RAMAIAH
UNIVERSITY
OF APPLIED SCIENCES

Programme Structure and Course Details

B. Tech. in Robotics

2022-26

Faculty of Engineering and Technology

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Bangalore

RAMAIAH UNIVERSITY
OF APPLIED SCIENCES

Programme Specifications

B. Tech. (Robotics)

Degree Programme

Programme Code: 409

Faculty of Engineering and Technology

Batch 2022-2026

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Programme Specifications: B. Tech. (Robotics)

Faculty	Engineering and Technology
Department	Mechanical Engineering
Programme Code	409
Programme Name	B. Tech. (Robotics)
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:** October 2020
7. **Date of Programme Approval by the Academic Council of MSRUAS:** 23-Oct-2020
8. **Next Review Date:** May 2025
9. **Programme Approving Regulating Body and Date of Approval:** All India Council for Technical Education, New Delhi, 30-Jun-2020
10. **Programme Accredited Body and Date of Accreditation:** Not Applicable
11. **Grade Awarded by the Accreditation Body:** Not Applicable
12. **Programme Accreditation Validity:** Not Applicable
13. **Programme Benchmark:** Not Applicable
14. **Rationale for the Programme**

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

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

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

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

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

15. Programme Mission

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

16. 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 analyze 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

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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. (Robotics) 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. (Robotics) program, the graduate will be able to:

PSO-1. Apply the knowledge of Mechanical Design, Control Systems and Robot Programming to develop efficient and customized robotic solutions for any given application

PSO-2. Design and develop sustainable robotic solutions using the principles and concepts of Mechanical, Electrical, Electronics, Computer Engineering through experimentation and usage of modern 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	ROC201A	Strength of Materials	3	0	0	3	100
3	ROC202A	Measurements, Data Acquisition and Processing	3	1	0	4	100
4	ROC203A	Introduction to Robotics and Mechatronics	3	0	0	3	100
5	ROC204A	Electrical Machines Drives and Actuators	3	1	0	4	100
6	ROL205A	Strength of Materials Laboratory	0	0	2	1	50
7	ROL206A	Measurements Laboratory	0	0	2	1	50
8	MEL205A	Machine Drawing	0	0	4	2	100
9	BTN101A	Environmental Studies	2	0	0	2	50
		Total	17	03	08	24	750
Total Number of Contact Hours per week			28				

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	ROC207A	Analog and Digital Electronics	3	0	0	3	100
4	ROC208A	Machine Dynamics and Laboratory	3	0	2	4	100
5	ROC209A	Artificial Intelligence for Robotics	2	2	0	4	100
6	ROC210A	Digital Signal Processing	3	1	0	4	100
7	ROC211A	Fluid Power Systems for Robots	3	0	0	3	100
8	ROL212A	Analog and Digital Electronics Laboratory	0	0	2	1	50
9	MEL206A	Mechanical Dissection	0	0	2	1	50
Total			20	04	06	27	800
Total Number of Contact Hours per week			27				

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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	ROC301A	Design of Machine Elements	3	1	0	4	100
2	ROC302A	Embedded Processor and Controllers	3	0	0	3	100
3	ROC303A	Robot Kinematics and laboratory	3	0	2	4	100
4	ROC304A	Computer Vision	3	1	0	4	100
	ROC305A	Control System	3	1	0	4	100
6	ROL306A	Control Systems Laboratory	0	0	2	1	50
7	ROL307A	Embedded Processor and Controllers Laboratory	0	0	2	1	50
		Total	15	03	06	21	600
Total Number of Contact Hours per week			24				

Semester 6							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	ROC308A	Robotic Programming and Simulation	2	0	2	3	100
2	ROC309A	Robotics Dynamics and Laboratory	3	0	2	4	100
3	ROC310A	Robotic System Design	3	1	0	4	100
4	ROC311A	Applied Control Systems	3	0	0	3	100
5	ROC312A	Digital Image Processing	3	1	0	4	100
6	ROC313A	Engineering Economics and Cost Estimation	3	0	0	3	100
7	ROE31XA	Professional Core Elective - 1	4	0	0	4	100
8	ROS314A	Seminar	0	0	2	1	50
Total			21	2	6	26	750
Total Number of Contact Hours per week							

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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	ROE41XA	Professional Core Elective - 2	4	0	0	4	100
2	ROE42XA	Professional Core Elective - 3	4	0	0	4	100
3	ROU401A	Open Elective - 1	3	0	0	3	100
4	ROP401A ROI401A	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	ROP402A	Project Work - 2	0	0	24	12	100
Total			**0**	**0**	**24**	**12**	**200**
Total Number of Contact Hours per week			**24**				

		Professional Core Electives (PCE):			
Group	**Stream**	**Applied Robotics**	**Collaborative Robotics**	**Data Sciences and Analytics**	**Applied Mathematics**
PCE-1, Sem. 6	**Course Code**	ROE411A	ROE412A	MTE301A	MTE302A
	Course Title	CAE for Robotics and Laboratory	Statistical & Optimization Tools for Robotics	Probability	Advanced Mathematics
PCE-2 Sem. 7	**Course Code**	ROE421A	ROE422A	and Statistics	MTE401A
	Course Title	Industrial Robotics and Automation	Multi-agent Systems for Robotics	CSE411A	Optimization Techniques - 1
PCE-3 Sem.7	**Course Code**	ROE431A	ROE432A	Data Science Foundation	MTE403A/ MTE402A
	Course Title	Autonomous Robots	Systems Engineering	CSE431A	Advanced Numerical Methods/ Optimization Techniques - 2

Note:

1. Students are required to select **two** Professional Core Elective Courses in the 7th Semester,

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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 the semester.

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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:

Laboratory Course			
Sub Component	SC1	SC2	SC3 (Optional)

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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:

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

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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

28. Quality Control Measures

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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	Strength of Materials	3	3											3		
3	Measurements, Data Acquisition and Processing	3	3	3										3		
3	Introduction to Robotics and Mechatronics	3	3			1								3	1	
3	Electrical Machines Drives and Actuators	3	3	3	2	2								3	2	
3	Strength of Materials Laboratory	3	3								1			3		1
3	Measurements Laboratory	3	3	3	2						3			3	2	3
3	Machine Drawing	3				3					2			3	3	2
3	Environmental Studies	1					3		1					1	3	1
4	Entrepreneurship Development									3	3					3
4	Engineering Mathematics –4	3	3	2										3		
4	Analog and Digital Electronics	3	3	3										3		
4	Machine Dynamics and Laboratory	3				3					2			3	3	2
4	Artificial Intelligence for Robotics	2	3	3										3		
4	Digital Signal Processing	3	3	3		2								3	2	
4	Fluid Power Systems for Robots	3	2	3		2								3	2	3
4	Analog and Digital Electronics Laboratory	3	2								3			3		3
4	Mechanical Dissection	3	2								3			3		3
5	Design of Machine Elements	3	3	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	Embedded Processor and Controllers	2	2	3		3								3	3	
5	Robot Kinematics and laboratory	3	3	3										3		
5	Computer Vision	3	2	2		2								2	2	
5	Control System	3	2	3		2								3	2	
5	Control Systems Laboratory		3	3							3			3		3
5	Embedded Processor and Controllers Laboratory		2	3							3			3		3
6	Robotic Programming and Simulation	3	3	3		2								3	2	
6	Robotics Dynamics and Laboratory	3	3	3		3								3	3	
6	Robotic System Design	3	3											3		
6	Applied Control Systems	3	3	3										3		
6	Digital Image Processing	3	2	3		3								3	3	
6	Engineering Economics and Cost Estimation	3	3					1				2		3	1	2
6	Seminar									2	3					3
7	Professional Core Elective-1															
7	CAE for Robotics and Laboratory	3	3	3		3								3	3	
7	Statistical Optimization Tools for Robotics	3	3	3	3									3	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	Industrial Robotics and Automation	3	3	3										3		
7	Multi-Agent Systems for Robotics	3	3	3										3		
7	Data Science Foundation	2	1	3	2	2	2		1			1	2	3	2	2
7	Optimization Techniques -1	3	2	3			1				2			3	1	2
7	Project Work-1	3	3	2	3	2	2		2		3	1	3	3	3	3
7	Internship	3	3	3	3	3			2	2	3	2	2	3	3	3
8	Professional Core Elective-3															
8	Autonomous Robots	3	3	2		3								3	3	
8	Systems Engineering	3	3						2					3		2
8	Data Analytics	2	1	3	2	2	2		1			1	2	3	2	2
8	Optimization Techniques -2	3	3	3			1					2		3	1	2
8	Advanced Numerical Methods	3	3	2	2	2					2			3	2	2
8	Project Work-2	3	3	2	3	2	2		2		3	1	3	3	2	3

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

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. 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 Transcendentals, 8th edition, Boston, Cengage Learning
2. Steven Leon, 2014, Linear Algebra with Application, 9th edition, New Jersey, Pearson

b. Recommended Reading

1. Maurice D. Weir and Joel Hass, 2017, Thomas Calculus, 13th edition, New Jersey, Pearson
2. Gilbert Strang, 2016, Introduction to Linear Algebra, 5th edition, Massachusetts, Cambridge Press

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/

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10. Course Organization

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		

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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

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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	
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			▯	▯
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

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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/

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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			

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Course Specifications: Engineering Physics and Laboratory

Course Title	Engineering Physics and Laboratory
Course Code	PYB102A
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

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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

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 NaCl and diamond crystals— Bragg's law—Identification of cubic crystals using Bragg's law

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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.

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		

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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		
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
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

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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

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

10. Course Organization

Course Code	PYB102A		
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			

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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, center 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 idealizations - 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 center 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

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(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

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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			

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Course Specifications: Elements of Electronics Engineering and Laboratory

Course Title	Elements of Electronics Engineering and Laboratory
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 analyze 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

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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, non-inverting 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)

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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	3												3		
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

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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	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

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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, 4th edition
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

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3. Digital trainer kit
4. Discrete electronic components

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			

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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

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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															

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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		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**

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)	

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Subcomponent ▶	SC1	SC2	SC3	Component 2: SEE (50 % Weightage)
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
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, 32^{nd} Edition, Shubhash Publishers

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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

<table>
<tr><td>Course Code</td><td colspan="3">MEF103A</td></tr>
<tr><td>Course Title</td><td colspan="3">Engineering Drawing</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"></td></tr>
<tr><td colspan="2">Next Course Specifications Review Date</td><td colspan="2"></td></tr>
</table>

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Course Specifications: Constitution, Human Rights and Law

Course Title	Constitution, Human Rights and Law
Course Code	LAN101A
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.

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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 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	
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 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

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beginning of the semester.
Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Face to face lectures
2.	Understanding	Face to face lectures, group discussions
3.	Critical Skills	
4.	Analytical Skills	Face to face lectures, activities, group discussions, 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
4. http://nptel.ac.in/

e. Other Electronic Resources

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

***10.* Course Organization**

<table>
<tr><td>Course Code</td><td colspan="3">LAN101A</td></tr>
<tr><td>Course Title</td><td colspan="3">Constitution, Human Rights and Law</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>080-49065555</td></tr>
<tr><td>E-mail:</td><td>School of Law</td></tr>
<tr><td colspan="2">Course Specifications Approval Date</td><td colspan="2"></td></tr>
<tr><td colspan="2">Next Course Specifications Review Date</td><td colspan="2"></td></tr>
</table>

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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

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

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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 electrode position, 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.

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

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)

	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

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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**

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 %)**

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	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
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

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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

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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 and uses, 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

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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

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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

<table>
<tr><td>Course Code</td><td colspan="3">MEF104A</td></tr>
<tr><td>Course Title</td><td colspan="3">Elements of Mechanical Engineering and Workshop Practice</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"></td></tr>
<tr><td colspan="2">Next Course Specifications Review Date</td><td colspan="2"></td></tr>
</table>

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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

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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**

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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 (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.

