoltaic power generation systems, Plant layout and maintenance, roof top solar power generation

3. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		05
1. Demonstration using Videos	03	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	02	
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		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

4. Method of Assessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification

5. Reassessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification

6. Achieving Learning Outcomes

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	Class room lectures, Assignments
2.	Understanding	Class room lectures, Assignments
3.	Critical Skills	Class room lectures, Assignments
4.	Analytical Skills	Class room lectures, Assignments
5.	Problem Solving Skills	Class room lectures, Assignments
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Assignment
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	--

III. Course Resources

a. Essential Reading

1. Class notes
2. P. K. Nag, 2005, Power Plant Engineering, McGraw Hill Publications, 3rd Edition
3. A. K. Raja, A. P. Srivastava, 2006, Manish Dwivedi, Power Plant Engineering, New Age International Publishers

b. Recommended Reading

1. Gilbert M. Masters, 2013, Renewable and Efficient Electric Power Systems, Wiley- Interscience
2. G. S. Sawhney, 2016, Non-Conventional Energy Resources, PHI
3. S. C. Arora and S. Domkundwar, 2011, A Course in Power Plant Engineering, Dhanpat Rai and Sons
4. Thomas Elliot, Kao Chen and Robert Swanekamp, 2010, Standard Handbook of Power Plant Engineering, McGraw Hill

c. Magazines and Journals

1. Journal of Energy Engineering
2. Energy Engineering- Taylor and Francis
3. American Journal of Energy Engineering
4. Power Engineering
5. IEEE Power & Energy Magazine

d. Websites

1. www.coursera.org
2. www.nptel.ac.in
3. www.khanacademy.org

e. Other Electronic Resources

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

IV. Course Organization

Course Code	MEE433A	
Course Title	Power Plant Engineering	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	080-49065555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May 2027	

Course Specifications: Robot Programming and Control

Course Title	Robot Programming and Control
Course Code	MEE435A
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

I. Course Summary

1. Aim and Summary

This course deals with the programming and control of robots for any application. Students are taught the principles programming embedded systems, sensor and peripheral interfacing, peripheral programming, and robot high level language essential to develop robots for various applications. Students are taught to determine system response for transient and frequency based inputs. Students will be able to perform the steady state error, dynamic error and stability analysis on linear and adaptive control system models.

2. Course Size and Credits:

Number of credits	04
Total hours of class room interaction during the semester	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Mechanical and Manufacturing Engineering
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

1. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No.	Intended Learning Outcome
1	Explain various methods of robot programming
2	Describe various robot languages and commands for robot operation, robot control system modules and their response
3	Design a controller to meet error, stability and relative stability specifications
4	Develop programs using high level robotic programming languages to control robotic operations
5	Select suitable drives and control circuits for developing a physical control system

2. Course Contents

Course Content

Overview of Robot Programming:
Robot software functions coordinate systems, position control, other control functions, subroutines, Program planning for Robot flow charting for robot programs with few examples

Methods of Robot Programming:

Online programming, off-line programming, advantages of off-line programming, lead through methods _ powered lead through, manual lead through, Teach pendant, Robot program as a path in space, defining position in space, motion interpolation, WAIT, SIGNAL and DELAY commands, Branching capabilities and Limitations of head through methods

Robot Languages:
Textual ROBOT Languages, first generation and second generation languages, structure of a robot language operating systems, Elements and Functions, constants, variables and other data objects, Motion commands, points in workspace, End effector and sensor commands, computations and operations, program control and subroutines, communications and Data processing, Introduction to high level robot programming languages

Control for Robotic Systems:
Feedback control, Second order linear systems, control of second order systems, trajectory following control, disturbance rejection, feedback linearization, conventional controller, sliding mode control, variable structure control, adaptive control

Stability Analysis:
Control problem, state equations, state space model of a robot, constant solutions, equilibrium point, Liapunov's first method, Liapunov's second method, domain of attraction, linear system stability, steady state tracking

Case Studies:
Modelling and Control of Manipulators, Feedback Control of a Robot, Trajectory and Position Control of a Robot, behavior based systems

3. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		05
1. Demonstration using Videos	03	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	02	
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		05
1. Case Study Presentation	05	
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

4. Method of Assessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification

5. Reassessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification

6. Achieving Learning Outcomes

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	Classroom Lectures, Assignments
4.	Analytical Skills	Classroom Lectures, Assignments
5.	Problem Solving Skills	Classroom Lectures, Assignments
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Coursework
15.	Leadership Skills	--

III. Course Resources

a. Essential Reading

1. Class Notes
2. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel and Nicholas G. Odrey, 1986, Industrial Robotics Technology, Programming and Applications, McGraw Hill
3. Robert J. Schilling, 1990, Fundamentals of Robotics: Analysis & Control, 2nd Edition, Pearson

b. Recommended Reading

1. Joseph L. Jones, 2004, Robot Programming: A Practical Guide to Behavior-Based Robotics, McGraw-Hill
2. Bernard Hodges, 1993, Industrial Robotics, Second Edition, Jaico Publishing House
3. K. S. Fu, R. C. Gonzalez and C. S. Lee, 1987, Robotics: Control, Sensing, Vision, and Intelligence, McGraw-Hill

4. J. J. Craig, 1989, Introduction to Robotics, Mechanics, and Control, 2nd Edition, Addison Wesley

c. Magazines and Journals

1. The International Journal of Robotics Research
2. Journal of Intelligent & Robotic Systems
3. Robotics and Autonomous Systems
4. Journal of Control, Automation and Electrical Systems

d. Websites

1. http://www.robotc.net/
2. http://www.robotvirtualworlds.com/
3. http://www.nptel.ac.in/courses/112101099/#

e. Other Electronic Resources

1. http://video.mit.edu/watch/omnidirectional-mobile-robot-kinematic-control-and- spin-motion-4042/
2. http://video.mit.edu/watch/dynamic-walking-2010-robert-gregg-control-and- planning-with-asymptotically-stable-gait-primitives-5972/
3. Electronic resources on the module area are available at RUAS library

IV. Course Organization

Course Code	MEE435A	
Course Title	Robot Programming and Control	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	080-49065555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May 2027	

Course Specifications: Data Analytics

Course Title	Data Analytics
Course Code	CSE441A
Department	Mechanical andManufacturing Engineering
Faculty	Engineering and Technology

I. Course Summary

1. Aim and Summary

This course enables the students to design, develop, analyse and evaluate Data Analytics applications employing appropriate techniques, methods and technology. The role and application of Data Analytics in various application domains of computing is discussed. Knowledge Representation and modern Data Warehousing techniques and technologies are dealt in detail. Machine Learning and Data Mining methods are employed for Knowledge Discovery in textual and other forms of structured and unstructured data. Students are trained in the use of modern techniques and technologies to develop Data Analytics applications.

2. Course Size and Credits:

Number of credits	04
Total hours of class room interaction during the semester	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	04
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

1. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No.	Intended Learning Outcome
1	Discuss data analytics application development using knowledge representation, data warehousing, machine learning and data mining techniques
2	Choose appropriate techniques and technology for data warehousing, machine learning and data mining for knowledge discovery
3	Design data analytics processes using data warehousing, machine learning and data mining techniques for knowledge representation and discovery
4	Analyse the data and the performance of data analytics applications
5	Synthesise data analytics applications using machine learning and data mining techniques and enterprise platforms
6	Solve problems associated with large scale data analysis, machine learning and data mining

2. Course Contents

Course Content

Introduction:
Data Analytics and its role in Business Intelligence and Knowledge Discovery. Data Analytics in a other fields. Data Analytics processes: Preparation, Warehousing, Analysis, Mining, Validation and Performance Evaluation. Data Analytics tools and platforms

Knowledge Representation:
Attributes. Data Sets. Storage. Learning. Classification. Prediction. Categories of knowledge representation. Knowledge representation schemes

Data modelling:
Traditional Data Base systems for data storage and processing. Big Data. Modern platforms for data storage and processing: Distributed and Cloud. Cloud based platforms such as Hadoop. Multidimensional Data Modelling. OLAP. Data Fusion

