RAMAIAH UNIVERSITY OF APPLIED SCIENCES

Programme Structure and Course Details of

B.Tech in Mechanical Engineering

2022-2026

Faculty of Engineering and Technology

Department of Mechanical Engineering

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RAMAIAH
UNIVERSITY
OF APPLIED SCIENCES

Programme Specifications

B. Tech. (Mechanical Engineering)

Degree Programme

Programme Code: 005

Faculty of Engineering and Technology

Batch 2022-2026

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Bangalore

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

Approved by the Academic Council at its 26th meeting held on 14th July 2022 and 27th meeting heldon 26th of September 2022

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Programme Structure and Course Details of B.Tech. in Mechanical Engineering 2022-2026

Faculty	Engineering and Technology
Department	Mechanical Engineering
Programme Code	005
Programme Name	B.Tech. (Mechanical Engineering)
Dean of the Faculty	Prof. Dilip Kumar Mahanty
Head of the Department	Dr. Mahendra Babu N. C.

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:** July 2022
7. **Date of Programme Approval by the Academic Council of MSRUAS:** 14-July-2022
8. **Next Review Date:** June 2026
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 isoutcome based and helps students to develop critical thinking abilities and imbibe relevant practical

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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 spreadacross 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 whichis 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. Graduate 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

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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

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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	MTB101A	Engineering Mathematics-1	3	1	0	4	100
2	PYB102A	Engineering Physics and Laboratory	3	0	2	4	100
3	CEF101A	Engineering Mechanics	3	0	0	3	100
4	ECF102A	Elements of Electronics Engineering and Laboratory	3	0	2	4	100
5	MEF103A	Engineering Drawing	2	0	2	3	100
6	LAN101A	Constitution, Human Rights and Law	2	0	0	2	50
		Total	**16**	**1**	**6**	**20**	**550**
	Total number of contact hours per week		**23**				

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	MTB101A	Engineering Mathematics - 1	3	1	0	4	100
2	CYB104A	Engineering Chemistry and Laboratory	3	0	2	4	100
3	MEF104A	Elements of Mechanical Engineering and Work shop Practice	2	0	2	3	100
4	EEF105A	Elements of Electrical Engineering and Laboratory	3	0	2	4	100
5	CSF106A	Elements of Computer Science and Engineering and Laboratory	3	0	2	4	100
6	TSN101A	Professional Communication	2	0	0	2	50
		Total	**16**	**1**	**8**	**21**	**550**
	Total number of contact hours per week		**25**				

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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	MTB102A	Engineering Mathematics-2	3	1	0	4	100
2	PYB102A	Engineering Physics and Laboratory	3	0	2	4	100
3	CEF101A	Engineering Mechanics	3	0	0	3	100
4	ECF102A	Elements of Electronics Engineering and Laboratory	3	0	2	4	100
5	MEF103A	Engineering Drawing	2	0	2	3	100
6	LAN101A	Constitution, Human Rights and Law	2	0	0	2	50
		Total	**16**	**1**	**6**	**20**	**550**
		Total number of contact hours per week	**23**				

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	MTB102A	Engineering Mathematics - 2	3	1	0	4	100
2	CYB104A	Engineering Chemistry and Laboratory	3	0	2	4	100
3	MEF104A	Elements of Mechanical Engineering and Work shop Practice	2	0	2	3	100
4	EEF105A	Elements of Electrical Engineering and Laboratory	3	0	2	4	100
5	CSF106A	Elements of Computer Science and Engineering and Laboratory	3	0	2	4	100
6	TSN101A	Professional Communication	2	0	0	2	50
		Total	**16**	**1**	**8**	**21**	**550**
		Total number of contact hours per week	**25**				

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Semester 3							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	MTF201A	Engineering Mathematics - 3	3	1	0	4	100
2	MEC201A	Materials Science	3	0	0	3	100
3	MEC202A	Engineering Thermodynamics	3	1	0	4	100
4	MEC203A	Fluid Mechanics	3	0	0	3	100
5	MEC204A	Manufacturing Processes	3	0	0	3	100
6	MEL205A	Machine Drawing	0	0	4	2	100
7	MEL206A	Mechanical Dissection	0	0	2	1	50
8	MEL207A	Foundry, Forging and Welding Laboratory	0	0	2	1	50
9	BTN101A	Environmental Studies	2	0	0	2	50
		Total	**17**	**02**	**08**	**23**	**750**
Total Number of Contact Hours per week			**27**				

Semester 4							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	BAU201A	Entrepreneurship Development	3	0	0	3	100
2	MTF202A	Engineering Mathematics – 4	3	1	0	4	100
3	MEC208A	Fluid Machines	3	1	0	4	100
4	MEC209A	Mechanisms and Kinematics of Machines	3	0	2	4	100
5	MEC210A	Strength of Materials	3	1	0	4	100
6	MEC211A	Conventional Machining Processes	4	0	0	4	100
7	MEL212A	Fluid Mechanics and Machines Laboratory	0	0	2	1	50
8	MEL213A	Materials Science and Strength of Materials	0	0	2	1	50
9	MEL214A	Machine Shop Practice	0	0	2	1	50
		Total	**19**	**03**	**08**	**26**	**750**
Total Number of Contact Hours per week			**30**				

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Semester 5							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	MEC301A	Applied Thermodynamics	3	1	0	4	100
2	MEC302A	Dynamics of Machinery	3	1	0	4	100
3	MEC303A	Design of Machine Elements - 1	3	1	0	4	100
4	MEC304A	Automation in Manufacturing	3	0	0	3	100
5	MEC305A	Mechanical Measurements and	3	0	2	4	100
6	MEL306A	Applied Thermodynamics Laboratory	0	0	2	1	50
7	MEL307A	Dynamics and Simulation Laboratory	0	0	2	1	50
8	MEL308A	CAM Laboratory	0	0	2	1	50
		Total	**15**	**03**	**08**	**22**	**650**
Total Number of Contact Hours per week			**26**				

Semester 6							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	MEC309A	Heat and Mass Transfer	3	1	0	4	100
2	MEC310A	Finite Element Methods and CAE Laboratory	3	0	2	4	100
3	MEC311A	Design of Machine Elements - 2	3	0	0	3	100
4	MEC312A	Control Systems Engineering and	3	0	2	4	100
5	MEC313A	Industrial Engineering and Management	3	0	0	3	100
6	MEC314A	Engineering Economics and Cost Estimation for Mechanical Engineers	3	0	0	3	100
7	MEE31XA	Professional Core Elective - 1	4	0	0	4	100
8	MEL315A	Heat and Mass Transfer	0	0	2	1	50
~~9~~	~~MES316A~~	~~Seminar~~	~~0~~	~~0~~	~~2~~	~~1~~	~~50~~
		Total	**22**	**1**	**8**	**27**	**800**
Total Number of Contact Hours per week			**31**				

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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 -	4	0	0	4	100
3	MEU401A	Open Elective - 1	3	0	0	3	100
4	MEP401A MEI401A	I] Project Work - 1 II]Internship	0	0	12	6	100
		Total	**11**	**0**	**12**	**17**	**400**
	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	MEP402	Project Work - 2	0	0	24	12	200
		Total	**0**	**0**	**24**	**12**	**200**
	Total Number of Contact Hours per week		**24**				

		Professional Core Electives (PCE):						
Group	**Stream ▸**	Design	Manufacturing	Thermal	Industrial Engineering	Robotics		
PCE-1, Sem. 6	**Course Code**	MEE411A	MEE412A	MEE413A	MEE414A	MEE415A	MTE301A	MTE302A
	Course Title	Advanced Mechanics of Materials	Advanced Manufacturing Technologies	Fluid power systems	Operations Research	Robotic Systems and automation	Probability and Statistics	Advanced Mathematics
PCE-2 Sem. 7	**Course Code**	MEE421A	MEE422A	MEE423A	MEE424A	MEE425A	CSE411A	MTE401A
	Course Title	Noise Vibration and Harshness	Advanced Materials and Process	Computational Fluid Dynamics	Supply Chain Management	Robot Kinematics and Dynamics	Data Science Foundation	Optimization Techniques -1
PCE-3 Sem. 7	**Course Code**	MEE431A	MEE432A	MEE433A	MEE434A	MEE435A	CSE431A	MTE403A/ MTE402A
	Course Title	Fatigue and Fracture Mechanics	Additive Manufacturing	Power Plant Engineering	Quality By Design	Robot Programming and Control	Data Analytics	Advanced Numerical Methods/ Optimization Techniques -2

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Note:

1. Students are required to select **two** Professional Core Elective Courses in the 7th Semester, one each from PCE-1 and PCE-2 Groups.

2. Students are required to select **one** Professional Core Elective course in the 8th Semester from the PCE-3 Group.

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.

22.1. Innovation Courses in Lieu of Open Elective Courses

Students can take the following 3-credit innovation courses in lieu of Open Elective Courses.

a) Design Thinking and Innovation (20INO250A)
b) Skill Development (20INO251A)
c) Industrial Problem Solving and Hackathons (20INO252A)

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

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the semester.

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

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

25.2. Continuous Evaluation Policies

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

25.2.1 Theory Courses

Theory Course				
Sub Component	SC1 (Midterm Exam)	SC2 (Assignment - 1)	SC3 (Assignment -2 Innovative Component)	SC4 (Optional- Makeup midterm. To be offered with approval)
Weightage	25 %	12.5%	12.5%	25%
Marks	50	25	25	50

For a theory course, there shall be three subcomponents of CE (SC1, SC2 and SC3). Each subcomponent is evaluated individually as indicated in the table. It is mandatory that the first and the second components (SC1 and SC2) have to compulsorily be a midterm exam and an assignment respectively. The third component (SC3) has to be an innovative component and the activities to be spread over the entire semester. The third component can be 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 three subcomponents are evaluated, the CE component marks are determined as:
CE Component Marks = (Total of the marks obtained in all the three subcomponents) ÷ 2

25.2.2 Laboratory Course

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

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Laboratory Course			
Sub Component	SC1	SC2	SC3 (Optional)
Weightage	25 %	25%	25%
Marks	25	25	25

The subcomponents can be of any of the following types:

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

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

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

25.2.3 Course Having a Combination of Theory and Laboratory

For a course that contains the combination of theory and laboratory sessions, the scheme for determining the CE marks is as under:

	Theory Course				
Sub Component	SC1 (Midterm Exam)	SC2 (Assignment - 1)	SC3 (Assignment -2 Innovative Component)	LSC4 (Laboratory Component)	SC4 (Optional- Makeup midterm .To be offered with approval from authorities)
Weightage	20 %	10%	10 %	10%	25%
Marks	50	25	25	25	50

For a course having a combination of theory and laboratory, there shall be four subcomponents of CE (SC1, SC2, SC3 and LSC4). Each subcomponent is evaluated individually as indicated in the table. It is mandatory that first and the second components (SC1 and SC2) have to compulsorily be a midterm exam and an assignment respectively. The third component (SC3) has to be an innovative component and the activities to be spread over the entire semester. The fourth subcomponent (LSC4) is mandatory and shall be set to evaluate the students' performance in the laboratory. The third component can be any of the following types:

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

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

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

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

After the four subcomponents are evaluated, the CE component marks are determined as:
CE Component Marks = (Total of the marks obtained in all the four subcomponents is reduced to 50).

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

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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)

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

Sem.	Course Title	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
1	Engineering Mathematics-1	3	3	2	3	3					2			3	3	2
1	Engineering Physics and Laboratory	3	3	3	3	1	1	1						3	3	
1	Engineering Mechanics	3	3											3		
1	Elements of Electronics Engineering and Laboratory	3	2	2										3		
1	Engineering Drawing	3	2			2					1			3	2	1
1	Constitution, Human Rights and Law	3	2								3			3		3
2	Engineering Mathematics - 2	3	3	2	2	2					1			3	2	1
2	Engineering Chemistry and Laboratory	3	3	3	2		3	3			3			3	3	3
2	Elements of Mechanical Engineering and Work shop Practice	3	3											3		
2	Elements of Electrical Engineering and Laboratory	3	3	3	2	2	2	2		1	1	1	1	3	2	1
2	Elements of Computer Science and Engineering and Laboratory	2	1	3	2	2	2		1			1	2	3	2	2
2	Professional Communication									3	3					3
3	Engineering Mathematics -3	3	3	3	2	2				1	1			3	2	1
3	Materials Science	3	3	3	2	2				1	1			3	2	1
3	Engineering Thermodynamics	3	3											3		
3	Fluid Mechanics	3	3											3		
3	Manufacturing Processes	3	3											3		
3	Machine Drawing	3				3					2			3	3	2
3	Mechanical Dissection	3	2								3			3		3
3	Foundry, Forging and Welding Laboratory	3	2								3			3		3
3	Environmental Studies	1					3		1					1	3	1
4	Entrepreneurship Development									3	3					3
4	Engineering Mathematics - 4	3	3	2		2				1	1			3	2	1
4	Fluid Machines	3	3											3		
4	Mechanisms and Kinematics of Machines and Laboratory	3	3		1	3								3	3	
4	Strength of Materials	3	3											3		
4	Conventional Machining Processes	3	3											3		
4	Entrepreneurship Development															
4	Fluid Mechanics and Machines Laboratory															
5	Applied Thermodynamics	3	3	3	2									3	2	
5	Dynamics of Machinery	3	3	3										3		
5	Design of Machine Elements - 1	3	3	3										3		

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Sem	Course Title	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
5	Automation in Manufacturing	3	3	3										3		
5	Mechanical Measurements and Metrology and Laboratory	3	3	2		2								3	2	
5	Applied Thermodynamics Laboratory	2	3							3	3			3		3
5	Dynamics and Simulation Laboratory	2	3			3				3	3			3	3	3
5	CAM Laboratory	3	3		2	3					3			3	3	3
6	Heat and Mass Transfer	3	3	2										3		
6	Finite Element Methods and CAE Laboratory	3	2	3										3		
6	Design of Machine Elements - 2	3	3	3										3		
6	Control Systems Engineering and Laboratory	3	3	3		2								3	2	
6	Industrial Engineering and Management	3	3				2					2		3	2	2
6	Engineering Economics and Cost Estimation for Mechanical Engineers	3	3					1				2		3	1	2
6	Heat and Mass Transfer Laboratory	3	3								3			3		3
6	Seminar									2	3					3
7	Additive Manufacturing	3	2											3		
7	Advanced Mechanics of Materials	3	3	3										3		
7	Advanced Manufacturing Technologies	3	3	2										3		
7	Fluid Power Systems	3	3	2		2								3	2	
7	Operations Research	3	2	3										3		
7	Robotic Systems and Automation	3	2											3		
7	Probability and Statistics	3	3	2	2						2			3	2	2
7	Advanced Mathematics	3	3	2	3						2			3	3	2
7	Professional Core Elective-2															
7	Noise Vibration and Harshness	3	3											3		
7	Advanced Materials and Processes	3	2											3		
7	Computational Fluid Dynamics	3	2			2								3	2	
7	Supply Chain Management	3	3											3		
7	Robot Kinematics and Dynamics	3	2											3		
7	Data Science Foundation	2	1	3	2	2	2		1			1	2	3	2	1
7	Optimization Techniques -1	3	3	3			1				2			3	1	2
7	Project Work-1	3	3	2	3	2	2		2		3	1	3	3	2	3
7	Internship	3	3	3	3	3			2	2	3	2	2	3	3	3
8	Professional Core Elective-3															
8	Fatigue and Fracture	3	3											3		

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8	Quality By Design	3	3	1	2									3	2	
8	Power Plant Engineering	3	3				2							3	2	
8	Robot Programming and Control	3	3	3		1								3	1	
8	Data Analytics	2	1	3	2	2	2		1			1	2	3	2	2
8	Advanced Numerical Methods	3	3	2	2	2					2			3	2	2
8	Optimization Techniques -2	3	3	3			1					2		3	1	2
8	Project Work-2	3	3	2	3	2	2		2		3	1	3	3	3	3

30. 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.

31. 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.

32. Sports and Athletics

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

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RAMAIAH UNIVERSITY OF APPLIED SCIENCES

Course Specifications

B.Tech in Mechanical Engineering

Programme Code: 005

Faculty of Engineering & Technology
Batch 2022-2026

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SEMESTER 1

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Course Specifications: Engineering Mathematics - 1

Course Title	Engineering Mathematics - 1
Course Code	MTB101A
Course Type	Core Theory
Department	Applicable to all Programmes
Faculty	Engineering and Technology

1. Course Summary

The course introduces students to the basic concepts in real analysis and matrix algebra. Students are taught the concepts of limits, continuity, and differentiation, series expansion for the functions of one and two variables, sequence and series, convergence of series. The mathematical operations in Matrix theory, Eigen value and Eigen vector, Inversion and diagonalization of matrix and matrix solution for linear system of equations.

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	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 and discuss basic concepts related to single, two variable calculus and matrix algebra

CO-2. Perform basic operations of matrix algebra and apply them to solve systems of linear equations

CO-3. Solve simple mathematical problems associated with linear algebra, single and two variable calculus

CO-4. Demonstrate competence with the basic ideas of linear systems, independence, bases and dimension, linear transformations, eigenvalues, eigenvectors and diagonalization

CO-5. Solve complex real-world problems associated with linear algebra, single and two variable calculus

4. Course Contents

Unit 1 (Single Variable Calculus): Functions of single real variable, limit, continuity and

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differentiation. 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: integral test, comparison test, ratio test and root test. Power series, Taylor and Maclaurin series.

Unit 2 (Two Variable Calculus): Functions of two variables, limits, continuity and partial differentiation. Total differential, errors and approximations, tangent plane approximation of a surface. Partial differentiation of composite and implicit functions, Taylor's theorem. Unconstrained and constrained extrema.

Unit 3 (Linear Algebra): Matrix algebra, elementary row operations, row and reduced row echelon forms. Linear system of equations, existence and uniqueness of solution. Vector spaces, subspaces, linear independence, basis and dimension. Row, column and null space of a matrix. Linear transformations. Eigenvalues, eigenvectors and diagonalization.

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	

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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. 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 (50% Weightage)			**Component 2: SEE (50% Weightage)**
Subcomponent ►	**SC1**	**SC2**	**SC3**	
Subcomponent Type ►	**Midterm exam**	**Assignment -1**	**Assignment-2**	**100 Marks**
Maximum Marks ►	**50**	**25**	**25**	
CO-1				
CO-2				
CO-3				
CO-4				
CO-5				
CO-6				
The details of SC1, SC2 or SC3 are presented in the Programme Specifications Document.				

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

8. Achieving COs

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

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S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
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 Transcendental, 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

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

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Course Code	MTB101A		
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	23-Oct-2021		
Next Course Specifications Review Date	May-2025		

Course Specifications: Engineering Mathematics - 2

Course Title	Engineering Mathematics - 2
Course Code	MTB102A
Course Type	Core Theory
Department	Applicable for all programmes
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)	3:1:0
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. Solve standard forms of ordinary differential equations

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 (First Order Differential Equation): First order differential equations - Introduction, basic concepts and geometrical meaning. Separable, linear and exact differential equations. Integrating factors and transformations. Applications of first order ordinary differential equations: orthogonal trajectories, growth/decay problems and mixture problems

Unit 2 (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. Cauchy-Euler equations. Application of second order linear differential equations with constant coefficients, mass-spring-dashpot system, electric circuits. System of linear differential equations of first order, solutions by matrix method.

Unit 3 (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

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	

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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. 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 (50% Weightage)			**Component 2: SEE (50% Weightage)**
Subcomponent ►	**SC1**	**SC2**	**SC3**	
Subcomponent Type ►	**Midterm exam**	**Assignment -1**	**Assignment -2**	**100 Marks**
Maximum Marks ►	**50**	**25**	**25**	
CO-1				
CO-2				
CO-3				
CO-4				
CO-5				
The details of SC1, SC2 or SC3 are presented in the Programme Specifications Document.				

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

1. Glyn James, 2016, Advanced Modern Engineering Mathematics, 4 t h e d i t i o n , Pearson Dennis Zill, 2012,
2. A First Course in Differential Equations, 10th edition, Massachusetts, Brooks/Cole
3. Shepley Ross, 2007, Introduction to Ordinary Differential Equations, 4th edition, New York, John Wiley & sons

b. Recommended Reading

1. George Simmons, 2017, Differential Equations with Applications and Historical Notes, 2nd edition, New Jersey, McGraw Hill
2. Dennis Zill and Warren Wright, 2011, Advanced Engineering Mathematics, 4th edition, Jones and Bartlet
3. Erwin Kreyszig, 2015, Advanced Engineering Mathematics, tenth edition, John Wiley & Sons Inc.

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	MTB102A		
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			
Next Course Specifications Review Date			

Course Specifications: Engineering Physics and Laboratory

Course Title	Engineering Physics and Laboratory
Course Code	PHB102A
Course Type	Core Theory and Laboratory
Department	Applicable to all Programmes
Faculty	Engineering and Technology

1. Course Summary:

The aim of this course is to impart concepts of Physics and its application to solve engineering problems. The students are taught the basic topics in modern physics which include wave particle duality, uncertainty principle, Schrodinger's wave equation, lasers and fiber optics. Electrical and mechanical properties of materials will be discussed in relation to the crystal structure. This course also intends to expose the students to the challenges and rewards related to experimental physics. Students gain hands-on experience by conducting experiments in a controlled laboratory environment. Students are trained to conduct experiments related to mechanics, optics and electric circuits. They are trained to analyze the measurements, results and infer appropriate conclusions based on fundamental concepts of physics

2. Course Size and Credits:

Number of credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:1
Total hours of interaction	75
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, electrical conductivity, quantum mechanics, crystal structure and material science, laser and fiber optics
CO - 2	Derive standard relationships in mechanics, electrical conductivity, quantum mechanics, crystal structure and material science, laser & fiber optics, and interpret them
CO - 3	Discuss the applications of mechanics, electrical conductivity, quantum mechanics, crystal structure and material science, laser and fiber optics
CO - 4	Solve problems in mechanics, electrical conductivity, quantum mechanics, crystal structure, material science, 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 – (Elasticity): Review of Elasticity — Expression for Y, h and K in terms of linear and lateral strains (Deformation of a cube)—Poisson's ratio—Twisting couple on a cylinder—Expression for couple per unit twist—Torsion Pendulum -- determination of rigidity modulus of a wire using torsion pendulum—Bending of beams— Geometrical moment of inertia of circular and rectangular cross sections—Single cantilever—Expression for Young's modulus of a cantilever beam

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Unit 2 – (Rigid body dynamics): 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 – (Quantum theory of radiation): Blackbody spectrum—Wien's law—Raleigh-Jeans law— Stefan-Boltzmann law—Planck's quantum theory—Reduction of Planck's formula to Raleigh Jeans and Wien's formulae—Compton effect—Wave particle dualism—de Broglie hypothesis and matter waves—Phase velocity and group velocity of matter waves

Unit 4 – (Quantum Mechanics): Heisenberg's uncertainty principle—Applications of Heisenberg's uncertainty principle—wave function and its properties - Setting up of 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 functions

Unit 5 – (Lasers): 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—Semiconductor laser—Applications of lasers—Lidar—laser isotope separation—laser fusion

Unit 6 – (Optical Fibers): Principle-- Angle of acceptance—Expression for Numerical aperture-- condition for propagation—Intermodal dispersion-- material dispersion—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 7 – (Crystal structure): Space lattice—Bravais lattice—Lattice parameters—unit cell and primitive cell—Crystal systems - Miller indices - Indexing directions and planes in a crystal - Atomic packing fraction and coordination number for simple, body centered and face centered cubic Crystals - Expression for inter planar Spacing - Structures of NaCland diamond crystals— Bragg's law—Identification of cubic crystals using Bragg's law

Unit 8 – (Electrical conductivity of metals): Review of Classical free electron theory - Failure of classical free electron - Quantum free electron theory—Density of States (Qualitative) – Fermi energy – Fermi factor - Effect of temperature on Fermi-Dirac Distribution function

Unit 9 – (Lab Experiments)

1 Determination of the relationship between the torque and angular acceleration of a flywheel
2 Determination of the (i) the moment of inertia of the given disc and (ii) the rigidity modulus of the material of a wire by torsional oscillations 3 Analysis of Powder X-ray diffraction pattern.
4 Determination of Young's modulus of material of a beam by uniform bending method.
5 Determination of radius of curvature of a plano-convex lens by setting up Newton's rings.
6 Determination of the wavelength of prominent spectral lines of Hg source using diffraction grating with minimum deviation method.
7 Determination of thickness of paper by air wedge experiment.

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8 Determination of efficiency of Solar cell.
9 Determination of Planck's constant using LED.
10 Study of I-V characteristics of Zener diode
11 Determination of the frequency response of series and parallel resonance circuit and to find the resonant frequency and quality factor.
12 Determination the width of the forbidden energy gap in a semiconductor diode.
13 Determination of dielectric constant of a material by charging and discharging a capacitor.

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	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		02
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems		
3. Demonstration on a Computer		
Numeracy		13
1. Solving Numerical Problems	13	
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		

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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 (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: 50 %)				SEE (Weightage: 35 %)	Lab (Weightage: 15 %)
	TSC1: (20 %) Midterm exam	TSC2: (10 %) Assignment	TSC3: (10 %) Innovative	LSC4: (10 %) CE	Written exam	LSEE: SEE
	50 marks	25 Marks	25 Marks	25 Marks	100 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	Class room lectures, and demonstrations
3.	Critical Skills	Assignment
4.	Analytical Skills	Class room, assignment
5.	Problem Solving Skills	Class room, assignment

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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, time management, achieving the learning

9. Course Resources

a. 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

b. Recommended Reading

1. Halliday, I.D., Resnick, R and Walker, J (2010) Fundamentals of Physics, 9th Ed, Wiley
2. Richtmeyer, F. K., Kennard, E.H. and Cooper, J.N (2007) Modern Physics, 6th Ed, TMH
3. Beisser, A. (2009) Concepts of Modern Physics, 6th Ed, TMH
4. Kittel, C. (2010) Introduction to Solid State Physics, 8th Ed, Wiley
5. S.O. Pillai (2011), A Textbook of Solid State Physics, 6th Ed, New Age International
6. Srinivasan M.R. (2011) Applied Solid State Physics, 1st Ed, New Age International
7. Giri, P.K., (2005) Physics Laboratory Manual for Engineering Undergraduates, Department of Physics, Indian Institute of Technology Guwahati

***c.* Magazines and Journals**

***d.* Websites**

1. http://nptel.ac.in/
2. Other Electronic Resources

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

10. Course Organization

Course Code	PHB102A		
Course Title	Engineering Physics and Laboratory		
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			
Next Course Specifications Review Date			

Course Specifications: Engineering Mechanics

Course Title	Engineering Mechanics
Course Code	CEF101A
Course Type	Core Theory
Department	Applicable to all Programmes
Faculty	Engineering and Technology

1. Course Summary

This subject deals with laws of engineering mechanics for static and dynamics equilibrium of rigid bodies. They will be trained on application of engineering mechanics to solve practical problems pertaining to static and dynamic equilibrium of rigid bodies. In addition, effects of friction, energy methods for analyzing static and dynamic analysis of rigid bodies will be dealt.