Unit 2 (Problem Solving using Computers): Algorithmic problem solving. Flowcharts: symbols and 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. Plotting and 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, testing and 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 and algorithms, 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 and Web 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

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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	--

9. Course Resources

a. Essential Reading

1. Class notes

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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/ computer science
2. Dr. Dobb's Journal, http://drdobbs.com/
3. Life hacker, 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/

10. *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	TSN101A
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		
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	04	04
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		
1. Case Study Presentation	02	
2. Guest Lecture	00	
3. Industry / Field Visit	00	06
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.

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

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

d. Other Electronic Resources

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

10. Course Organization

Course Code	TSN101A		
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 and Manufacturing 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

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

Unit 3 (MATLAB): Introduction to MATLAB, Basic algebraic and matrix operations, built-in and command 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, complex Fourier 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	
Practical Work		15
1. Course Laboratory		
2. Computer Laboratory	15	

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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. (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, 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.

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8. Achieving COs

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

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

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10. Course Organization

Course Code	MTF201A		
Course Title	Engineering Mathematics - 3		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	+91-804-906-5555
		E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date		23-Oct-2020	
Next Course Specifications Review Date		May-2024	

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Course Specifications: Strength of Materials

Course Title	Strength of Materials
Course Code	ROC201A
Course Type	Core Theory
Department	Mechanical and Manufacturing 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 analyze 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	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	45
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 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 analyze 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 & 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

Columns and Struts: Elastic stability of columns; critical load of a slender column; eccentrically loaded columns; Euler's and Rankine Gordon theory of columns

Unit 6 (Strain Energy in Elastic Structural Members): 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

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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		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. (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, 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
CO-2	X		X		X
CO-3		X	X		X
CO-4		X	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	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.Course notes

b. Recommended Reading

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

c. Magazines and Journals

1. International Journal of Engineering Science
2. International Journal of Mechanical Sciences
3. Mechanics of Materials

d. Websites

1. www.asme.org

e. Other Electronic Resources

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

10. Course Organization

Course Code	ROC201A		
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-2024	

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Course Specifications: Elements of Electrical Engineering

Course Title	Measurements, Data Acquisition and Processing
Course Code	ROC202A
Course Type	Core Theory
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

The course deals with basic principles of electrical and electronic measuring instrumentation, data acquiring and processing systems. Students are taught sensors, transducers, signal conditioning circuits, recording and display devices. Design and implementation of an industrial automation process using embedded systems is discussed. Students are equipped with programming skills expected by the automation industry and are also introduced to data post processing techniques.

2. Course Size and Credits:

Number of Credits	4
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Electrical Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Specifications section 23
Attendance Requirement	As per the Academic Specifications section 24

3. Course Outcomes (COs)

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

CO-1. Explain measurement systems, display devices, recording devices, embedded controller architecture and programming methods
CO-2. Discuss DAS, Signal processing techniques, embedded controllers, embedded communication protocols and data processing techniques
CO-3. Describe the functions of digital multimeter, cathode ray oscilloscopes and transducers in the measurement of physical variables
CO-4. Choose embedded protocols applicable in the design of an embedded system
CO-5. Develop an instrumentation system to measure various physical parameters and other relevant quantities using sensors and transducers

4. Course Contents

Unit 1 (Measurement, Instrumentation and Calibration): Introduction, General instrumentation system, Objectives of instrumentation, performance characteristics, error in measurements,

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calibration and standards, static and dynamic characteristics of instrument.

Unit 2 (Electronics Instrumentation and Signal Conditioning Circuits): Signal generators, Digital multi-meters, Cathode Ray Oscilloscopes (CRO's), Bridge circuits, operational amplifier circuits for signal processing, instrumentation amplifier, filters.

Unit 3 (Sensors and Transducers): Classification of transducers, selection of transducers, temperature transducers: RTD, thermistor, thermocouple. Displacement transducer: LVDT, strain gauges, resistive, capacitive & inductive transducers. Piezoelectric, Hall effect transducer, photo-conductive and photo-voltaic cells, applications.

Unit 4 (Data acquisition and control): Objectives of Data Acquisition Systems (DAS), block diagram, general configuration, single and multichannel DAS, Display and recording systems: classification, comparison and characteristics of digital devices, transmission and recording systems, analog to digital convertors

Unit 5 (Embedded Controllers): Architecture and peripheral interfacing with embedded microcontrollers. Micro-controllers: PIC18F Family, PIC18F in embedded applications, architecture, registers, Programming: Assembly and C language programming; timers, parallel port, stepper motors, LCD, keyboard, serial port, ADC, DAC, sensor Interfacing, interrupt handling, PWM generation, DC motor control Case Study: Application development using I/O for automotive embedded system

Unit 6 (Embedded Communication Protocols): Serial and parallel interfaces, synchronous and asynchronous communication interfaces, UART USART, SPI, I2C and USB, microcontroller based DAS development, hardware communication interface programming to connect data loggers
(RS-232 interface, RS-485 interface, Ethernet interface, USB Interface)
Case Study: Demonstration of standalone logger/controller hardware

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		45

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Demonstrations		07
1.Demonstration using Videos	06	
2. Demonstration using Physical Models / Systems	01	
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		01
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		**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. (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, 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 Talk**	**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	Classroom lectures
2.	Understanding	Classroom lectures
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. William D. Cooper and Albert D. Helfrick., 2016, Modern Electronic Instrumentation and Measuring Techniques, PHI
3. A. K. Sawhney, 2015, Electrical and Electronic Measurements and Instrumentation, Dhanpatrai and Sons, New
4. M. Rafiquzzaman (2018) Microcontroller Theory and Applications with the PIC18F, wiley

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b. *Recommended Reading*

1. David A. Bell, 2015, Electronic Instrumentation and Measurements, Prentice Hall of India
2. Walt Boyes, 2014, Instrumentation Reference Book, 3rd Edition, Elsevier Science
3. John P. Bentley, 2014, Principles of Measurement Systems, 3rd Edition, Pearson Education
4. Joseph J. Carr., 2012, Elements of Electronic Instrumentation and Measurements, 3rd Edition, Pearson
5. Hackworth, JR., Hackworth , F.D, Jr., 2005, Programmable Logic Controllers, Programming Method and Applications, Pearson

c. Magazines and Journals

1. IEEE Transactions on Instrumentation and Measurement
2. Journal of Instrumentation (JINST)
3. Journal of Instrumentation Science and Technology
4. Journal of Instrumentation Technology and Innovations
5. Instrument Society of India Journal

d. Websites

1. https://www.edx.org/
2. https://www.coursera.org/
3. http://nptel.ac.in/
4. https://ocw.mit.edu/index.htm
5. http://www.ieee-ims.org
6. http://www.ni.com/academic/measurements.htm

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">ROC202A</td></tr>
<tr><td>Course Title</td><td colspan="3">Measurements, Data Acquisition and Processing</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.ee.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 2024</td></tr>
</table>

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Course Specifications: Introduction to Robotics and Mechatronics

Course Title	Introduction to Robotics and Mechatronics
Course Code	ROC203A
Course Type	Core Theory
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with the concepts Present status and future trends, Need for robots, Specifications of Robots, and application of electro-mechanical systems. Students are taught different types of end effectors, drives and actuators associated with end effectors and their design considerations. Students are taught different types of sensors and their use, the programming of microcontrollers and interfacing these embedded computers with the real world.

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 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. Explain the basic terminology of robots and end effectors
CO-2. Describe the specifications, applications and current trend in robots
CO-3. Discuss the key elements of mechatronics system and its representation in terms of block diagram
CO-4. Discuss the microcontroller concepts, sensors and actuators for robot
CO-5. Integrate and demonstrate the working of a mechatronic system for a robot

4. Course Contents

Unit 1 (Introduction to Robotics): History of robotics, Present status and future trends, Need for robots, Classifications of robots and applications

Unit 2 (Specifications of Robots): Basic terminology- Accuracy, Repeatability, Resolution, Degree

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of freedom. Mechanisms and transmission, End effectors, Grippers-different methods of gripping, Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, Cam type gripper, Magnetic grippers, Vacuum grippers, Air operated grippers

Unit 3 (Introduction to Mechatronics): Definition, Multidisciplinary Scenario, Evolution of Mechatronics, Key elements of a mechatronic system, Design of Mechatronics system, Objectives, advantages and disadvantages of Mechatronics, Examples of mechatronic systems

Unit 4 (Sensors and Actuators for Robots): Sensors and classifications – Characteristics, environmental parameters – Inductive and capacitive sensors, Force / stress sensors using quartz resonator – Ultrasonic sensors

Electrical actuator systems: Electromagnetic transducers, Solenoids, Relays, Electric motors, Direct current motors, DC motors, servomotor, stepper motor and BLDC motor.

Unit 5 (Microcontrollers): Introduction to Micro-controller, Architecture, Memory organization, Special function registers, Port Operation, Memory Interfacing, I/O Interfacing, Programming resources, interrupts, Programmer's model, Operand types, Operand addressing, Data transfer instructions, Arithmetic instructions, Logic instructions, control transfer instructions, Programming.

Unit 6 (Robot control and programming): Robot controls-Point to point control, Continuous path control, Intelligent robot, Control system for robot joint, Control actions, Feedback devices, Encoder, Resolver, LVDT, Motion Interpolations, Adaptive control.

Introduction to Robotic Programming, On-line and off-line programming, programming examples.

Unit 7 (Robot applications): Material handling, Machine loading and unloading, Assembly, Inspection, Welding, Spray painting, Service, vacuum cleaning, professional cleaning, and logistic 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	3												3		
CO-4	3				1								3	1	
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		15

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1. Demonstration using Videos	05	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	10	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**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. (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, 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
CO-4			X	X	
CO-5			X	X	
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of 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 note
2. J. J. Craig (2005) Introduction to Robotics: Mechanics and Controls, 3rd edition, Pearson Education Inc., Harlow.
3. Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, "Industrial Robotics, Technology programming and Applications", McGraw Hill, 2012
4. W. Bolton, —Mechatronics – Electronic control systems in Mechanical & Electrical Engineering, Pearson Education Ltd., 2003.

b. Recommended Reading

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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, New York.
3. Robert J. Schilling (2003) Fundamentals of Robotics: Analysis and Control Prentice-Hall, Inc., New Delhi

c. Magazines and Journals

1. IEEE Circuits and Devices Magazine

d. Websites

1. http://www.electronicsforu.com/electronicsforu/lab/

e. Other Electronic Resources

1. MULTISIM/ PROTEUS
2. Data sheets of general purpose transistors: http://www.farnell.com/datasheets/661741.pdf

10. Course Organization

Course Code	ROC203A		
Course Title	Introduction to Robotics and Mechatronics		
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	July 2020		
Next Course Specifications Review Date	July 2024		

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Course Specifications: Electrical Machine Drives and Actuators

Course Title	Electrical Machine Drives and Actuators
Course Code	ROC204A
Course Type	Core Theory
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with the basics of electrical machine drives and actuators. Students are taught the principles of AC and DC machines drives, control of electrical drives, actuators. Students are trained on the design and develop a driver circuit for electrical machines with appropriate tools tests.

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	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 working of DC and AC machines and drives for automotive and residential applications
CO-2. Describe the working of brushless DC motors, stepper motor, switched reluctance motor and its drives
CO-3. Analyze the characteristics of AC and DC machine drives
CO-4. Evaluate and select AC and DC drives for a given application using speed and torque characteristics
CO-5. Design, model, simulate and analyze appropriate drives for a given application **CO-6.** Use suitable software tools to develop a drive for an application

4. Course Contents

Unit 1 (Introduction Electrical Machine Drives): Electrical drives, Parts of Electrical drives, choice of electrical drives, status of DC and AC drives, Merits and demerits of electrical drives.