Data Warehousing and Analysis:
Initial data analysis: Data Cleaning, Data Quality, Data Quality measurement, Initial transformations, Handling outliers and missing data, Bootstrapping. Univariate, Bivariate and Graphical analysis of data. Statistical data analysis methods: General and Generalised Linear models. Exploratory data analysis. Stability: cross-validation and sensitivity analysis

Machine Learning and Knowledge Discovery:
Unsupervised learning: clustering and association rules. Supervised learning: Statistical methods. Bayesian networks. Decision trees. Markovian learning networks. Artificial neural networks

Data Mining:
Knowledge generation from Data Mining. Relation and contrast with Machine Learning. Supervised and unsupervised approaches to data mining. Text mining. Mining other forms of data. Prediction and Forecasting

Data Visualisation and Reporting: Concepts, methods and tools for enterprise data visualisation and reporting of enterprise data warehousing and knowledge repositories

3. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours

Face to Face Lectures		40
Demonstrations		05
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	05	
Numeracy		10
1. Solving Numerical Problems	10	
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

4. Method of Assessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification

5. Reassessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification

6. Achieving Learning Outcomes

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 and Demonstrations
2.	Understanding	Classroom Lectures, Tutorials, Assignment and Demonstrations
3.	Critical Skills	Assignment
4.	Analytical Skills	Classroom Lectures, Tutorials and
5.	Problem Solving Skills	Assignment
6.	Practical Skills	Tutorials and Assignment
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment
10.	Verbal Communication Skills	Tests, Examination and Assignment
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Interaction with peers, instructors and tutors
14.	Personal Management	Assignment and Examination
15.	Leadership Skills	Peer interaction

III. Course Resources

a. Essential Reading

1. Class Notes
2. El-Haik, B., and Al-Aomar, R., 2006, Simulation-Based Lean Six-Sigma and Design for Six- Sigma, Wiley & Sons, Inc.
3. Kelton, W. D., Sadowski, R. P., and Sadowski, D. A., 1998, Simulation with ARENA, McGraw-Hill.
4. Banks, J., 2002, Discrete Event System Simulation, Prentice Hall.

b. Recommended Reading

1. Altiok, T., and Melamed, B., 2007, Simulation Modelling and Analysis with Arena, Academic Press, Elsevier Inc.
2. Papadopoulos, H. T., 1993, Queuing Theory in Manufacturing System Analysis and Design, Chapman.

c. Magazines and Journals

1. International Journal of Operations and Production Management, Emerald Group Publishing Limited.
2. International Journal of Physical Distribution and Logistics Management, Emerald Group Publishing Limited.
3. Journal of Manufacturing Technology Management and Journal of Enterprise Information Management, Emerald Group Publishing Limited.

d. Websites

1. http://www.arenasimulation.com
2. http://www.simio.com

3. http://www.intechopen.com

e. Other Electronic Resources

1. Course area Data Analytics

IV. Course Organization

Course Code	CSE441A	
Course Title	Data Analytics	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	49065555
	E-mail:	hod.cs.et@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May 2027	

Course Specifications: Optimization Techniques 2

CourseTitle	Optimization Techniques 2
Course Code	MTE441A
Department	Mathematics and Statistics
Faculty	Faculty of Engineering and Technology

I. Course Summary

The main aim of this course is to present methods of solving unconstraint optimization problems in the three areas of linear programming and nonlinear programming. In addition, the course introduces basic theory related to Integral equations and methods to solve integro-differential equations. This course focuses on optimization methods that are commonly used in modern statistical machine learning. The course will cover theory on calculus of variations such as vibrational problems involving fixed and moving boundaries. The course also introduces to linear search and algorithms like descent algorithms, Newton's method, conjugate direction methods, and quasi-Newton methods in the nonlinear case.

1. Aim and Summary

.