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	Civil 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 and describe the laws of Statics, Friction and Dynamics and their contexts of application.
CO-2. Interpret standard mathematical relationships and apply for solving simple static and dynamic problems in engineering mechanics
CO-3. Calculate moment of inertia, determine centroid, centre of gravity for the structural members
CO-4. Apply the laws of statics and dynamics for the equilibrium analysis of rigid bodies with and without friction
CO-5. Apply energy methods in analyzing of static and dynamic aspects of engineering structures made of rigid bodies

4. Course Contents

Unit 1 (Engineering Mechanics): Branches of mechanics and its importance: Engineering Design , Mechanics in engineering, Introduction to SI units , Basic idealisations - Particle, Continuum, Rigid body and Point force with examples, principles of mechanics with examples- laws of parallelogram, law of transmissibility, gravitation, Classification of force and force systems; Principle of physical independence of forces, Principle of superposition of forces; constraints on rigid bodies and corresponding reactions, Moment of a force, couple, moment of a couple, characteristics of couple, Equivalent force - couple system; Resolution of forces, composition of forces; Numerical problems on moment of forces and couples, equivalent force and couples.

Unit 2 (Analysis of Coplanar Concurrent and Non-Concurrent System of Forces): Varignon's theorem, resultant of Concurrent and non-concurrent force systems. Equilibrium of Structural Systems: Types of forces acting on a body, Free Body diagram Analysis, Lami's Theorem, Equilibrium of connected bodies, types of supports in beams, determination of support reactions, Applications to engineering problems. Classification of Structures –Axial force members, trusses, frames, beams and cables, Numerical Examples.

Unit 3 (Centroid of planes and Moment of inertia of area): Differences between centre of gravity and Centroid, use of axis of symmetry, Centroid of simple built-up sections by integration, Moment of Inertia of planes, radius of gyration, Theorems of moment of inertia, moments of inertia of standard sections by integration, Numerical Examples.

Unit 4 (Friction in Engineering Systems): Laws of friction, angle of friction, angle of repose, cone of friction, Analysis of blocks resting on horizontal and inclined planes; rolling friction, rope friction, Application to wedge and ladder problems, problems involving non concurrent force systems.

Unit 5 (Energy methods in engineering mechanics): Application of principle of virtual work and Castigliano's theorem. Energy relations in rigid bodies- conservation of energy principle, examples on kinetic energy, potential energy and total energy, power as applied to rigid bodies.

Unit 6 (Introduction to dynamics): General principles and types of motions and D'Alembets principle with examples, Newton's laws of motion. Linear motions and projectiles -Motion with uniform velocity and acceleration, motion with varying acceleration, motion of bodies projected horizontally, projection on inclined planes, Numerical examples.

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		30
Demonstrations		0
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
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		**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. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

	Component 1: CE (50% Weightage)			**Component 2: SEE (50 % Weightage)**
Subcomponent ►	**SC1**	**SC2**	**SC3**	
Subcomponent Type ►	**Mid Term**	**Assignment -1**	**Assignment -2**	**100 Marks**
Maximum Marks ►	**50**	**25**	**25**	
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 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, 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. Satheesh Gopi (2010), Basic Civil Engineering, Dorling Kindersley (India) Pvt Ltd
3. R K Rajput (2011), A Text Book of Applied Mechanics, 3rd Edn, Laxmi Publications
4. Richard H. McCuen, Edna Z. Ezzell (2011), "Fundamentals of Civil Engineering: An Introduction to the ASCE Body of Knowledge", CRC press

b. Recommended Reading

1. S. S. Bhavikatti, K. G. Rajashekarappa (2004), Engineering Mechanics, New Age International
2. C. Lakshamanarao, J. Lakshinarashiman, Raju Sethuraman, Srinivasan M.

Sivakumar (1993), Engineering Mechanics: Statics and Dynamics, PHI, New Delhi

c. Magazines and Journals d. Websites

e. Other Electronic Resources

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

10. Course Organization

Course Code	CEF101A		
Course Title	Engineering Mechanics		
Course Leader's Name	As per Timetable		
Course Leader's Contact Details	**Phone:**	+91-804-906-5555	
	E-mail:	hod.ce.et@msruas.ac.in	
Course Specifications Approval Date			
Next Course Specifications Review Date			

Course Specifications: Elements of Electronics Engineering and Laboratory

Course Title	Elements of Electronics Engineering and Laboratory

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Course Code	ECF102A
Course Type	Core Theory and Laboratory
Department	Applicable to all Programmes
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to create a strong foundation of Digital Electronics. The students are taught the basic components of digital systems and the process of their implementation.The students are also taught Boolean algebra, logic gates, basics of memories, and implementation of combinational and sequential digital circuits using logic gates. This course also emphasizes on different types of memories and logic designing platforms and their merits and demerits. Students are trained to employ the principles of digital electronics to implement digital design for the given problem. Basic electronics laboratory deals with practical applications of electronic circuits and their theoretical concepts.

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	Electronics and Communication 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 working principles of PN junction diode, Zener diode, transistors, amplifier configurations, Op-Amps, power supply, logic gates and electronic displays
CO-2. Derive mathematical relationships for electronic devices and circuits
CO-3. Solve simple numerical and design problems related to analog / digital circuits as well as devices
CO-4. Design and analyse operation of standard analog / digital circuits for a given application
CO-5. Conduct experiments as per the standard procedures and tabulate/calculate/plot the measured values
CO-6. Interpret and compare with standard results, and draw conclusions and Write report as per the prescribed format

4. Course Contents

Unit 1 (Basic concepts in Electronics): Semiconductor: p-type, n-type; p-n junction diode, its characteristics, half wave, full wave and bridge type rectifiers, basic filter circuits, Diode as voltage multiplier, clipper and clamper circuit, Zener diode characteristics, Zener diode as a voltage regulator.

Unit 2 (Transistor- BJT): Transistor configurations: CB, CE and CC; Transistor parameters: alpha, beta and gamma, working of transistor as a switch, Amplifier; Transistor biasing – Base, Collector-to-base and Voltage Divider Bias.

Unit 3 (Amplifiers): Differential amplifiers and their transfer characteristics, IC Op-Amps, their ideal and practical characteristics, Op-Amp in different modes as inverting amplifier, noninverting amplifier, summing amplifier, scale changer, differentiator and integrator.

Unit 4 (Power Supplies): Introduction and working of Switched Mode Power Supply (SMPS), Voltage Regulator, Introduction to Inverters and UPS.

Unit 5 (Digital Electronics): Binary, Octal and Hexadecimal number systems and conversions, Boolean Algebra, Truth table of logic gates- AND, OR, NOT, NAND, NOR; Universal gates; Generation of Integrated Circuits- SSI, MSI, LSI and VLSI.

Unit 6 (Laboratory): List of Experiments

1	Forward and Reverse bias V-I Characteristics of a P-N Junction diode
2	Forward and Reverse bias V-I Characteristics of Zener diode
3	Half wave and Full wave Rectifier circuits: a) Output of half/full wave rectifier with and without capacitor filter.
4	Bridge Rectifier circuits: a) Output of bridge rectifier with and without capacitor filter
5	Clipping circuits (Shunt clippers) Clipping circuits (Series clippers)
6	Clamping circuits
7	Characteristics of Op-amp inverting and non- inverting amplifiers
8	Logic Gates circuits: Verification of the truth tables of AND, OR, NOT, NAND, NOR, and EX-OR gates.

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		

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CO-3		3	2										3		
CO-4		3	2										3		
CO-5		3											3		
CO-6		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		33
Demonstrations		02
1. Demonstration using Videos	02	
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		**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. 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 and LSC4), COs are assessed as illustrated in the following Table.

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Focus of COs on each Component or Subcomponent of Evaluation						
Course Outcome	CE (Weightage: 50 %)				SEE (Weightage: 35 %)	Lab (Weightage: 15 %)
	TSC1: (20 %) Midterm exam	TSC2: (10 %) Assignment	TSC3: (10 %) Innovative	LSC4: (10 %) CE	Written exam	LSEE: SEE
	50 marks	25 Marks	25 Marks	25 Marks	100 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	Class room lectures, Assignments, Laboratory instruction
2.	Understanding	Class room lectures, Assignments, Laboratory instructions and experiments
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 Work
7.	Group Work	Laboratory Work
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, examination, Laboratory work
10.	Verbal Communication Skills	Laboratory work
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, examination, Laboratory
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

4. Class Notes
5. Millman and Halkias, 2001, Integrated Electronics, Tata McGraw-Hill Education
6. Robert Boylestad and Louis Nashelsky, Electronic Devices and Circuit Theory, 7th Ed. Prentice Hall
7. Dale R. Patrick, 1989, Electricity and Electronics Laboratory, The Goodheartwillcox Company Inc, Illinois

b. Recommended Reading

1. Albert Malvino, 2006, Electronic Principles, Tata McGraw - Hill Education 2. Donald L. Shilling & Charles Belowl, 1968, Electronic Circuits,New York: McGraw-Hill
3. Tocci R J and Widmer N S, 2001, Digital Systems – Principles and Applications, 8th Ed., Pearson Education India, New Delhi
4. Cooper and Helfrick, 1996, Modern Electronic Instrumentation and Measuring Techniques, 4th print Prentice Hall of India, New Delhi
5. H S Kalsi, 2007, Electronic Instrumentation, TMH, 2nd Edition
6. R A Gaikwad, 2001, Op-Amps and Linear Integrated Circuits, PHI, 4thedition
7. Millman and Grabel, 1999, Microelectronics, 2nd Ed. Tata McGraw-Hill
8. Louis R. Nardizzi, 1973, Basic circuits and electronics experiments, Van Nostrand
9. George B. Rutkowski, 1984, Basic electricity for electronics, Bobbs-Merrill Educational Pub.
10. Russell L. Meade, 2003, Foundations of Electronics: Circuits and Devices,Delmar learning, a division of Thomson learning, Inc.

***c.* Magazines and Journals**

1. Electronics For You
2. IEEE Transaction on Circuits and System I and II

***d.* Websites**

1. http://www.electronics-lab.com
2. http://www.labmanager.com
3. http://electronicsforu.com
4. http://www.lifescienceleader.com

e. Other Electronic Resources

1. https://ocw.mit.edu/index.htm MultiSim software
2. Analog trainer kit
3. Digital trainer kit
4. Discrete electronic components

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10. Course Organization

Course Code	ECF102A		
Course Title	Elements of Electronics Engineering and Laboratory		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	080-49065555
		E-mail:	hod.ec.et@msruas.ac.in
Course Specifications Approval Date			
Next Course Specifications Review Date			

Course Specifications: Engineering Drawing

Course Title	Engineering Drawing
Course Code	MEF103A
Course Type	Core Theory and Laboratory
Department	Applicable to all Programmes
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 and isometric projection of points, lines, planes and solids. The students will be taught sections and development of solids. The students will be equipped to visualize and apply principles of orthographic projection to given application. The students will also be trained to use CAD tool to carry out these geometric projections.

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	2:0:1
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mechanical and Manufacturing 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, 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/3D 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- Points and Lines): 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 projection), True and apparent lengths, True and apparent inclinations to reference planes (simple problems).

Unit 3 (Orthographic Projections - Planes (First Angle Projection): Definitions–projections of plane surfaces–triangle, square, rectangle, pentagon, hexagon and circle. Planes in different positions by change of position method only.

Unit 4 (Orthographic Projections – Solids (First Angle Projection): Definitions – Projections of solids– cube, prisms, cylinder, pyramids, cones and tetrahedron in different positions.

Unit 5 (Orthographic Projections – Section of Solids and Development of Surfaces (First Angle Projection): Section planes, Sections, Section views, Apparent shapes and True shapes of sections of right regular prisms, pyramids, cylinders and cones resting in simple positions.

Unit 6 (Isometric Projections using Isometric Scale) : Section planes, Sections, Section views, Apparent shapes and True shapes of sections of right regular prisms, pyramids, cylinders and cones resting in simple positions. Application of Projection of points and lines to given situation.

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		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		30
1. Course Laboratory	00	
2. Computer Laboratory	30	
3. Engineering Workshop / Course/Workshop /	00	
Kitchen		
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**

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7. Course Assessment and Reassessment

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

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

	Component 1: CE (50% Weightage)			Component 2: SEE (50 % Weightage)
Subcomponent ▶	SC1	SC2	SC3	
Subcomponent Type ▶	Mid Term	Assignment -1	Assignment -2	100 Marks
Maximum Marks ▶	50	25	25	
CO-1				
CO-2				
CO-3				
CO-4				
CO-5				
CO-6`				

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

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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	MEF103A	
Course Title	Engineering Drawing	
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		
Next Course Specifications Review Date		

Course Specifications: Constitution, Human Rights and Law

Course Title	Constitution, Human Rights and Law
Course Code	TSN101A
Course Type	Ability Enhancement Compulsory Course
Department	Applicable to all Programmes
Faculty	Engineering and Technology

1. Course Summary

This course aims at enabling students understand the key principles of Indian Constitution, Human Rights and Law. The course facilitates the understanding of the framework of Indian constitution and the judicial and the legal systems that guides Indian citizens. It aims at building awareness about the application of Human Right principles and Law. It allows students to work towards the formulating realistic solutions for protection of human 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	School of 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. Explain the key principles of the Indian Constitution
CO-2. Explain Indian legal system and judicial structure that govern the citizens
CO-3. Discuss UN Declaration of Human Rights
CO-4. Discuss the scope and application of Human Rights Principles and Law
CO-5. Suggest strategies for protection of human rights and resolving legal issues in compliance with applicable laws

4. Course Contents

Unit 1 (Constitution of India): The framework of Constitution of India, Constituent Assembly, The Constitution and the government, The constitution and the judiciary, The constitution and the legislature.

Unit 2 (Introduction to Law): Indian Legal System and Judicial Structure, Liability under the Law, Issues relating to Good Corporate Governance, Company Law.

Unit 3 (Concept of Human Rights and Duties): Inherent, inalienable, universal, indivisible, values, dignity, liberty, equality, justice, unity in diversity, classification of rights, classification of duties, correlation of rights and duties, need for balance between rights and duties, freedom and responsibility.

Unit 4 (International Human Rights Standards and UN): Universal declaration of human rights 1948, international covenant on civil and political rights 1966, international covenant on economic, social and cultural rights 1966, UN system and human rights, convention on elimination of all forms of racial discrimination 1965, convention on elimination of all forms of discrimination against women 1979, convention on the rights of the child 1989, UN

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declaration and duties and responsibilities of individuals 1997, UN agencies to monitory compliance such as UN high commission for human rights.

Unit 5 (Contract Law and Disputes): Formation of Contract: offer and acceptance, Terms of Contract: avoidance, representation, illegality, Breach of Contract and Remedies, Industrial Disputes Act, Negligence, Trespass and Breach of Statutory Duty, Litigation, Arbitration, Judicial Remedies.

Unit 6 (Intellectual Property Law): Copyright, Protection and Infringement of Copyright, Trade Marks, Protection of Trade Marks and Passing-off, Patents, Ownership and Protection of Patents, Product Liability, Government Schemes for IPR Protection.

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		2
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		0
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		0
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	

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5. Hospital	00	
6. Model Studio	00	
Others		
1. Case Study Presentation	00	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**

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 (CE or SEE) or subcomponent of CE (SC1, SC2), COs are assessed as illustrated in the following Table.

	Component 1: CE (50% Weightage)		**Component 2: SEE (50% Weightage)**
Subcomponent ▶	**SC1**	**SC2**	
Subcomponent Type ▶	**Midterm Exam**	**Assignment**	**50 Marks**
Maximum Marks ▶	**25**	**25**	
CO-1	X	X	X
CO-2			X
CO-3		X	X
CO-4	X		
CO-5	X	X	X

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

8. Achieving COs

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

S. No	**Curriculum and Capabilities Skills**	**How imparted during the course**
1.	Knowledge	Face to face lectures

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2.	Understanding	Face to face lectures, group discussions
3.	Critical Skills	
4.	Analytical Skills	Face to face lectures, activities, group discussions, assignments
5.	Problem Solving Skills	
6.	Practical Skills	Face to face lectures, activities, group discussions, course work
7.	Group Work	Course work, practice, assignment, group discussion
8.	Self-Learning	Course work, practice, assignment, group discussion
9.	Written Communication Skills	Face to face lectures, Course work, practice, assignment, group discussion
10.	Verbal Communication Skills	Face to face lectures, Course work, practice, assignment, group discussion
11.	Presentation Skills	
12.	Behavioral Skills	Course work, practice, assignment, group discussion, presentation practice, role plays
13.	Information Management	Assignment
14.	Personal Management	Face to face lectures
15.	Leadership Skills	Face to face lectures, group discussions

9. Course Resources

a. Essential Reading

1. Course notes
2. Tulsian, PC. (2008) Business Law, Tata McGraw Hill, New Delhi
3. Donnelly, J. (1998) International Human Rights, 2nd edn, Westview Press

b. Recommended Reading

1. Gulshan , S. S and Kapoor, G. K. (2005) Business Law including Corporate Laws, New Age International (P) Ltd. Publishers, New Delhi
2. Perry, M. (1998) The Idea of Human Rights, Oxford University Press
3. K Swamyraj (2017), Law of Contract (General Principles), God's Grace Publication, New Delhi
4. D D Basu (1983), Constitutional Law of India, Lexis Nexis Butterworths Publication, Nagpur
5. Introduction to Intellectual Property Theory and Practice (1997), World Intellectual Property Organisation, Geneva
6. Smith, R. (2007) Textbook on international human rights 3rd edn, Oxford University Press

c. Magazines and Journals d. Websites

1. http://industrialrelations.naukrihub.com/industrial-relation-policy.htm
2. http://labour.nic.in/
3. http://whitepapers.businessweek.com/tlist/Legal-Environment.html

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4. 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	TSN101A		
Course Title	Constitution, Human Rights and Law		
Course Leader's Name	As per Timetable		
Course Leader's Contact Details	**Phone:**	080-49065555	
	E-mail:	School of Law	
Course Specifications Approval Date			
Next Course Specifications Review Date			

Course Specifications: Engineering Chemistry and Laboratory

Course Title	Engineering Chemistry and Laboratory
Course Code	CYB104A
Course Type	Core Theory and Laboratory
Department	Applicable to all Programmes
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)	3:0:1
Total Hours of Interaction	75
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

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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 – electro less 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-Cadmium, Nickel-Metal hydride, Zinc – Air, Lithiumion 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– Potentialuses of nanomaterials in electronics, robotics, computers, sensors, vehicles and transportation – Medical applications of nanomaterials.

Unit 9 – (Lab 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)**

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	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		35
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		**85**

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7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. 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 (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: 50 %)				SEE (Weightage: 35 %)	Lab (Weightage: 15 %)
	TSC1: (20 %) Midterm exam	TSC2: (10 %) Assignment	TSC3: (10 %) Innovative	LSC4: (10 %) CE	Written exam	LSEE: SEE
	50 marks	25 Marks	25 Marks	25 Marks	100 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

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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 and Laboratory		
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			
Next Course Specifications Review Date			

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Course Specifications: Elements of Mechanical Engineering and Workshop Practice

Course Title	Elements of Mechanical Engineering and Workshop Practice
Course Code	MEF104A
Course Type	Core Theory
Department	Applicable to all Programmes
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, refrigeration and air-conditioning and power transmission elements. Students are also exposed to basic operations and applications of machine tools.

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	2:0:1
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mechanical and Manufacturing Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Demonstrate the understanding on Classification of energy sources, energy conversion systems, mechanical power transmission systems, machine tools and processes
- **CO-2.** Describe various energy conversion systems, mechanical power transmission systems and machine tools
- **CO-3.** Explain the working principle of refrigeration systems, biomass conversion technologies and machining operations
- **CO-4.** Solve numerical problems on IC engines and mechanical power transmission systems
- **CO-5.** Apply principles of energy conversion systems, power transmission systems, machining processes and mechanical joints to practical applications

4. Course Contents

Unit 1 (Energy Sources and its Conversion Devices): Energy sources and their classification, Fuels and their properties. Bio-mass energy, OTEC, Solar energy, Wind energy, Geo-thermal energy, Tidal energy, Nuclear Energy. Demonstration of Gas Turbine

Unit 2 (Boilers and Accessories): Steam boilers – classification, Lancashire boiler, Babcock and Wilcox boiler; working and function of boiler mountings and accessories. Demonstration of Steam Turbine

Unit 3 (Hydraulic Pumps and IC engines): Classification, Principles and operations of Reciprocating and rotary types of pumps and compressors.
Internal Combustion Engines: Classification of IC Engines, engines components, 2 and 4–Stroke Petrol and diesel engines, P-V diagrams for Otto and Diesel cycles, IC engine performance numerical on IC engines, electric and Hybrid vehicles. Demonstration of Pumps, Blower Compressors and Multi-cylinder Engine.

Unit 4 (Refrigeration and Air Conditioning): Properties of refrigerants, Performance of Refrigeration System - Refrigerating effect, Ton of Refrigeration, Ice making capacity, COP, Relative COP, Unit of Refrigeration, Energy Efficiency Ratio (EER). Principle and working of vapour compression refrigeration, vapour absorption refrigeration, comparison of vapour compression and vapour absorption refrigeration. Principles and applications of air conditioners, Room air conditioner, automotive air conditioning system

Unit 5 (Mechanical Power Transmission): Belt Drives - Classification and applications,Length of belt, Velocity ratio, Creep and slip, Idler pulley, stepped pulley and fast and loose pulley, belt and pulley construction. Demonstration of Open and Cross Belt drive. Applications of chain drive and rope drives. Gear Drives: Definitions, Terminology, types anduses, Gear Drives and Gear Trains – Simple problems on gear drives. Demonstration of Simple and Compound Gear Trains. Importance of machining and machine tools

Unit 6 (Machine Tools and Mechanical Joints): Lathe - Principle of working of a Centre Lathe, Parts of a lathe, Lathe Operations. Drilling Machine – Principle of working and classification of drilling machines, types of drilling machines, drilling operations. Demonstration of working of Lathe and drilling machines along with different operations performed. Mechanical Joints: Temporary and permanent fasteners- Threaded fasteners, Riveted joints, welded joints, Knuckle joint, cotter and pin joints, couplings. Demonstration of Fitting operations, Sheet Metal operations, Arc Welding, Fasteners and Couplings.

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		

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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		40
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		20
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. 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. 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.

	Component 1: CE (50% Weightage)			Component 2: SEE (50 % Weightage)
Subcomponent ►	SC1	SC2	SC3	
Subcomponent Type ►	Mid Term	Assignment -1	Assignment -2	100 Marks
Maximum Marks ►	50	25	25	
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 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. 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

10. Course Organization

Course Code	MEF104A		
Course Title	Elements of Mechanical Engineering and 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			
Next Course Specifications Review Date			

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Course Specifications: Elements of Electrical Engineering and Laboratory

Course Title	Elements of Electrical Engineering and Laboratory
Course Code	EEF105A
Course Type	Core Theory and Laboratory
Department	Applicable to all Programmes
Faculty	Engineering and Technology

1. Course Summary

This course deals with basic principles and concepts of electric and magnetic circuits. Students are taught construction, principle of operation, working, characteristics of DC machines, transformers and AC rotating machines. They are introduced to fractional-kW motors, special purpose machines and facilitated to understand measuring instruments, domestic wiring and earthing techniques. Basic electrical laboratory deals with practical applications of circuits and their theoretical concepts.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:1
Total Hours of Interaction	75
Number of Weeks in a Semester	15
Department Responsible	Electrical 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 and explain various laws of electric circuits, magnetic circuits and their significance, phasor diagrams for electrical elements

CO-2. Explain construction, principle of operation, working and characteristics of DC machines, transformers, AC rotating machines and their applications

CO-3. Derive equations for electrical circuits, magnetic circuits and performance of various AC and DC machines

CO-4. Solve problems on electric circuits, magnetic circuits, DC machines, transformers and AC rotating machines

CO-5. Conduct experiments as per the standard procedures and tabulate/calculate/plot the measured values

CO-6. Interpret and compare with standard results, and draw conclusions and Write report as per the prescribed format

4. **Course Contents**

Unit 1 (Circuit Analysis Technique-I): DC Fundamentals: Circuit elements, voltage and current division, Ohm's law and Kirchhoff's laws, mesh analysis, nodal analysis, source transformations, application of star delta transformation, Thevenin's theorem, maximum power transfer theorem, superposition theorem.

Unit 2 (Circuit Analysis Technique-II): A.C. Fundamentals: Sinusoidal voltage and currents, period, frequency, instantaneous, peak, average, r.m.s. values, peak factor and form factor, phase difference, lagging, leading and in phase quantities. Simple R, L and C circuits.

Unit 3 (Magnetic Circuits): Magnetic effect of electrical current, cross and dot convention, right hand thumb rule and cork screw rule, Fleming's right hand rule, Fleming's left hand rule, Faraday's law of electromagnetic induction, statically and dynamically induced EMF's, concepts of m.m.f, flux, flux density, reluctance, permeability and field strength, basic analogy between electric and magnetic circuits.

Unit 4 (DC Machines): Constructional details, working principle and methods of excitation of DC machine as a generator and a motor. EMF equation of generator, relation between induced EMF and terminal voltage with brush contact drop, back EMF, torque equation of a DC motor.

Unit 5 (Transformers and AC Rotating Machines): Single Phase Transformers: Necessity of transformer, Constructional Details (core and shell types), Principle of operation, Ideal Transformer and Practical Transformer. EMF equation, Losses, Transformer Test, Circuit Model of Transformer, Determination of Parameters of Circuit Model of Transformer, Impedance shifting, Efficiency and Regulation Calculations
Three phase induction machine: Constructional details, principle of operation, slip and rotor frequency.

Unit 6 (Domestic Wiring): Domestic wiring, concealed conduit wiring, two-way and three-way control

Unit 7 (Laboratory): List of Experiments

No.	Course Content for Laboratory
1	Verification of KVL and KCL for DC circuits
2	Verification of superposition theorem
3	Verification of Thevenin's theorem
4	Verification of maximum power transfer theorem
5	Verification of mesh analysis
6	Verification of node analysis
7	Determination of relationship between phase and line voltages; Phase and line currents in a three phase system
8	Determination of efficiency of a single phase transformer
9	Analysis of load characteristics of DC shunt motor
10	Wiring of two-way and three-way switching of lamp

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	2				2	2			1		1	3	2	1
CO-2	3	2				2	2					1	3	2	1
CO-3	3	2	2									1	3		1
CO-4	3	3	2		2				1	1		1	3	2	1
CO-5	3	3	3	2	2	2			1	1	1	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		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	30	
Practical Work		30
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. 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. 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 and LSC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation						
Course Outcome	CE (Weightage: 50 %)				SEE (Weightage: 35 %)	Lab (Weightage: 15 %)
	TSC1: (20 %) Midterm exam	TSC2: (10 %) Assignment	TSC3: (10 %) Innovative	LSC4: (10 %) CE	Written exam	LSEE: SEE
	50 marks	25 Marks	25 Marks	25 Marks	100 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, 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

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

9. Course Resources

a. Essential Reading

1. Course notes
2. Edward Hughes, 2011, Electrical and Electronics Technology, 10th edition, Dorling Kindersley India Pvt. Ltd.
3. Del Toro V. 2008, Electrical Engineering Fundamentals, PHI

b. Recommended Reading

1. Mittle V. and Arvind Mittle, 2007, Basic Electrical and Electronics Engineering, Tata McGraw Hill, New Delhi
2. Delton Horn T. 1993, Basic Electricity and Electronics, McGraw-Hill Limited,
   Europe

***c.* Magazines and Journals**

1. IEEE Circuits and Designs magazine

***d.* Websites**

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

e. Other Electronic Resources

1. MULTISIM/ PROTEUS

10. Course Organization

Course Code	EEF105A		
Course Title	Elements of Electrical Engineering and Laboratory		
Course Leader's Name	As per Timetable		
Course Leader's Contact Details	**Phone:**	+91-804-906-5555	
	E-mail:	hod.ee.et@msruas.ac.in	
Course Specifications Approval Date			
Next Course Specifications Review Date			

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Course Specifications: Elements of Computer Science and Engineering

Course Title	Elements of Computer Science and Engineering and Laboratory
Course Code	CSF106A
Course Type	Core Theory and laboratory
Department	Applicable to all Programmes
Faculty	Engineering and Technology

1. Course Summary

This course is intended to provide an understanding of the elements of computer science and engineering and development of computer programs using algorithmic and programming constructs, for students across streams. Elements and methods of computer science and engineering and their applications to engineering computational problems are discussed using illustrative examples. Students are taught the methodology of solving computational problems algorithmically, programming concepts and constructs, basic algorithms and data structures. They are also exposed to the practice of software development, modern computing systems and their scope for engineering applications.