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Unit 2 (DC Motor Drive): Introduction and fundamentals of DC motor, EMF and torque equation of DC motor, Speed and torque characteristics of DC motor, four mode operation of DC motor, open loop and closed loop systems of DC motor, Braking controllers for DC motor, Application of DC motors drives in robotic systems

Unit 3 (Induction Motor Drive) : Introduction and fundamentals of induction motor, EMF and torque equations of induction motor, speed and torque characteristics of induction motor, Braking controllers of induction motors, Application of Induction Motor drives in robotic systems

Unit 4 (Synchronous Motor and Brushless DC Motor Drive) : Introduction and fundamentals synchronous motor, EMF and torque equations of synchronous motor, speed and torque characteristics of synchronous motor, Industrial applications.
Introduction and fundamentals of brushless DC motor, Speed and torque characteristics of brushless DC motor, Position control of Brushless DC motors, Applications of brushless DC motors in electric bi-cycles, elevator door systems and traction machines, Case Studies

Unit 5 (Stepper Motor Drive) : Introduction and fundamentals of stepper motor, EMF and torque equations of stepper motor, speed and torque characteristics of stepper motor, stepper motor drive circuits-unipolar switching, bipolar switching, chopper and bi-level drives, Automotive and medical industry application of stepper motor

Unit 6 (Switched Reluctance Motor Drive): Introduction and fundamentals of switched reluctance motor, EMF and torque equations of switched reluctance motor, speed and torque characteristics of switched reluctance motor, starting and braking of switched reluctance motor, speed and position control, current and torque control for switched reluctance motor, Robotic application, Case Studies

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

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

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Face to Face Lectures		40
Demonstrations		05
1. Demonstration using Videos	01	
2. Demonstration using Physical Models / Systems	01	
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. (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, 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
CO-2	X	X			X
CO-3		X			X
CO-4			X	X	X
CO-5			X	X	X
CO-6			X	X	
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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2. John Hindmarsh (2013), Electrical Machines & Drives, Second Edition, Pergamon Press
3. Jan A. Melkebeek, (2018), Electrical Machines and Drives: Fundamentals and Advanced Modelling, 1st Edition, Springer International Publishing

b. Recommended Reading

1. Gopal K. Dubey (2002), Fundamentals of Electrical Drives, Second Edition, Narosa Publishing House
2. H. Janocha. (2004), Actuators Basics and Applications, 1st Edition, SpringerVerlag Berlin Heidelberg
3. Theodore Wildi (2007), Electrical Machines, Drives and Power Systems, 6th Edition, Pearson Education, Inc.

c. Magazines and Journals

1. CES Transactions on Electrical Machines and Systems
2. IEEE journals on Electrical Engineering

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

Course Code	ROC204A		
Course Title	Electrical Machine Drives and Actuators		
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		23-Oct-2020	
Next Course Specifications Review Date		May-2024	

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Course Specifications: Strength of Materials Laboratory

Course Title	Strength of Materials Laboratory
Course Code	ROL205A
Course Type	Laboratory
Department	Mechanical and Manufacturing 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 are taught experimental methods to analyse material behavior under different types of loading conditions. Students are able to determine mechanical properties of materials. Students are trained to perform tests, analyze 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 and Manufacturing 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 tabulate 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 tensile test on ductile (Mild Steel, Aluminum) materials to determine various mechanical properties as per ASTM E8(M)
2	Conduct compression test on ductile (Aluminum) and brittle (Cast iron) materials to determine compressive strength as per ASTM E9
3	Conduct single and double shear test to determine shear strength of the given material

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4	Conduct Izod and Charpy impact test to determine the energy absorbed by the test specimen as per ASTM E23
5	Conduct Rockwell hardness test on ferrous materials to determine Rockwell Hardness number for the test material as per ASTM E18
6	Conduct Brinnell hardness test non-ferrous materials to determine Brinell
	hardness number for the test material as per ASTM E10
7	Conduct Vickers hardness test on ferrous and non-ferrous materials to determine Vickers hardness number for the test material as per ASTM E92
8	Demonstration on Torsion test to determine torsional shear strength
9	Demonstration on Photo elasticity method to illustrate contours of distributionof 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											3		
CO-3		3											3		
CO-4		3											3		
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		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 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, 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(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
CO-6	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.

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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 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
4. Ghatu Subhash and Shannon Ridgeway, 2018, Mechanics of Materials Laboratory Course, Morgan & Claypool Publishers

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
3. Materials Today Magazine

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d. Websites

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

a. Other Electronic Resources

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

10. Course Organization

Course Code	ROL205A	
Course Title	Strength of Materials 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-2024	

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Course Specifications: Measurements Laboratory

Course Title	Measurements Laboratory
Course Code	ROL206A
Course Type	Laboratory
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

This laboratory deals with augmenting theoretical concepts of measurements. Students are taught to measure displacement, temperature, pressure, stress using various sensors and analyze the sensor characteristics. Also, interface sensor with data acquisition system.

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	Electrical 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. Identify the type of sensors and instruments used based on the type of measurement to be conducted
CO-3. Conduct experiments as per the standard procedures and tabulate the measured values
CO-4. Study the characteristics of various sensors
CO-5. Interface a sensor with data acquisition system
CO-6. Write laboratory report as per the prescribed format

4. Course Contents

1	Characteristic of Temperature transducers (LDR, thermistor and thermocouple).

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2	Study of various Temperature Measuring Instruments and to Estimate their Response times. (a) Mercury – in glass thermometer (b) Thermocouple (c) Electrical resistance thermometer (d) Bio-metallic strip
3	Measurement of displacement using Linear Variable Differential Transformer (LVDT)
4	Measurement of strain, Load and Level using strain gauges
5	Measurement of torque and Pressure using strain gauges
6	Measurement of load (tensile/compressive) using load cell on a tutor.
7	Characteristics of proximity sensors
8	Characteristics of hall effect sensors
9	Measurement of torque of a rotating shaft using torsion meter/strain gauge torque transducer
10	Measurement of stress & strain using strain gauges mounted on simply supported beam/cantilever beam.
11	Interfacing of any Sensor with Data Acquisition System

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

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

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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 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. Rosario Bartiromo, Mario De Vincenzi, 2016, Electrical Measurements in the Laboratory Practice, Springer
3. John G. Webster, Halit Eren, 2014, Measurement, Instrumentation, and Sensors

b. Recommended Reading

1. Ian Sinclair, 2011, Sensors And Transducers, Elsevier
2. A. K. Sawhney, 2003, Electrical and Electronic Measurements and Instrumentation, Dhanpatrai and Sons, New Delhi

c. Magazines and Journals

1. IEEE Transactions on Instrumentation and Measurement
2. Journal of Sensors and Sensor Systems (JSSS)

d. Websites

1. http://nptel.ac.in/
2. http://www.ni.com/academic/measurements.htm
3. https://www.coursera.org/

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a. Other Electronic Resources

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

10. Course Organization

Course Code	ROL206A	
Course Title	Measurement 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	23-Oct-2020	
Next Course Specifications Review Date	May 2024	

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Course Specifications: Machine Drawing

Course Title	Machine Drawing
Course Code	MEL205A
Course Type	Core Theory with Laboratory
Department	Mechanical and Manufacturing 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 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 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. (Robotics) Programme. The

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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-2024	

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Course Specifications: Environmental Studies

Course Title	Environmental Studies
Course Code	BTN101A
Course Type	Ability Enhancement Compulsory Course
Department	Mechanical and Manufacturing 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.

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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, fertilizerpesticide 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).

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**

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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. (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 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
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--

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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	BTN101A		
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		
Next Course Specifications Review Date	May 2024		

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Course Specifications: Additional Mathematics - 1

Course Title	Additional Mathematics - 1
Course Code	MTB103A
Course Type	Core Theory
Department	Mechanical and Manufacturing 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	16
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

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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	

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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. (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, 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			✓	✓	✓

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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. 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

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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="3">MTB103A</td></tr>
<tr><td>Course Title</td><td colspan="3">Additional Mathematics - 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>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-2024</td></tr>
</table>

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Course Specifications: Entrepreneurship Development

Course Title	Entrepreneurship Development
Course Code	22MCM201A
Course Type	Core Theory Course
Department	Management Studies
Faculty	Management and Commerce

1. Course Summary

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

2. Course Size and Credits:

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	1:1:1
Total Hours of Interaction	
Number of Weeks in a Semester	15
Department Responsible	Respective Department of the Faculty
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Discuss the concepts and process of entrepreneurship
- **CO-2.** Construct and apply the idea generation techniques
- **CO-3.** Examine the opportunities for launching of new venture and various entry strategies
- **CO-4.** Acquire the skills for creation and management of entrepreneurial venture
- **CO-5.** Present a viable business plan, for business success

Course Contents

Unit 1: Introduction to Entrepreneurship

Introduction to entrepreneurship, Evolution of the concept, Entrepreneurial process, Types of

Entrepreneurship - Social entrepreneurship, rural entrepreneurship. Characteristics of an entrepreneur, incorporation of a company, managing a family business, corporate entrepreneurship

Unit 2:

Creativity and the Business idea): Key elements in an entrepreneur's background. Types of Innovations. Identify various sources of ideas for new ventures- methods available for generating new venture ideas- creativity, design thinking and the techniques for creative problem solving. Aspects of the product planning and development process

Unit 3

New Venture:
Creating opportunities, resources, role of new ventures and small businesses in the economy, types of entry strategies, launch a new venture and the generic strategies

Unit 4

Strategies to Sustain and Grow
Strategies for expansion, joint ventures, acquisitions, merges, franchising, public issues, rights issues, bonus issues, growth strategy, exit strategy.

Unit 5 Business Plan

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

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

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

5. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		20

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Demonstrations		02
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Posters	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		03
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	03	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		15
1. Case Study Presentation	05	
2. Guest Lecture	01	
3. Industry / Field Visit	02	
4. Brain Storming Sessions	02	
5. Group Discussions	04	
6. Discussing Possible Innovations	01	
Term Tests, Laboratory Examination/Written Examination, Presentations		05
Total Duration in Hours		**45**

6. Course Assessment and Reassessment

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

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, 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 – Group Task/Activity (50% Weightage)**
Subcomponent ▶	**SC1**	**SC2**	
Subcomponent Type ▶	**Mid Term Test**	**Assignment/Presentation Deck of Innovative Ideas**	**50 Marks**
Maximum Marks ▶	**25**	**25**	
CO-1	▯		▯
CO-2	▯		▯
CO-3		▯	▯
CO-4		▯	▯

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CO-5		▯	▯
The details of SC1 and SC2 are presented in the Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

7. Achieving COs

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

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

8. Course Resources

a. Essential Reading

1. Course notes
2. Rajeev Roy, (2011), *Entrepreneurship*, Oxford University Press, 2nd Edition
3. Robert D. Hisrich, Michael P. Peters, *Entrepreneurship (2017)* Dean A. Shepherd. Tenth edition. New York, NY : McGraw-Hill Education

b. Recommended Reading

1. Poornima. M. Charantimath, *Entrepreneurship Development* (2006) Small Business Enterprises, Pearson Education

c. Magazines and Journals

1. Business World: ABP Group - Fortnightly business magazine
2. Journal of small business management , Blackwell publishing- yearly

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3. Business Strategy: PwC Strategy& Inc. - Quarterly issue

d. **Websites**
   1. www. startup India.org
   2. www. allsharktankproducts .com

e. **Other Electronic Resources**
   NA

9. Course Organization

Course Code	22MCM201A		
Course Title	Entrepreneurship Development and Startups		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	+91-80-4536-6666
		E-mail:	
Course Specifications Approval Date		17 June 2022	
Next Course Specifications Review Date		June 2024	

Meeha.S.Rao

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Course Specifications: Engineering Mathematics - 4

Course Title	Engineering Mathematics - 4
Course Code	MTF202A
Course Type	Core Theory
Department	Mechanical and Manufacturing Engineering
Faculty	Mathematical and Physical Sciences

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

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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		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. (Robotics) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

Focus of 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

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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. 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/tutorial.math.lamar.edu/

10. Course Organization

Course Code	MTF202A	
Course Title	Engineering Mathematics - 4	
Course Leader/s Name		As per timetable

Course Leader Contact Details	Phone:	080 4906 5555
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	23-Oct-2020	
Next Course Specifications Review Date:	May-2024	

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Course Specifications: Analog and Digital Electronics

Course Title	Analog and Digital Electronics
Course Code	ROC207A
Course Type	Core Theory
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with the analysis and design of basic transistor amplifier circuits, oscillators wave shaping circuits, multivibrators. The students are taught the basic fundamentals of digital design such as logic gates, combinational and sequential circuits and memory devices.