Number of credits	4
Total hours of class room interaction during the semester	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Mathematics and Statistics (FMPS)
Course marks	As per the Programme Specifications section 23
Pass requirement	As per the Programme Specifications section 23
Attendance requirement	As per the Programme Specifications section 24

II. Teaching, Learning and Assessment

2. Intended Learning Outcomes (ILO)

After undergoing this course students will be able to:

No.	Intended Learning Outcome
1	Describe fundamental of integral equations, variational problems and unconstrained optimization
2	State and explain important classical techniques to solve integral equations and numerical methods of unconstrained optimization
3	Demonstrate the skill to analyze variational problem and choose effective optimization tools
4	Apply optimization techniques to model real world problems involving linear and non-linear optimization
5	Solve complex problems associated with integral equations, calculus of variations and unconstrainted optimization of function of several variables

2. CourseContents

Course Content

Module 1:
Integral Equations: Volterra and Fredholm integral equations, of first and second kinds.
Methods to solve integral equations based on Laplace transform, Neumann series. Solution of integrodifferential equations

Module 2:

Calculus of Variations: Introduc tion. Functionals and its properties, Deduction of Euler's equations for functionals of first order and higher order for fixed boundaries. Shortest distance between two nonintersecting curves. Isoperimetric problems. Jacobi and Legendre conditions. Variational problems with the fixed boundaries and moving boundaries. Sufficiency conditions

Module 3:

Unconstrained optimization: Line search methods – Golden section, Fibonacci, Secant and Newton's method. Unconstrained optimization of functions of several variables, Basic theory, Classical techniques, Numerical methods for unconstrained optimization - Gradient methods, Newton's method, Conjugate Direction methods, and Quasi-Newton methods.

3. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		0
1. Demonstration using Videos	0	
2. Demonstration using Physical Models/Systems	0	
3. Demonstration on a Computer	0	
Numeracy		15
1. Solving Numerical Problems	15	
PracticalWork		15
1. Course Laboratory	0	
2. Computer Laboratory	15	
3. Engineering Workshop/Course Workshop/Kitchen	0	
4. Clinical Laboratory	0	
5. Hospital	0	
6. Model Studio	0	
Others		0
1. Case Study Presentation	0	
2. Guest Lecture	0	
3. Industry/Field Visit	0	
4. Brain Storming Sessions	0	
5. Group Discussions	0	
6. Discussing Possible Innovations	0	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		70

4. Method of Assessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program specification

5. Reassessment

Course assessment will be followed as per section 23 “Assessment and Grading” of program Specification

6. Achieving Learning Outcomes

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	Class Room Lectures, Assignments
2.	Understanding	Class Room Lectures, Assignments
3.	Critical Skills	Class Room Lectures, Assignments
4.	Analytical Skills	Class Room Lectures, Assignments
5.	Problem Solving Skills	Class Room Lectures, Assignments
6.	Practical Skills	Assignments, Laboratory Demonstrations
7.	Group Work	Assignments
8.	Self-Learning	Assignments
9.	Written Communication Skills	Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Class Room Interaction
13.	Information Management	Assignments, Examination
14.	Personal Management	Assignments
15.	Leadership Skills	--

III. Course Resources

e. Essential Reading

3. Class Notes
4. Chong, E.K.P., Zak, S.H. (2013): An Introduction to Optimization, 4thEdn., Wiley.

f. Recommended Reading

3. Luenberger, David G., Ye, Yinyu (2016)Linear and Non Linear Programming., 2thEdn.,Springer International publication.
4. Rao, S. S. (2009) Engineering Optimization: Theory and Practice; Revised 4thEdn.,Wiley.

g. Magazinesand Journals

1. https://www.springer.com/journal/10957
2. https://www.springer.com/journal/11081
3. https://www.tandfonline.com/toc/gopt20/current

h. Other Electronic Resources

2. NPTEL Course Materials

IV. Course Organization

Course Code	MTE441A	
Course Title	Optimization Techniques-2	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	Phone:	49065555
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May 2027	

Course Specifications: Internship-3

Course Title	Internship-3
Course Code	MEI401A
Course Type	Core course
Department	Skill Enhancement Course
Faculty	Engineering and Technology

1. **Course Summary**

Students are required to undergo an internship session of 4 to 6 weeks during the vacation post the completion of 6th Semester, in an industry which may be a business organization, research organization or any other university/technical institution. During the 3rd week of training the students shall submit synopsis report of the training which will be evaluated for 40% of the total marks based on choice of the agency, type of training or and possible outcomes of the training or internship. The students shall submit a final report which is ratified by the agency which has provided the training. The students shall be evaluated based on the final report, presentation and viva-voce for 60% of marks. The students have to submit the certificate from the company indicating the period of training and certifying student's performance. The students are expected to work in an area / topic of relevance which need to have prior approval from the Directorate of Placement Department Head and Dean of the Faculty.