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:1
Total Hours of Interaction	75
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 and methodology of Computer Science and Engineering
CO-2. Explain the basic principles and techniques of algorithms and programming
CO-3. Select appropriate approach to solve a computational problem
CO-4. Design an algorithmic solution and draw a flow chart of the solution
CO-5. Develop computer programs for moderately complex problems **CO-6.** Test and validate developed computer programs

4. Course Contents

Unit 1 (Introduction): Computers and other computing devices, interface between Computer Science and Engineering (CSE) and other disciplines, idea of computing, nature and purpose of CSE, software and computer programs, practice of CSE. Relationship between data, information and knowledge.

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Unit 2 (Problem Solving using Computers): Algorithmic problem solving. Flowcharts: symbolsand meaning. Drawing flowcharts for simple problems. Fundamental algorithms, efficiency. Example of algorithms in practice: Illustration of algorithms for numerical computation,simulation and data processing in engineering domains. Lab Exercises on Problem Solving Using Computers.

Unit 3 (Building Blocks of Computer Programs): Programming languages and process of compiling and program execution. Data representation and storage. Python programming language, IDEs and Workbooks. Data types, variables and keywords. Program structure.Simple data manipulation and logical statements, lists, tuples, sets and dictionaries, conditional and looping control statements, functions, nested expressions, recursion. Plottingand other utility libraries. Lab Exercises on Building Blocks of Computers.

Unit 4 (Elements of Computer Programming): Elements of good programming style, decomposing problems, moving from algorithm to code, random number generation, testingand validation of programs. Lab Exercises on Problem Solving Using random number generation.

Unit 5 (Basic Algorithms and Data Structures): Iterative and recursive algorithms, algorithms for search, sorting algorithms, idea of a data structure, basic data structures andalgorithms, and their use. Lab Exercises on Problem Solving Using Iterative and recursive algorithms.

Unit 6 (Algorithm Design): Recursion, Brute force, Divide and conquer, Greedy approaches. Introduction to Backtracking and Dynamic programming.

Unit 7 (Modern Computing Systems): Software development process, operating systems, network of computers, distributed computing, high performance computing, Internet andWeb technology, cloud computing.

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

Meenha G. Rao

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		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		**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. 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

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Course Outcome	CE (Weightage: 50 %)				SEE (Weightage: 35 %)	Lab (Weightage: 15 %)
	TSC1: (20 %) Midterm exam	TSC2: (10 %) Assignment -1	TSC3: (10 %) Assignment -2	LSC4: (10 %) CE	Written exam	LSEE: SEE
	50 marks	25 Marks	25 Marks	25 Marks	100 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, 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	--

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9. Course Resources

a. Essential Reading

1. Class notes
2. Dromey, R. G., 1982, How to Solve It by Computer, New Delhi: Pearson Education.

b. Recommended Reading

1. Downey, A. B., 2016, Think Python: How to Think like a Computer Scientist, O'Rielly.
2. Polya, G., 1990, How to Solve It: A New Aspect of Mathematical Method, 2nd edn. New Delhi: Penguin Books.
3. Aho, A. V., Hopcropt, J. E., and Ulman, J. D., 1974, The Design and Analysis of Computer Algorithms, New Delhi: Pearson Education.

c. Magazines and Journals

1. Quanta Magazine Computer Science Section, http://www.quantamagazine.org/ computerscience
2. Dr. Dobb's Journal, http://drdobbs.com/
3. Lifehacker, https://lifehacker.com/

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/

2. *Course Organization*

Course Code	CSF106A		
Course Title	Elements of Computer Science and Engineering		
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			
Next Course Specifications Review Date			

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Course Specifications: Professional Communication

Course Title	Professional Communication
Course Code	TSN102A
Course Type	Ability Enhancement Compulsory Course
Department	Applicable to all Programmes
Faculty	Engineering and Technology

1. Course Summary

This course aims at equipping students with the skills required for effective communication in professional context. The students will be guided through professional practices of written and oral communication. Students will be sensitized to the importance of professional etiquette. Students will be taught to apply oral and written communication skills in a given situation.

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	Directorate of Transferable Skills and Leadership Development
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. Apply the concepts of grammar for communication
CO-2. Compose precise paragraphs
CO-3. Demonstrate professional etiquette
CO-4. Demonstrate appropriate verbal and non-verbal communication in the given context **CO-5.** Develop professional written document

4. Course Contents

Unit 1 (Grammar for Effective Communication): Sentence formation, sentence types, different parts of speech, adjectives and articles, verbs and preposition, present and past tense, future tense, use of participles in different tenses, usage of tenses, rules of subject verb agreement, Direct and indirect sentences, usage of direct and indirect sentences

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Unit 2 (Communication – Verbal: Written): Paragraph Writing: Structure of a paragraph – topic sentence, supporting sentence, conclusion sentence, functions of paragraph, paragraph patterns, paragraph writing principles – coherence, unity, order, length; Précis Writing: Paraphrasing techniques, Usage of appropriate words;
Report Writing: Purpose of report writing, report format, use of language while report writing

Unit 3 (Communication-Nonverbal): Meaning, Nature and importance, Kinesics, Proxemics, Time, Paralanguage, Touching Behavior, Body Language, effects of nonverbal communication on verbal communication

Unit 4 (Professional Etiquette): Etiquette and its importance, types of etiquette - email etiquette, telephone etiquette, conversation; Body language in conversation, tones in conversation, conversation manners, stages of conversation – introduction, feed forward, close, order of introduction, conversation barriers

Unit 5 (Presentation): The importance of presentation skills, various stages of presentation planning – development of structure and style, interpersonal sensitivity, presentation accessories and equipment, time management during presentation, stages of presentation – introduction, body and conclusion, presentation etiquette

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

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

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		0

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1. Solving Numerical Problems	00	
Practical Work		04
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	04	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		06
1. Case Study Presentation	02	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	02	
5. Group Discussions	02	
6. Discussing Possible Innovations	00	
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 is 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 (CE or SEE) or subcomponent of CE (SC1, SC2), COs are assessed as illustrated in the following Table. Focus of CO's on each Component or Subcomponent of Evaluation:

	Component 1: CE (50% Weightage)		**Component 2: SEE (50% Weightage)**
Subcomponent►	**SC1**	**SC2**	
Subcomponent Type ►	**Midterm Exam**	**Assignment**	**50 Marks**
Maximum Marks►	**25**	**25**	
CO-1	X	X	X
CO-2			X
CO-3		X	X
CO-4	X		
CO-5	X	X	X

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

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Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

1. Class Notes
2. Raman M and Sharma S (2004) Technical Communication: Principles and Practice. New Delhi: Oxford University Press
3. Hory Sankar Mukherjee, (2013), Business Communication, Oxford University Press
4. 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:
3. An Integrated Approach, Tata McGraw Hill
4. Kaul, Asha (2007) Effective Business Communication, Prentice Hall India
5. Bienvenu, Sherron (2008) The Presentation Skills Workshop, Prentice Hall

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6. KavitaTyagi and Padma Misra (2011) Professional Communication, PHI Learning Private Limited, New Delhi

c. Magazines and Journals d. Websites

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

e. Other Electronic Resources

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

10. Course Organization

Course Code	TSN102A		
Course Title	Professional Communication		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	+91-80-453666666
		E-mail:	director.tsld@msruas.ac.in
Course Specifications Approval Date			
Next Course Specifications Review Date			

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Course Specifications: Engineering Mathematics - 3

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

1. Course Summary

This course deals with vector calculus, various transform techniques in the context of engineering problems. The rudimentary principles and important theorems in vector calculus are taught in this course. The assumptions, principles and distinguishing features of Fourier series, Fourier transform and Laplace transform are emphasized. This course also covers the underlying principles and applications of transform techniques in various engineering disciplines. This course also aims at solving engineering problems associated with Fourier series, Fourier transform and Laplace transform methods using MATLAB.

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	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 and explain the important theorems in Fourier series, transforms and vector integral calculus

CO-2. Solve simple problems in Fourier series, transforms and vector calculus

CO-3. Apply Fourier series, transforms and vector calculus in solving complex real world engineering problems

CO-4. Implement the programs to solve system of linear equations and non-linear equations of single variable using MATLAB

CO-5. Apply interpolation and numerical integration method in analyzing some real world problems

4. Course Contents

Unit 1 (Fourier Series and Fourier Transform): Periodic functions, Dirichlet's conditions for convergence of Fourier series, Fourier series for a periodic function of period T, half range Fourierseries, complex Fourier series. Fourier Transform - Definition, Fourier transform of elementary functions, properties. Inverse Fourier transform, solution of initial value problems.

Unit 2 (Vector Calculus): Review of vector algebra, vector and scalar fields, derivatives of vectorvalued 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 (MATLAB): Introduction to MATLAB, Basic algebraic and matrix operations, built-in andcommand line functions, Plots Scripts and functions. Interpolation - Lagrange interpolation, Newton's divided difference interpolation, Newton-Raphson method and Numerical solution of system of linear equations by Gauss Seidel method, MATLAB function for real Fourier series, complexFourier series and harmonic series, Newton-Cotes' quadrature, trapezoidal, Simpson's 1/3 and Simpson's 3/8 rules, and Gaussian quadrature.

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

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

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	

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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**

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 and Warren Wright, 2011, Advanced Engineering Mathematics, 4th edition, Jones and Bartlett
3. Erwin Kreyszig, 2015, Advanced Engineering Mathematics, tenth edition, John Wiley & Sons Inc.

b. Recommended Reading

1. L. Chanparro, 2010, Signals and Systems using MATLAB, Academic Press
2. S.D. Stearns and D. R. Hush, 2011, Digital Signal Processing with Examples in MATLAB, CRC Press

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	MTB103A		
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	23-Oct-2020		
Next Course Specifications Review Date	May-2025		

3.

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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 develop an understanding of structure of metals, ceramics, polymers and composites. Physical and mechanical properties of engineering materials will be discussed. Concepts of strengthening mechanisms, creep, fracture and fatigue in engineering materials will be taught.
Students will be exposed to application of phase diagrams, TTT diagrams and heat treatment methods. Students will be able to correlate the defects with respect to mechanical behavior. Students will develop an understanding on various advanced materials with respect to physical properties of 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 crystalline structures in solids, engineering materials and mechanical properties of metals and their alloys
CO-2. Describe phase diagrams and heat treatment processes of metals
CO-3. Discuss the importance of non-metals and smart materials depending on thefunctionality
CO-4. Solve numerical problems in diffusion of solids and phase diagrams of metals
CO-5. Analyse various modes of failure and correlate it to material behavior
CO-6. Identify different methods for improving the properties of materials for specific requirements and applications

4. Course Contents

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Unit 1 (Introduction to Crystal Structure): Classification of materials, Advanced Materials, Future materials
Overview of Crystalline Structure of solids - Atomic bonding in solids, Crystal structures,Crystalline and non- crystalline materials; Miller indices
Imperfections in Solids - Point defects, Theoretical yield point, Line defects and dislocations, Interfacial defects, Bulk or volume defects, Atomic vibrations
Diffusion - Diffusion mechanisms, Steady and non-steady state diffusion, Factors that influence diffusion

Unit 2 (Mechanical Behaviour and Failure of Materials): Concept of stress and strain; Stress straindiagram; properties of engineering materials; Hooke's law; Poisson's ratio; elastic modulus; Elasticdeformation, Plastic deformation, Interpretation of tensile stress-strain curves, Yield criteria and macroscopic aspects of plastic deformation, Plastic deformation due to slip and twinning.
Hardness Tests - Overview, Need, Types of testing - Rockwell, Brinell and Vickers test. Fatigue and Fracture – Stage I, II and III fracture, Ductile and brittle fracture, Impact fracture, Ductile brittle transition.
Creep - Generalized creep behaviour, Stress and temperature effects.

Unit 3 (Phase Diagram): Equilibrium phase diagrams, Particle strengthening by precipitation, Iron-Iron carbide system, Phase transformations, Transformation rate effects and TTT diagrams, Microstructure and property changes in iron-carbon system
Strengthening Mechanisms - Mechanisms of strengthening in metals, Recovery, recrystallization and grain growth

Unit 4 (Metal Alloys and Heat Treatment of Metals): Metals and Alloys - Types of metals and alloys, Ferrous alloys – low carbon steels, medium carbon steels, high carbon steels, stainless steels, gray cast iron, ductile iron, white and malleable cast iron
Nonferrous alloys – aluminium alloys, copper alloys, magnesium alloys, zinc alloys, titanium, Superalloys, Comparison of Ferrous and Non-ferrous alloys
Heat Treatment of Metals - Annealing Processes, Stress relief, normalising, Hardening, Tempering, Austempering; Surface hardening like case hardening, carburising, cyaniding, nitriding, induction hardening, Precipitation hardening; Hardenability, Jominy end-quench test

Unit 5 (Non-Metals and Advanced Materials): Ceramics – Ceramic Structures, Mechanical properties, Types and applications of ceramics Polymers – Polymer types, Mechanical behaviour of polymers, Polymer applications and processing
Composites – Classification and Types of composites, Properties, Processing and their Applications
Smart materials – overview of piezo-electric materials, dielectric materials, shape memory alloys, photovoltaic materials, battery materials, fuel cell materials, ferromagnetic materials, optic materials, thermal insulation materials
Nanomaterial - Importance and classification of nanomaterials, Applications
Biomaterials – Overview of human implant materials, bioceramics and dental ceramics
Overview of Characterisation techniques – Metallurgical Microscope, Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), X-Ray diffraction (XRD)

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3		2					1	1			3	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
CO-6	3	3	3		2				1	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		40
Demonstrations		03
1. Demonstration using Videos	03	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	0	
Numeracy		02
1. Solving Numerical Problems	02	
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	

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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 (50% Weightage)				**Component 2: SEE (50% Weightage)**
Subcomponent ►	**SC1**	**SC2**	**SC3**	**SC4**	
Subcomponent Type ►	**Term Test**	**Term Test**	**Assignment**	**Group Task**	**100 Marks**
Maximum Marks ►	**25**	**25**	**25**	**25**	
CO-1					
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
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, 2010, Materials Science and Engineering: An ntroduction, 8th Edition, Wiley Publications.

b. Recommended Reading

1. H. Van Vlack, 2002, Elements of Materials Science and Engineering, 6th Edition, Addison-Wesley.
2. V. Raghavan, 2004, Materials Science and Engineering: A First Course, 5th Edition, PHI.
3. Donald R. Askeland, 2011, The Science and Engineering of Materials, 6th Edition, Chapman and Hall.
4. Z. L. Wang and Z. C. Kang, 2012, Functional Materials: Structural Evolution and Structure Analysis, Plenum, New York.

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

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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

<table>
<tr><td>Course Code</td><td colspan="3">MEC201A</td></tr>
<tr><td>Course Title</td><td colspan="3">Materials Science</td></tr>
<tr><td colspan="2">Course Leader's Name</td><td colspan="2">As per Timetable</td></tr>
<tr><td colspan="2" rowspan="2">Course Leader's Contact Details</td><td>Phone:</td><td>+91-804-906-5555</td></tr>
<tr><td>E-mail:</td><td>hod.me.et@msruas.ac.in</td></tr>
<tr><td colspan="2">Course Specifications Approval Date</td><td colspan="2">23-Oct-2020</td></tr>
<tr><td colspan="2">Next Course Specifications Review Date</td><td colspan="2">May-2025</td></tr>
</table>

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Course Specifications: Engineering Thermodynamics

Course Title	Engineering Thermodynamics
Course Code	MEC202A
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 taught macroscopic and microscopic approach to thermodynamic systems and concept of thermodynamic equilibrium. Zeroth, First, Second and Third Law of Thermodynamics and their application for energy conversion will be taught. Students will be able to differentiate between availability and available energy for energy conversion, identify different thermodynamic processes and relate their properties to estimate the work and heat interaction.

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. Define thermodynamic system, properties, processes, thermodynamic equilibrium, work and heat, available and unavailable

CO-2. State and explain Zeroth, First, Second and Third Law of Thermodynamics

CO-3. Explain various thermodynamic processes and cycles on P-V, T-s and h-s diagrams of steam and air as working fluids

CO-4. Derive steady flow energy equation and second law efficiencies for given thermodynamic systems

CO-5. Solve numerical using various thermodynamic relations

CO-6. Apply work and heat interactions to evaluate various thermal systems

4. Course Contents

Unit 1(Fundamental Concept and Definitions): Thermodynamics definition and scope, Microscopic and Macroscopic approaches. Types of thermodynamic Systems, Characteristics of system boundary and control-volume, Thermodynamic properties; intensive and extensive properties. Thermodynamic state and processes, Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium, Zeroth law of thermodynamics, Temperature concepts, scales, fixed points and measurements

Unit 2 (Properties of Pure Substances: Concept of pure substance; phase equilibrium thermodynamic property diagrams (P-V-T), Steam and its properties: Steam and its formation; T-h, p-h and h-s diagrams; Wet steam; Dry saturated steam; Super-heated steam, dryness fraction; Quality of steam; triple point, sublimation line; Tables of thermodynamic properties; Mollier chart

Unit 3 (Work and Heat Mechanics): Definition of work and its limitations; Thermodynamic definition of work; examples, sign convention; Displacement work and Quasistatic process, Path function and point function, Different types of work-Shaft work; Electrical work, Stirring work, Flow work, etc. Definition of Heat, units and sign convention; Heat transfer as path function, Comparison between heat and work; Joule's experiments equivalence of heat and work

Unit 4(First Law of Thermodynamics): Statement of the First law of thermodynamics, First law for a closed system undergoing -cyclic processes and a non-cyclic process/change of state, Energy as a property of a system, Different forms of energy, Specific heat at constant volume, Enthalpy, Specific heat at constant pressure, 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, Analysis of unsteady processes, Examples for unsteady process-filing up and evacuating gas tank

Unit 5(Second Law of Thermodynamics): Limitations of first law, 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 6(Entropy and Exergy): Clausius theorem, Property of entropy, Entropy as a property of a system, Clausius Inequality: calculation of entropy change for different processes, Entropy principle, Application of entropy principle, Entropy transfer, Entropy generation in closed and opensystem, Entropy and disorder. Concept of availability, Available energy referred to a cycle, Quality of energy, Maximum work in a reversible process, Available energy for systems with heat transfer, Availability analysis for steady flow open systems, and for closed systems, II law analysis of open systems, II law efficiency illustrative examples, Energy balance, and second law efficiency.

Unit 7(Properties of Ideal Gases and Real Gases): Definition, Universal gas constant, Dalton's laws of partial pressures, Gibbs law and Amagat's law of additive volumes, Evaluation of properties of mixture of ideal gases, Analysis of processes executed by mixture of ideal gases. Introduction. Van-der Waal's Equation of state, Van-der Waal's constants in terms of critical properties, Law of corresponding states, compressibility factor; compressibility charts

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	1											3		
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		05
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	03	
3. Demonstration on a Computer	00	
Numeracy		25
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		00
1. Case Study Presentation	00	
2. Guest Lecture	00	

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3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**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	Group Task	100 Marks
Maximum Marks ►	25	25	25	25	
CO-1					
CO-2					
CO-3					
CO-4					
CO-5					
CO-6					
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Class room lectures, Assignments
2.	Understanding	Class room lectures, Assignments

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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

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

10. Course Organization

Course Code	MEC202A		
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		23-Oct-2020	
Next Course Specifications Review Date		May-2025	

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Course Specifications: Fluid Mechanics

Course Title	Fluid Mechanics
Course Code	MEC203A
Course Type	Core Theory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with the principles of fluid mechanics and 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.

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 various fluid properties

CO-2. Explain various types of fluid flows, fluid kinematics and dynamics, viscous and turbulent flow through pipes, boundary layer phenomenon and dimensional analysis

CO-3. Derive fluid equations based on Hydrostatic law, Pascal's law, Archimedes principle, Conservation laws, Bernoulli's theorem

CO-4. Discuss the significance of fluid statics, kinematics and kinetics in engineering applications

CO-5. Solve numerical problems on manometers, pitot tube, venturimeters, friction factor and applications of dimensional analysis

CO-6. Apply principles of fluid mechanics to solve practical fluid flow problems

4. Course Contents

Unit 1 (Fluid Properties and Classification of Fluids): History and scope of Fluid Mechanics, Concept of a continuum, Distinction between solids and fluids, Distinction between liquids and gases

Units and dimensions, Properties of fluids, Viscosity, No-slip condition, Newtonian and

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nonNewtonian 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, laminar and turbulent; numerical problems

Unit 2 (Fluid Statics): Pressure Distribution in a Fluid and its Measurement:
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, mechanical pressure gauges; numerical problems
Hydrostatic forces on plane and curved surfaces, centre of pressure, Archimedes principle, buoyancy and stability

Unit 3 (Kinematics of Fluid Flow): 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): Derivation of Euler's equation and Bernoulli's equation, assumptions and limitations, Application of Bernoulli's equation - Pitot tube, Venturimeter
Fundamental laws governing fluid flows, Continuity Equation, Momentum Equation

Unit 4 (Viscous and Turbulent Flow): Viscous Flow: Flow through a circular pipe, flow between two parallel plates, Couette flow, Hagen-Poiseuille equation, Viscous resistance in different applications, Viscosity measurement
Turbulent Flow: Reynolds Experiment, Reynolds number regimes, Laminar and turbulent fully developed pipe flow, entrance flow, Major and Minor losses in pipe derivation of DarcyWeisbach equation, Chezy's equation, friction factor, Moody chart, flow through non-circular ducts; numerical problems
Hydrodynamic Boundary Layer: Laminar and Turbulent boundary layer flows, velocity profiles, boundary layer thickness, Boundary layer on a flat plate, boundary layer separation

Unit 5 (Dimensional Analysis and Similarity): Principle of dimensional homogeneity, Buckhingam's π - theorem, Non-dimensionalisation of the basic equations, Non-dimensional parameters and their importance, Concept of model testing

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

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6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		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		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 (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ►	SC1	SC2	SC3	SC4	

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Subcomponent Type ►	Term Test	Term Test	Assignment	Group Task	100 Marks
Maximum Marks ►	25	25	25	25	
CO-1					
CO-2					
CO-3					
CO-4					
CO-5					
CO-6					
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
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. R. K. Bansal, 2011, A Textbook of Fluid Mechanics and Hydraulic Machines, Lakshmi Publications

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3. Y. A. Cengel and J. M. Cimbala, 2010, Fluid Mechanics: Fundamentals and Applications, McGraw Hill Education.

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.

c. Magazines and Journals

1. Journal of Fluid Mechanics
2. Physics of Fluids
3. Journal of Aerospace Science and Technologies

d. Websites

1. https://www.coursera.org/
2. http://nptel.ac.in/
3. www.e-fluids.com

e. Other Electronic Resources

1. G. M. Homsy, (Editor), 2008, Multimedia Fluid Mechanics (DVD-ROM), 2nd Edition, Cambridge University Press
2. Electronic resources on the course area are available on RUAS library

10. Course Organization

Course Code	MEC203A	
Course Title	Fluid 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	23-Oct-2020	
Next Course Specifications Review Date	May-2025	

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Course Specifications: Manufacturing Processes

Course Title	Manufacturing Processes
Course Code	MEC204A
Course Type	Core Theory
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	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 working principles and operations of equipment required for metal casting, metal forging, welding 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, rolling, welding and sheet metal forming processes

CO-4. Select appropriate manufacturing process for given component based on features and applications

CO-5. Develop a gating system for a given metal casting component

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, Casting design guidelines

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, Numerical problems on calculation of forming load in rolling process
Extrusion and Drawing: Working Principle, Types, Extrusion equipment, Wire, rod and tube drawing, Extrusion defects, Numerical problems on calculation of forming load in extrusion and drawing processes.

Unit 5 (Welding Brazing and Soldering): Classification of joining processes, Heat Affected Zone (HAZ), Welding defects. Working principles and applications of Oxy-acetylene welding Arc Welding: Working principles and applications of Shielded metal arc welding, Gas metal arc welding, Gas tungsten arc welding and Submerged arc welding. Working principles and applications of Spot, Seam, Projection and Butt welding Working Principle and types, Application, Torch brazing, Induction brazing, Furnace brazing, Soldering processes, Filler materials for brazing and soldering. Advances welding processes- Working principles and applications of Laser beam welding, Electron beam welding

Unit 5 (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.

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		

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CO-3		3											3		
CO-4	3	2											3		
CO-5	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		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		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 (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ►	SC1	SC2	SC3	SC4	
Subcomponent Type ►	Term Test	Term Test	Assignment	Group Task	100 Marks
Maximum Marks ►	25	25	25	25	
CO-1					
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

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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	MEC204A		
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	23-Oct-2020		
Next Course Specifications Review Date	May-2025		

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Course Specifications: Machine Drawing

Course Title	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.

2. Course Size and Credits:

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	0:0:2
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. Demonstrate competency in using CAD software for machine drawing

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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	Software Tools: Sketching, Part modeling, Assembly and Drafting
5	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
6	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
7	Demonstration of complex assemblies like transmission system and their role

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

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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)

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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 (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ▶	SC1	SC2	SC3	SC4	
Subcomponent Type ▶	Term Test	Assignment	Term Test	Assignment	100 Marks
Maximum Marks ▶	25	25	25	25	
CO-1					
CO-2					
CO-3					
CO-4					
CO-5		X			
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	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

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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	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		23-Oct-2020	
Next Course Specifications Review Date		May-2025	

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Course Specifications: Mechanical Dissection

Course Title	Mechanical Dissection
Course Code	MEL206A
Course Type	Laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to develop basic aptitude for engineering and engineering design. This course introduces the students to the construction and working of simple machines and products to enable them to relate fundamentals of engineering theory to practice. The students are trained to dis-assemble simple machines and products, identify and document components, their functionality, form, features and material. The students will be able to disassemble a given machine/product, comprehend the working and prepare a report on construction and working.