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	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 the principles, characteristics and properties of various amplifier configurations
CO-2. Describe the principles of stability of an amplifier, oscillators, wave shaping circuits and multivibrators
CO-3. Design of the amplifiers, oscillators and wave shaping circuits
CO-4. Solve simple problems on logic design and logic minimization
CO-5. Analyze various combinational and sequential circuits for digital design **CO-6.** Apply digital design concepts for applications

4. Course Contents

Unit 1 (Stability and Midband Analysis of Amp transistor Analysis): BJT biasing circuits and stability factors – Fixed bias, Self-bias (voltage divider bias), Approximate small signal equivalent circuit of transistor, Approximate h-parameter based midband analysis of various types of single stage amplifiers to obtain gain, input impedance and output impedance - Comparison of CB, CE and CC amplifiers and their uses – amplifier frequency response and cutoff frequencies

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Unit 2 (Oscillators): Classification, Barkhausen Criterion – Mechanism for start of oscillation and stabilization of amplitude, General form of an Oscillator, RC and LC Oscillators, Crystal oscillators

Unit 3 (Wave Shaping and Multivibrator Circuits): RC & RL Integrator and Differentiator circuits, Astable multivibrator, Monostable multivibrator, Bistable multivibrators, Schmitt trigger circuit **Unit 4 (Digital Fundamentals):** Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Minterms and Maxterms, Karnaugh map Minimization and Quine-McCluskey method of minimization.

Unit 5 (Combinational and Sequential Circuits): Combinational Circuits-Design of Half and Full Adders, Half and Full Subtractors, Multiplexer, Demultiplexer, Decoder, Encoder, Priority Encoder. Sequential circuits-Flip flops – SR, JK, T, D, Master/Slave FF – operation and excitation tables, Triggering of FF- Design -Design of Counters- Ripple Counters, Ring Counters, Shift registers, Universal Shift Register.

Unit 6 (Memory Devices): Basic memory structure – ROM -PROM – EPROM – EEPROM –EAPROM, RAM – Static and dynamic RAM – Programmable Logic Devices – Programmable Logic Array (PLA) – Programmable Array Logic (PAL) – Field Programmable Gate Arrays (FPGA) – Implementation of combinational logic circuits using PLA, PAL.

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		
CO-6		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	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	05	

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Numeracy		10
1. Solving Numerical Problems	10	
Practical Work		10
1. Course Laboratory	00	
2. Computer Laboratory	10	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		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. (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, 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		X
CO-4		X	X	X	X

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CO-5				x	x
CO-6				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. S. S. Rattan, 2014, Theory of Machines, Tata McGraw-Hill Education 3. Singiresu S.Rao, (2011), Mechanical Vibrations, Pearson

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

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6. S Graham Kelley, (2012), Mechanical Vibrations: Theory and Application SI, Global Engineering

c. Magazines and Journals

1. Journal of Mechanisms
2. Journal of Vibration and Control, Sage Publications
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

10. Course Organization

Course Code	ROC207A		
Course Title	Analog and Digital Electronics		
Course Leader's Name	As per Timetable		
Course Leader's Contact Details	**Phone:**	+91-804-906-5555	
	E-mail:	hod.ec.et@msruas.ac.in	
Course Specifications Approval Date	23-Oct-2020		
Next Course Specifications Review Date	May-2024		

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Course Specifications: Machine Dynamics and Laboratory

Course Title	Machine Dynamics and Laboratory
Course Code	ROC208A
Course Type	Core Theory with Laboratory
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to prepare the students to perform kinematic and dynamic analysis of planar mechanisms and use such mechanisms during design of different types of machinery. Students are taught kinematic analysis and force analysis of mechanisms to accomplish desired motions of the machinery and their rigid body dynamic behaviour during design. Vibration theory, applications, and benefits of vibration analysis in machinery design will be explained. Students will be able to perform design/selection of different motion/power transmission mechanisms such as gears and to calculate inertia forces at various joints of mechanism. Students will also be able to calculate vibration parameters using graphical and analytical methods

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 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 basic concepts and principles of kinematics and dynamics of machines, mechanical vibrations, model and analyze simple mechanical systems for vibration behavior

CO-2. Illustrate kinematic construction and working of commonly used planar mechanisms Discuss models of sound waves, sound sources and solid structure interaction with sound waves.

CO-3. Solve for displacement, velocity and accelerations in planar mechanisms using graphical and

CO-4. Construct gear drive for the desired kinematic motion.

CO-5. Develop simulation model of planar mechanisms and analyze for position, velocity, accelerations and inertia forces of links using ADAMS.

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4. Course Contents

Unit 1 (Kinematics of Motion and Fundamentals of Mechanisms:): Overview; Types of Motion; Displacement; Velocity, Acceleration; Relation between Linear and Angular Motion, Mechanisms and Machines; Links, Kinematic pairs and Kinematic chains; Planar and Spatial Mechanisms; Degree of Freedom in Planar and Spatial Mechanisms; Kinematic Diagrams, Kutzbach and Gruibler's criterion; Grashof's criterion. Four- bar chain and its inversions; Slider crank chain and its inversions; Double slider crank chain and its inversions; Quick return motion mechanisms

Unit 2 (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 3 (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 4 (Dynamics of Machinery and Force Analysis of Machinery): Review of fundamentals of dynamics, basic principles of force analysis, D'Alembert's principle and inertia forces. 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

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

Unit 6 (Kinematic and Dynamic Analysis using ADAMS): 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 Perform dynamic analysis on four bar, slider crank and quick return mechanism to determine inertiaforces of links

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		40
Demonstrations		05
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	02	
3. Demonstration on a Computer	01	
Numeracy		10
1. Solving Numerical Problems	10	
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. (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, 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		X
CO-3		X	X		X
CO-4			X	X	X
CO-5				X	X
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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2. S. S. Rattan, 2014, Theory of Machines, Tata McGraw-Hill Education 3. Singiresu S.Rao, (2011), Mechanical Vibrations, Pearson

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
6. S Graham Kelley, (2012), Mechanical Vibrations: Theory and Application SI, Global Engineering

c. Magazines and Journals

1. Journal of Mechanisms
2. Journal of Vibration and Control, Sage Publications
3. Mechanism and Machine Theory
4. 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	ROC208A	
Course Title	Machine Dynamics 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-2024	

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Course Specifications: Artificial Intelligence for Robotics

Course Title	Artificial Intelligence for Robotics
Course Code	ROC209A
Course Type	Core Theory
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

The course on Artificial Intelligence and Robotics deals with the principles of Artificial Intelligence and their applications in enabling Robots to behave intelligently in sensing, perceiving and acting. Emphasis is laid on planning, reasoning as well as learning from examples, supervised and unsupervised.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	2:2:0
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. Explain the techniques of solving problems by searching, adversarial search and constraint satisfaction problems
CO-2. Discuss intelligent agents, knowledge, reasoning and planning as well as uncertain knowledge and reasoning
CO-3. Apply Learning from examples, knowledge in learning, learning from probabilistic models and elementary concepts of reinforcement learning
CO-4. Discuss principles of Robotics; communicating, perceiving and acting
CO-5. Explain principles of localization, tracking and control with a focus on examples from Robotics/Self-driving cars/Aviation

4. Course Contents

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

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

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

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

Unit 5 (Communicating, Perceiving and acting): Perception; Robotics: Robot Hardware, Robot Perception, Planning Movements, Robotic Software Architecture

Unit 6 (Case Studies): Localization, tracking and control with a focus on examples from Robotics/Selfdriving cars/Aviation

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	2												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		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		10

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1. Solving Numerical Problems	10	
Practical Work		20
1. Course Laboratory	00	
2. Computer Laboratory	20	
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. (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, 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 Work**	**100 Marks**
Maximum Marks ▶	**25**	**25**	**25**	**25**	
CO-1	**X**				**X**
CO-2	**X**	**X**	**X**		**X**
CO-3		**X**	**X**	**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.					

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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. Rattan, 2014, Theory of Machines, Tata McGraw-Hill Education
3. SingiresuS.Rao, (2011), Mechanical Vibrations, Pearson

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
6. S Graham Kelley, (2012), Mechanical Vibrations: Theory and Application SI, Global Engineering

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c. Magazines and Journals

1. Journal of Mechanisms
2. Journal of Vibration and Control, Sage Publications
3. Mechanism and Machine Theory
4. 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	ROC209A		
Course Title	Artificial Intelligence for Robotics		
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-2024	

Medha Y Rao

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Course Specifications: Digital Signal Processing

Course Title	Digital Signal Processing
Course Code	ROC210A
Course Type	Core Theory
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with the basic concepts of digital signal processing. It deals with the discrete time signals and principles of discrete Fourier transform techniques. Students are taught Fourier transforms as applied to discrete signals, digital filter design techniques, and IIR and FIR structures. Brain computer interface and applications in signal processing are explained. Students are taught to design simple digital systems based on system response.

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	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 discrete-time signals, periodic sequences, Sampling theorem, discrete Fourier transform, inverse discrete Fourier transform and its properties
CO-2. Describe filter design techniques, prototype transformation, Bilinear Realization, FIR and IIR realization of filters and Brain Computer Interface in signal process
CO-3. Solve simple problems in signal operations, DFT,FFT, FIR and IIR filters
CO-4. Apply principles of Fourier transforms for spectral analysis of digital signals and systems
CO-5. Design digital FIR and IIR filters with structures
CO-6. Use standard software tool to analyze discrete signals for various applications

4. Course Contents

Unit 1 (Introduction to Signals): Basic definitions, continuous and discrete time signals, transformation of the independent variable, classification of signals, operations on signals.

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Unit 2 (Sampling): The sampling theorem, reconstruction of signal from its samples, Aliasing, discrete time processing of continuous time signals, sampling of discrete signals, effect of time domain sampling on frequency domain representation of signals, Verification of sampling theorem using MATLAB code.

Unit 3 (Discrete Fourier Transform (DFT)): Computation of DFT, Properties of DFT, Fast Fourier transforms (FFT) - Radix-2 decimation in time and decimation in frequency FFT Algorithms, Inverse FFT. Introduction to signal processing toolbox in MATLAB

Unit 4 (Finite Impulse Response (FIR) Filters): Design of linear phase FIR filters windowing and Frequency sampling methods, Realization structures for FIR filters – Transversal and Linear phase structures, Comparison of FIR & IIR filters.

Unit 5 (Infinite Impulse Response (FIR) Filters): Analog filters – Butterworth filters, Analog Transformation of prototype LPF to BPF /BSF/ HPF. Transformation of analog filters into equivalent digital filters using Impulse invariant method and Bilinear Z transform method- Realization structures for IIR filters – direct, cascade and parallel forms.

Unit 6 (Brain Computer Interface (BCI)): Fundamentals of BCI, classification of BCI -Invasive, Partially invasive, Non-invasive, Brain signals and modalities for BCI -EEG, MEG, Typical EEG Features used in BCIs.