Internship Activities/Credit Framework (AICTE):

Internship with Industry/ Govt. /NGO/ PSU/ Any Micro/ Small/Medium enterprise/Online Internship

2. **Course Size and Credit Framework**

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	0:0:4
Total Hours of Interaction	180
Number of Weeks in a Semester	15
Department Responsible	All the Branches
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

Course Outcomes (COs)

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

CO-1: Choose an industry based on the area of the interest and Apply academic knowledge to real-world problems through active engagement in industry projects

CO-2: Develop practical skills and build professional connections

CO-3: Synthesize project learning and experiences into a well-structured technical report adhering to professional standards.

CO-4: Demonstrate professional communication skills through effective presentation and defense of project outcomes.

3. Course Contents

UNIT 1: Industry Orientation and Process Understanding

This unit introduces students to the foundational aspects of industrial environments, including workflows, organizational structures, and domain-specific technologies. Students will gain insights into the roles and responsibilities within engineering teams, project lifecycles, and the importance of safety, ethics, and professional conduct. Through case studies and real-world examples, learners will develop the ability to analyze and interpret how engineering principles are applied in industry settings.

UNIT 2: Project Engagement and Application of Knowledge

In this unit, students are assigned to live or ongoing industry projects where they actively engage in solving real-world problems. They will identify project requirements, apply academic concepts to practical tasks, and collaborate with industry mentors and team members. Regular progress reviews and feedback sessions will help students refine their approach and deepen their understanding of professional practices, thereby bridging the gap between classroom learning and industry application.

UNIT 3: Documentation and Presentation

The final unit focuses on synthesizing the internship experience into a structured technical report that adheres to institutional and industry standards. Students will learn to format, reference, and present their work effectively. Emphasis will be placed on developing professional communication skills, including the preparation of impactful presentations and confidently defending their work during the final presentation and viva-voce.

4. 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	PSO-1	PSO-2	PSO-3
CO-1	1	1		2		1	2	2	2	2	3	1	2	3
CO-2	1	1		2		1	2	2	2	2	3	1	2	3
CO-3	1	1		2		1	2	2	2	2	3	1	2	3
CO-4	1	1		2		1	2	2	2	2	3	1	2	3
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution														

5. 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. (Mathematics and Computing) 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 (60% Weightage)				Component 2: SEE (40% Weightage)
Subcomponent ▸	SC1-	SC2	SC3	SC4	
Subcomponent Type ▸	Monthly Progress Report	Mid-Term Review / Presentation	Project Report / Documentation -	Industry Feedback / Attendance / Discipline -	Final Viva / Evaluation

Maximum Marks ▸					
CO-1	√				√
CO-2	√	√			√
CO-3			√		√
CO-4	√	√		√	√
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Mentor assigned to the Students in consultation with the Head of the Department, shall provide the focus of COs in the component of assessment in the above template at the beginning of the semester and the entire semester, at regular intervals, till the conduct of Presentation and submission of the Industry Work Done Report.

Course Specifications: Integrated Design Project

Course Title	Integrated Design Project
Course Code	MEP401A
Course Type	Skill Enhancement Course
Department	Mechanical Engineering Departments
Faculty	Engineering and Technology

1. Course Summary

This course aims to provide engineering students an opportunity to consolidate their learning from previous coursework by undertaking a team-based, multidisciplinary design project. Students will identify a real-world problem, formulate objectives, and work collaboratively to design, analyze, prototype, and evaluate a practical engineering solution. The project emphasizes end-to-end development—from initial concept through design and fabrication—enhancing students' technical, research, and project management skills. Throughout the course, students will gain hands-on experience in system design, modeling, simulation, testing, and documentation, along with essential soft skills such as teamwork, leadership, communication, and ethical practice in engineering.