2. Course Size and Credits:

Number of Credits	01
Credit Structure (Lecture: Tutorial: Practical)	0:0:1
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. Dissect a given machine/product and identify components
CO-2. Examine components for form, features, functionality and material
CO-3. Develop 2D/3D sketches of components
CO-4. Explain the construction and working of the machine/product **CO-5.** Write laboratory report as per the prescribed format

4. Course Contents

1	Dissection of flanged coupling
2	Dissection of machine vice
3	Dissection of single cylinder four stroke IC engine
4	Dissection of brake assembly

5	Dissection of products like 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												3		
CO-3	3									2			3		2
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		02
Demonstrations		02
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	02	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		26
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	

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

	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent ▶	SC1	SC2	SC3(optional)	
Subcomponent Type ▶	Lab Report	Test an Viva Voce		50 Marks
Maximum Marks ▶	25	25	25	
CO-1	X	X		X
CO-2	X	X		X
CO-3	X	X		X
CO-4	X	X		X
CO-5	X	X		X
The details of SC1 and SC2 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. Laboratory Manual
2. Robert O. Parmley, Machine devices and components illustrated sourcebook, 2005, McGraw-Hill 3. Neil Sclater, Mechanisms and mechanical devices sourcebook, 2011, McGraw-Hill

b. Recommended Reading

1. J. J. Uicker, G. R. Pennock and J. E. Shigley, 2003, Theory of Mechanisms and Machines, Oxford University Press
2. Thomas Bevan, 1984, Theory of Machines, CBS Publishers and Distributors 3. E. Charles, J. Wilson and Peter Sadler, 2003, Kinematics and Dynamics of Machinery, Prentice Hall 4. W. L. Cleghorn, 2005, Mechanics of Machines, Oxford University Press

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

1. Course Organization

Course Code	MEL206A		
Course Title	Mechanical Dissection		
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		23-Oct-2020	

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Next Course Specifications Review Date	May-2025

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Course Specifications: Foundry, Forging and Welding Laboratory

Course Title	Foundry, Forging and Welding Laboratory
Course Code	MEL207A
Course Type	Laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with practice of foundry, forging, fitting and welding operations. Students are exposed to various foundry sand tests for determining the strength, permeability, fineness and other relevant properties significant to casting process. Students will be trained on usage of tools and equipment to carry out sand moulding, fitting, welding and hot forging operations. The student will be exposed to the practical application of welding operations. Students will be able to prepare sand moulds, cast components, perform welding, identify and analyse the defects.

2. Course Size and Credits:

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

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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

Number of Credits	01
Credit Structure (Lecture: Tutorial: Practical)	0:0:1
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. Identify forging ,fitting and foundry tools and equipment
CO-2. Test for moulding sand properties and recommend suitable composition
CO-3. Prepare sand moulds using single and split patterns
CO-4. Prepare components through hand forging and fitting as per drawing
CO-5. Examine cast and forged parts and record the defects
CO-6. Write the report as per the prescribed format

4. Course Contents

7	Preparation of green sand moulding using cope and drag for single piece pattern
8	Preparation of green sand moulding using cope and drag for split piece pattern and core mould
9	Conduction of hot forging operations, fitting operations and discuss the outcome
10	Demonstration of melting of Aluminum alloys and pouring of castings. Study the melt treatment like degasification, grain refinement, fettling operations and defect analysis in the cast components and prepare a report
11	Preparation of welding models: Butt joint/ Corner joint.

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		

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CO-3	3												3		
CO-4	3												3		
CO-5		2											2		
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		00
Demonstrations		04
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	04	
3. Demonstration on a Computer	00	
Numeracy		0
1. Solving Numerical Problems	00	
Practical Work		26
1. Course Laboratory	26	
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**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the

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Programme Specifications document pertaining to the B. Tech. (Mechanical Engineering) Programme. The procedure to determine the final course marks is also presented in theProgramme 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.

	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent ►	SC1	SC2	SC3 (Optional)	
Subcomponent Type ►	Experiment conduction and Lab Report	Internal Test and Viva Voce		50 Marks
Maximum Marks ►	25	25	25	
CO-1				
CO-2				
CO-3				
CO-4				
CO-5				
CO-6				

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 instruction
2.	Understanding	Laboratory instructions and experiments
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 Record
10.	Verbal Communication Skills	Viva-Voce
11.	Presentation Skills	Laboratory Record
12.	Behavioral Skills	--

13.	Information Management	Laboratory Manual
14.	Personal Management	--
15.	Leadership Skills	Laboratory Work

9. Course Resources

a. Essential Reading

1. Laboratory Manual
2. P. N. Rao, 2003, Manufacturing Technology, Foundry Forming and Welding, 2nd Edition, Tata McGraw-Hill

b. Recommended Reading

1. Heine, Loper and Rosental, 2008, Principles of Metal Casting, McGraw-Hill
2. Serope Kalpakjian and Steven R. Schmid, 2004, Manufacturing Engineering and Technology, 4th Edition, Pearson Education
3. J. R. Davies, 1992, Tensile Testing, ASM International
4. John G. Lenard, 2002, Metal Forming Science and Practice, Elsevier

c. Magazines and Journals

d. Websites

1. http://www.efoundry.iitb.ac.in
2. http://www.foseco.com
3. www.asm.org

a. Other Electronic Resources

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

10. Course Organization

<table>
<tr><td>Course Code</td><td colspan="3">MEL207A</td></tr>
<tr><td>Course Title</td><td colspan="3">Foundry, Forging and Welding Laboratory</td></tr>
<tr><td>Course Leader's Name</td><td colspan="3">As per Timetable</td></tr>
<tr><td rowspan="2">Course Leader's Contact Details</td><td>Phone:</td><td colspan="2">+91-804-906-5555</td></tr>
<tr><td>E-mail:</td><td colspan="2">hod.me.et@msruas.ac.in</td></tr>
<tr><td>Course Specifications Approval Date</td><td colspan="3">23-Oct-2020</td></tr>
<tr><td>Next Course Specifications Review Date</td><td colspan="3">May-2025</td></tr>
</table>

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Ramaiah University of Applied Sciences
Bangalore

Course Specifications: Environmental Studies

Course Title	Environmental Studies
Course Code	CEN201A
Course Type	Ability Enhancement Compulsory Course
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with essential aspects of environment and ecosystem with relevance to engineering and technology. 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	00
Credit Structure (Lecture: Tutorial: Practical)	0:0:0
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	Civil Engineering
Total Course Marks	00
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 the multidisciplinary nature of environmental studies and recognize the need for public awareness

CO-2. Classify and explain the various natural resources and their associated problems, ecosystem and environmental pollution

CO-3. Describe biodiversity at local, national and global levels

CO-4. Discuss various social issues pertaining to environment including sustainable development and energy issues

CO-5. Assess the impact of human population on the environment

4. Course Contents

Unit 1 (Introduction and natural resources): The multidisciplinary nature of environmental studies, Definition, scope and importance, Need for public awareness. Natural resources and associated problems. Forest resources: Use and over-exploitation, deforestation, case studies.

Timber extraction, mining, dams and their effects on forests and tribal people. 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, case studies.
Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

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): Introduction – 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, and 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 4 (Environmental Pollution and Disaster Management): 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, Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides.

Unit 5 (Social Issues, Human Population and Environmental Ethics): 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. Case studies. 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 – Family Welfare Programmes, Environment and human health, Human Rights, Value Education, Role of Information Technology in Environment and Human Health, Case Studies.

Unit 5 (Field Work): Visit to a local area to document environmental assets river/forest /grassland/hill/mountain, Visit to a local polluted site – Urban / Rural / Industrial / Agricultural, Study of common plants, insects, birds, Study of simple ecosystems-pond, river, hill slopes, etc (Field work equal to 5 lecture hours).

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	1					3							1	3	
CO-2	1					3							1	3	
CO-3	1					3							1	3	
CO-4	1					3		1					1	3	1
CO-5	1					3							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		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 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 or 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)		Component 2: SEE (50% Weightage)
Subcomponent ▶	SC1	SC2 (Optional)	
Subcomponent Type ▶	Test		50 Marks
Maximum Marks ▶	25	25	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4			X
CO-5			X

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination

Approved by the Academic Council at its 26th meeting held on 14th July 2022

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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

b. Recommended Reading

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

c. Magazines and Journals

1. The Green Guide, Natural Geographic Society
2. Sanctuary Asia
3. Xover
4. Indian Journal of Environmental Protection

d. Websites

1. http://www.indiaenvironmentportal.org.in/
2. http://envfor.nic.in/
3. https://earthdirectory.net/India

e. Other Electronic Resources

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

10. Course Organization

Course Code	CEN201A		
Course Title	Environmental Studies		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		Phone:	+91-804-906-5555
		E-mail:	hod.ce.et@msruas.ac.in
Course Specifications Approval Date		23-Oct-2020	

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Next Course Specifications Review Date	May 2025

Course Specifications: Additional Mathematics - 1

Course Title	Additional Mathematics - 1
Course Code	MTB105A
Course Type	Core Theory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

The course introduces students to the basic concepts in real analysis, MATLAB programing 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, Eigen value and Eigen vector, Inversion and diagonalization of matrix and matrix solution for linear system of equations and implementation of the same using MATLAB are discussed in this course.

2. Course Size and Credits:

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	2:1:0
Total Hours of Interaction	45
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 and explain the important theorems and solve simple mathematical problems in one variable calculus and vector algebra
CO-2. State theorems and solve simple problems in two variable calculus
CO-3. Solve complex real world problems associated with one and two real analysis
CO-4. Illustrate fundamentals of MATLAB programming and write simple programs
CO-5. Solve complex mathematical problems associated with linear algebra and compare the results with that of solutions obtained using MATLAB

4. Course Contents

Unit 1 (Single Variable Calculus): Functions of single real variable, limit, continuity and differentiation. Mean value theorems and their applications. Taylor's Theorem, Taylor and Maclaurin series. Indefinite integrals, methods of integration - integration by parts, integration by substitution, integration by method of partial fractions. Definite integral and its properties, the fundamental theorem of Calculus, areas between curves.

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

Unit 3 (Vector Algebra): Vectors, properties, vector components, magnitude and argument, dot and cross products.

Unit 4 (MATLAB fundamentals): Introduction to MATLAB, Basic algebraic and matrix operations, built-in and command line functions. Graphics using MATLAB, 2D and 3D plots. Scripts and functions. Relational and logical operators, conditional statements and looping structures, simple programs.

Unit 5 (Linear Algebra): Matrix algebra, elementary row operations, row and reduced row echelon forms. Linear system of equations, existence and uniqueness of solution. Vector spaces, subspaces, linear independence, basis and dimension. Row, column and null space of a matrix. Linear transformations. Eigenvalues, eigenvectors and diagonalization

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	2							1			3		1
CO-3	3	3	2	1						1			3	1	1
CO-4	3	3	2	3						2			3	3	2
CO-5	3	3	2	3						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		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		**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 (50% Weightage)				**Component 2: SEE (50% Weightage)**
Subcomponent ►	**SC1**	**SC2**	**SC3**	**SC4**	
Subcomponent Type ►	**Term Test**	**Term Test**	**Assignment**	**Group Task**	**100 Marks**

Maximum Marks ▶	25	25	25	25	
CO-1					
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
3. Rudra Pratap, 2013, Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers, New York, Oxford University Press

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

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	MTB105A		
Course Title	Additional 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		23-Oct-2020	
Next Course Specifications Review Date		May-2025	

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Course Specifications: Engineering Mathematics - 4

Course Title	Engineering Mathematics - 4
Course Code	MTB104A
Course Type	Core Theory
Department	Mechanical Engineering
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)	3:1:0
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. 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

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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

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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					
	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					
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
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

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Bangalore

10. Course Organization

Course Code	MTB104A	
Course Title	Engineering Mathematics - 4	
Course Leader/s Name	As per timetable	
Course Leader Contact Details	Phone:	080 4906 5555
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	23-Oct-2020	
Next Course Specifications Review Date:	May-2025	

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Course Specifications: Fluid Machines

Course Title	Fluid Machines
Course Code	MEC208A
Course Type	Core Theory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course aims to impart knowledge on working principles of fluid machines and their applications. In this course, students are taught the constructional features, operating principles, velocity triangles and the performance characteristics of radial and axial flow power absorbing and power producing fluid machines, such as fans, blowers, compressors, turbines and pumps. Students will be able to apply laws of fluid mechanics and 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)	3:1:0
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 the types, working principle and applications of fluid machines
CO-2. Construct velocity triangles for performance analyses of axial and radial flow machines
CO-3. Describe various design and performance parameters of fluid machines
CO-4. Solve numerical problems to examine fluid machine performance
CO-5. Apply steady flow energy equation to determine energy exchange across a fluid machine and derive the Euler turbine equation
CO-6. Select the relevant fluid machine suitable for different field applications based on the performance parameters

4. Course Contents

Unit 1(Fundamental Concept and Definitions): Types; Comparison between fluid machines and positive displacement machines; Static and stagnation states; Application of first and second law of thermodynamics to fluid machines; Efficiencies and Performance characteristics of fluid machines; Flow coefficient, Specific head, Specific power, Specific speed and unit quantities

Unit 2 (Energy Transfer in 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 3 (Axial Flow Fans and Blowers): Classification; Working principle; Applications of fans and blowers; Fan laws; Performance parameters and performance characteristics

Unit 4 (Axial and Centrifugal Compressors): Constructional features and application; Working principle; Velocity triangles; Stage pressure rise; Blade loading and flow coefficient; Temperature-entropy diagram, Degree of reaction; Slip factor; Significance of compressor cascade; Stage efficiency and losses; Work done Factor; Performance characteristics; Choke, surge and stall

Unit 5 (Steam Turbines): Types of steam turbines; Axial variation of pressure and velocity through various types of 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

Unit 6 (Hydraulic Turbines): 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

Unit 7 (Hydraulic Pumps): 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

Unit 8 (Axial and Radial Flow Gas Turbines): Constructional features and application; Working principle; Velocity triangles; Stage pressure rise; specific work, degree of reaction; Temperature-entropy diagram; Slip factor; Stage efficiency and losses;
Performance characteristics

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		

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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		25
Demonstrations		05
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	03	
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**

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	Group task	100 Marks
Maximum Marks ▶	25	25	25	25	
CO-1	X		X		X
CO-2	X		X		X
CO-3	X		X		X
CO-4	X	X	X		X
CO-5		X		X	X
CO-6		X		X	X
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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a. Essential Reading

1. Class Notes
2. S.M Yahya, 2002, Turbines, Compressors and Fans, Second Edition, TataMcGraw Hill
3. Vedanth Kadambi and Manohar Prasad, 2011, An Introduction to Energy Conversion Volume III Turbomachinery, Second Edition, New Age International Publishers

b. Recommended Reading

1. D. G. Shepherd, 1956, Principles of Turbomachinery, New York, MacMillan Company
2. S. L. Dixon, 1998, Fluid Mechanics and Thermodynamics of Turbo machinery,Reed Educational and Professional Publishing Ltd
3. G. Gopalkrishna and D. Privithiraj, 2002, A Treatise on Turbo machines, Scitech
4. H. I. H. Saravanamuttoo, H. Cohen and G. F. C. Rogers, 1996, Gas Turbine Theory, Longman Publications
5. Earl Logan Jr, 1993, Turbo machinery: Basic Theory and Applications, MarcelDekker
6. G. F. Round, 2004, Incompressible Flow Turbomachines, Gulf Publishers

c. Magazines and Journals

1. ASME Journal of Turbo machinery
2. ASME Journal of Engineering for Gas Turbine and Power
3. International Journal of Rotating Machinery, Hindawi Corporation
4. AIAA Journal of Propulsion and Power

d. Websites

1. Websites of Research Organisations, NAL and GTRE (Bangalore, India), ONERA (France), NASA (USA), DLR (Germany)
2. www.nptel.ac.in
3. www.turbomachinerymag.com

e. Other Electronic Resources

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

10. Course Organization

Course Code	MEC208A	
Course Title	Fluid Machines	
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	23-Oct-2020	
Next Course Specifications Review Date	May-2025	

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Course Specifications: Mechanisms and Kinematics of Machines and Laboratory

Course Title	Mechanisms and Kinematics of Machines and Laboratory
Course Code	MEC209A
Course Type	Core Theory
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, cams and belt drive.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:1
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 and arrive at a gear arrangement 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;

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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; Pantograph; 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, cycloidal motion; construction of CAM profiles

Unit 5 (Gears and Gear Trains): Law of gearing; Gear tooth nomenclature; Interference and undercutting; Gear types; Simple gear trains; Compound gear trains; Epicyclic gear trains

Unit 6 (Kinematic analysis using experiments and ADAMS software): Identify kinematic pairs in a simple four-bar linkage mechanism and test type of motion transmission; Identify kinematic pairs in a slider crank mechanism and test type of motion transmission; Identify kinematic pairs in a scotch yoke mechanism and test type of motion transmission;
Overview of ADAMS software, commands and hot keys Modelling of four bar, slider crank and quick return mechanisms in ADAMS environment; Modelling and simulation of four bar and six bar mechanisms to determine link velocities and plot results with respect to time and input angle; Simulation of four bar and six bar mechanisms to determine acceleration of links and discuss results

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															

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6. Course Teaching and Learning Methods

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

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SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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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	MEC209A
Course Title	Mechanisms and Kinematics of Machines and Laboratory

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	23-Oct-2020	
Next Course Specifications Review Date	May-2025	

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Course Specifications: Strength of Materials

Course Title	Strength of Materials
Course Code	MEC210A
Course Type	Core Theory
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)	3:1:0
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. 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

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

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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, 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

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; 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 (Statically Indeterminate Structural Elements and Strain Energy of Elastic Members): Definition of determinate and indeterminate structural elements; method of superposition. Definition of strain energy, computation of strain energy under different types of loading, uses of strain energy concepts

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		
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		43
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		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**	**Group task**	**100 Marks**

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Maximum Marks ▶	25	25	25	25	
CO-1	X		X		X
CO-2	X		X		X
CO-3	X		X		X
CO-4	X	X	X		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. 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.

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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	MEC210A		
Course Title	Strength of Materials		
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	23-Oct-2020		
Next Course Specifications Review Date	May-2025		

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Course Specifications: Conventional Machining Processes

Course Title	Conventional Machining Processes
Course Code	MEC211A
Course Type	Core Theory
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. The student will be given an overview of various nontraditional machining and additive manufacturing processes.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
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. 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

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

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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
Center lathe, Features of center lathe, Specifications of lathes, Lathe tools, Tool and work holding devices, Lathe attachments, 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): Shaper and Planer machines and Cutting tools, Power and machining time calculations. 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 (Drilling, Boring and Tapping Machines and Grinding Machines): Drilling machine features, Drilling bits, Reaming, Boring and Tapping operations, Reamers, Taps and Boring tools. Grinding wheel, Grinding operations, Types of grinding machines, Honing, Lapping and Super finishing

Unit 6 (Overview of Non-Traditional and Additive Manufacturing Processes): Non-traditional machining process, types, advantages and disadvantages. Additive manufacturing process, types, advantages and disadvantages

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		50
Demonstrations		02
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		8

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1. Solving Numerical Problems	08	
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	Group task	100 Marks
Maximum Marks ▶	25	25	25	25	
CO-1	X		X		X
CO-2	X		X		X
CO-3	X		X		X
CO-4	X	X	X		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	Coursework
15.	Leadership Skills	--

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

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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

<table>
<tr><td>Course Code</td><td colspan="3">MEC211A</td></tr>
<tr><td>Course Title</td><td colspan="3">Conventional Machining Processes</td></tr>
<tr><td colspan="2">Course Leader's Name</td><td colspan="2">As per Timetable</td></tr>
<tr><td colspan="2" rowspan="2">Course Leader's Contact Details</td><td>Phone:</td><td>+91-80-49065555</td></tr>
<tr><td>E-mail:</td><td>hod.me.et@msruas.ac.in</td></tr>
<tr><td colspan="2">Course Specifications Approval Date</td><td colspan="2">23-Oct-2020</td></tr>
<tr><td colspan="2">Next Course Specifications Review Date</td><td colspan="2">May-2025</td></tr>
</table>

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Course Specifications: Fluid Mechanics and Machines Laboratory

Course Title	Fluid Mechanics and Machines Laboratory
Course Code	MEL212A
Course Type	Laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with the experimental aspects of fluid mechanics and machines. This course facilitates students to plan and execute flow measurements from first principles using venturi meter, orifice meter etc. Students are also taught the working principles, mechanical details and performance evaluation of power absorbing and power producing fluid machines. Students are trained to operate the experimental test rigs of hydraulic turbines and pumps. Students will be able to measure and record the experimental data, plot performance curves, and interpret the results.

2. Course Size and Credits:

Number of Credits	01
Credit Structure (Lecture: Tutorial: Practical)	0:0:1
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. Plan the experimental setup to achieve the stated aim
CO-2. Conduct experiments as per the standard procedures and tabulate the measured values
CO-3. Calculate the required parameters and plot the results
CO-4. Interpret, compare with standard results and draw conclusions **CO-5.**
Write laboratory report as per the prescribed format

4. Course Contents

1	Determination of coefficient of discharge of orifice plate of various diameters
2	Determination of coefficient of discharge of Venturimeter
3	Determination of major losses in fluid flow through pipes
4	Determination of minor losses in fluid flow through pipe fittings and valves

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5	Determination of coefficient of impact of jets on different shaped vanes
6	Determination of the performance of a Multi stage Centrifugal pump and plotting operating Characteristic curves
7	Determination of the performance of Pelton wheel and plotting main and operating characteristic curves
8	Determination of the performance of Francis turbine and plotting main and operating characteristic curves
9	Determination of the performance of Kaplan turbine and plotting main and operating characteristic curves
10	Determination of the performance of Centrifugal blower and plotting operating characteristic curves
11	Determination of experimental uncertainty
12	Determination of the performance of reciprocating pump and plotting operating characteristic Curves

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								1			3		1
CO-4		3		1									3	1	
CO-5										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		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	30	
2. Computer Laboratory	00	

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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**

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 (Optional)**	
Subcomponent Type ►	**Lab exercise**	**Lab record**	**Term test**	
Maximum Marks ►	**25**	**25**	**25**	**50 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 SC1, SC2, SC3 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

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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. Laboratory Manual
2. Rathakrishnan, 2007, Instrumentation, Measurements and Experiments in Fluids, CRC Press.
3. S.M. Yahya, 2002, Turbines, Compressors and Fans, Second Edition, TataMcGraw Hill Co.

b. Recommended Reading

1. F. M. White, 2008, Fluid Mechanics, 6th Edition, Tata McGraw-Hill
2. J. P. Holman, 2000, Experimental Methods for Engineers, 7th Edition, Tata McGraw- Hill.
3. S. Tavoularis, 2009, Measurement in Fluid Mechanics, Cambridge University Press.
4. S. L. Dixon, 1998, Fluid Mechanics and Thermodynamics of Turbo machinery,Reed Educational and Professional Publishing Ltd.

c. Magazines and Journals

1. Experiments in Fluids
2. Physics of Fluids
3. ASME Journal of Fluids Engineering
4. ASME Journal of Turbo machinery

d. Websites

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1. www.e-fluids.com
2. Websites of Research Organisations, NAL and GTRE (Bangalore, India), ONERA (France), NASA (USA), DLR (Germany)

3. www.grc.nasa.gov.in

e. **Other Electronic Resources**

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

10. Course Organization

Course Code	MEL212A	
Course Title	Fluid Mechanics and Machines Laboratory	
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	23-Oct-2020	
Next Course Specifications Review Date	May-2025	

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Course Specifications: Material Science and Strength of Materials Laboratory

Course Title	Material Science and Strength of Materials Laboratory
Course Code	MEL213A
Course Type	Laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

The laboratory aims to develop knowledge of major types of materials and their properties through experimental investigation. The students will study the microstructure of various metals. The course will help in analyzing the changes in property and microstructure due to heat treatment process. Students are taught experimental methods to analyse material behaviour under different types of loading conditions. Students are able to determine mechanical properties of materials. Students are trained to perform tests, analyse the data and present the results as per standards.

2. Course Size and Credits:

Number of Credits	01
Credit Structure (Lecture: Tutorial: Practical)	0:0:1
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. Plan the experimental setup to achieve the stated
CO-2. Conduct experiments as per the standard procedures and tabulate the measured values
CO-3. Calculate the required parameters and plot the results
CO-4. Interpret, compare with standard results and draw conclusions **CO-5.**
Write laboratory report as per the prescribed format

4. Course Contents

1	Conduct the mechanical tests to determine mechanical properties (Tensile and Hardness Rockwell as per ASTM standards E8(M) and E18-19) for different materials (heattreated and untreated) and discuss the results
2	Conduct compression test on ductile (Aluminum) and brittle (Cast iron) materials to determine compressive strength as per ASTM E9 (M)

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3	Conduct single and double shear test to determine shear strength of given material
4	Preparation of samples through heat treatment process such as Annealing, Normalizing, Hardening and Tempering
5	Conduct Izod and Charpy impact test to determine the energy absorbed by the test specimen as per ASTM E23(M)
6	Prepare samples and perform metallographic examination on plain carbon steel, medium carbon steel and tool steel to study microstructure as per ASTM standards E9 (M)
7	Conduct the test to determine the transition temperature from brittle to ductile behavior as per ASTM standard E23(M)
8	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
9	Conduct the test to determine the creep rate
10	Demonstration on Photoelasticity method to illustrate contours of distribution of stress

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								1			3		1
CO-4		3		1									3	1	
CO-5										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		00
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	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	

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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		**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 (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 (Optional)**	
Subcomponent Type ▶	**Lab exercise**	**Lab record**	**Term test**	
Maximum Marks ▶	**25**	**25**	**25**	**50 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 SC1, SC2, SC3 are presented in the Programme Specifications Document				

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

8. Achieving COs

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

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S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Laboratory instruction
2.	Understanding	Laboratory instructions and experiments
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 work, Examination
10.	Verbal Communication Skills	Laboratory work
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Laboratory work
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Laboratory Manual
2. C. Suryanarayana, 2011, Experimental Techniques in Materials and Mechanics, CRC Press
3. A. K. Bhargava and C. P. Sharma, 2011, Mechanical Behaviour and Testing of Materials, Prentice Hall India

b. Recommended Reading

1. ASTM Standards for Structural Testing
2. Sam Zhang, Lan Li and Ashok Kumar, 2011, Materials Characterization Techniques, CRC Press
3. J. R. Davies, 1992, Tensile Testing, ASM International
4. Joshua Pelleg, 2013, Mechanical Properties of Materials, Springer

c. Magazines and Journals

1. Journal of Testing and Evaluation, ASTM International
2. Characterization and Evaluation of Materials, Springer

d. Websites

1. http://www.asminternational.org
2. http://www.mrs.org

a. Other Electronic Resources

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

10. Course Organization

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<table>
<tr><td>Course Code</td><td colspan="3">MEL213A</td></tr>
<tr><td>Course Title</td><td colspan="3">Material Science and Strength of Materials Laboratory</td></tr>
<tr><td>Course Leader's Name</td><td colspan="3">As per Timetable</td></tr>
<tr><td rowspan="2">Course Leader's Contact Details</td><td>Phone:</td><td colspan="2">+91-804-906-5555</td></tr>
<tr><td>E-mail:</td><td colspan="2">hod.me.et@msruas.ac.in</td></tr>
<tr><td>Course Specifications Approval Date</td><td colspan="3">23-Oct-2020</td></tr>
<tr><td>Next Course Specifications Review Date</td><td colspan="3">May-2025</td></tr>
</table>

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Course Specifications: Machine Shop Practice

Course Title	Machine Shop Practice
Course Code	MEL214A
Course Type	Laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with various machine tools, cutting tools and their applications. Students will be equipped with basic knowledge, constructional features and operations of various machines like lathe, milling, drilling and grinding. Student will be trained to select and perform suitable machine operation/s required for machining a component. In addition, the student will be trained to select and use suitable tools and processes required for sheet metal fabrication.

2. Course Size and Credits:

Number of Credits	01
Credit Structure (Lecture: Tutorial: Practical)	0:0:1
Total Hours of Interaction	30
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.** Identify the machine tools, cutting tools and accessories for turning, milling, drilling and grinding processes
- **CO-2.** Operate the machine tools and perform machining operations like turning, milling, gear cutting, drilling and grinding.
- **CO-3.** Conduct experiments as per the standard procedure and tabulate measured values
- **CO-4.** Select appropriate instruments for measuring dimensional accuracy of developed models
- **CO-5.** Write laboratory report as per the prescribed format

4. Course Contents

1	Conduction of facing, plain turning, chamfering and step turning operations on component -1 using lathe
2	Conduction of grooving, taper turning and thread cutting operations on component -2 using lathe

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3	Conduction of Knurling, Parting, Drilling, Boring, Tapping operations on component -3 using lathe.
4	Conduction of Face milling, End/side milling and Step milling operations on component -4 using vertical milling machine.
5	Conduction of Gear cutting and Key way cutting with indexing table on component -5 using vertical milling machine.
6	Conduction of Drilling, Reaming and Tapping operations on component -6 using drilling machine.
7	Conduction of Surface grinding and cylindrical grinding operations on component -7 using grinding machines.