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		
CO-2		3											3		
CO-3		3											3		
CO-4		3											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		40
Demonstrations		05
1. Demonstration using Videos	05	
2. Demonstration using Physical Models / Systems	00	

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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. (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, 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 Work**	**100 Marks**
Maximum Marks ▶	**25**	**25**	**25**	**25**	
CO-1	X				X
CO-2	X	X	X		X
CO-3		X	X	X	X

CO-4			x	x	x
CO-5			x	x	x
CO-6				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. Class Notes
2. Simon Haykins and Van Veen, 2004, Signals and Systems. John Wiley and Sons
3. John G. Proakis, Dimitris Manolakis, G.(2007) Digital Signal Processing Principles, Algorithms, and Applications, Pearson Education / PH

b. Recommended Reading

1. Mitra, S.K. (1998) Digital Signal Processing- A Computer Based approach, Tata McGraw- Hill
2. Oppenheim, A.V., and Schaffer R.W. (2004) Discrete Time Signal Processing. PHI
3. Jonathan R.Wolpaw and Elizabeth Winter Wolpaw, Brain-Computer Interfaces: Principles and Practice 1st Edition

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c. Magazines and Journals

1. IEEE Signal Processing Magazine
2. IEEE Transactions on Signal Processing

d. Websites

1. https://ccrma.stanford.edu/~jos/st/
2. http://www.dspguide.com/
3. https://www.tutorialspoint.com/digital_signal_processing/index.htm
4. https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring2011/
5. http://nptel.ac.in/courses/117102060/

e. Other Electronic Resources

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

10. Course Organization

Course Code	ROC210A	
Course Title	Digital Signal Processing	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.ec.et@msruas.ac.in
Course Specifications Approval Date	23-Oct-2020	
Next Course Specifications Review Date	May-2024	

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Course Specifications: Fluid Power Systems for Robots

Course Title	Fluid Power Systems for Robots
Course Code	ROC211A
Course Type	Core Theory
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with imparting the knowledge of 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	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	45
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. Explain the principles and components of fluid power systems
CO-2. Describe the working of components of fluid power systems
CO-3. Select the different component such as cylinders, actuators and control valves to arrive at the fluid power circuit
CO-4. Develop simple hydraulic or pneumatic circuit and draw circuit diagrams
CO-5. Design and analyze hydraulic / pneumatic circuit for a particular application using simulation software

4. Course Contents

Unit 1 (Introduction to Fluid Power): Review of fundamental properties of fluids; fundamental laws and equations of fluid mechanics applicable to pneumatic and hydraulic systems; History,

applications, advantages and limitations of fluid power systems; General components of a basic fluid power systems
Energy and power in hydraulic systems: Pascal's law and its applications; Conservation of energy, Continuity equation, Bernoulli's equation, Hydraulic power, Hydraulic circuit analysis

Unit 2 (Hydraulic pumps and Actuators): Pump and its classification, pumping theory, pressure regulation, Pump performance and its ratings; Pump noise; pump selection
Hydraulic Actuators: Hydraulic cylinders, operating features and types; cylinder mountings and cushioning in hydraulic cylinders; Gear, vane and piston motors; hydraulic motor theoretical torque, power, flow rate and its performance characteristics

Unit 3 (Control Valves): Control valves, types and its working principle, Non-return valves, flow control valves, direction control valves, pressure control valves

Unit 4 (Pneumatic Systems): 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 circuits to accomplish push-pull, fail-safe, quick-return mechanisms

Unit 6 (Design and Analysis of Hydraulic and Pneumatic Circuits): Design and analysis of simple hydraulic and pneumatic circuits using simulation software for better understanding of relationships and interactions of various fluid power system components Practical/Laboratory content:
Modelling and Simulation of hydraulic and Pneumatic circuits using Simulink software

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	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. Anthony Esposito, 2000, Fluid Power with Applications, Pearson Education 3. A. Parr, (2011), Hydraulics and Pneumatics, 3rd Edition, Elsevier

b. Recommended Reading

1. Johnson James L. (2002) Introduction to Fluid Power, Thomson Delmar Learning.

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2. G. E. Totten (1999) Handbook of Hydraulic Fluid Technology, CRC Press.
3. Ilango Sivaraman, Introduction to Hydraulics and Pneumatics, PHI, 3rd Edition

c. Magazines and Journals

1. International Journal of Fluid Power
2. International Journal of Fluid Power System
3. Hydraulics and Pneumatics Magazine 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. http://nptel.ac.in/

10. Course Organization

Course Code	ROC211A	
Course Title	Fluid Power Systems for Robotics	
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-2024	

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Course Specifications: Analog and Digital Electronics Laboratory

Course Title	Analog and Digital Electronics Laboratory
Course Code	ROL212A
Course Type	Laboratory
Department	Mechanical and Manufacturing 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 are taught experimental methods to analyze material behavior under different types of loading conditions. Students are able to determine mechanical properties of materials. Students are trained to perform tests, analyze 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	Electronics and Communication 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. Estimate the voltages and currents in a network consisting of resistors, voltage and current csources, and BJTs
CO-2. Recognize the common emitter amplifiers and be able to calculate gain and input/output impedance
CO-3. Estimate the oscillation frequency of an oscillators
CO-4. Recognize the multiplexer and demultiplexer circuits for their operation
CO-5. Recognize the four different flip flop configurations, shift register for their operation **CO-6.** Write laboratory report as per the prescribed format

4. Course Contents

1	Fixed and voltage-divider biasing (self-bias) circuits
2	BJT self-biased amplifier circuit for gain, input and output impedances
3	BJT self-biased amplifier for frequency response
4	Oscillator circuits (Hartley/Colpitts) for oscillation frequency and amplitude

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5	Half Adder, Full Adder and Subtractor
6	Multiplexer and Demultiplexer
7	Flip flops (SR, JK, T and D)
8	Shift register

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												3		
CO-3	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		00
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	
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. (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, 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(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**
CO-6		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 instruction
2.	Understanding	Laboratory instructions and experiments

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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
4. Ghatu Subhash and Shannon Ridgeway, 2018, Mechanics of Materials Laboratory Course, Morgan & Claypool Publishers

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
3. Materials Today Magazine

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
3. http://nptel.ac.in/

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10. Course Organization

<table>
<tr><td>Course Code</td><td colspan="3">ROL212A</td></tr>
<tr><td>Course Title</td><td colspan="3">Analogue and Digital Electronics Laboratory</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.ec.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-2024</td></tr>
</table>

Medha. Y. Rao

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Course Specifications: Mechanical Dissection

Course Title	Mechanical Dissection
Course Code	MEL206A
Course Type	Core Laboratory Course
Department	Mechanical and Manufacturing 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 and Manufacturing 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

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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	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	

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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

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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	
Next Course Specifications Review Date		May-2024	

Course Specifications: Additional Mathematics - 2

Course Title	Additional Mathematics - 2
Course Code	MTB104A
Course Type	Core Theory
Department	Mechanical and Manufacturing 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. (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, 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

b. Recommended Reading

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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/

e. Other Electronic Resources

10. Course Organization

Course Code	MTB104A	
Course Title	Additional Mathematics - 2	
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-2024	

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Course Specifications: Design of Machine Elements

Course Title	Design of Machine Elements
Course Code	ROC301A
Course Type	Core Theory
Department	Mechanical and Manufacturing 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 robots. Students will acquire the knowledge on stress analysis of different components subjected to different types of loadings to predict state of stress under static condition. Students will be taught to design machine components based on predicted stress state and appropriate failure theories. Students will be able to analyze and design machine components like shafts, power screws, couplings and mechanical joints like fastener joints, gears, bearings and chains.

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 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 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, gears, chains
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 (Introduction, Load Analysis, Stress, Strain and Deflection): 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 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

Unit 2 (Stress concentrations and Static Failure Theories): Stress concentration under static loading, determination of stress concentration factors, designing to avoid stress concentrations; Examples involving different types of machinery components. 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

Unit 3 (Design of shafts, keys and coupling): Types of shafts, shaft design on strength and torsional rigidity basis, ASME Code, design of hollow shafts; types of keys, design of flat and square key, design of splines; types of couplings, design procedure for couplings, design of rigid flange coupling and flexible coupling

Unit 4 (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 5 (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 6 (Design of Rolling Contact Bearings and Design of Chain Drives): 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. 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

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	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	05	
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		**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. (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, 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 Work	100 Marks
Maximum Marks ▶	25	25	25	25	
CO-1	X		X		X
CO-2	X		X		X
CO-3		X	X		X
CO-4		X		X	X
CO-5				X	
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. 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

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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. Allen S. Hall, Alfred R. Holowenko, Herman G. Laughlin, 2000, Schaum's Outline of Theory and Problems of Machine Design, McGraw-Hill Professional
5. Robert L. Mott, 1992, Machine Elements in Mechanical Design, Merrill

c. Magazines and Journals

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

d. Websites

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

e. Other Electronic Resources

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

10. Course Organization

Course Code	ROC301A		
Course Title	Design of Machine Elements		
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-2024		

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Course Specifications: Embedded Processor and Controllers

Course Title	Embedded Processor and Controllers
Course Code	ROC302A
Course Type	Core Theory
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with the architecture and applications of embedded processors and controllers. This course facilitates the students to understand the concepts of architecture and operation of embedded processors and controllers. Students are taught to program embedded processors and controllers to realise the given functionality. Students are trained to solve practical problems involving interfacing of embedded processors and controllers with the external peripherals.

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	Electronic 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 architectures of microprocessors microcontrollers, embedded development boards and their applications

CO-2. Describe concepts of peripheral interfacing and programming of microprocessors and microcontrollers

CO-3. Design an application using microprocessors, microcontrollers and embedded board with external peripherals

CO-4. Program and verify functionality of given application using microprocessor or microcontroller

CO-5. Perform external peripheral interfacing using microprocessor or microcontroller for a given application Demonstrate the understanding of digital logic design

CO-6. Develop applications using embedded boards such as Arduino board Classify and describe types of digital circuits

4. Course Contents

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Unit 1 (Introduction to Microprocessor): Overview on evolution of Microprocessors , 8086 Architecture, Bus Interface Unit and Execution Unit, The Instruction Pipeline, Data and Address Bus Configuration, Memory Segmentation, Memory Address generation, I/O Port addressing. Functions of all signals, Minimum and Maximum Mode signals, Bus Cycles, Bus driver 8288.

Unit 2 (Programming the Microprocessor): Addressing Modes, Instruction Set in detail, Assembler directives, Assembly Language Programming, Macros, DOS function, interrupt processing, Types of interrupts, Internal interrupts.

Unit 3 (Peripherals interfacing and applications using 8086): Memory interfacing, Programmable Peripherals interface-8255, Programmable I/O Interface 8254, Programmable Interval Timer 8251 Programmable USART, Programmable Interrupt Controller 8259.

Unit 4 (Introduction to Microcontroller): Introduction to Microcontroller, Difference between Microprocessors and Microcontrollers, Difference between CISC and RISC Microcontrollers, Advantages and applications of Microcontrollers, Evolution of 8051 family, Architectural features of 8051, Programming model, pin details, I/O Ports, Addressing modes.

Unit 5 (Programming the Microcontroller): Instructions set of 8051, Counters and Timers programming, RS 232 standard, Serial I/O in 8051, Interrupts in 8051, Interrupt based Timer/Counter and Serial programming.

Unit 6 (Peripherals interfacing using 8051 and Embedded Development Boards): External memory interface, LCD, ADC, DAC, Sensor, Seven segment display, DC motor, Stepper Motor, Keyboard, Interfacing using 8255, Types of embedded systems, Overview of Arduino board, Peripheral interfacing using Arduino, Programming concepts for Arduino, Overview of Raspberry Pi board, Interfacing capabilities and environment setup of Raspberry Pi.