2. Course Size and Credits:

Number of Credits	4
Credit Structure (Lecture: Tutorial: Practical)	0:0:8
Total Hours of Interaction	120
Number of Weeks in a Semester	15
Department Responsible	Mechanical 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: Work effectively as a team to plan and complete an engineering project.
CO-2: Apply engineering knowledge to design a functional system or solution.
CO-3: Use research methods to define the problem and support design decisions.
CO-4: Design, analyze, and build a prototype based on project requirements.
CO-5: Communicate project work clearly through reports and presentations.

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

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	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	5.00
	Presentation to Reviewers	2.00
System Design	Group work with supervisors guidance	15.00
System Modelling, Simulation and Analysis	Group work with supervisors guidance	30.00
Model Building, Instrumentation, Testing and Evaluation	Group work with supervisors guidance	30.00
Verification/Validation	Group work with supervisors guidance	10.00
Drawing Conclusions	Group work with supervisors guidance	5.00
Video creation, Presentation ,Thesis/Report Writing and Viva Voce	Presentation and Viva voce - Group	3.00
	Project report writing - Group	10.00
	Tests/Examinations/Presentations	10.00
	Total	120.00

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. Programme. The procedure to determine the final course marks is also outlined in the same document.
The evaluation instruments and rubrics are designed to measure the attainment of the Course Outcomes (COs). In either component—Continuous Evaluation (CE) or Semester End Evaluation (SEE)—or in the subcomponents of CE (SC1, SC2, SC3, or SC4), the COs are assessed as illustrated in the table below.
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.

	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)	
Subcomponent ►	**SC1**	**SC2**	**SC3**	**SC4**
Subcomponent Type ►	Minutes of Meeting & Task List	Progress Report with guide signatures	Midterm Presentation	Final Project Report and Prototype Presentation
Maximum Marks ►	10	15	25	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

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
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

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”
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/**
4. **https://www.elsevier.com/products/journals?query=&page=1&sortBy=relevance**

d. Websites

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

e. Other Electronic Resources

1. https://ocw.mit.edu/index.htm
2. https://nbaind.org/files/2-SAR-UG-EG-T1_1%20August%202024_Format_20240801124948.pdf

10.Course Organization

Course Code	MEP401A	
Course Title	**Integrated Design Project**	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	May 2023	
Next Course Specifications Review Date	May 2027	

Course Specifications: Capstone Project

Course Title	Capstone Project
Course Code	MEP411A
Course Type	Skill Enhancement Course
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course aims to provide engineering students an opportunity to consolidate their learning from previous coursework by undertaking a team-based, multidisciplinary design project. Students will identify a real-world problem, formulate objectives, and work collaboratively to design, analyze, prototype, and evaluate a practical engineering solution. The project emphasizes end-to-end development—from initial concept through design and fabrication—enhancing students' technical, research, and project management skills.

The Capstone Project – Phase 1 may also serve as a continuation of a project initiated during the seventh semester, allowing students to extend their work into more advanced stages of development and implementation. This extended engagement enables deeper exploration, refinement, and realization of technical solutions. Throughout the course, students will gain hands-on experience in system design, modeling, simulation, testing, and documentation, while also developing essential soft skills such as teamwork, leadership, communication, and ethical practice in engineering.

2. Course Size and Credits:

Number of Credits	12
Credit Structure (Lecture: Tutorial: Practical)	0:0:24
Total Hours of Interaction	180
Number of Weeks in a Semester	15
Department Responsible	Mechanical Engineering
Total Course Marks	300
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:

CO1: Identify and formulate complex engineering problems by analyzing requirements, constraints, and user needs in a chosen domain.

CO2: Design and develop engineering solutions using advanced tools, modeling techniques, and simulation strategies aligned with industry standards.

CO3: Integrate multi-disciplinary concepts to implement and validate functional prototypes or systems addressing real-world challenges.

CO4: Apply appropriate research methods and project management principles to plan, execute, and monitor project progress effectively.

CO5: Communicate project work and outcomes clearly and professionally through technical documentation, reports, and oral presentations.