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					1				3	2	1
CO-4		2											2		
CO-5										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		00
Demonstrations		05
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	05	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		25
1. Course Laboratory	25	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	

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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**

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 and Manufacturing 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 (Optional)**	
Subcomponent Type ►	**Lab Record**	**Test and Viva Voce**		
Maximum Marks ►	**25**	**25**	**25**	**50 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 Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

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8. **Achieving COs**

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Laboratory instruction
2.	Understanding	Laboratory instruction and experiments
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 Examination
10.	Verbal Communication Skills	Laboratory Examination
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Laboratory work
14.	Personal Management	Course work
15.	Leadership Skills	--

9. **Course Resources**

a. Essential Reading

1. Laboratory Manual
2. S. K. Hajra Choudhary, S. K. Bose, A. K. Hajra Choudhary and Roy Nirjha, 2007, Elements of Workshop Technology Volume No. II: Machine Tools, Media Promoters and Publishers Pvt. Limited

a. Recommended Reading

1. W. Chapman, 2007, Workshop Technology - Part 2, Butterworth Heinemann.
2. Alan S. Morris, 1997, The Essence of Measurement, 1st Edition, Prentice Hall.

a. Magazines and Journals

1. International Journal of Machine Tools and Manufacture: Design, Research and Application
2. International Journal of Precision Engineering and Manufacturing
3. Efficient Manufacturing

a. Websites

1. Efficientmanufacturing.in
2. http://www.tolcap.com
3. http://www.nplindia.org

a. Other Electronic Resources

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

10. Course Organization

Course Code	MEL218A		
Course Title	Machine Shop 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	23-Oct-2020		
Next Course Specifications Review Date	May-2025		

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Course Specifications: Additional Mathematics - 2

Course Title	Additional Mathematics - 2
Course Code	MTB106A
Course Type	Core Theory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with analytical solutions of ordinary differential equations, numerical analysis and data modelling techniques. Students are taught the concepts of fundamentals of ordinary differential equations. 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. The significance of data modelling in applied engineering problems are discussed with the help of MATLAB. Numerical methods for the solution of nonlinear equations and linear systems are elucidated using MATLAB.

2. Course Size and Credits:

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	2:1:0
Total Hours of Interaction	45
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 State theorems and solve simple problems in two variable calculus

CO-2. Solve standard forms of ordinary differential equations Illustrate fundamentals of Linear algebra

CO-3. Model real world problems using ordinary differential equations and solve complex problems associated with ordinary differential equations

CO-4. Apply numerical methods to solve nonlinear equations in one variable, system of linear equations, interpolation and numerical quadrature, and implement the same using MATLAB

CO-5. Solve complex problems associated with nonlinear equations and linear systems, interpolation and numerical integration using MATLAB

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4. Course Contents

Unit 1 (First Order Differential Equations): Introduction, basic concepts and geometrical meaning. Separable, linear and exact differential equations. Integrating factors and transformations. Applications of first order ordinary differential equations, orthogonal trajectories, growth/decay problems and mixture problems.

Unit 2 (Higher Order Differential Equations): 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, electric circuits.

Unit 3 (System of Linear Differential Equations): Homogeneous system of linear differential equations of first order, solutions by matrix method.

Unit 4 (Single Variable Equations and System of Equations): Numerical solution of algebraic and transcendental equations, Newton-Raphson method and error analysis. Numerical solution of linear system of equations, Gauss-Seidel methods.

Unit 5 (Interpolation and Numerical Integration): Interpolation - Lagrange interpolation, Newton's divided difference interpolation. Numerical Integration - Newton-Cotes' quadrature, trapezoidal, Simpson's 1/3 and Simpson's 3/8 rules.

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		
CO-2	2	3	2										3		
CO-3	3	3	1										3		
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		30

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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		**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 (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**	

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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. Shepley Ross, 2007, Introduction to Ordinary Differential Equations, 4th edition, New York, John Wiley & sons
2. Dennis Zill, 2012, A First Course in Differential Equations, 10th edition, Massachusetts, Brooks/Cole
3. Richard Burden and Douglas Faires, 2017, Numerical Analysis, 9th edition, Massachusetts, Brooks/Cole

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b. Recommended Reading

1. George Simmons, 2017, Differential Equations with Applications and Historical Notes, 2nd edition, New Jersey, McGraw Hill
2. Steven Chapra and Raymond Canale, 2016, Numerical Methods for Engineers, 7th edition, New Jersey, McGraw Hill

c. Magazines and Journals

d. Websites

1. https://www.coursera.org/
2. http://nptel.ac.in/
3. https://ocw.mit.edu/index.htm
4. tutorial.math.lamar.edu/

10. Course Organization

<table>
<tr><td>Course Code</td><td colspan="3">MTB106A</td></tr>
<tr><td>Course Title</td><td colspan="3">Additional Mathematics - 2</td></tr>
<tr><td colspan="2">Course Leader's Name</td><td colspan="2">As per Timetable</td></tr>
<tr><td colspan="2" rowspan="2">Course Leader's Contact Details</td><td>Phone:</td><td>080 4906 5555</td></tr>
<tr><td>E-mail:</td><td>hod.mt.mp@msruas.ac.in</td></tr>
<tr><td colspan="2">Course Specifications Approval Date</td><td colspan="2">23-Oct-2020</td></tr>
<tr><td colspan="2">Next Course Specifications Review Date</td><td colspan="2">May-2025</td></tr>
</table>

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Course Specifications: Applied **Thermodynamics**

Course Title	Applied Thermodynamics
Course Code	MEC301A
Course Type	Core Theory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. 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), vapour power cycle (Rankine cycle). Students will be able to estimate the performance parameters like power, efficiency for reciprocating compressor, 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 fuel will be discussed. Students willbe 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)	3:1:0
Total Hours of Interaction	70
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 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 combustion thermodynamics of fuels, 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

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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.

Unit 2 (Fuel 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

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 multi stage compressors, Capacity control of compressors

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

Unit 5 (Refrigeration):

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 (Vapor Compression Refrigeration):

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 7 (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

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3												3		
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	02	
2. Demonstration using Physical Models / Systems	03	
3. Demonstration on a Computer	00	
Numeracy		25
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		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	

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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**	**Group task**	**100 Marks**
Maximum Marks ▶	**25**	**25**	**25**	**25**	
CO-1	**X**		**X**		**X**
CO-2	**X**		**X**		**X**
CO-3	**X**		**X**		**X**
CO-4	**X**	**X**	**X**		**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

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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. C. Borgnakke and Sonntag, 2010, Fundamentals of Thermodynamics, Wiley-India

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

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

10. Course Organization

Course Code	MEC301A	
Course Title	Applied 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	23-Oct-2020	
Next Course Specifications Review Date	May-2025	

Medha G. Rao

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Course Specifications: Dynamics of Machinery

Course Title	Dynamics of Machinery
Course Code	MEC302A
Course Type	Core Theory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to prepare the students to understand and apply concepts of machine dynamics and dynamic effects. 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.

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 basic concepts and principles of dynamics of machines
CO-2. Describe basic concept and principles of mechanical vibrations, model and analyse simple mechanical systems for vibration behaviour
CO-3. Determine static and dynamic forces in planar mechanism
CO-4. Analyse mechanical systems with rotating and reciprocating masses for static and dynamic balancing and assess the influence of gyroscopic effect due to rotating masses
CO-5. Apply Solve problems to calculate inertia forces at various joints, balancing force, gyroscopic forces and vibration parameters

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

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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 (Balancing of Reciprocating Masses): Dynamics of Reciprocating Machines with Single Slider, Unbalance in Single Cylinder Mechanisms. Balancing of multi cylinder engines

Unit 5 (Gyroscope): Concept of gyroscopic action, gyroscopic effect in ships, airplanes, two wheelerand four wheeler vehicles, gyroscopic stabilization

Unit 6 (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

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		40
Demonstrations		03
1. Demonstration using Videos	03	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	

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Practical Work		
1. Course Laboratory	00	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**

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**	**Group task**	**100 Marks**
Maximum Marks ►	**25**	**25**	**25**	**25**	
CO-1	**X**		**X**		**X**
CO-2	**X**		**X**		**X**
CO-3	**X**		**X**		**X**
CO-4	**X**	**X**	**X**		**X**
CO-5		**X**		**X**	**X**
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
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

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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 course area are available on RUAS library

10. Course Organization

<table>
<tr><td>Course Code</td><td colspan="3">MEC302A</td></tr>
<tr><td>Course Title</td><td colspan="3">Dynamics of Machinery</td></tr>
<tr><td>Course Leader's Name</td><td colspan="3">As per Timetable</td></tr>
<tr><td rowspan="2">Course Leader's Contact Details</td><td>Phone:</td><td colspan="2">+91-804-906-5555</td></tr>
<tr><td>E-mail:</td><td colspan="2">hod.me.et@msruas.ac.in</td></tr>
<tr><td>Course Specifications Approval Date</td><td colspan="3">23-Oct-2020</td></tr>
<tr><td>Next Course Specifications Review Date</td><td colspan="3">May-2025</td></tr>
</table>

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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

1. 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	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.** 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

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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 squarekey, 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															

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6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		33
Demonstrations		05
1. Demonstration using Videos	05	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		20
1. Solving Numerical Problems	20	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		02
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	Group task	100 Marks
Maximum Marks ►	25	25	25	25	
CO-1	X		X		X
CO-2	X		X		X
CO-3	X		X		X
CO-4	X	X	X		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	--

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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. V. B. Bhandari, 2007, Design of Machine Elements, Tata McGraw-Hill
3. K. Lingaiah, 2002, Machine design Data Hand Book, Volume I and II, Suma Publications
4. Joseph Shigley, Charles Mischke, and Richard Budynas, 2003, Mechanical Engineering Design, McGraw-Hill Professional

b. Recommended Reading

1. Robert C. Juvinall, Kurt M. Marshek, 2000, Fundamentals of Machine Component Design, John Wiley and Sons
2. Joseph Shigley, Charles Mischke, Thomas H. Brown, 2004, Standard Handbook of Machine Design, McGraw-Hill Professional
3. Robert L. Norton, 2005, Machine Design: An Integrated Approach, Prentice Hall
4. Boris M. Klebanov, David Barlam, Frederic E. Nystrom, 2007, Machine Elements: Life and Design, CRC Press
5. Allen S. Hall, Alfred R. Holowenko, Herman G. Laughlin, 2000, Schaum's Outline of Theory and Problems of Machine Design, McGraw-Hill Professional
6. Robert L. Mott, 1992, Machine Elements in Mechanical Design, Merrill

c. Magazines and Journals

1. Design 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 course area are available on MSRUAS library

10. Course Organization

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Course Code	MEC303A		
Course Title	Design of Machine Elements - 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		23-Oct-2020	
Next Course Specifications Review Date		May-2025	

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Course Specifications: Automation in Manufacturing

Course Title	Automation in Manufacturing
Course Code	MEC304A
Course Type	Core Theory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with concepts of automation and its significance in manufacturing. The students are taught the need, methods of automation systems, cost benefit and performance analysis. Basic principles and usage of various sensors, actuators, PLC's, drives, motion controllers, PC-based control technology and their applications are taught. Knowledge on automated work-piece feeding, processing, material handling, storage and assembly systems, identification and data collection using robots are taught. Students will also be taught the working principles, programming and operations of CNC machines. Students will be able to develop appropriate layout for producing components and sub-assemblies. They will be able to write NC part program and execute for a given component.

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 need, significance and types of automation in manufacturing and the working principles and operations of CNC machine tools
CO-2. Describe the types of CNC machines, elements and accessories of automation systems and layout required for automating a manufacturing line
CO-3. Discuss aspects of automation in material handling, storage, part identification, assembly
CO-4. Solve simple problems on material handling, automated production and assembly lines
CO-5. Select appropriate automation layout for production of components and subassemblies
CO-6. Develop NC part programming for machining a given part drawing

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4. Course Contents

Unit 1 (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 analysis of the automated flow line using cycle time, manufacturing lead time, production rate, utilization and availability of the machines

Unit 2 (Automation Technology and Sub-Systems): Sensors – generic and sensors for motioncontrol (force, torque, acceleration, encoders), Actuators, PLC's, CNC, Motors, Drives, Motion controllers, Vision systems and inspection, PC-based control technology, Flexible manufacturing systems

Unit 3 (CNC Machine Tools): Computer numerical control, direct /distributed numerical control, Classification of CNC machines, Features of CNC machine tools, coordinate systems, G-codes, M-codes and miscellaneous codes, Manual part programming methods, Computer aided part programming

Unit 4 (Automated Work-Piece Feeding, Material Handling and Assembly Systems): Classification of continuous and discontinuous transport mechanisms, Specification of internal transport systems, Design and application of continuous transport systems. Line balancing problems in automated assembly line. Components of and an AGV system, Indexing mechanisms, Piece part bulk feeders, Feeder selection, Automated storage and retrieval systems, On-line storage systems,Vision systems, Intelligent sensing. Computer aided process planning (CAPP), Material planning and Capacity Planning. Case studies on automation in various manufacturing processes

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		
CO-6										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

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Face to Face Lectures		33
Demonstrations		05
1. Demonstration using Videos	05	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		07
1. Solving Numerical Problems	07	
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 (50% Weightage)				**Component 2: SEE (50% Weightage)**
Subcomponent ►	**SC1**	**SC2**	**SC3**	**SC4**	

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Subcomponent Type ►	Term test	Term test	Assignment	Group task	100 Marks
Maximum Marks ►	25	25	25	25	
CO-1	X		X		X
CO-2	X		X		X
CO-3	X		X		X
CO-4	X	X	X		X
CO-5		X		X	X
CO-6		X		X	X
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	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. Mikell P. Groover, 2008, Automation, Production Systems and Computer-Integrated Manufacturing, PHI Learning Private Ltd.

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3. Asai K and Takshima. S., 1994, Manufacturing Automation Systems and Computer Integrated Manufacturing Factories, Chapman
4. P. N. Rao, 2003, Manufacturing Technology, Machine Tools and Machining Operations, Tata McGraw-Hill

b. Recommended Reading

1. James H. Harter, 2005, Electromechanics: Principles, Concepts and Devices, Second Edition, Pearson Prentice Hall.
2. W. Bolton, 2005, Mechatronics - Electronics Control Systems in Mechanical and Electrical Engineering, Pearson Education Press.
3. Richard M. Crowder, 2006, Electric Drives and Electromechanical Systems, Newness.

c. Magazines and Journals

1. Journal of Programmable Industrial Automation
2. Journal of Advances in Robotics and Automation
3. International Journal of Control, Automation, and Systems
4. Journal of Assembly Automation

d. Websites

1. www.automation.com
2. www.progea.com (Movicon software)
3. www.nptel.ac.in

e. Other Electronic Resources

Electronic resources on the course area are available at MSRUAS library

10. Course Organization

Course Code	MEC304A	
Course Title	Automation in Manufacturing	
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	23-Oct-2020	
Next Course Specifications Review Date	May-2025	

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Course Specifications: Mechanical Measurements, Metrology and Laboratory

Course Title	Mechanical Measurements, Metrology and Laboratory
Course Code	MEC305A
Course Type	Core Theory
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	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:1
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 generalized measurement system, errors in measurement systems, calibration procedure, system of limits and fits and measuring techniques

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

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

CO-4. Apply Geometric Dimensioning & Tolerance techniques for dimensional control

CO-5. Analyze maximum and minimum material conditions for the design of Go and No Go gauges using Taylor's principle

CO-6. Utilize appropriate instruments for measurement of physical and geometrical parameters for a given application

4. Course Contents

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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, Photo detectors, 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 (Engineering metrology): Engineering tolerance-Unilateral, Bilateral and Compound tolerance; System of limits and fits and their types; hole and shaft basis systems; interchangeability and selective assembly; Numericals

Unit 4 (Limit gauges and Geometric dimensioning): Classification of gauges, Taylors principle, Maximum and Minimum Material conditions, Design of Go and No Go gauges, Numericals; GD & T symbols and their interpretations, Applications of GD & T techniques for dimension control, case studies on applications of GD & T techniques
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 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

Unit 6 (Screw thread and gear measurement): Elements of screw thread, Measurement of major and minor diameter, angle of thread, thread pitch, effective diameter- Two or three wire method; Elements of gear, Gear measuring instruments, gear tooth profile measurement.

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

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CO-1	3												3		
CO-2	3												3		
CO-3	3	2											3		
CO-4		3	2										3		
CO-5		2											3		
CO-6		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		02
1. Demonstration using Videos	02	
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		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

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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	Group task	100 Marks
Maximum Marks ►	25	25	25	25	
CO-1	X		X		X
CO-2	X		X		X
CO-3	X		X		X
CO-4	X	X	X		X
CO-5		X		X	X
CO-6		X		X	X
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments

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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	MEC305A	
Course Title	Mechanical Measurements, Metrology and Laboratory	
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	23-Oct-2020	
Next Course Specifications Review Date	May-2025	

Course Specifications: Applied Thermodynamics Laboratory

Course Title	Applied Thermodynamics Laboratory
Course Code	MEL306A
Course Type	Laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

In this course students are trained on methods to determine fuel properties like flash point, fire point, viscosity and calorific value. Students are able to demonstrate the working of fuel supply, lubrication and ignition system and valve/port timing for IC engines. Students are trained to conduct the experiment, measure the properties and analyze the performance including heat balance for IC engine, steam turbine, air conditioning test rig and reciprocating compressor. Students will be able to evaluate the performance of vapour power cycle and refrigeration cycles.

2. Course Size and Credits:

Number of Credits	01
Credit Structure (Lecture: Tutorial: Practical)	0:0:1
Total Hours of Interaction	30
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:

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CO-1. Plan the experimental setup to achieve the stated aim
CO-2. Conduct experiments as per the standard procedures and tabulate the measured values
CO-3. Calculate the required parameters and plot the results
CO-4. Interpret, compare with standard results and draw conclusions **CO-5.**
Write laboratory report as per the prescribed format

4. Course Contents

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
4	Determination of performance of Multi cylinder Petrol IC engine using Morse test
5	Determination of performance of 4 stroke diesel engine
6	Determination of performance of a two stage reciprocating compressor
7	Construction of valve timing diagram of a 4 stroke petrol engine
8	Determination of Boiler Efficiency of packaged boiler using indirect method
9	Determination of Dryness Fraction of Steam using separating and throttling calorimeter
10	Determination of Steam turbine efficiency of a two stage steam turbine
11	Determination of Heating capacity in Sensible heating mode in an air conditioning system
12	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	2	2											2		
CO-2		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		00
Demonstrations		00
1. Demonstration using Videos	00	

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2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		
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	
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 (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 (Optional)**	
Subcomponent Type ►	**Lab exercise**	**Test and Viva Voce**		

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Maximum Marks ▶	25	25	25	50 Marks
CO-1	X	X		X
CO-2	X	X		X
CO-3	X	X		X
CO-4	X	X		X
CO-5	X	X		X

The 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. Laboratory Manual
2. Y. A. Cengel and Boles, 2011, Thermodynamics An Engineering Approach (SI Units), Tata McGraw-Hill Education Pvt. Ltd

b. Recommended Reading

1. C. Borgnakke and Sonntag, 2010, Fundamentals of Thermodynamics, Wiley-India
2. P. K. Nag, 2008, Engineering Thermodynamics, McGraw-Hill Education India Pvt. Ltd

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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
4. www.grc.nasa.gov.in

e. Other Electronic Resources

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

10. Course Organization

Course Code	MEL306A	
Course Title	Applied Thermodynamics Laboratory	
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	23-Oct-2020	
Next Course Specifications Review Date	May-2025	

Course Specifications: Dynamics and Simulation Laboratory

Course Title	Dynamics and Simulation Laboratory
Course Code	MEL307A
Course Type	Laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to provide practical and laboratory basis to the students for the design of machines based on dynamic analysis. Experiments related to dynamic study using balancing apparatus, cam apparatus and universal vibration apparatus will be carried out. Students are trained to analyze the experimental results and draw important conclusions related to machine dynamics. 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	01
Credit Structure (Lecture: Tutorial: Practical)	0:0:1
Total Hours of Interaction	30
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. Perform dynamic analysis of various mechanisms through simulation
CO-2. Plan the experimental setup to achieve the stated aim
CO-3. Conduct experiments as per the standard procedures and tabulate the measured
CO-4. Calculate the required parameters and plot the results
CO-5. Interpret, compare with standard results and draw conclusions **CO-6.**
Write laboratory report as per the prescribed format

4. Course Contents

1	Perform dynamic analysis of slider crank mechanism to determine inertia forces
2	Perform dynamic analysis of four bar mechanism to determine inertia forces

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3	Perform dynamic analysis on quick return mechanism to determine inertia forces of links
4	Perform dynamic analysis on single degree spring mass system to determine damping response and natural frequency of the system
5	Conduct test to determine spring stiffness and natural frequency for different springs mass systems and discuss results
6	Conduct experiment to study torsional vibration of a single rotor system
7	Conduct experiment to study damped vibration in a single degree freedom system
8	Conduct experiment to achieve static and dynamic balancing of rotating masses
9	Conduct experiment to determine reactive gyroscopic couple for a given rotating disc
10	Demonstration of whirling of shaft

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								2	3	
CO-2	2	2											2		
CO-3		2							3				2		3
CO-4		3											3		
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		00
Demonstrations		02
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	02	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		28
1. Course Laboratory	14	
2. Computer Laboratory	14	
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**

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 (Optional)**	
Subcomponent Type ►	**Lab Record**	**Test and Viva Voce**	**Term test**	
Maximum Marks ►	**25**	**25**	**25**	**50 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
CO-6	X	X		

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

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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 instruction
2.	Understanding	Laboratory instructions and experiments
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 work, examination
10.	Verbal Communication Skills	Laboratory examination
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Laboratory work
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading
1. Laboratory Manual
2. R.L. Norton , 2004, Design of Machinery , McGraw-Hill

b. Publications Recommended Reading
1. J. J. Uicker, G. R. Pennock and J. E. Shigley, 2003, Theory of Mechanisms and Machines, Oxford University Press
2. Thomas Bevan, 1984, Theory of Machines, CBS Publishers and Distributors
3. E. Charles, J. Wilson and Peter Sadler, 2003, Kinematics and Dynamics of Machinery, Prentice Hall
4. W. L. Cleghorn, 2005, Mechanics of Machines, Oxford University Press
5. Jacob Pieter Den Hartog , 1985, Mechanical Vibrations, Courier Dover Publications
6. J. S. Rao and K. Gupta, 1999, Introductory Course on Theory and Practice of Mechanical Vibrations, New Age International

c. Other Electronic Resources
1. RUAS Laboratory Videos
2. Electronic resources on the course area are available on MSRUAS library

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10. Course Organization

Course Code	MEL307A		
Course Title	Dynamics and Simulation Laboratory		
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	23-Oct-2020		
Next Course Specifications Review Date	May-2025		

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Course Specifications: Computer Aided Manufacturing (CAM) Laboratory

Course Title	Computer Aided Manufacturing (CAM) Laboratory
Course Code	MEL308A
Course Type	Laboratory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with CNC machine tool operations and their applications. Students will be equipped with basic knowledge and understanding of various CNC turning, milling, CNC Wire EDM operations, tools used and work holding devices for CNC machines. In addition, student will be trained to develop part programing for CNC turning, milling operations and tool path simulation using CAM software.

2. Course Size and Credits:

Number of Credits	01
Credit Structure (Lecture: Tutorial: Practical)	0:0:1
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. Describe the process of NC part programming
CO-2. Develop manual and CAM based NC part programme for simple turning and milling operations using appropriate software
CO-3. Simulate machining operations, generate CNC codes and tool path using appropriate software
CO-4. Evaluate the cutting time by comparing different tool path generation **CO-5.** Write a report as per the prescribed format

4. Course Contents

1	Write manual part program for face and finish turning operations using G-codes, Mcodes

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2	Write manual part program for turning and grooving operations using G-codes, Mcodes
3	Write manual part program for threading operation using G-codes, M-codes
4	Write manual part program for drilling operation using G-codes, M-codes
5	Write manual part program for milling using G-codes, M-codes
6	Write manual part program for side milling using G-codes, M-codes
7	Write manual part program for pocket milling using G-codes, M-codes
8	Write manual part program for milling and drilling operations using G-codes, M-codes
9	CAM based NC part program for turning operations: Develop NC part programme for face and finish turning operations by selecting appropriate cutting tools and cutting parameters and generate tool path using appropriate software
10	Develop NC part programme for turning and grooving operations by selecting appropriate cutting tools and cutting parameters and generate tool path using appropriate software
11	Develop NC part programme for threading operation by selecting appropriate cutting tools and cutting parameters and generate tool path using appropriate software
12	Develop NC part programme for drilling operations by selecting appropriate cutting tools and cutting parameters and generate tool path using appropriate software
13	CAM based NC part program for Milling and drilling operations: Develop NC part programme for milling by selecting appropriate cutting tools and cutting parameters and generate tool path using appropriate software
14	Develop NC part programme for side milling by selecting appropriate cutting tools and cutting parameters and generate tool path using appropriate software
15	Develop NC part programme for milling and drilling operations by selecting appropriate cutting tools and cutting parameters and generate tool path using appropriate software
16	Develop NC part programme for pocket milling operations by selecting appropriate cutting tools and cutting parameters and generate tool path using appropriate software
17	Demonstration of Facing, Plain turning, Step turning, Taper turning, Thread cutting and Boring operations using CNC Lathe and prepare a report consisting of surface characteristics
18	Demonstration of Face milling, side milling, Pocketing, Drilling and slotting operations using vertical CNC Milling Machine
19	Demonstrations of CNC Wire Electro Discharge Machining operations on difficult to cut materials
20	Demonstrations of 3D Printing machine and develop prototypes\end products from the CAD models

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					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		06
1. Demonstration using Videos	02	
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	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		**40**

7. Course Assessment and Reassessment

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The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the 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 (Optional)	
Subcomponent Type ▶	Lab Record	Test and Viva Voce	Term test	
Maximum Marks ▶	25	25	25	50 Marks
CO-1	X	X		X
CO-2	X	X		X
CO-3	X	X		X
CO-4	X	X		X
CO-5	X	X		X

The 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 instruction
2.	Understanding	Laboratory instructions and experiments
3.	Critical Skills	Laboratory instruction
4.	Analytical Skills	Laboratory instruction
5.	Problem Solving Skills	Laboratory instruction
6.	Practical Skills	Laboratory instruction
7.	Group Work	Laboratory instruction
8.	Self-Learning	Laboratory instruction

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9.	Written Communication Skills	Laboratory work, Examination
10.	Verbal Communication Skills	Laboratory Examination
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Laboratory work
14.	Personal Management	Course Work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. P. N. Rao, 2002, CAD/CAM: Principle & Applications, New Delhi, Tata McGraw-Hill
3. Ibrahim zeid,2006, Master in CAD/CAM: McGraw Hill Education; 2 edition

b. Recommended Reading

1. W. Chapman, 2007, Workshop Technology, Part 2, ButterworthHeinemann.
2. Wit Grzesik, 2008, Advanced Machining Processes of Metallic Materials: Theory, Modelling and Applications, Elsevier.
3. Serope Kalpakjian and Stephen Schmid, 2009, Manufacturing, Engineering and Technology, Pearson.
4. Mikell P. Groover, 2017, Industrial Robotics-SIE-Technology-Programming and Applications, McGraw-Hill.

c. Magazines and Journals

1. International Journal of Machine Tools and Manufacture: Design, Research and Application
2. International Journal of Precision Engineering and Manufacturing.
3. Efficient Manufacturing

d. Websites

1. https://www.effectivmanufacturing.in
2. https://www.americanmachinist.com

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	MEL308A
Course Title	Computer Aided Manufacturing (CAM) Laboratory

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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	23-Oct-2020	
Next Course Specifications Review Date	May-2025	

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Course Specifications: Heat and Mass Transfer

Course Title	Heat and Mass Transfer
Course Code	MEC309A
Course Type	Core Theory
Department	Department of 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)	3:1:0
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.** 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

Unit 6 (Mass Transfer): Analogy between heat and mass transfer; Mass diffusion; Fick's Law; Boundary conditions; steady mass. Diffusion through a wall, cylinder and sphere; Water vapour migration in buildings; Transient mass. Diffusion; Mass transfer in a moving medium; Diffusion of vapour through a stationary gas: StefanFlow

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

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

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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**	**Group task**	**100 Marks**
Maximum Marks ▶	**25**	**25**	**25**	**25**	
CO-1	X		X		X
CO-2	X		X		X
CO-3	X		X		X
CO-4	X	X	X		X
CO-5		X		X	X
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study

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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, McGrawHill 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

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10. Course Organization

Course Code	MEC309A	
Course Title	Heat and Mass 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	23-Oct-2020	
Next Course Specifications Review Date	May-2025	

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Bangalore

Course Specifications: Finite Element Methods and CAE Laboratory

Course Title	Finite Element Methods and CAE Laboratory
Course Code	MEC310A
Course Type	Core Theory Course
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is aimed at introducing the students to the concepts of FEM/FEA and to apply the same for engineering analysis. Students are taught variational principles in solid mechanics, formulations of finite elements and finite element analysis technique. Application of finite element methodology to solve structural linear, dynamic and thermal problems will be explained. Students will be able to perform finite element modelling and analysis of simple linear static, dynamic and thermal 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 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 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, Non Linear, static, dynamic, harmonic, thermal, CFD,

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Crash 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:
Modelling Considerations: Element selection (kind, type, size, order), Representation of geometry, Application of loads, Representation and application of boundary conditions, hmethod and p-method of analysis; Iso-parametric, sub-parametric and super-parametric element formulation
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	

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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	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	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		**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.