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	2												2		
CO-3		2	3										3		
CO-4		2	3		3								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		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		10
1. Solving Numerical Problems	10	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		05
1. Case Study Presentation	05	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**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. (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, 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		X
CO-4		X	X		X
CO-5				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	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. Brey, Barry B. (2008), 'The Intel Microprocessors', Prentice Hall Press.
3. Mazidi, Muhammad Ali, Janice Gillispie Mazidi, and Rolin McKinlay D. (2006),' The 8051 microcontroller and embedded systems: using Assembly and C', Vol. 626. Pearson/Prentice Hall.

b. Recommended Reading

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1. Ray, Ajoy K., and Kishor,M., Bhurchandi(2006) Advanced microprocessors and peripherals: architecture, programming and interfacing, Tata McGraw Hill Education Private Limited.
2. Liu, Yu-Cheng, and Glenn Gibson, A. (1986) Microcomputer systems: the 8086/8088 family architecture, programming and design
3. Ayala, Kenneth,J. (2004) The 8051 microcontroller, Cengage Learning.Magazines and

c. Magazines and Journals

1. The IUP Journal of Electrical and Electronics
2. Microcomputer Journal
3. Electronic Engineering Times
4. The Computer Journal

d. Websites

1. www.sci.electronics.com
2. http://www.embeddedrelated.com/usenet/embedded.php

e. Other Electronic Resources

1. https://www.electronicshub.org

10. Course Organization

Course Code	ROC302A	
Course Title	Embedded Processor and Controllers	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.ec.et@msruas.ac.in
Course Specifications Approval Date	23 Oct 2020	
Next Course Specifications Review Date	May 2024	

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Course Specifications: Robot Kinematics and Laboratory

Course Title	Robot Kinematics and Laboratory
Course Code	ROC303A
Course Type	Core Theory with Laboratory
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

The course deals with kinematic analysis of robots. Students are taught basics of kinematics of robotic manipulators. Students are able to analyze rigid body motion and carry out forward and inverse kinematics for position analysis of articulated arms and evaluate manipulator velocity and acceleration analytically. They are also able to develop kinematic model and estimate the velocity and acceleration for standard robotic configuration using ADAMS software.

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 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. Discuss basics of planar and spatial description, transformation, kinematics, path and trajectory planning and their importance in robotics
CO-2. Apply D-H convention and arrive at parameters for given robotic manipulator
CO-3. Derive forward and inverse kinematics equations for a given manipulator and analyze
CO-4. Evaluate link velocity and acceleration required to operate manipulators
CO-5. Solve problems on kinematics of robots and trajectory planning
CO-6. Develop simulation model for a robot and analyze for position, velocity, accelerations of links using ADAMS

4. Course Contents

Unit 1 (Introduction): Introduction to robotics; Classification of robot; Basics of robot arm mechanisms – link and its types, joints and its types, joint motion and its representation, rigid body, degrees of freedom; Principles of spatial mechanisms; Kutzbach's equation; Robotic manipulators;

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Robotic systems; Robot Anatomy; Standard robotic configuration; Robot specifications

Unit 2 (Spatial Description and Transformation): Representation of object in 3D space- Position, orientation; frames; operators-types of operators and its properties; mappings- translation, rotation and transformation; Composition of transformation, Compound transformation, Inverting a transform, transform equations; Euler angle representation and Fixed angle representation

Unit 3 (Manipulator Kinematics): Link description, link connection description; frames to link fixing conventions; Denavit-Hartenberg parameters; Forward kinematics of serial manipulators; workspace; Inverse kinematics of serial manipulator; solvability; algebraic solution methods

Unit 4 (Velocity and Acceleration Analysis of Robotic Manipulator): Time varying position and orientation; linear and rotational velocity, angular velocity; Motion of a link; velocity propagation; Acceleration of a robotic manipulator using analytical method; Jacobians; Singularities-work space boundary singularities and work space interior singularities

Unit 5 (Trajectory planning and generation): General considerations in path description and generation, joint-space schemes, Cartesian-space schemes, geometric problems with Cartesian paths, Path generation at run time; Description of paths with a robot programming language, Planning paths when using the dynamic model, Collision-free path planning

Unit 6 (Kinematic simulation using ADAMS):
Modelling and simulation of two link system and three link system to determine link velocities and plot results with respect to time and input angle. Simulation of Cartesian Robot and Polar robot configuration 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											3		
CO-5		3	2										3		
CO-6		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		04

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1. Demonstration using Videos	01	
2. Demonstration using Physical Models / Systems	02	
3. Demonstration on a Computer	01	
Numeracy		15
1. Solving Numerical Problems	15	
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		**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. (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, 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			▯	▯	▯
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
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. J. J. Craig (2005) Introduction to Robotics: Mechanics and Controls, 3rd edition, Pearson Education Inc., Harlow.

b. Publications Recommended Reading

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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, New York.
3. Robert J. Schilling (2003) Fundamentals of Robotics: Analysis and Control, Prentice-Hall, Inc., New Delhi.
4. J. M. Selig (1992) Introductory Robotics, Prentice Hall, New York.
5. Ashitava Ghosal (2006) Robotics: Fundamental Concepts and Analysis, Oxford University Press.

c. Magazines and Journals

1. ASME Journal of Mechanisms and Robotics
2. IEEE Robotics and Automation Magazine
3. International Journal of Dynamics and Control, Springer
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. http://www.technologystudent.com
6. www.nptel.ac.in

e. Other Electronic Resources

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

10. Course Organization

Course Code	ROC303A		
Course Title	Robot Kinematics 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 2024	

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Course Specifications: Computer Vision

Course Title	Computer Vision
Course Code	ROC304A
Course Type	Core Theory
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

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

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
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 fundamentals of Digital Images with Image Formation and processing
CO-2. Discuss Image processing Techniques
CO-3. Analyze and apply Image processing algorithms to solve recent computer vision problems
CO-4. Gather a basic understanding about the geo-metric relationships between 2D images world.
CO-5. Apply classification, clustering algorithms for a given computer vision application **CO-6.** Implement machine learning algorithms for computer vision applications

4. Course Contents

Unit 1(Introduction to Computer Vision): History of Computer Vision, Applications of Computer Vision, Challenges in Computer Vision, market survey on Computer Vision, Block diagram of Computer Vision.

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Unit 2 (Digital Image Fundamentals) : Human Visual System, A simple image model, Image Acquisition, Sampling and quantization, Color models and Color imaging, Pixels, Image Coordinates, Basic Relationships Between Pixels, Identify Individual Objects

Unit 3 (Digital Image Formation and processing Overview): Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing, Morphological operations

Unit 4 (Feature Extraction): Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters

Unit 5 (Texture Analysis Overview): Textures Features, Texture Representation, Grey level Co-occurrence matrix, Binary Local Pattern, Gabor Filters, Law's Texture Energy Measures.
Image Segmentation:- Region Growing, Region Merging, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Object detection

Unit 6 (Machine Learning Models for Images): Supervised- Artificial Neural Network, Gradient Descent algorithm, Back propagation Algorithm Convolution Neural Network. Unsupervised- K-Means, Rein enforcement learning. Case Studies:-Automated diagnosis, Inspection (Factory monitoring: Analyze components for deviations, Robot vision– Obstacle avoidance.

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										3		
CO-5	3		3										3		
CO-6		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		45
Demonstrations		05

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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		04
1. Course Laboratory	04	
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. (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, 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		X
CO-4		X	X		X
CO-5				X	X
CO-6				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. R. C. Gonzalez and R.E. Woods, 1992, Digital Image Processing, Addison- Wesley.
3. M. C. Bishop, 2006, Pattern Recognition and Machine Learning, Springer
4. S. Theodoridis, K. Koutroumbas, 2008, Pattern Recognition, Academic Press

b. Recommended Reading

1. R. Szeliski, 2010, Computer Vision: Algorithms and Application, Springer Verlag Inc

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2. D. A. Forsyth, J. Ponce, 2003, Computer Vision: A Modern Approach, Pearson Education

c. Magazines and Journals

1. IEEE Transactions of Image Processing

d. Websites

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

e. Other Electronic Resources

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

10. Course Organization

Course Code	ROC304A	
Course Title	Computer Vision	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cs.et@msruas.ac.in
Course Specifications Approval Date	July-2020	
Next Course Specifications Review Date	July-2024	

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Course Specifications: Control System

Course Title	Control System
Course Code	ROC305A
Course Type	Core Theory
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with the basic concepts of linear time invariant systems. The students are taught mathematical modelling, time, frequency and stability analysis. They are also facilitated to understand modelling and simulation of linear control systems using standard software tools.

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	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 and types of control system
CO-2. Obtain transfer function of various physical systems
CO-3. Analyze the time and frequency response of a system
CO-4. Determine the stability of a system represented as a transfer function using Routh-Hurwitz criteria and root locus techniques
CO-5. Design controllers for given specifications
CO-6. Model and simulate the controller for a given robotic system and analyze its time response

4. Course Contents

Unit 1 (Introduction to Control System): System, Components of control system, Open loop and closed loop control system, Examples of control system.

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Unit 2 (Transfer Function of Physical Systems): Review of Laplace transforms, Transfer function - Translational mechanical system, Rotational mechanical system and Electrical system, Block diagram representation of physical systems.

Unit 3 (Time Response Analysis): Poles, Zeros, System response, first order systems, second order systems – General second order system and Performance specifications.
Unit 4 (Stability Analysis): Characteristic equation, Necessary and sufficient conditions, Routh – Hurwitz criterion, Special cases – Zero only in the first column, Stability via epsilon method and Row of zeros, Root locus - Properties of root locus and Sketching the root locus.

Unit 5 (Controller Design):
Proportional, integral, derivative, proportional integral, proportional integral derivative controllers, closed loop transfer function, applications.

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

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

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

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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		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. (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, 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
CO-6				**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. Course notes
2. Norman S. Nise, (2010), Control Systems Engineering, Wiley Publications 3. Katsuhiko, (2010), Modern Control Engineering, Prentice Hall

b. Recommended Reading

1. Dorf, Richard, C. and Bishop, R.H., (2008), Modern Control Systems, Pearson Education

c. Magazines and Journals

1. International Journal of Control
2. IEEE Control Systems Magazine

d. Websites

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

e. Other Electronic Resources

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

10. Course Organization

Course Code	ROC305A		
Course Title	Control system		
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	23-Oct-2020		
Next Course Specifications Review Date	May-2024		

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Course Specifications: Control Systems Laboratory

Course Title	Control Systems Laboratory
Course Code	ROL306A
Course Type	Laboratory
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

Control system laboratory deals with augmenting theoretical concepts of control systems. This course facilitates students to design, model and analyze linear control system in both time and frequency domain.

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	Robotics Engineering
Total Course Marks	50
Pass Criterion	As per the Programme Specifications section 23
Attendance Requirement	As per the Programme Specifications section 24

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. Identify the type of sensors and instruments used based on the type of measurement to be conducted
CO-3. Conduct experiments as per the standard procedures and tabulate the measured values
CO-4. Study the characteristics of various sensors
CO-5. Interface a sensor with data acquisition system
CO-6. Write laboratory report as per the prescribed format

4. Course Contents

1	Mathematical model of robotic systems
2	Time response analysis of first order systems
3	Time response analysis of second order systems
4	Stability analysis using Routh-Hurwitz criteria
5	Stability analysis using root locus technique

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6	Frequency response analysis using Bode plot
7	Stability analysis using Bode plot
8	Position control of a robotic system
	Speed control of a robotic system
10	Design of PID controller for a robotic system

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3												3		
CO-2		3											3		
CO-3		3											3		
CO-4		3											3		
CO-5			3										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		
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		30
1. Course Laboratory	30	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00

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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. (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), 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 instructions

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. Rao Dukkipati, V., 2006, Analysis and Design of Control Systems Using MATLAB, New Age International
3. Ashish Tewari, 2002, Modern Control Design with MATLAB and Simulink, John Wiley, New Delhi

b. Recommended Reading

1. Shahian, B., Michael Hassul, 1992, Control System Design Using MATLAB

c. Magazines and Journals

1. IEEE Control Systems Magazine

d. Websites

1. http://ctms.engin.umich.edu/CTMS/index.php?aux=Home
2. https://www.edx.org
3. https://www.coursera.org
4. http://nptel.ac.in
5. https://ocw.mit.edu/index.htm

e. Other Electronic Resources

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

10. Course Organization

Course Code	ROL306A
Course Title	Control Systems 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.ee.et@msruas.ac.in
Course Specifications Approval Date	23-Oct-2020	
Next Course Specifications Review Date	May-2024	

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Course Specifications: Embedded Processor and Controller Laboratory

Course Title	Embedded Processor and Controller Laboratory
Course Code	ROL307A
Course Type	Laboratory
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

This laboratory deals with developing applications using microprocessor and microcontroller. The students are taught programming microprocessor, microcontroller and embedded board such as Arduino. Students are trained to solve practical problems involving interfacing of microprocessors and controllers with the external peripherals. In addition, students are trained to design applications for given practical scenarios.