Course Contents

Unit 1: Team Formation, Problem Identification & Project Planning:
Team formation and role assignment, Identification of real-world/industry problems considering environmental impact, sustainability, and safety factors; Defining project objectives and scope based on the nature and type of the project (application, product, research, or review); Project scheduling (WBS, Gantt chart), and incorporating cost estimation and risk assessment including ethical and feasibility considerations.

Unit 2: Literature Review and Requirement Analysis:
Conducting literature review based on recognized engineering standards and practices; Identifying knowledge gaps with respect to current sustainable and safe solutions; Functional and non-functional requirement specification including constraints related to cost, environment, and ethics; Benchmarking existing systems; Preparing requirement specification document with justification for project type and its alignment to societal and environmental goals.

Unit 3: System Design and Architecture:
Selection of design methodology aligned with engineering standards and ethical practices; System decomposition and modular design with focus on sustainability, safety, and cost optimization; Architectural diagram and flowcharts; Interface definition; Design feasibility review ensuring conformance to environmental regulations and project type relevance.

Unit 4: Modeling, Simulation, and Analysis:
Selection of simulation/modeling tools considering environmental and economic impact; Development of analytical/simulation models with ethical compliance and safety margins; Parameter analysis and performance evaluation based on sustainability indicators; Design validation through simulation; Comparative analysis of alternate designs considering cost, environmental footprint, and societal benefit.

Unit 5: Implementation Planning and Documentation:
Planning for prototyping and resource allocation based on cost constraints and sustainability goals; Cost estimation and budgeting with focus on resource efficiency; Compliance with safety standards, environmental guidelines, and ethical principles; Technical report preparation adhering to professional documentation norms; Interim presentation and project review with justification of project type and contribution to relevant POs and PSOs.

4. 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															

5. Course Teaching and Learning Methods

Topics	Teaching methods	Hours
Problem Identification & Objective Formulation	Literature review, Group discussions, Faculty interaction	30
Review Meetings & Presentations	Interim reviews, peer and supervisor feedback	20
System Design	Group work with faculty guidance	30
Modeling, Simulation, Analysis	Tool-based simulation, guided group sessions	60
Prototyping and Testing	Hands-on development, instrumented testing	100
Validation and Improvement	Performance evaluation, optimization	50
Conclusion Drawing	Review findings, synthesis of results	20
Final Documentation and Viva Voce	Report writing, presentations, viva voce	50
	Total	360.00

6. 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. Programme. The procedure to determine the final course marks is also outlined in the same document.
The evaluation instruments and rubrics are designed to measure the attainment of the Course Outcomes (COs). In either component—Continuous Evaluation (CE) or Semester End Evaluation (SEE)—or in the subcomponents of CE (SC1, SC2, SC3, or SC4), the COs are assessed as illustrated in the table below.
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.

	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)	
Subcomponent ►	**SC1**	**SC2**	**SC3**	**SC4**
Subcomponent Type ►	Minutes of Meeting & Task List	Progress Report with guide signatures	Midterm Presentation	Final Project Report and Presentation
Maximum Marks ►	10	15	25	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, guided research
2	Understanding	Project work, review sessions
3	Critical Thinking	Design analysis, decision making
4	Analytical Skills	Simulations, comparisons
5	Problem Solving	Implementation phase
6	Practical Skills	Prototyping, lab sessions
7	Group Work	Team-based execution
8	Self-Learning	Individual contribution, research
9	Written Communication Skills	Report writing, documentation
10	Verbal Communication Skills	Presentations, viva voce
11	Presentation Skills	Midterm/final presentations
12	Behavioral Skills	Team dynamics, leadership
13	Information Management	Task tracking tools
14	Personal Management	Task distribution, time logs
15	Leadership Skills	Role-based responsibility

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/**
4. **https://www.elsevier.com/products/journals?query=&page=1&sortBy=relevance**

d. Websites

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

e. Other Electronic Resources

1. https://ocw.mit.edu/index.htm
2. https://nbaind.org/files/2-SAR-UG-EG-T1_1%20August%202024_Format_20240801124948.pdf

9. Course Organization

Course Code	MEP411A		
Course Title	Capstone Project		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	+91-804-906-5555
		E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date		May 2023	
Next Course Specifications Review Date		May 2027	