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
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

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1. Class Notes
2. T. R. Chandrupatla and Ashok D. Belegundu, 2001, Introduction to Finite Elements in Engineering, Prentice Hall India
3. J. N. Reddy, 2005, An Introduction to the Finite Element Method, McGrawHill International Edition

b. Publications Recommended Reading

1. O. C. Zienkiewicz, 2005, The Finite Element Method, Tata McGraw-Hill Publishing Co. Ltd.
2. M. J. Fagan, 1992, Finite Element Analysis, Theory and Practice, Longman Scientific and Technical Affiliated East West Press
3. K. J. Bathe, 1997, Finite Element Procedures, Prentice Hall India
4. Vince Adams and Abraham Askenazi, 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.com
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	MEC310A	
Course Title	Finite Element Methods and CAE Laboratory	
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	23-OCT-2020	
Next Course Specifications Review Date	May 2025	

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Course Specifications: Design of Machine Elements-2

Course Title	Design of Machine Elements-2
Course Code	MEC311A
Course Type	Core Theory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is aimed at preparing the students to apply engineering principles and methods for the design and analysis of common machine elements under various loading conditions used in machinery. Stress analysis of machine elements and fatigue design methodologies will be taught. Students will be trained to design machine components using prescribed standards, correction factors and codes based on loading conditions. Students will be able to design mechanical components like springs, bearings, gears, clutches, brakes and chain drives.

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 basic concepts and principles of machine component and system design under static and fluctuating loads
- **CO-2.** Identify appropriate governing criteria / standard for designing machine components based on its criticality under fluctuating load conditions
- **CO-3.** Design machine components like springs, clutches, brakes, gears, wire ropes, chains and sliding contact bearings
- **CO-4.** Select appropriate rolling contact bearing for an application
- **CO-5.** Perform iterative design calculations to achieve induced stress values well within design stress values for various machine elements

4. Course Contents

Unit 1 (Design for Fatigue Strength): Introduction- S-N Diagram, Low Cycle Fatigue, High Cycle

Fatigue, Endurance Limit, Modifying Factors: Size effect, Surface effect, Stress Concentration effects, Fluctuating Stresses: Goodman and Soderberg relationship; Numerical examples on fatigue design.

Unit 2 (Design of Springs): Stresses in Helical coil springs of circular cross sections; Tension and compression springs, springs under fluctuating loads, Energy stored in springs, Torsion springs, Leaf Springs: Stresses in leaf springs, Equalized stresses

Unit 3 (Design of Gear): Classification of gears; Nomenclature; Law of gearing, Conjugate action, Gear profiles, Pressure angle, Standard gear tooth, Backlash, Interference and undercutting; Simple and compound gear trains; Force analysis, Gear tooth failure, Material selection, Gear blank design, Strength of gear tooth, Permissible stress, Module estimation with beam and wear strength; Design of spur gear; Internal gear, helical gear, Herringbone gear, bevel and worm gears.

Unit 4 (Design of Rolling and Sliding Contact Bearings): Overview of types and classification of bearings, static and dynamic load bearing capacity, Stribeck's equation, equivalent bearing load, load-life relationship, load factor, equivalent bearing load, selection of bearings from manufacturer's catalogue, mounting of bearing. Comparison of rolling and sliding bearings, basic lubrication modes, Petroff's equation, Reynold's equation, bearing design-selection of parameters, bearing materials, bearing failure-causes and remedies

Unit 5 (Design of Clutches and Brakes): Energy equation and thermal Considerations of clutch and brakes, Torque transmission capability, design of single and multidisc clutches, cone clutches, centrifugal clutches, Block brake with short and long shoe, Band brake and Disc brake

Unit 6 (Design of Chain Drives and Wire Ropes): Advantages of Chain drives over other drives, geometrical relationships in roller chains, polygonal effects, power rating based on failure criteria's, design of chain drives, Advantages of wire ropes, construction of wire ropes, stresses in wore ropes, examples on analysis of wire ropes

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		2	3										3		

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		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	01	
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. (Electronics and Communication Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				**Component 2: SEE (50% Weightage)**
Subcomponent ►	**SC1**	**SC2**	**SC3**	**SC4**	
Subcomponent Type ►	**Term test**	**Term test**	**Assignment**	**Group task**	**100 Marks**
Maximum Marks ►	**25**	**25**	**25**	**25**	
CO-1	**X**		**X**		**X**
CO-2	**X**		**X**		**X**

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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	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. V. B. Bhandari, 2007, Design of Machine Elements, Tata McGraw-Hill
3. Joseph Shigley, Charles Mischke and Richard Budynas, 2003, Mechanical Engineering Design, Boston, McGraw-Hill
4. K. Lingaiah, 2006, Machine Design Data Hand Book, Volume I and II, Suma

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b. Publications Recommended Reading

1. Robert C. Juvinall, Kurt M. Marshek, 2000, Fundamentals of Machine Component Design, John Wiley and Sons
2. Robert L. Norton, 2005, Machine Design: An Integrated approach, Pearson - Prentice Hall
3. Allen S. Hall, Alfred R. Holowenko, Herman G. Laughlin, 2000, Schaum's Outline of Theory and Problems of Machine Design, McGraw-Hill Professional
4. Robert L. Mott, 1992, Machine Elements in Mechanical Design, Westerville, Merrill Publishing Company
5. Boris M. Klebanov, David Barlam, Frederic E. Nystrom, 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. https://nptel.ac.in/

e. Other Electronic Resources

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

10. Course Organization

Course Code	MEC311A		
Course Title	Design of Machine Elements-2		
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		23-Oct-2020	
Next Course Specifications Review Date		May-2025	

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Course Specifications: Control Systems Engineering and Laboratory

Course Title	Control Systems Engineering and Laboratory
Course Code	MEC312A
Course Type	Core Theory
Department	Department of Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with the modeling and analysis of linear control systems. The course provides students an understanding of classification of systems, mathematical modeling of linear systems and analyse stability of a system. Students are taught the time and frequency response analysis of linear systems. Students will be able to model, apply control system techniques to a given application and analyse the response for suitability of design using suitable software.

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	Electrical 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 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 and frequency response analysis and stability of a system
CO-4. Design controller for a system and analyse performance of the system
CO-5. Perform stability analysis for a given system and interpret results
CO-6. Apply control system techniques to a given application and analyse the response for suitability of design using standard software

4. Course Contents

Unit 1 (Overview of Control Systems): Concepts of Control Systems- Open Loop and closed loop control systems and their differences- A few illustrations of control systems- Effects of feedback; Classification of control systems, linear, nonlinear, Time invariant, Time variant, Analog and Digital system; Requirements of control systems.

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Unit 2 (Mathematical Modelling of Physical Systems): Review of mathematical fundamentals - Linear differential equations, Order and degree of a system, Laplace transforms, Complex numbers; Mathematical models and transfer functions of mechanical, electrical, electro mechanical, analogous systems; Block diagram and signal flow graph analysis. Simulation of mathematical models using transfer function, block diagram reduction

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

Unit 4 (Controller Design): On/off, proportional, integral, derivative, proportional integral, proportional integral derivative controllers, their transfer function and physical examples. Effect of PI, PID controller on steady state error, stability and relative stability Analysis of time response characteristics of a closed loop system with controller

Unit 5 (Concept of Stability and Relative Stability): Characteristic equation, Necessary and sufficient conditions, Routh – Hurwitz criteria of stability Stability analysis of closed loop system using Routh – Hurwitz criteria

Unit 6 (Root locus method and Frequency Response Analysis): Root locus plots and determination of time response specification and system gain Stability analysis of closed loop system using Root Locus method
Polar plot, Nyquist stability criterion, Nyquist plot, Bode plot Stability analysis of closed loop system using frequency response method

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			2								3	2	
CO-6		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		35

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Demonstrations		02
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		10
1. Solving Numerical Problems	10	
Practical Work		28
1. Course Laboratory	28	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop /	00	
Kitchen		
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					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ►	SC1	SC2	SC3	SC4	
Subcomponent Type ►	Term test	Term test	Assignment	Group task	100 Marks

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Maximum Marks ►	25	25	25	25	
CO-1	X		X		X
CO-2	X		X		X
CO-3	X		X		X
CO-4	X	X	X		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. Course notes
   2. M. Gopal, 2002, Control Systems: Principles and Design, Tata McGraw-Hill Education
b. **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
c. **Magazines and Journals**
   1. IEEE Control Systems Magazine
d. **Websites**
   1. http://ctms.engin.umich.edu/CTMS/index.php?aux=Home
   2. 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	MEC312A		
Course Title	Control Systems Engineering and Laboratory		
Course Leader's Name	As per Timetable		
Course Leader's Contact Details	**Phone:**	+91-80-49065555	
	E-mail:	hod.ee.et@msruas.ac.in	
Course Specifications Approval Date	23-Oct-2020		
Next Course Specifications Review Date	May-2025		

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Course Specifications: Industrial Engineering and Management

Course Title	Industrial Engineering and Management
Course Code	MEC313A
Course Type	Core Theory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

The course aims to provide knowledge about the various aspects of Industrial Engineering and Management. The methods of optimizing and standardizing industrial operations that influence the productivity of an organization will be taught. Industrial engineering concepts like work study, job design, ergonomics and quality control techniques will be discussed. Students will also be introduced to various theories and philosophies of management, organizational structure, and materials management. Major selection factors that affect plant location and facility layout will be discussed.

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 productivity and its types, the methods of measuring productivity and measures for improving productivity

CO-2. Explain various principles of management, functions of industrial engineering, materials management and organization structure with their applications

CO-3. Discuss human factors and ergonomics in industries

CO-4. Apply concepts of industrial engineering, materials management, and quality management for a given application

CO-5. Select location for setting up a facility by considering the economic and noneconomic factors

4. Course Contents

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Unit 1 (Fundamentals of Industrial Engineering and Management): Concepts of industrial engineering, productivity, types of productivity, productivity measurement, productivity analysis, productivity improvement through BPR, TPM.

Unit 2 (Concepts of Management and Organization): Functions of Management – Evolution of Management Thought : Taylor's Scientific Management, Fayol's Principles of Management, Douglas Mc-Gregor's Theory X and Theory Y, Hertzberg's Two Factor Theory of Motivation, Maslow's Hierarchy of Human Needs – Systems Approach to Management.

Unit 3 (Designing Organizational Structures): Basic concepts related to Organization - Departmentation and Decentralization, Types of mechanistic and organic structures of organization (Line organization, Line and staff organization, functional organization, Committee organization, matrix organization, Virtual Organisation, Cellular Organisation, team structure, boundary less organization, inverted pyramid structure, lean and flat organization structure) and their merits, demerits and suitability.

Unit 4 (Facilities Layout): Selection of plant location: Consideration of various factors, Plant Layout – definition, objectives, types of production, types of plant layout – various data analyzing forms-travel chart, basics of facility planning, facility layout planning procedure, calculation of facility requirement, systematic layout planning, non-production activity, production activity, and group technology layout.

Unit 5 (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 6 (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 7 (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 8 (Quality Control): Inspection and quality control, types of inspections - Statistical Quality Control-techniques variables and attributes-assignable and non-assignable causes- variable control charts, and R charts, attributes control charts, P charts and C charts.

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

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	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	--

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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

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

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

a. Other Electronic Resources

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

10. Course Organization

Course Code	MEC313A	
Course Title	Industrial Engineering and Management	
Course Leader's Name		As per Timetable

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Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	23-Oct-2020	
Next Course Specifications Review Date	May-2025	

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Course Specifications: Engineering Economics and Cost Estimation for Mechanical Engineers

Course Title	Engineering Economics and Cost Estimation for Mechanical Engineers
Course Code	MEC314A
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 microeconomics, 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

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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.

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

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	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	--

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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	MEC314A		
Course Title	Engineering Economics and Cost Estimation 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	

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Course Specifications Approval Date	23-Oct-2020
Next Course Specifications Review Date	May-2025

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Course Specifications: Seminar

Course Title	Seminar
Course Code	MES316A
Course Type	Core Theory
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of the course is to train the students on data collection, analysis and presentation about a chosen topic. In this course students are required to deliver seminars on various relevant topics from the broad areas mentioned in the course content. Students will be trained to prepare a brief report on the chosen seminar topic.

2. Course Size and Credits:

Number of Credits	01
Credit Structure (Lecture: Tutorial: Practical)	0:0:1
Total Hours of Interaction	30
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. Prepare and deliver seminar on a given topic.
CO-2. Write a report on the seminar topic.

4. Course Contents

Indicative list of topics: Food Security, Energy Crisis, National Water Management, Cyber- warfare, Genetically modified food, Technology innovation, Non-Proliferation Treaty (NPT), MSME and National Economy, Right to Information (RTI) Act, Right to Educate (RTE), FDI, Corporate Social Responsibility, Work Life Balance, Political Stability and National growth, Demography, Impact of Science and Technology on society.

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

	Programme Outcomes (POs)	Programme Specific Outcomes (PSOs)

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	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									2	3					3

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		06
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		24
1. Case Study Presentation	15	
2. Guest Lecture	00	
3. Industry / Field Visit	05	
4. Brain Storming Sessions	00	
5. Group Discussions	04	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		02
Total Duration in Hours		**32**

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

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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 (Optional)	
Subcomponent Type ►	Presentation	Report	25 Marks
Maximum Marks ►	25	25	
CO-1	X	X	X
CO-2	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	Seminar Preparations
2.	Understanding	Seminar Preparations
3.	Critical Skills	Seminar Preparations
4.	Analytical Skills	Seminar Preparations
5.	Problem Solving Skills	Seminar Preparations
6.	Practical Skills	Seminar Preparations
7.	Group Work	--
8.	Self-Learning	Seminar Preparations
9.	Written Communication Skills	Seminar Report
10.	Verbal Communication Skills	Presentation and Viva Voce
11.	Presentation Skills	Presentation
12.	Behavioral Skills	Seminar Preparations
13.	Information Management	Seminar Report
14.	Personal Management	Presentation
15.	Leadership Skills	Seminar Report

9. Course Resources

a. Essential Reading

1. Jerry Weissman, Presenting to Win

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2. Cliff Atkinson, Beyond Bullet Points
3. Bruce R. Gibrielle, Speaking Powerpoint
4. Garr Reynolds, Presentation Zen Design

b. Recommended Reading

1. Based on the topic chosen.

c. Magazines and Journals

1. Based on the topic chosen.

d. Websites

1. Based on the topic chosen.

e. Other Electronic Resources

1. Relevant resources available in RUAS Library

10. Course Organization

Course Code	MES316A		
Course Title	Seminar		
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		23-Oct-2020	
Next Course Specifications Review Date		May-2025	

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Course Specifications: Heat and Mass Transfer Laboratory

Course Title	Heat and Mass Transfer Laboratory
Course Code	MEL315A
Course Type	Laboratory
Department	Department of Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course imparts knowledge to determine thermal characteristics like thermal conductivity, convection coefficients, emissivity of materials. Students will be able to measure the heat transfer rate using conduction, convection, radiation, boiling and condensation principles. Students are trained to conduct experiments to determine the performance characteristics of various types of heat exchangers with boiling and condensation modes.

2. Course Size and Credits:

Number of Credits	01
Credit Structure (Lecture: Tutorial: Practical)	0:0:1
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. Plan the experimental setup to achieve the stated aim
CO-2. Conduct experiments as per the standard procedures and tabulate the measured values
CO-3. Calculate the required parameters and plot the results
CO-4. Interpret, compare with standard results and draw conclusions
CO-5. Write laboratory report as per the prescribed format

4. Course Contents

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

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5	Determination of transient heat transfer and temperature distribution of a metal rod
6	Determination of heat transfer coefficient for natural and forced convection
7	Determination of emissivity of a surface/test plate using Stefan Boltzmann apparatus
8	Determination of Stefan-Boltzmann constant using graphical method
9	Determination of Log Mean Temperature Difference (LMDT) and effectiveness in a counter flow and parallel flow heat exchangers
10	Determination of effectiveness of cross-flow heat exchanger
11	Demonstration of boiling heat transfer
12	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											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		00
Demonstrations		0
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		0
1. Solving Numerical Problems	00	
Practical Work		30
1. Course Laboratory	30	
2. Computer Laboratory	00	

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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**

7. **Course Assessment and Reassessment:** The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertainingto 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 (Optional)	
Subcomponent Type ►	Lab exercise	Lab record	Term test	
Maximum Marks ►	25	25	25	50 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 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.

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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	Laboratory work
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Laboratory Record
10.	Verbal Communication Skills	Viva-Voce
11.	Presentation Skills	Laboratory Record
12.	Behavioral Skills	--
13.	Information Management	Laboratory Manual
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Laboratory Manual
2. J. P. Holman, 2008, Heat Transfer, McGraw-Hill Inc.

b. Recommended Reading

1. Y. A. Cengel, 2006, Heat and Mass Transfer: A Practical Approach, McGrawHill Higher Education
2. P. K. Nag, 2011, Heat and Mass Transfer, Tata McGraw-Hill

c. Magazines and Journals

1. International Journal of Heat and Mass Transfer
2. Journal of Thermo-physics and Heat Transfer, AIAA
3. International Communications in Heat and Mass Transfer
4. Journal of Heat Transfer, ASME

d. Websites

1. http://nptel.ac.in/
2. www.machinedesignonline.com
3. ocw.mit.edu
4. www.class-central.com

e. Other Electronic Resources

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

10. Course Organization

Course Code	MEL315A	
Course Title	Heat and Mass Transfer Laboratory	
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	23-OCT-2020	
Next Course Specifications Review Date	May 2025	

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Course Specifications: Advanced Mechanics of Materials

Course Title	Advanced Mechanics of Materials
Course Code	MEE411A
Course Type	Core Elective Course
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course 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
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
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 material behaviour under various loading conditions
- **CO-2.** Perform stress analysis for given loading and boundary condition from the first principles
- **CO-3.** Identify the critical region of the structure and use appropriate failure model to analyse the failure
- **CO-4.** Develop mathematical models to predict material behaviour under various loading conditions
- **CO-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

4. Course Contents

Unit 1 (Introduction): General consideration in mechanics of material; types of forces, types of materials; stress-strain behaviour for ductile and brittle material

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Unit 2 (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 stress-strain relation, thermal stresses; combined loading, failure theories

Unit 3 (2D Approximation): Plane stress, plane strain and axisymmetric

Unit 4 (Plasticity and Creep): True stress and strain; flow curves, yield criteria, yield locus, flow rules; plastic stress-strain relations; hardening behavior. Time dependent mechanical behaviour, the creep curve, structural changes during creep, fracture at elevated temperature

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		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	

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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**

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**	**Group Task**	**100 Marks**
Maximum Marks ►	**25**	**25**	**25**	**25**	
CO-1	X				X
CO-2	X	X			X
CO-3	X	X			X
CO-4			X	X	X
CO-5			X	X	X
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

8. Achieving COs

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

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

b. Recommended Reading

1. A. P. Boresi and R. J. Schmidt , 2009, Advanced Mechanics of Materials, John Willey and Sons
2. J. M. Gere and S. P. Timoshenko, 2002, Mechanics of Materials, CBS

c. 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

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

10. Course Organization

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Course Code	MEE411A	
Course Title	Advanced Mechanics of Materials	
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	23-Oct-2020	
Next Course Specifications Review Date	May-2025	

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Course Specifications: Advanced Manufacturing Technologies

Course Title	Advanced Manufacturing Technologies
Course Code	MEE412A
Course Type	Professional Core Elective
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course 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
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
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 the working principles, operations, merits and demerits of non-traditional machining and additive manufacturing processes
CO-2. Describe the types of non-traditional machining and additive manufacturing processes and the effect process parameters
CO-3. Compare the suitability of non-traditional machining and additive manufacturing technologies for various applications
CO-4. Develop CAD model, slicing and tool path generation for additive manufacturing processes
CO-5. Select appropriate process for manufacturing a given component and criteria

4. Course Contents

Unit 1 (Non-Traditional Machining Processes and Mechanical energy based non-traditional process): Need and importance of Non-traditional machining process, comparison between traditional and non-traditional machining process, advantages and disadvantages

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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)

Unit 2 (Electrical, Chemical and Electro chemical 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
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)

Unit 3 (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)

Unit 4 (Additive manufacturing): Overview, need, importance, applications and challenges of additive manufacturing process in product development, materials for additive manufacturing technology. CAD model preparation, part orientation and support generation, model slicing and tool path generation
Unit 5 (Liquid, Solid and Powder based additive manufacturing systems): Working principle, process characteristics, surface finish, compatibility, advantages and applications of Stereo lithographic 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)

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		
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		50
Demonstrations		05

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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**

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**	**Group Task**	**100 Marks**
Maximum Marks ►	**25**	**25**	**25**	**25**	
CO-1	**X**				**X**
CO-2	**X**	**X**			**X**
CO-3	**X**	**X**			**X**

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CO-4			X	X	X
CO-5			X	X	X
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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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

10. Course Organization

Course Code	MEE412A	
Course Title	Advanced Manufacturing Technologies	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-80-49065555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	July 2020	
Next Course Specifications Review Date	July 2024	

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Course Specifications: Fluid Power Systems

Course Title	Fluid Power Systems
Course Code	MEE413A
Course Type	Professional Core Elective
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course 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
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
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 the principles and components of fluid power systems
CO-2. Describe the working of fluid power systems
CO-3. Select cylinders, actuators and control valves for given application
CO-4. Develop hydraulic or pneumatic systems with circuit diagrams
CO-5. Design and analyze hydraulic/pneumatic circuit for a given application

4. Course Contents

Unit 1(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

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Unit 2 (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

Unit 3 (Hydraulic pumps and Hydraulic Actuators in Fluid Power): Pump classification, pumping theory, pressure regulation, Pump performance and its ratings; Pump noise; pump selection 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

Unit 4(Control Valves and Pneumatic System): Non return valves, flow control valves, direction control valves, proportional valves
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

Unit 5(Hydraulic and Pneumatic Circuits): Circuit symbols, simple hydraulic and pneumatic circuitsto 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

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		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		45
Demonstrations		03
1. Demonstration using Videos	03	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	

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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**

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**	**Group Task**	**100 Marks**
Maximum Marks ▶	**25**	**25**	**25**	**25**	
CO-1	X				X
CO-2	X	X			X
CO-3	X	X			X
CO-4			X	X	X
CO-5			X	X	X

The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	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	Laboratory, Assignment
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	--
13.	Information Management	Assignment, examination
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. Anthony Esposito, 2000, Fluid Power with Applications, Pearson Education 3. Andrew Par, 2005, Hydraulics and Pneumatics, Jaico Publishing House

b. Recommended Reading

1. Ilango Sivaraman, Introduction to Hydraulics and Pneumatics, PHI, 3rd Edition
2. James L. Johnson, Introduction to Fluid Power, Delmar - A Thomson learning Inc
3. G. E. Totten, 1999, Handbook of Hydraulic Fluid Technology, CRC Press

c. Magazines and Journals

1. International Journal of Fluid Power
2. International Journal of Fluid Power System
3. Hydraulics and Pneumatics Magazine

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4. Drives and controls by Bosch Rexroth

d. Websites

1. www.hydraulicspneumatics.com
2. www.hpmag.co.uk
3. www.nptel.ac.in
4. www.coursera.org

e. Other Electronic Resources

1. Electronic resources on the course area are available on RUAS library
2. EBook on Hydraulics and Pneumatics by Elsevier

10. Course Organization

<table>
<tr><td>Course Code</td><td colspan="2">MEE413A</td></tr>
<tr><td>Course Title</td><td colspan="2">Fluid Power Systems</td></tr>
<tr><td>Course Leader's Name</td><td colspan="2">As per Timetable</td></tr>
<tr><td rowspan="2">Course Leader's Contact Details</td><td>Phone:</td><td>080-49065555</td></tr>
<tr><td>E-mail:</td><td>hod.me.et@msruas.ac.in</td></tr>
<tr><td>Course Specifications Approval Date</td><td colspan="2">23-Oct-2020</td></tr>
<tr><td>Next Course Specifications Review Date</td><td colspan="2">May-2025</td></tr>
</table>

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*Course Specifications: **Operations Research***

Course Title	Operations Research
Course Code	MEE414A
Course Type	Professional Core Elective
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course 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
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. Describe different problem solving methods for optimal utilization of resources
CO-2. Formulate appropriate mathematical models in order to obtain the optimal solution and analyze their sensitivity
CO-3. Solve numerical problems for obtaining optimal solution by considering the objectives and constraints of a system and draw conclusions
CO-4. Compute normal and standard time of an activity and estimated times for completion of a project
CO-5. Optimize a given system by adhering to the constraints and achieving the desired objectives

4. Course Contents

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Unit 1 (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

Unit 2 (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

Unit 3 (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

Unit 4 (Sequencing and Transportation Model): 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

Unit 5 (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

Unit 6 (Queuing Theory and Simulation): 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

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										3		
CO-4		3											3		
CO-5		3											3		

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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		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		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**

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.