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	Electronic and Communication 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. Develop the assembly level program on a Microprocessor / Microcontroller for a given application
CO-2. Interface external peripherals with Microprocessor / Microcontroller to realize the given application
CO-3. Design circuits for performing given tasks using Arduino board
CO-4. Interface external peripherals with Arduino board for given applications
CO-5. Demonstrate the developed designs on for different applications **CO-6.**
Write the report as per the prescribed format

4. Course Contents

1	**(Basic Operations using Microprocessor 8086):** Programs to perform: - Arithmetic operations (addition, subtraction, multiplication and division) for 8/16 bits, List sorting in ascending or descending order, binary to gray conversion and vice versa

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2	**(Peripheral Interface using Microprocessor 8086):** Design applications: - Temperature controller and water level controller using 8255, 8253 Timer IC, 8279 Keyboard/display IC and 8251 serial communication
3	**(Basic Operations and peripheral interface using Microcontroller 8051):** Programs to perform: - Store data in specific register or memory location, Arithmetic operations for 8/16 bits, sum of elements in an array, decimal to hexadecimal/octal/binary conversion, BCD conversion, stepper motor interface, LCD controller, Keypad controller.
4	**(Hands-on with Arduino board):** Programs to perform: - LED blinking, controlling (fading, circling and even odd blinking) of LED array using a switch, seven segment display and display messages on LCD.
5	**(Applications using Arduino board):** Introduction to Sensors and Actuators. Design applications: - IR sensor interface, Ultrasonic sensor interface, Stepper motor controller, Traffic controller.

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										3		
CO-2		2	3										3		
CO-3		2	2										3		
CO-4		2	2										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		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		30
1. Course Laboratory	30	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	

4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
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, 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(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
CO-6	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.

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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 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	Laboratory instruction

9. Course Resources

a. Essential Reading

1. Lab Manual
2. Brey, Barry B(2008), 'The Intel Microprocessors', Prentice Hall Press
3. Mazidi, Muhammad Ali, Janice Gillispie Mazidi, and Rolin McKinlay, D., (2006), The 8051 microcontroller and embedded systems: using Assembly and C, Vol. 626. Pearson/Prentice Hall

b. Publications Recommended Reading

1. Ray, Ajoy, K. and Kishor Bhurchandi, M. (2006) Advanced microprocessors and peripherals: architecture, programming and interfacing, Tata McGraw Hill Education Private Limited.
2. Liu, Yu-Cheng, and Glenn Gibson, A.,(1986) Microcomputer Systems: The 8086/8088 family architecture, programming and design.
3. Ayala, Kenneth, J. (2004), The 8051 Microcontroller, Cengage Learning.

c. Magazines and Journals

1. The IUP Journal of Electrical and Electronics
2. Microcomputer Journal
3. Electronic Engineering Times
4. The Computer Journal

d. Websites

1. www.sci.electronics.com
2. http://www.embeddedrelated.com/usenet/embedded.php

e. Other Electronic Resources

1. https://www.arduino.cc/en/Tutorial/HomePage

10. Course Organization

Course Code	ROL307A	
Course Title	Embedded Processor and Controller Laboratory	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.ec.et@msruas.ac.in
Course Specifications Approval Date	23-Oct-2020	
Next Course Specifications Review Date	May 2024	

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Course Specifications: Robot Programming and Simulation

Course Title	Robot Programming and Simulation
Course Code	ROC308A
Course Type	Core Theory
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

The course introduces simulators to deal with programming the robot and its system and subsystems for performing various function in an integrated manner. Students are taught to configure the controllers and interface them with various components of the robot. Students will learn to use fast algorithm development, factory automation simulations, fast prototyping and verification, robotics related activities, remote monitoring and safety.

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	Computer Sciences 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. Explain integrated development environment (IDE) and basic control of robotic functions
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. Write programs using high level robotic programming languages to control robotic operations
CO-5. Suggest suitable drives and control circuits for developing a physical control system

4. Course Contents

Unit 1 (Introduction to Robot simulation): Robot software functions - coordinate systems, position control, other control functions, subroutines, Program planning for Robot flow charting for robot programs with few examples.

Unit 2 (Methods of Robot Programming): Online programming, off-line programming, advantages of off-line programming, lead through methods - powered lead through, manual lead through,

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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 using python, C&C++, JAVA and MATLAB.

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 and Data 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): Control problem, state equations, state space model of a robot, constant solutions, equilibrium point, liapunov's first method, liapunov's second method, domain of attraction, linear system stability, steady state tracking.

Unit 6 (Case Studies): Modelling and Control of Manipulators, Feedback Control of a Robot, Trajectory and Position Control of a Robot, behavior based systems.
Example: Service robots, Domestic robots, Security, Surveillance and Entertainment robots

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

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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		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. (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, 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		X
CO-3		X	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.					

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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	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, 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
4. J. J. Craig, 1989, Introduction to Robotics, Mechanics, and Control, 2nd Edition, Addison Wesley

b. Recommended Reading

1. Joseph L. Jones, 2004, Robot Programming: A Practical Guide to Behavior Based Robotics, McGraw-Hill
2. Bernard Hodges, 1993, Industrial Robotics, Second Edition, Jaico Publishing House
3. K. S. Fu, R. C. Gonzalez and C. S. Lee, 1987, Robotics: Control, Sensing, Vision, and Intelligence, McGraw-Hill

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4. M. W. Spong and M. Vidyasagar, 1989, Robot Dynamics and Control, New York, Wiley

c. Magazines and Journals

1. The International Journal of Robotics Research
2. Journal of Intelligent & Robotic Systems
3. Robotics and Autonomous Systems, Elsevier
4. Journal of Control, Automation and Electrical Systems, Springer

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 MSRUAS library

10. Course Organization

Course Code	ROC308A		
Course Title	Robot Programming and Simulation		
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 2024		

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Course Specifications: Robot Dynamics and Laboratory

Course Title	Robot Dynamics and Laboratory
Course Code	ROC309A
Course Type	Core Theory with Laboratory
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

The course deals with Dynamic analysis of robots. Students are taught basics of dynamics of robotic manipulators. Students are able to understand the difference between differential motion and large scale motion in robot motion and importance of trajectory planning to move robot from one location to another in a controlled manner. Equation of motion of robot will be derived to evaluate the joint variables necessary to position robotic manipulator in a desired position and orientation. They are also able to develop computer model of standard robot configuration and estimate joint force and torque using ADAMS.

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 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 concept of dynamic model, equivalent system, free body diagrams, mass distribution, mass moment of inertia; Force and moments and their importance in robotics

CO-2. Derive static and dynamic force equations and perform force analysis of a manipulator

CO-3. Evaluate forces and torque required to operate manipulators.

CO-4. Solve problems on robot manipulator statics and dynamics

CO-5. Develop simulation model of robot and analyze for Joint forces and torques using ADAMS

4. Course Contents

Unit 1 (Review of fundamentals of dynamics:): Understanding the concepts of dynamic model, equivalent system, free body diagrams, mass distribution, mass moment of inertia; Force and moments; D'Alembert's principle

Unit 2 (Differential Motions): Introduction to differential motions; Differential Relationships; Jacobian; Differential motion of a frame- translation, rotation and transformation; differential changes between frames; Relation between differential operator and Jacobian

Unit 3 (Robot Statics): Static forces in manipulators; static force / torque relationships, Jacobian in the force domain, Cartesian transformation of static forces

Unit 4 (Manipulator Dynamics): Acceleration of a rigid body; Mass distribution; Newton's equations; Euler's Equation; Iterative Newton-Euler Dynamic Formulations; Closed Form Dynamic Equations; Iterative vs Closed form, Example of closed form dynamic equation, Structure of Manipulator Dynamic Equations; Lagrangian mechanics; Lagrangian Formulation, Manipulator Dynamics in Cartesian Space, Inclusion of non-rigid body effects, Dynamic simulation, Computational considerations

Unit 5 (Dynamic simulation using ADAMS):
To perform dynamic analysis of three link system to determine joint force and torque. To perform dynamic analysis of articulated robot to determine joint force and torque. To perform dynamic analysis of cylindrical robot to determine joint force and torque.

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	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	

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

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the programme specifications of the B. Tech. (Robotics) Programme. The procedure to determine thefinal 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	
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, Pearson Education Inc., Harlow
3. Ashitava Ghosal (2006) Robotics: Fundamental Concepts and Analysis, Oxford University Press

b. 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, Prentice-Hall, Inc., New Delhi.
4. Saeed B Niku (2014) Introduction to Robotics: Analysis, Control, Application, John Wiley & Sons.

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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, Springer
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. www.nptel.ac.in

e. Other Electronic Resources

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

10. Course Organization

Course Code	ROC309A	
Course Title	Robot Dynamics 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-2024	

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Course Specifications: Robotic System Design

Course Title	Robotic System Design
Course Code	ROC310A
Course Type	Core Theory
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is intended to provide an understanding on the functional aspects of Robots, design philosophy, robotic subsystems and its components. Students are exposed to arrive at design configuration, tools and criteria used in the mechanical design, structural dynamic characteristics of Robot manipulators, selection of critical design components and identification of suitable sensors and actuators.

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 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. Explain the functionality of various systems/subsystems/elements of a robot
CO-2. Explain tools and criteria used in the mechanical design and performance evaluation of robots
CO-3. Discuss importance of structural dynamic characteristics of Robot manipulators
CO-4. Select critical design components like guide ways, bearings and transmissions CO-5. Identify suitable sensors and actuators for a particular robot application

4. Course Contents

Unit 1 (Introduction) : Review of robots for various applications, their subsystems, concepts and design philosophies, robot specifications; Workspace Criteria, Reaching a Set of Goal Frames, Workspace Volume and Topology, Dexterity Indices, Other Performance Indices, Acceleration Radius, Elasto-static Performance, Elasto-dynamic Performance

Unit 2 (Manipulator-mechanism design) : Introduction, Basing the Design on Task Requirements,

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Kinematic Configuration, Quantitative Measures of Workspace Attributes, Redundant and Closed-Chain Structures, Actuation Schemes, Stiffness and Deflections, Position Sensing, Force Sensing

Unit 3 (Structural dynamic characteristics of Robot manipulators): Selection of materials, Stiffness versus mode of loading, Influence cross section shape, Non-linearity of a load deflection characteristics, Contact stiffness, Strength to stiffness transformation, Compliance break down in Robotics systems, Inertia and natural frequencies if revolute links, Damping enhancement techniques for manipulators. Suitable Case studies to reinforce the concepts.

Unit 4 (Critical design components): Guide ways for prismatic joints, Bearings for revolute joints, Guide ways and bearings for limited travel displacements, Transmissions, Rotational transmissions, connecting components for transmissions. Suitable case studies to illustrate the selection of critical components.