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	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

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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 course area are available in RUAS library

10. Course Organization

Course Code	MEE414A		
Course Title	Operations Research		
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		23-Oct-2020	
Next Course Specifications Review Date		May-2025	

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Course Specifications: Robotic Systems and Automation

Course Title	Robotic Systems and Automation
Course Code	MEE415A
Course Type	Professional Core Elective
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course 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
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
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 the evolution and future of robotic systems and applications
CO-2. Describe the anatomy of given robotic system
CO-3. Discuss the need, significance and types of automation in manufacturing
CO-4. Select appropriate end effector for the robotic application
CO-5. Determine various robot configurations and robot cell features in automation

4. Course Contents

Unit 1 (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

Unit 2 (Anatomy of Robotic Systems): Robot physical configurations; Basic robot motions;

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Different parts and functions in a robotic systems, sensors, manipulator, actuators, power sources, terminologies in robotics

Unit 3 (End-Effectors): Types of end effectors, grippers, applications; drives and actuator system for end effectors and grippers; design considerations and guidelines for end effectors

Unit 4 (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

Unit 5 (Automation Technology and Sub-Systems): Sensors – generic and sensors for motion control (force, torque, acceleration, encoders), Actuators, PLC's, CNC, Motors, Drives, Motion controllers, Vision systems and inspection, PC-based control technology, Flexible Manufacturing Systems

Unit 6 (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

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		40
Demonstrations		05
1. Demonstration using Videos	05	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	

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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**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Tech. (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**	**Group Task**	**100 Marks**
Maximum Marks ►	**25**	**25**	**25**	**25**	
CO-1					
CO-2					
CO-3					
CO-4					

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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	--
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. Harry H. Poole, 1989, Fundamentals of Robotics Engineering, 1st Edition, New York, Van Nostrand Reinhold.
3. Mikell P. Groover, 2008, Automation, Production Systems and Computer Integrated Manufacturing, PHI Learning Private Ltd.

b. Recommended Reading

1. Mikell P. Groover, 2012, Specifications of Industrial Robotics: Technology, Programming, and Applications, 2nd Edition, Mcgraw Hill Education
2. Siciliano Bruno and Oussama Khatib, 2008, Handbook of Robotics, Springer.
3. Asai K. and Takshima S., 1994, Manufacturing Automation Systems and Computer Integrated Manufacturing Factories, Chapman

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c. Magazines and Journals

1. Journal of Robotics
2. Journal of Robotics and Autonomous Systems
3. Journal of Robotics and Computer-Integrated Manufacturing
4. http://www.botmag.com
5. http://www.roboticmagazine.com

d. Websites

1. http://www.robotics.org
2. http://www.ieee-ras.org/agricultural-robotics
3. http://robohub.org
4. http://spectrum.ieee.org/robotics/medical-robots

e. Other Electronic Resources

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

10. Course Organization

Course Code	MEE415A		
Course Title	Robotic system and Automation		
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		23-OCT- 2020	
Next Course Specifications Review Date		May 2025	

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Course Specifications: Probability and Statistics

Course Title	Probability and Statistics
Course Code	MTE401A
Course Type	Professional Core Elective
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course 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	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
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. Explain the concepts of random variables, probability distribution, joint probability distribution and sampling distribution
CO-2. Explain the principles of convex optimization, regression, confidence interval and hypothesis testing
CO-3. Solve simple problems associated with probability distribution, regression, confidence interval and hypothesis testing
CO-4. Model real word problems by using probability distribution and regression
CO-5. Solve complex problems associated with probability distribution, regression, confidence interval and hypothesis testing

4. Course Contents

Unit 1 (Random variables and Discrete Probability Distributions): Discrete and continuous

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Definitions, illustrations and properties of random variables, univariate transformations with illustrations. Probability density function, cumulative distribution function, expected values, variance and their properties. Mean, variance, standard deviation of Binomial, Poisson, Uniform and Negative Binomial along with their characteristic properties and limiting/approximation cases.

Unit 2 (Continuous Probability Distributions and Joint Probability Distribution): 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. Introduction, Joint Probability density function, marginal probability density function, independent random variables, mathematical expectation.

Unit 3 (Sampling Distribution and Convex Optimization Algorithms): The sampling distribution of sample mean, sample proportions and sample variance. Central limit theorem. Steepest descent and conjugate gradient.

Unit 4 (Regression and Estimation): Multivariate linear and non-linear regression. Correlation and covariance. 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.

Unit 5 (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.

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	2						2			3	2	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

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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					

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CO-2					
CO-3					
CO-4					
CO-5					
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

1. Class notes
2. Sheldon Ross, 2010, A First Course in Probability, 8th edition, Pearson

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

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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

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

<table>
<tr><td>Course Code</td><td colspan="2">MTE401A</td></tr>
<tr><td>Course Title</td><td colspan="2">Probability and Statistics</td></tr>
<tr><td>Course Leader's Name</td><td colspan="2">As per Timetable</td></tr>
<tr><td rowspan="2">Course Leader's Contact Details</td><td>Phone:</td><td>080 4906 5555</td></tr>
<tr><td>E-mail:</td><td>hod.mt.mp@msruas.ac.in</td></tr>
<tr><td>Course Specifications Approval Date</td><td colspan="2">23-Oct-2020</td></tr>
<tr><td>Next Course Specifications Review Date</td><td colspan="2">May-2025</td></tr>
</table>

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Course Specifications: Advanced Mathematics

Course Title	Advanced Mathematics
Course Code	MTE411A
Course Type	Professional Core Elective
Department	Mechanical Engineering
Faculty	Mathematical and Physical Sciences

1. Course Summary

The aim of the course is to provide an understanding of tensors, differential geometry, Riemannian geometry, special functions and its applications to engineering problems. In this course, the students will be taught the concepts of differential geometry and Riemannian geometry such as curves, surfaces, orthogonal curvilinear coordinates, vectors, tensors, and manifolds. The utility of to solve complex engineering problems of Legendre's and Bessel differential equation in modeling real world problems are highlighted. The significance and use of curvilinear coordinates, curvature, torsion, Tangent vectors, Tangential space, manifolds, tensors and coordinate transformation for tensors are emphasized.

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	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 Legendre and Bessel differential equation, curvature, torsion, geodesics, manifolds and tensors

CO-2. State the results and theorems and solve simple problems in Legendre differential equations, Bessel differential equation, theory of curves and surfaces

CO-3. Apply differential geometry techniques to compute Gaussian curvature, mean curvature, principal curvature and torsion

CO-4. Solve complex engineering problems associated with Bessel differential equation, theory of curves and surfaces, orthogonal curvilinear coordinates and spherical curvilinear system

CO-5. Analyze real world problems associated with Bessel differential equation and curvature of space curves

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4. Course Contents

Unit 1 (Tensors): Summation convention, dummy index, free index, Kronecker tensor(special tensor), Alternate tensor(special tensor), scalar , vectors, definition of tensor, covariant vectors, contravariant vectors , coordinate transformation for tensors, zero tensor, tensor of order second, covariant tensors of order two, contravariant tensor of order two, mixed tensor of order two, Algebra of tensors-multiplication of tensors, addition and subtraction of tensors, multiplication of tensors, Equality of tensors, symmetric and skew symmetric tensor, contraction of tensor, Quotient law.

Unit 2 (Differential Geometry): Theory of curves and surfaces: tangent vector, normal and binomial vectors to a space curve, arc-length, curvature, torsion, fundamental theorem of curves, orthogonal curvilinear coordinates, and spherical curvilinear system. Local theory of surfaces, parametric representation of surfaces, gauss map, Gaussian, mean and principle curvature.

Unit 3 (Manifolds): Differential manifolds, coordinate charts, examples of differentiable manifolds, Tangent spaces, diffeomorphisms, Riemannian metric, Riemannian curvature, Ricci curvature, Geodesics.

Unit 4 (Special Functions): Bessel differential equation and Bessel function , generating function, recurrence relations involving Bessel functions, orthogonality, applications of Bessel functions; Legendre's differential equation and Legendre polynomials, generating function for Legendre polynomials, recurrence relation for Legendre polynomials, orthogonality, zeros of Legendre polynomials.

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
`	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	

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

1. Class Notes
2. Barrett O' Neil, 1966, Elementary Differential Geometry, Academic Press, New York and London

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3. Peter V. O'Neil, 2012, Advanced Engineering mathematics, Cengage Learning India Private Limited
4. Nazrul Islam, 2006, Tensors and their Applications, New age International limited Publishers

b. Recommended Reading

1. Andrew Pressley, 2001, Elementary Differential Geometry, Springer-verlag, London
2. T.J. Willmore, 1959, An introduction to Differential Geometry. Clarendon Press, Oxford
3. John M. Lee, 1997, Riemannian manifolds an introduction to curvature, Springer-Verlag, New York
4. U.C De, A.A Shaikh and Joydeep Sengupta, 2004, Tensor Calculus, Narosa Publishing House

c. Magazines and Journals

d. Websites

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

e. Other Electronic Resources

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

10. Course Organization

Course Code	MTE411A	
Course Title	Advanced Mathematics	
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	23-Oct-2020	
Next Course Specifications Review Date	May-2025	

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Course Specifications: Noise Vibration and Harshness

Course Title	Noise Vibration and Harshness
Course Code	MEE421A
Course Type	Professional Core Elective
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course 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
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
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 the phenomena of noise, vibration, harshness and their sources in machines.
- **CO-2.** Determine vibration parameters of multi degree freedom of system and interpret results
- **CO-3.** Discuss models of sound waves, sound sources and solid structure interaction with sound waves.
- **CO-4.** Outline techniques of measurement and control of noise and vibration.
- **CO-5.** Identify and analyse sources of noise in mechanical machinery.
- **CO-6.** Solve noise and vibration problems in mechanical components like gears, rotors and shaft, bearing, fans, etc.

4. Course Contents

Unit 1 (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.

Unit 2 (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

Unit 3 (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.

Unit 4 (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

Unit 5 (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.

Unit 6 (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

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		
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		40
Demonstrations		03
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	01	
Numeracy		15
1. Solving Numerical Problems	15	

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Practical Work		
1. Course Laboratory	00	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**

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	Group Task	100 Marks
Maximum Marks ►	25	25	25	25	
CO-1	X				X
CO-2	X	X			X
CO-3	X	X			X
CO-4				X	X
CO-5			X	X	X
CO-6			X	X	
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

1. Course notes
2. S.S. Rao, (1995), Mechanical Vibrations, 3rd edition, Addison
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

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d. Websites

1. http://admin.audionlinetraining.com/Upload/SSP/448_SSP_Audi_Noise_Vibration_ Hars
2. http://vw.nateonline.com/techdocs/Noise,%20Vibration,%20and%20Harshn-ess.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

10. Course Organization

Course Code	MEE421A	
Course Title	Noise Vibration and Harshness	
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	23-Oct-2020	
Next Course Specifications Review Date	May-2025	

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Course Specifications: Advanced Materials and Processes

Course Title	Advanced Materials and Processes
Course Code	MEE422A
Course Type	Professional Core Elective
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course 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, nanomaterials, 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
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
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 the importance, properties and applications of advanced materials and surface engineering processes
- **CO-2.** Describe the principles, properties and usage of advanced alloys, ceramics, polymers and composites for different applications
- **CO-3.** Discuss the various advanced materials and surface engineering techniques used in various applications
- **CO-4.** Identify an appropriate advanced materials and surface modification technique for applications based on sustainable technology
- **CO-5.** Select an appropriate processing method for advanced materials and surface modification technique to achieve required functionality

4. Course Contents

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Unit 1 (Advanced Alloys): 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.

Unit 2 (Ceramics and Polymers): 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.

Unit 3 (Composite Materials): 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.

Unit 4 (Surface Engineering): Importance, Benefits, Surface cleaning processes, Coating and Deposition: Plating, Conversion coating, Physical Vapour Deposition, Chemical Vapour Deposition, Ceramic coatings, Thermal coating

Unit 5 (Advanced Materials): Nanomaterials – Introduction, importance and classification of carbon based nanomaterials; Synthesis of fullerene, carbon nanotubes and graphene Other Advanced 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

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: 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		08

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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**

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**	**Group Task**	**100 Marks**
Maximum Marks ►	**25**	**25**	**25**	**25**	
CO-1	X				X

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CO-2	X	X			X
CO-3	X	X			X
CO-4			X	X	X
CO-5			X	X	X
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Assignments
4.	Analytical Skills	Assignments
5.	Problem Solving Skills	Assignments
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	--
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, 2010, Materials Science and Engineering: An Introduction, 8th Edition, Wiley Publications.
3. Michael F. Ashby, 2011, Materials Selection in Mechanical Design, Processing and Design, Elsevier.

b. Recommended Reading

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1. C. Barry Carter and Grant M. Norton, 2013, Ceramic Materials: Science and Engineering, Springer
2. Sanjay Mazumdar, 2001, Composites Manufacturing: Materials, Product, and Process Engineering, CRC Press
3. J. A. Brydson, 1999, Plastic Materials, Butterworth-Heinmann
4. Z. L. Wang and Z. C. Kang, 2012, Functional Materials: Structural Evolution and Structure Analysis, Plenum, New York
5. Bharat Bhushan, 2004, Handbook of Nanotechnology, Springer
6. Peter Martin, 2011, Introduction to Surface Engineering and Functionally Engineered Materials, John Wiley & Sons Publications
7. ASM Handbook, 1994, Volume 5, Surface Engineering, ASM International.

c. Magazines and Journals

1. Advanced Functional Materials, Wiley Publications
2. Functional Materials Letters, World Scientific Publications
3. Advanced Materials, Wiley Publications
4. Materials Today Magazine
5. Reinforced Plastics Magazine

d. Websites

1. http://www.mrs.org
2. http://www.mrsi.org.in
3. http://www.asminternational.org
4. http://www.iom3.org/content/electronics-division
5. http://ceramics.org/
6. https://www.coursera.org/
7. 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	MEE422A	
Course Title	Advanced Materials and 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	23-OCT-2020	
Next Course Specifications Review Date	May 2025	

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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**

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**	**Group Task**	**100 Marks**
Maximum Marks ▶	**25**	**25**	**25**	**25**	
CO-1	X				X
CO-2	X	X			X
CO-3	X	X			X
CO-4			X	X	X
CO-5			X	X	X
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
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. 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. Moin, 2010, Fundamentals of Engineering Numerical Analysis, 2nd Edition, Cambridge University Press.

c. Magazines and Journals

1. Journal of Fluid Mechanics

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2. Physics of Fluids
3. ASME Journal of Fluids Engineering
4. Journal of Heat and Fluid Flow

d. Websites

1. www.cfd-online.com
2. www.simscale.com
3. www.learncax.com

e. Other Electronic Resources

1. ANSYS
2. COMSOL
3. Electronic resources on the course area are available on MSRUAS library

10. Course Organization

Course Code	MEE423A	
Course Title	Computational Fluid Dynamics	
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	23-Oct-2020	
Next Course Specifications Review Date	May 2025	

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Course Specifications: Supply Chain Management

Course Title	Supply Chain Management
Course Code	MEE424A
Course Type	Professional Core Elective
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course 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
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
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. Describe the concepts of logistics and supply chain management
CO-2. Explain the role of supply chain drivers in achieving competitive advantage at various decision phases
CO-3. Determine capacity and inventory requirements for optimality and interpret results
CO-4. Select factors to design distribution and supply chain network for achieving feasibility in managing supply and demand
CO-5. Apply principles and concepts of logistics and supply chain in manufacturing and service based organizations for performance improvement

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4. Course Contents

Unit 1 (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.

Unit 2 (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.

Unit 3 (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.

Unit 4 (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.

Unit 5 (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.

Unit 5 (Supply Chain Coordination): RCo-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, Ebusiness 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

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

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

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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**	**Group Task**	**100 Marks**
Maximum Marks ►	**25**	**25**	**25**	**25**	
CO-1	X				X
CO-2	X	X			X
CO-3	X	X			X
CO-4			X	X	X
CO-5			X	X	X
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Classroom lectures, Assignments
4.	Analytical Skills	Classroom lectures, Assignments
5.	Problem Solving Skills	Classroom lectures, Assignments
6.	Practical Skills	Assignments

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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	---

9. Course Resources

a. 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

b. 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

c. 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.

d. Websites

1. www.supplychainmanagement.in
2. www.scmr.com

e. Other Electronic Resources

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

10. Course Organization

Course Code	MEE424A
Course Title	Supply Chain Management

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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	23-Oct-2020	
Next Course Specifications Review Date	May-2025	

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Course Specifications: Robot Kinematics and Dynamics

Course Title	Robot Kinematics and Dynamics
Course Code	MEE425A
Course Type	Professional Core Elective
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course 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
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
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 basics of planar and spatial description, transformation, kinematics, dynamics and their importance in robotics
CO-2. Describe D-H convention and its application in robotic system
CO-3. Develop kinematics equations and analyze for forward and inverse kinematics
CO-4. Solve for time varying position and orientation of robotic manipulator **CO-5.** Analyze for joint forces and torque required to operate manipulators

4. Course Contents

Unit 1 (Overview of Robot Kinematics:): Principles of spatial mechanisms; Kutzbach's equation; Robotic manipulators; Robotic systems; Common robotic arrangements

Unit 2 (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

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Course Specifications: Computational Fluid Dynamics

Course Title	Computational Fluid Dynamics
Course Code	MEE423A
Course Type	Professional Core Elective
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with concepts of fluid mechanics and the use of Computational Fluid Dynamics (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
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
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 different models of fluid flow, boundary conditions, discretization schemes, viscous and turbulence models

CO-2. Discuss the importance, applications of CFD and stability of a discretization scheme

CO-3. Formulate fluid flow equations for different models

CO-4. Apply appropriate model and discretization scheme for solution of fluid flow problems

CO-5. Solve fluid flow problems using CFD methods and software

4. Course Contents

Unit 1 (Introduction to CFD): Need and Importance of CFD in solving fluid flow problems, Applications of CFD, Concept of gradient, divergence and curl
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

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Unit 2 (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

Unit 3 (Discretization Schemes): Finite-Difference Methods: Taylor's Series, Explicit methods, Implicit Methods, Semi-Implicit Methods, 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

Unit 4 (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

Unit 5 (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

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

	Programme Outcomes (POs)														
	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			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		37
Demonstrations		05
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	05	
Numeracy		15

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Unit 3 (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.

Unit 4 (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

Unit 5 (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-Euler Dynamic Formulation, Closed form dynamic equations; Lagrange's form of Newton's equations, Lagrangian mechanics, robot Lagrange dynamics, robot statics

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		40
Demonstrations		02
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	02	
Numeracy		15
1. Solving Numerical Problems	15	

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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**

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**	**Group Task**	**100 Marks**
Maximum Marks ▶	**25**	**25**	**25**	**25**	
CO-1	X				X
CO-2	X	X			X
CO-3	X	X			X
CO-4			X	X	X
CO-5			X	X	X
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
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. 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

b. Publications 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

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c. 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

d. 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. https://nptel.ac.in/

e. Other Electronic Resources

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

10. Course Organization

Course Code	MEE425A		
Course Title	Robot Kinematics and Dynamics		
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		23-Oct-2020	
Next Course Specifications Review Date		May 2025	

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Course Specifications: Data Sciences Foundation

Course Title	Data Sciences Foundation
Course Code	CSE421A
Course Type	Professional Core Elective
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course aims to teach Python programming platform facilities—features, constructs, idioms, patterns and packages—for data science tasks. Facilities for data storage and processing using Python collections and operations are covered. Parallel programming in Python for performance and scalability of data processing is detailed. Testing and advanced programming constructs are discussed. Students are trained to design and develop Python scripts and programs for data science tasks and applications.

2. Course Size and Credits:

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

3. Course Outcomes (COs)

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

- **CO-1.** Describe the facilities—features, constructs, idioms, patterns and packages—of Python programming platform for building data science tasks
- **CO-2.** Explain the applicability of the Python programming constructs for a given task
- **CO-3.** Choose/recommend appropriate facilities of Python for data science tasks
- **CO-4.** Design data science tasks using the facilities of Python platform
- **CO-5.** Use parallelization and advanced programming constructs in the design of data science tasks
- **CO-6.** Synthesize and test data science tasks employing the Python platform facilities

4. Course Contents

Unit 1 (Introduction): Python language platform and programming ecosystem: Python core, its

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standard library, external libraries, Zen of python. Python core language: Review of syntax and core constructs. Python for data science: An overview of the facilities of Python platform for building data science tasks and workflows. Development: Edit-Compile-Run and Execute-Explore approaches using IDEs and notebooks. Deployment.

Unit 2 (Facilities for Data Processing): Core collections (tuple, list, dict and set), advanced collections (namedtuple, OrderedDict, counter, heapq, ChainMap, etc.), Operations and use in data storage and processing. Comprehensions: List, set and dict comprehensions, Nested comprehensions. Data processing applications. Functions: Namespaces and scopes, returning multiple values, functions as objects, anonymous (lambda) functions, currying. Generators: Iterator protocol, iterators, generators, generator expressions, Itertools module. Exception handling: Tryexcept block, Exception class and writing own exceptions. Filesystem and OS interface: File I/O, working with the filesystem, binary and text (Unicode) mode file data handling. Visualisation: Plotting 2D charts and plots, Surface 3D plots and Square Map plots using matplotlib and other plotting packages. Interactive visualisations: IPython notebooks, packages such as Bokeh.

Unit 3 (Libraries for Data Science Applications): Data modelling, processing and visualization packages/libraries: E.g., matplotlib and others, interactive visualisation packages, SQLAlchemy, NumPy, Pandas, SciPy, scikit-learn and statsmodels.

Unit 4 (Parallel Programming): Python support for parallel programming for data science tasks. CPU bound threads, GIL bottleneck and workarounds. Thread pooling. Process oriented parallelism: Multiprocessing communication support. Support for host based and distributed Inter Process Communication (IPC). Distributed computation: Distributed task queue, task scheduling, message transport brokers. Asynchronous operations: select, poll and epoll. Event loops. Coroutines and futures.

Unit 5 (Testing): Python Unit Testing module, Acceptance Testing of python software, Test Driven Development (TDD) and Behaviour Driven Development (BDD). Virtual environments for testing. Debugging and Python debugger, pdb.

Unit 6 (Advanced Python Programming): Functional Programming: Decorators, Context Managers, Generators and Iterators. Applications. zip and map. OO Programming: Magic methods, operator overloading, Collections, Python object model, Metaclasses, metaclass programming, inspection and other uses. Class Factories and run time attributes, Abstract Base Classes (ABCs) and protocol declaration.

Tutorials: Demonstrations and Case studies, Data Science Application design and scripting

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

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

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

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		05
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	03	
Numeracy		20
1. Solving Numerical Problems	20	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		05
1. Case Study Presentation	03	
2. Guest Lecture	02	
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 attainmentof the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3, 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		√		√	√
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	Face to Face Lectures, Tutorials, Assignments
2.	Understanding	Face to Face Lectures, Tutorials
3.	Critical Skills	Class Work, Tutorials, Assignments
4.	Analytical Skills	Class Work, Tutorials
5.	Problem Solving Skills	Class Work, Tutorials, Assignments
6.	Practical Skills	Tutorials, Assignments
7.	Group Work	Tutorials
8.	Self-Learning	Assignments, Home Work
9.	Written Communication Skills	Examinations, Assignments
10.	Verbal Communication Skills	Classroom interactions, Tutorials

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11.	Presentation Skills	--
12.	Behavioral Skills	Class Work, Tutorials
13.	Information Management	Assignments
14.	Personal Management	Assignments, Examinations
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. Handouts from books and published literature.

b. Recommended Reading

1. Padmanabhan, T. R., 2016, Programming Python, Springer Nature.
2. McKinney, W., 2018, Python for Data Analysis, 2nd edn., O'Reilly.
3. Palash, J., 2014, Parallel Programming with Python, Packt Publishing.
4. Sneeringer, L., 2016, Professional Python, Wrox Press.
5. van Hatten, R., 2016, Mastering Python, Packt Publishing..

c. Magazines and Journals

1. Journal of Big Data, a Springer Open Journal
2. Analytics Magazine from INFORMS
3. Big Data Open Access Journal

d. Websites

1. Python website: www.python.org
2. Data Science Central: www.datasciencecentral.com
3. Knowledge Discovery Nuggets: www.kdnuggets.com
4. Data Science Weekly: www.datascienceweekly.org

e. Other Electronic Resources

1. KDNuggets: Data Sets for Data Mining and Data Science, www.kdnuggets.com/ datasets/index.htm
2. Quora: www.quora.com

10.Course Organization

Course Code	CSE421A		
Course Title	Data Sciences Foundation		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	49065555
		E-mail:	hod.cs.et@msruas.ac.in
Course Specifications Approval Date		23-Oct-2020	
Next Course Specifications Review Date		May-2025	

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Course Specifications: Optimization Techniques – 1

Course Title	Optimization Techniques – 1
Course Code	MTE421A
Course Type	Professional Core Elective
Department	Mechanical Engineering
Faculty	Faculty of Engineering and Technology

1. Course Summary

The main aim of this course is to present different methods of solving problems in the areas of linear programming and constraint nonlinear optimization. In addition to theory, there will be some introduction to numerical methods for optimization problems and transportation problems. This course focuses on optimization methods that are commonly used in modern statistical machine learning. The course will cover some theory such as duality, simplex, convexity and algorithms related to non-simplex problems like Karmarkar's Method and KuhnTucker theory are covered.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	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 fundamentals of convex and concave functions, linear programming and constraint nonlinear optimization

CO-2. State and explain important classical techniques and numerical methods of constraint optimization

CO-3. Demonstrate the skill to analyze a problem by choosing effective optimization tools

CO-4. Apply optimization techniques to model real world problems

CO-5. Solve complex problems associated with linear programming and constraint optimization of function of several variables

4. Course Contents

Unit 1 (Module 1): Introduction: Convex and Concave Functions, polytopes and polyhydra. Function

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of several variables – limits, continuity and differentiability

Unit 2 (Module 2): Linear Programming: Basic Solutions and their properties, Formulation and Geometrical Ideas of Linear Programming Problems using graphical method, Simplex Method, Revised Simplex Method, Duality, Sensitivity Analysis, Transportation and Assignment Problems, Non-Simplex methods - Introduction to Interior-Point Methods, Ellipsoid Method, Karmarkar's Method

Unit 3 (Module 3): Constrained nonlinear optimization of functions of several variables, Method of Lagrange multipliers, Kuhn-Tucker theory, Convex optimization, Quadratic optimization, Numerical methods for constrained optimization, Dynamic programming.

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		
CO-3	2	2								2			2		2
CO-4			3			1				1			3	1	1
CO-5			3			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		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	

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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

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
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. Chong, E.K.P., Zak, S.H. (2013): An Introduction to Optimization, 4th Edn., Wiley.

b. Recommended Reading

1. Luenberger, David G., Ye, Yinyu (2016) Linear and Non Linear Programming., 2th Edn., Springer International publication.
2. Rao, S. S. (2009) Engineering Optimization: Theory and Practice; Revised 4th Edn., Wiley.

c. Magazines and Journals

1. https://www.springer.com/journal/10957
2. https://www.springer.com/journal/11081
3. https://www.tandfonline.com/toc/gopt20/current

d. Websites

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

e. Other Electronic Resources

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

10. Course Organization

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<table>
<tr><td>Course Code</td><td colspan="3">MTE421A</td></tr>
<tr><td>Course Title</td><td colspan="3">Optimization Techniques – 1</td></tr>
<tr><td colspan="2">Course Leader's Name</td><td colspan="2">As per Timetable</td></tr>
<tr><td colspan="2" rowspan="2">Course Leader's Contact Details</td><td>Phone:</td><td>+91-804-906-5555</td></tr>
<tr><td>E-mail:</td><td>hod.mt.mp@msruas.ac.in</td></tr>
<tr><td colspan="2">Course Specifications Approval Date</td><td colspan="2">23-Oct-2020</td></tr>
<tr><td colspan="2">Next Course Specifications Review Date</td><td colspan="2">May-2025</td></tr>
</table>

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Course Specifications: Project Work - 1

Course Title	Project Work -1
Course Code	MEP401A
Course Type	Project
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to give students an experience of identifying an engineering problem, conceptualise a solution, perform basic design calculations, model, solve, analyze and demonstrate its performance in a virtual environment and or prototype. The students are expected to work in a team of not more than 4 members and are required to develop an appropriate solution by identifying a problem for which a better or new engineering solution is required. The team needs to demonstrate the working of the solution and write a technical report. Student are required to choose a project from student's projects database available.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	0:0:4
Total number of hours available per student	120
Total number of hours for the team of 4 members	480
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. Recognise the need for developing a new or improving an existing engineering product/system through an organised survey of literature **CO-2.** Define engineering design specifications.
CO-3. Design, model, solve analyse the product/system to meet the design specifications.
CO-4. Evaluate the performance of the modelled system and justify its performance. **CO-5.** Demonstrate the system working and make a presentation **CO-6.** Write a technical report.

4. Course Contents

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- Collection of relevant literature and review of literature.
- Interaction with the users and collection of data.
- Data analysis, formulation of a problem of suitable size.
- Writing down the specifications.
- Detail design calculations.
- Choosing a modelling environment, learning the appropriate tools and techniques.
- Modelling, simulation and analysis of design.
- Defining performance parameters, evaluation of performance, presentation of performance characteristics, verification of results.
- Demonstration to the defined audience and making a presentation to the assessing team.

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

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Approximate Duration in Hours
Literature collection, Review of literature, Deciding the sample For data collection, Developing a questionnaire, Data collection, Analysis of data, Problem formulation and Defining specifications	80
Development of design concept, Basic design calculations	80
Selection of tools, techniques and learning on how to use them	80
Modelling, Simulation, Analysis	80
Evaluation, Verification of results	80
Demonstration, Presentation and Technical Report Writing	80
Total Duration in Hours	480

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 and 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)		Component 2: Project Report (SEE) (50% Weightage)
Subcomponent ►	SC1	SC2	
Subcomponent Type ►	Interim Presentation	Final Presentation	100 Marks
Maximum Marks ►	30	70	
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 / coordinator / mentor / guide assigned to the course /student group, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.
Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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9.	Written Communication Skills	Project Report
10.	Verbal Communication Skills	Project Presentation, Viva-Voce
11.	Presentation Skills	Project Presentation
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 ofProject work"

b. Recommended Reading

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

c. Magazines and Journals

Will be suitably advised based on chosen topic

d. Websites

Will be suitably advised based on chosen topic

e. Other Electronic Resources

Will be suitably advised based on chosen topic

10. Course Organization

Course Code	MEP401A		
Course Title	Project Work - 1		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	+91-80-4906-5555
		E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date		23-Oct-2020	
Next Course Specifications Review Date		May-2025	

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Course Specifications: Internship

Course Title	Internship
Course Code	MEI401A
Course Type	Internship
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to give real-world experience to the students. The student can undergo internship in an industrial, business organization, research organization or any other university on a topic of relevance during vacation after 6th semester with prior approval from the department head and faculty Dean.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	0:0:4
Total Hours of Interaction	120
Number of Weeks in a Semester	15
Department Responsible	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. Write a report on experiences during internship.
CO-2. Make a presentation to a panel of examiners.

4. Course Contents

- Collection of relevant literature and review of literature
- Interaction with the users and collection of data
- Data Analysis, Formulation of a problem of suitable size
- Writing down the design specifications
- Detail design calculations
- Choosing a modeling environment, learning the appropriate tools and techniques

- Modelling, simulation and analysis of design
- Defining performance parameters, Evaluation of performance, presentation performance characteristics, Verification of results
- Demonstration to the defined audience and making a presentation to the assessing team

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	3	3			2	2	3	2	2	3	3	3
CO-2	3	3	3	3	3			2	2	3	2	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		00
Demonstrations		0
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		0
1. Solving Numerical Problems	0	
Practical Work		80
1. Course Laboratory	00	
2. Computer Laboratory	30	
3. Engineering Workshop / Course/Workshop / Kitchen	50	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		40
1. Case Study Presentation	30	
2. Guest Lecture	00	
3. Industry / Field Visit	06	

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4. Brain Storming Sessions	04	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**130**

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 (optional), 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: Internship Report (50% Weightage)**
Subcomponent ►	**SC1**	
Subcomponent Type ►	**Presentation**	**100 Marks**
Maximum Marks ►	**100**	
CO-1		
CO-2		
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.		

The Course Leader / Mentor / Guide / 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

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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. 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,
2. Manuals of Tools and Techniques Chosen to Solve the Design Problem

c. Magazines and Journals

Will be suitably advised based on chosen topic

d. Websites

Will be suitably advised based on chosen topic

e. Other Electronic Resources

Will be suitably advised based on chosen topic

10. Course Organization

Course Code	MEI401A	
Course Title	Internship	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-80-4906-5555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	23-Oct-2020	
Next Course Specifications Review Date	May-2025	

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Course Specifications: Fatigue and Fracture Mechanics

Course Title	Fatigue and Fracture Mechanics
Course Code	MEE431A
Course Type	Professional Core Elective
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course 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
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
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. Describe basic concepts of metal fatigue and fracture mechanics
CO-2. Explain different types fatigue loading, fatigue design methods and fracture mechanics principles
CO-3. Discuss fatigue and fracture phenomena and governing laws applied to machinery design
CO-4. Solve problems of metal fatigue analysis involving simple mechanical components
CO-5. Apply theory of fracture mechanics to carry out stress analysis of cracked components and structures

4. Course Contents

Unit 1 (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

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Unit 2 (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 fatiguestrength; Effect of mean stress on fatigue life estimation – mathematical models

Unit 3 (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

Unit 4 (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

Unit 5 (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

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		35
Demonstrations		04
1. Demonstration using Videos	03	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	01	

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Numeracy		16
1. Solving Numerical Problems	16	
Practical Work		05
1. Course Laboratory	05	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		60
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**	**Group Task**	**100 Marks**
Maximum Marks ▶	**25**	**25**	**25**	**25**	
CO-1	X				X
CO-2	X	X			X
CO-3	X	X			X
CO-4			X	X	X
CO-5			X	X	X

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The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.

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

8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

1. Class Notes
2. 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. Publications 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

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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

10. Course Organization

Course Code	MEE431A	
Course Title	Fatigue and Fracture 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	23-Oct-2020	
Next Course Specifications Review Date	May 2025	

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Course Specifications: Quality by Design

Course Title	Additive Manufacturing
Course Code	MEE432A
Course Type	Professional Core Elective
Department	Mechanical Engineering
Faculty	Engineering and Technology

11. Course 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.

12. 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

13. Course Outcomes (COs)

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

CO-1. Describe the various principles and concepts of statistically designed experiment

CO-2. Explain the guiding principles of designing experiments and their applications for building robustness in product/process

CO-3. Discuss the process of experimentation adopting suitable designs namely, single factor, factorial, special and Taguchi techniques

CO-4. Formulate problems to conduct experiments for arriving at optimal solutions

CO-5. Determine optimal process parameters for a given problem and interpret result

CO-6. Apply experimental design techniques to given situation and analyze results for optimal criteria

14. Course Contents

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Unit 1 (Need for Experiments): 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

Unit 2 (Analysis of Variance Using Simple Experiments): ANOVA, Chi-Square distribution, T distribution, F distribution, confidence intervals, One-way ANOVA, Two-way ANOVA, Multivariant ANOVA, Model Adequacy Checking, Regression Approach to ANOVA. Deriving the Critical Input Parameters Using Single Factor Experiments - Completely randomized design, Randomized block design, effect of coding the observations, Latin Square design, orthogonal contrasts, comparison of treatment means.

Unit 3 (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

Unit 4 (Factorial Experimentation and Special Experimental Designs): 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 like Blocking and confounding in 2k factorial design, Two-level fractional factorial designs, exercises

Unit 5 (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 concepts, Steps in experimentation, Orthogonal Taguchi's inner and outer arrays-selection and utilization, Data Analysis using ANOVA and Response Graph methods, Signal to Noise ratios, parameter design strategy, Illustration through Numerical example

Unit 6 (Emerging Concepts): Multi-level Factor Designs, Multi-response optimization, Response Surface Methodology, Shainin DOE and their applications, Case studies on DOE applications

15. 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		
CO-6		3	1	2									3	2	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

16. Course Teaching and Learning Methods

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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**

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 (50% Weightage)	**Component**

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

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

Course reassessment policies are presented in the Academic Regulations document.

1. 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
3.	Critical Skills	Classroom lectures
4.	Analytical Skills	Classroom lectures
5.	Problem Solving Skills	Classroom lectures, Assignment
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	Course Work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course Work
15.	Leadership Skills	--

1. Course Resources

a. Essential Reading

1. Course notes

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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

2. Recommended Reading

4. Ajit C. Tamhane, 2009, Statistical Analysis of Designed Experiments: Theory and Applications, John Wiley & Sons.
5. K. Krishnaiah and P. Shahabudeen, 2013, Applied Design of Experiments and Taguchi Methods, PHI Learning Pvt. Ltd.
6. Angela M.Dean and Daniel Voss, 2000, Design and Analysis of Experiments, Springer
7. Nicolo Belavendram, 1999, Quality by Design - Taguchi Techniques for Industrial Experimentation, Prentice Hall
8. Jiju Antony, 2003, Design of Experiments for Engineers and Scientists, Butterworth- Heinemann Newness.

b. 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

c. Websites

1. https://www.statease.com
2. https://www.stats.gla.ac.uk

d. Other Electronic Resources

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

Course Organization

Course Code	MEE432A	
Course Title	Additive Manufacturing	
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	23-Oct-2020	
Next Course Specifications Review Date	May-2025	

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`Course Specifications: Power Plant Engineering

Course Title	Power Plant Engineering
Course Code	MEE433A
Course Type	Professional Core Elective
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course 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
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
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 plant layout, working and various sub components of conventional and renewable power plants
CO-2. Discuss energy scenario, maintenance, small scale power generation and selection of site for power plant
CO-3. Solve simple numerical problems on power plant performance
CO-4. Select appropriate power plant for a specified power generation capacity
CO-5. Analyze the potential of various energy sources suitable for power generation

4. Course Contents

Unit 1(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 managementof demand forecast in India, review of thermodynamic cycles related to power generation

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Unit 2 (Steam Power Plant and Gas Turbine 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 ofSteam power plant, Demonstration of Rankine cycle simulation in MatLab. 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

Unit 3 (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

Unit 4(Diesel Power Plant and Hydro-Electric Power Plant): Layout, choice and characteristics, plant layout and maintenance
Classification, plant layout and site selection requirements of power plant, Run-off, Hydrograph and flow duration curves, mass curves, Micro hydel power plants

Unit 5(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

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											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		40

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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**

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	Group Task	100 Marks
Maximum Marks ►	25	25	25	25	

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CO-1	X				X
CO-2	X	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	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	--

9. Course Resources

a. Essential Reading

1. Class Notes

2. P. K. Nag, 2005, Power Plant Engineering, McGraw Hill Publications, 3rd Edition
3. 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.khanacademy.org
2. www.nptel.ac.in
3. www.coursera.org

e. Other Electronic Resources

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

10. Course Organization

Course Code	MEE433A		
Course Title	Power Plant Engineering		
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	23-Oct-2020		
Next Course Specifications Review Date	May-2025		

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Course Specifications: Quality by Design

Course Title	Quality By Design
Course Code	MEE434A
Course Type	Professional Core Elective
Department	Mechanical Engineering
Faculty	Engineering and Technology

5. Course 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.

6. 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

7. Course Outcomes (COs)

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

CO-1. Describe the various principles and concepts of statistically designed experiment
CO-2. Explain the guiding principles of designing experiments and their applications for building robustness in product/process
CO-3. Discuss the process of experimentation adopting suitable designs namely, single factor, factorial, special and Taguchi techniques
CO-4. Formulate problems to conduct experiments for arriving at optimal solutions
CO-5. Determine optimal process parameters for a given problem and interpret result
CO-6. Apply experimental design techniques to given situation and analyze results for optimal criteria

8. Course Contents

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Unit 1 (Need for Experiments): 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

Unit 2 (Analysis of Variance Using Simple Experiments): ANOVA, Chi-Square distribution, T distribution, F distribution, confidence intervals, One-way ANOVA, Two-way ANOVA, Multivariant ANOVA, Model Adequacy Checking, Regression Approach to ANOVA. Deriving the Critical Input Parameters Using Single Factor Experiments - Completely randomized design, Randomized block design, effect of coding the observations, Latin Square design, orthogonal contrasts, comparison of treatment means.

Unit 3 (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

Unit 4 (Factorial Experimentation and Special Experimental Designs): 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 like Blocking and confounding in 2k factorial design, Two-level fractional factorial designs, exercises

Unit 5 (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 concepts, Steps in experimentation, Orthogonal Taguchi's inner and outer arrays- selection and utilization, Data Analysis using ANOVA and Response Graph methods, Signal to Noise ratios, parameter design strategy, Illustration through Numerical example

Unit 6 (Emerging Concepts): Multi-level Factor Designs, Multi-response optimization, Response Surface Methodology, Shainin DOE and their applications, Case studies on DOE applications

8. 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		
CO-6		3	1	2									3	2	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

9. Course Teaching and Learning Methods

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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**

10. 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**

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

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

Course reassessment policies are presented in the Academic Regulations document.

11. 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
3.	Critical Skills	Classroom lectures
4.	Analytical Skills	Classroom lectures
5.	Problem Solving Skills	Classroom lectures, Assignment
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	Course Work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course Work
15.	Leadership Skills	--

12. Course Resources

a. Essential Reading

1. Course notes

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Bangalore

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

b. 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 Newness.

c. 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

d. Websites

1. https://www.statease.com
2. https://www.stats.gla.ac.uk

e. Other Electronic Resources

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

13. Course Organization

Course Code	MEE434A		
Course Title	Quality By Design		
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		23-Oct-2020	
Next Course Specifications Review Date		May-2025	

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Course Specifications: Robot Programming and Control

Course Title	Robot Programming and Control
Course Code	MEE435A
Course Type	Professional Core Elective
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course 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 stabilityanalysis on linear and adaptive control system models

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
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 various methods of robot programming
CO-2. Describe various robot languages and commands for robot operation, robot control system modules and their response
CO-3. Design a controller to meet error, stability and relative stability specifications
CO-4. Develop programs using high level robotic programming languages to control robotic operations
CO-5. Select suitable drives and control circuits for developing a physical control system

4. Course Contents

Unit 1 (Overview of Robot Programming): Robot software functions – coordinate systems, position control, other control functions, subroutines, Program planning for Robot flow chartingfor robot programs with few examples

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Unit 2 (Methods of Robot Programming): Online programming, off-line programming, advantagesof 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

Unit 3 (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 andData processing, Introduction to high level robot programming languages

Unit 4 (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

Unit 5 (Stability Analysis): Control problem, state equations, state space model of a robot, constant solutions, equilibrium point, Liapunov's first method, Liapunov's second method, domainof attraction, linear system stability, steady state tracking

Unit 6 (Case Studies): Modelling and Control of Manipulators, Feedback Control of a Robot,Trajectory and Position Control of a Robot, behavior based 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	3												3		
CO-2	3												3		
CO-3		2	3		1								3	1	
CO-4		2	3		1								3	1	
CO-5		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		45
Demonstrations		05
1. Demonstration using Videos	03	

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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**

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**	**Group Task**	**100 Marks**
Maximum Marks ►	**25**	**25**	**25**	**25**	
CO-1	X				X
CO-2	X	X			X

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CO-3	X	X			X
CO-4			X	X	X
CO-5			X	X	X
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom Lectures, Assignments
2.	Understanding	Classroom Lectures, Assignments
3.	Critical Skills	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	Course Work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course 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 BasedRobotics, McGraw-Hill

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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-kinematiccontrol-and- spin-motion-4042/
2. http://video.mit.edu/watch/dynamic-walking-2010-robert-gregg-controland-planning-with-asymptotically-stable-gait-primitives-5972/
3. Electronic resources on the module area are available at RUAS library

10. Course Organization

Course Code	MEE435A	
Course Title	Robot Programming and Control	
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	23-Oct-2020	
Next Course Specifications Review Date	May-2025	

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*Course Specifications: **Data Analytics***

Course Title	Data Analytics
Course Code	CSE441A
Course Type	Professional Core Elective
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course enables the students to design, develop, analyze and evaluate Data Analytics applications employing appropriate techniques, methods and technology. The role and applicationof 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
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Discuss data analytics application development using knowledge representation, data warehousing, machine learning and data mining techniques.
CO-2. Choose appropriate techniques and technology for data warehousing, machine learning and Data mining for knowledge discovery.
CO-3. Design data analytics processes using data warehousing, machine learning and data mining techniques for knowledge representation and discovery.
CO-4. Analyze the data andthe performance of data analytics applications.
CO-5. Synthesize data analytics applications using machine learning and data mining techniques and enterprise platforms.
CO-6. Solve problems associated with large scale data analysis, machine learning and data

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mining.

4. Course Contents

Unit 1 (Introduction): Data Analytics and its role in Business Intelligence and Knowledge Discovery. Data Analytics processes (Life Cycle): Preparation, Warehousing, Analysis, Mining, Validation and Performance Evaluation. Data Analytics tools and platforms

Unit 2 (Data Management): Data Definitions and Analysis Techniques, Elements, Variables, andData categorization, Levels of Measurement, Data management and indexing, Measures of centraltendency, Measures of location of dispersions, Normalization techniques.

Unit 3 (Big Data Processing): Traditional Data Base systems for data storage and processing. Data Warehousing and Analysis, Big Data. Modern platforms for data storage and processing: Cloud computing.

Unit 4: (Data Analysis Techniques): Regression analysis, Classification techniques, Clustering, Association rules analysis, Artificial neural networks, Handling of outliers and Anomalies, cross-validation and sensitivity analysis.

Unit 5: (Data Visualization): Text Mining, Mining other forms of data. Data Visualization andReporting: Concepts, methods and tools for enterprise data visualization and reporting.

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

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

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		05
1. Demonstration using Videos	01	

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2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	03	
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**	**Group Task**	**100 Marks**
Maximum Marks ►	**25**	**25**	**25**	**25**	
CO-1					X

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CO-2	X				X
CO-3	X				X
CO-4		X	X	X	X
CO-5		X	X	X	X
CO-6		X	X	X	X
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
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. Data Mining and Analysis, Mohammed J. Zaki, Wagner Meira, Cambridge, 2012.

b. Recommended Reading

1. Probability & Statistics for Engineers & Scientists (9th Edn.), Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Prentice Hall Inc.

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2. The Elements of Statistical Learning, Data Mining, Inference, and Prediction (2nd Edn.), Trevor Hastie Robert Tibshirani Jerome Friedman, Springer, 2014
3. An Introduction to Statistical Learning: with Applications in R, G James, D. Witten, T Hastie, and R. Tibshirani, Springer, 2013
4. Mining Massive Data Sets, A. Rajaraman and J. Ullman, Cambridge University Press, 2012
5. Advances in Complex Data Modeling and Computational Methods in Statistics, Anna Maria Paganoni and Piercesare Secchi, Springer, 2013
6. Hadoop: The Definitive Guide (2nd Edn.) by Tom White, O'Reilly, 2014.

c. Magazines and Journals

1. Analytics Magazine from INFORMS
2. Big Data Open Access Journal

d. Websites

1. http://flowingdata.com/Abbott Analytics
2. http://abbottanalytics.blogspot.com/

e. Other Electronic Resources

1. How it works: Analytics: http://youtu.be/_HbjsNaUJ2A
2. A brief history of intelligence: http://youtu.be/yVIcIRcAhxc
3. What can Business Analytics Do for You? http://youtu.be/uP89kaDU40c

10. Course Organization

Course Code	CSE441A	
Course Title	Data Analytics	
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	23-Oct-2020	
Next Course Specifications Review Date	May-2025	

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Course Specifications: Advanced Numerical Methods

Course Title	Advanced Numerical Methods
Course Code	MTE431A
Course Type	Professional Core Elective
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

The module aims at training students in handling various aspects numerical computations. In this specialization module, the students learn the basics of numerical methods to solve nonlinear ordinary and partial differential equations. Numerical techniques like finite difference, and finite element methods to solve partial differential equations are discussed. The module aims at training students in handling various aspects numerical computations.

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	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. Illustrate various methods of numerical computation of Eigen values
CO-2. Illustrate various methods to solve partial differential equations
CO-3. Apply numerical methods to solve partial differential equations using MATLAB
CO-4. Analyze real world problems associated with computing eigenvalues and partial differential equations
CO-5. Solve complex problems arising in real world using finite volume and finite elementsmethods to solve partial differential equations

4. Course Contents

Unit 1 (Linear Algebra): Eigenvalue computations. Power methods, Subspace iteration, Inverseiteration and Rayleigh quotient iteration for symmetric and non-symmetric problems. QR algorithm for symmetric problems. Jacobi methods and tridiagonal methods for symmetric problems.

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Unit 2 (Finite Volume Method): Finite volume method to solve hyperbolic PDEs and a linear system of hyperbolic PDEs. General formulation of conservation laws. Advection equation, characteristics and Riemann problem for linear hyperbolic equations. Necessary components for convergence and CFL conditions, Lax-Wendroff method and upwind method.

Unit 3 (Finite Element Approximation): Triangulations and polynomial approximation. Finite element methods for elliptic problems, variational formulation for the Poisson problem. Discretization of the Poisson problem in one dimension, formulation, theory and implementation. FEM for the Poisson problem in two dimensions.

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		
CO-3	3	3	1	2									3	2	
CO-4	3	3	2	2	2					2			3	2	2
CO-5	3	3	2	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	

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Others		
1. Case Study Presentation	00	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

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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. Kincaid, D and W. Cheney, W. (2002) Numerical Analysis: Mathematics of Scientific Computing, 3rd Ed, Brooks/Cole
3. Leveque, R. J. (2004) Finite Volume Methods for Hyperbolic Problems, Cambridge University Press.
4. Reddy, J. N. (2005) An Introduction to the Finite Element Method, 3rd edition, McGraw-Hill Higher Education.

b. Recommended Reading

1. Smith, G. D. (1978) Numerical Solutions of Partial Differential Equations, 2nd edition, Oxford University Press.

c. Magazines and Journals

d. Websites

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

e. Other Electronic Resources

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

10. Course Organization

Course Code	MTE431A	
Course Title	Advanced Numerical Methods	
Course Leader's Name		As per Timetable

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Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	23-Oct-2020	
Next Course Specifications Review Date	May-2025	

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Course Specifications: Optimization Techniques – 2

Course Title	Optimization Techniques – 2
Course Code	MTE441A
Course Type	Professional Core Elective
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. 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 integrodifferential 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.

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	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 fundamental of integral equations, variational problems and unconstrained optimization

CO-2. State and explain important classical techniques to solve integral equations and numerical methods of unconstrained optimization

CO-3. Demonstrate the skill to analyze variational problem and choose effective optimization tools

CO-4. Apply optimization techniques to model real world problems involving linear and non-linear optimization

CO-5. Solve complex problems associated with integral equations, calculus of variations and unconstrainted optimization of function of several variables

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4. Course Contents

Unit 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 integro-differential equations

Unit 2 (Calculus of Variations): Introduction 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

Unit 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

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		
CO-3	2	2									2		2		2
CO-4			3			1					1		3	1	1
CO-5			3			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		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	

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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

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
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. Chong, E.K.P., Zak, S.H. (2013): An Introduction to Optimization, 4th Edition, Wiley.

b. Recommended Reading

1. Luenberger, David G., Ye, Yinyu, 2016. Linear and Non Linear Programming, 2nd Ed., Springer International publication.
2. Rao, S. S., 2009. Engineering Optimization: Theory and Practice; Revised 4th Ed., Wiley.

c. Magazines and Journals

1. https://www.springer.com/journal/10957
2. https://www.springer.com/journal/11081
3. https://www.tandfonline.com/toc/gopt20/current

d. Websites

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

e. Other Electronic Resources

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

10. Course Organization

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Course Code	MTE441A		
Course Title	Optimization Techniques - 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	23-Oct-2020		
Next Course Specifications Review Date	May-2025		

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Course Specifications: Project Work - 2

Course Title	Project Work -2
Course Code	MEP402A
Course Type	Project
Department	Mechanical Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to give students an experience of identifying an engineering problem, conceptualise a solution, perform basic design calculations, model, solve, analyze and develop a prototypeor working model and demonstrate its performance. The students are expected to work in a team of not more than 4 members and are required to develop an appropriate solution by identifying a problem for which a better or new engineering solution is required. The team needs to demonstrate the working of thesolution and write a technical report. Student are required to choose a project from student's projects database available.

2. Course Size and Credits:

Number of Credits	08
Total number of hours available per student	240
Total number of hours for the team of 4 members	960
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.** Recognise the need for developing a new or improving an existing engineering product/system through an organised survey of literature
- **CO-2.** Define engineering design specifications.
- **CO-3.** Design, model, solve analyse the product/system to meet the design specifications.
- **CO-4.** Evaluate the performance of the modelled system and justify its performance
- **CO-5.** Demonstrate the system working in a virtual environment and make a presentation.
- **CO-6.** Write a technical report.

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4. Course Contents

- Collection of relevant literature and review of literature.
- Interaction with the users and collection of data.
- Data analysis, formulation of a problem of suitable size.
- Writing down the specifications.
- Detail design calculations.
- Choosing a modelling environment, learning the appropriate tools and techniques.
- Modelling, simulation and analysis of design.
- Defining performance parameters, evaluation of performance, presentation of performance characteristics, verification of results.
- Demonstration to the defined audience and making a presentation to the assessing team.

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

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Approximate Duration in Hours
Literature collection, Review of literature, Deciding the sample For data collection, Developing a questionnaire, Data collection, Analysis of data, Problem formulation and Defining specifications	160
Development of design concept, Basic design calculations	160
Selection of tools, techniques and learning on how to use them	160

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Modelling, Simulation, Analysis	160
Evaluation, Verification of results	160
Demonstration, Presentation and Technical Report Writing	160
Total Duration in Hours	960

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7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. (Mechanical Engineering) Programme. The procedure todetermine 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 and 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)		Component 2: Project Report (SEE) (50% Weightage)
Subcomponent ►	SC1	SC2	
Subcomponent Type ►	Interim Presentation	Final Presentation	100 Marks
Maximum Marks ►	30	70	
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 / coordinator / mentor / guide assigned to the course /student group, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.
Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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10.	Verbal Communication Skills	Project Presentation, Viva-Voce
11.	Presentation Skills	Project Presentation
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"

b. Recommended Reading

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

c. Magazines and Journals

Will be suitably advised based on chosen topic

d. Websites

Will be suitably advised based on chosen topic

e. Other Electronic Resources

Will be suitably advised based on chosen topic

10. Course Organization

Course Code	MEP402A		
Course Title	Project Work - 2		
Course Leader's Name	As per Timetable		
Course Leader's Contact Details	**Phone:**	+91-80-4906-5555	
	E-mail:	hod.me.et@msruas.ac.in	
Course Specifications Approval Date	23-Oct-2020		
Next Course Specifications Review Date	May-2025		

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