Unit 5 (Wrists): Definitions and classifications, Simple and oblique three DOF wrists, Compound wrists

Unit 6 (Selection of Sensors and Actuators): Overview of sensors and transducers in robotic application, Characteristics of sensors, Configuration of sensors, Criteria for selection of sensor/transducer, Feedback system and control system, Selection of actuators and drive system with suitable Case studies.

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3												3		
CO-2	3												3		
CO-3	3												3		
CO-4		3											3		
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		25
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	

Numeracy		30
1. Solving Numerical Problems	30	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		70

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, 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**

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	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. J. J. Craig (2005) Introduction to Robotics: Mechanics and Controls, 3rd edition, Pearson Education Inc., Harlow
3. Eugene I. Rivin, (1987) Mechanical Design of Robots, McGraw-Hill Book Company

Recommended Reading

1. K. S. Fu, R. C. Gonzalez and C. S. Lee (1987) Robotics: Control, Sensing and Vision Richard C. Dorf and Robert H. Modern Control Systems, 12th Edition, Prentice Hall Publication
2. Jorge Angeles (2007), Fundamentals of Robotic Mechanical Systems, Theory, Methods, and Algorithms, Third Springer Science

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3. Robert J. Schilling (2003), Fundamentals of Robotics: Analysis and Control, Prentice-Hall India
4. Saeed Benjamin Niku (2011) Introduction to Robotics: Analysis, control, Applications, Second Edition John Wiley

b. Magazines and Journals

1. IEEE Transactions on Solid State Circuits and Systems
2. IEEE Transactions on Analog and Mixed Signal Circuits
3. IEEE Transactions on Computer-Aided Design
4. Journal of Dynamical and Control Systems. United States.
5. The International Journal of Robotics Research
6. Journal of Field Robotics

c. Websites

1. http://www.electronicsforu.com/electronicsforu/lab/
2. http://www.robotvirtualworlds.com/
3. http://www.robotc.net/

d. Other Electronic Resources

1. Electronic resources on the module area are available at MSRUAS library

10. Course Organization

Course Code	ROC310A	
Course Title	Robotic System 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	July 2020	
Next Course Specifications Review Date	July 2024	

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Course Specifications: Applied Control Systems

Course Title	Applied Control Systems
Course Code	ROC311A
Course Type	Core Theory
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of the course is to deal with mathematical modelling of robotic systems and design of control techniques to analyze the behavior of the system. Students are taught the concepts of state space techniques, phase plane analysis and feedback linearization method for designing nonlinear controllers for the robotic system. Students are trained to model, simulate and analyze control techniques for a given robotic system using software tools.

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	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. Obtain the mathematical model of a robotic system
CO-2. Linearize a nonlinear robotic system to obtain the transfer function
CO-3. Discuss the principles of state space analysis, phase plane analysis and singular points in robotic control system
CO-4. Develop conventional controllers to meet the design requirements
CO-5. Design controllers and observers in state space using pole placement techniques
CO-6. Model and simulate the controller for a given robotic system and analyze its time response

4. Course Contents

Unit 1 (Introduction): Nonlinear system, Behavior of nonlinear systems, Common nonlinearities, Examples of non-linear systems.

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Unit 2 (Mathematical Modelling of Robotic Systems): Linearization, Transfer function of manipulators, Concepts of state, state variables, state model, State variable representation of linear and nonlinear systems, State variable representation for a n-link manipulator, Conversion of state variable models to transfer functions and vice versa, Solution of state equations.

Unit 3 (State Feedback Controller and Observer Design): Controllability and observability, state transition matrix basics of state space design: design of controller and observer, pole placement techniques, stability analysis.

Unit 4 (Stability Analysis Methods):
Phase plane analysis - Phase portraits, singular points and limit cycles, Lyapunov's stability method.

Unit 5 (Controller Design): Conventional controller design, nonlinear controller design via feedback linearization, Adaptive 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											3		
CO-3	3												3		
CO-4		3	2										3		
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		05
1. Demonstration using Videos	05	
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. (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, 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**	
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. Saeed B Niku, 2016, Introduction to Robotics, Analysis, Control, Applications, Wiley Publications
3. Khalil, H., 2001, Non-linear Systems. 3rd Edition, Prentice Hall

b. Recommended Reading

1. Karl J Astrom, B. Wittenmark, 2006, Adaptive Control, Pearson Publishers
2. Alessandro Astolfi, Dimitris Karagiannis, Romeo Ortega, 2008, Nonlinear and Adaptive Control with Applications, Springer

c. Magazines and Journals

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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

Course Code	ROC311A

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Course Title	Applied Control Systems		
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		23-Oct-2020	
Next Course Specifications Review Date		May-2024	

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Course Specifications: Digital Image Processing

Course Title	Digital Image Processing
Course Code	ROC312A
Course Type	Core Theory
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with fundamental concepts of digital Image processing and development of image processing algorithms for robotic applications. Students are taught the various Image processing concepts, image quality enhancement, filtering, segmentation and feature extraction techniques are discussed.

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	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. Describe the underlying principles of image formation and processing techniques
CO-2. Discuss various mathematical and geometric manipulations on images
CO-3. Discuss the restoration, enhancement, segmentation, feature extraction concepts and their applications
CO-4. Solve problems on image manipulations in both time and frequency domains **CO-5.** Use standard software tools to analyse digital images for various applications.

4. Course Contents

Unit 1 (Digital Image Fundamentals): Elements of visual perception, Image formation model, image sampling and quantization, some basic relationships between pixels, matrix and singular value representation of discrete images. Introduction to Image processing toolbox in MATLAB.

Unit 2 (Operations on Digital Images): Arithmetic operations - Addition, Subtraction, Multiplication, Division-Logical operations NOT, OR, AND, XOR-Set operators-Spatial operations Single pixel, neighborhood, geometric-Contrast Stretching-Intensity slicing-Bit plane slicing Power Law

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transforms.

Unit 3 (Image Enhancement): Gray level transformation, Histogram processing, enhancement using arithmetic/logic operations, spatial filtering –smoothening and sharpening, filtering in frequency domain-smoothening and sharpening frequency domain filters- homomorphic filtering. MATLAB code for histogram equalization, spatial and frequency domain filter.

Unit 4 (Image restoration): Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters. MATLAB code for restoring an image after degradation using adaptive filter

Unit 5 (Image Segmentation and Feature Extraction): Intensity based segmentation, Edge based segmentation, Region based segmentation, segmentation by morphological watersheds, statistical and GLCM features. MATLAB code for edge detection and GLCM feature Extraction.

Unit 6 (Case Studies): Modelling and Control of Manipulators, Feedback Control of a Robot, Trajectory and Position Control of a Robot, behavior based systems. Example: Service robots, Domestic robots, Security, Surveillance and Entertainment robots

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		2	3										3		
CO-5					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		40
Demonstrations		05
1. Demonstration using Videos	02	
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	

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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. (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, 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	
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	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. Rafael C. Gonzalez, Richard E. Woods (2004) Digital Image Processing, Second Edition, Prentice Hall
3. Anil k. Jain (2004) Fundamentals of Digital Image Processing. Third Edition, Prentice Hall

b. Recommended Reading

1. John G. Proakis, Dimitris Manolakis, G. (2007) Digital Signal Processing Principles,Algorithms, and Applications, Pearson Education
2. Alan Bovik. (2009) The essential guide to image processing, Academic Press
3. B.Chanda & D.Dutta Majumder – Digital Image Processing and Analysis – Prentice Hall of India – 2002
4. William K. Pratt – Digital Image Processing – John Wiley & Sons-2nd Edition, 2004

c. Magazines and Journals

1. IEEE Transactions of Image Processing

d. Websites

1. https://www.tutorialspoint.com/digital_signal_processing/index.htm
2. http://www.ece.arizona.edu/~dia

e. Other Electronic Resources

1. https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring2011/

10. Course Organization

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Course Code	ROC312A	
Course Title	Digital Image Processing	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.ec.et@msruas.ac.in
Course Specifications Approval Date	23 Oct 2020	
Next Course Specifications Review Date	May 2024	

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Bangalore

Course Specifications: Engineering Economics and Cost Estimation for Mechanical Engineers

Course Title	Engineering Economics and Cost Estimation for Mechanical Engineers
Course Code	ROC313A
Course Type	Core Theory
Department	Mechanical and Manufacturing 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 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 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)

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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	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. (Robotics) 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
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	--

9. Course Resources

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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	ROC313A		
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	
Course Specifications Approval Date	23-Oct-2020		
Next Course Specifications Review Date	May-2024		

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Course Specifications: Seminar

Course Title	Seminar
Course Code	ROS314A
Course Type	Core Theory
Department	Mechanical and Manufacturing 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 and Manufacturing 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. Prepare and deliver seminar on a given topic.
CO-2. Write a report on the seminar topic.

4. Course Contents

Unit 1 : 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. (Robotics) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▶	SC1	SC2 (Optional)	
Subcomponent Type ▶	Report		25 Marks
Maximum Marks ▶	25	25	
CO-1			X
CO-2	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
2. Cliff Atkinson, Beyond Bullet Points

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3. Bruce R. Gibrielle, Speaking Power point
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	ROS314A	
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-2024	

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Course Specifications: CAE for Robotics and Laboratory

Course Title	CAE for Robotics and Laboratory
Course Code	ROE411A
Course Type	Professional Core Elective with Laboratory
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

The course introduces the role of CAE systems in product development and emerging trends in CAE systems for robotic system development. The course deals with creation of geometric models of engineering components/assemblies as part of product. Students are taught the principles of geometric modeling, analysis and are trained to use commercial 3D modeling and finite element analysis tools.

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 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 basic concepts and principles of design
CO-2. Specify and evaluate tools and techniques of CAE
CO-3. Create geometric models of engineering components and sub-systems related to Robot
CO-4. Develop finite element model of components for different types of analysis
CO-5. Perform engineering analysis using geometric modelling tools like CATIA and ANSYS software

4. Course Contents

Unit 1 (Introduction CAE Systems): CAE systems in product, Emerging trends in CAE systems, Fundamental of Geometric modelling, Computer graphics techniques, Considerations for selection of Computer Aided Design(CAD)

Unit 2 (CAD techniques): CAD techniques for wire frame, surface, and solid models, Preparation of

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design documents according to Current ISO and ANSI standards.

Unit 3 (CEA): The laboratory sessions involve the study of drawings, sketching, part modelling, surface modelling, assembly modelling, detailing techniques of engineering components using industry standard CAD package. Introduction to modelling tool environment, wire frame sketching and constraining modifying dimensions, methods of solids construction and editing, use of history tree, creating patterns, draft, shells, etc.
Difference between surface and solid models, creating surfaces, advanced surfaces with the use of variation sweep, surface by boundary and curves, editing surfaces, regular exercises to get a hands on surfacing Introduction to assemblies, creating assemblies, assembly constraints, managing assemblies, animation in assemblies. Introduction to drafting set-up, managing views, adding annotations, dimensions etc, creating bill of materials, import and export of files.

Unit 4 (Finite element theory): A Finite element theory: An overview of finite element methods and its applications. Commercial FEM systems: Capabilities. GUI, basics and general analysis procedure, Pre-processing: Creating geometries, assigning material properties, Introduction to meshing, Basic element types, Discretization of components using 1D, 2D, 3D elements, application of boundary conditions, solution procedure and post processing. Case studies on structural analysis of components related Robot using ANSYS.

Unit 5 (Laboratory Practice): Geometric Modelling exercises using CATIA and Demonstration of structural analysis of components using ANSYS tool

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								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	05	
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		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. (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, 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		X
CO-3	X	X	X	X	X

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	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. Chris McMahon and Jimmie Browne, (2005), CAD-CAM Principles, Practice and Manufacturing Management, 2nd Edition, Pearson Education
3. Ibrahim Zeid, (2008), Mastering CAD/CAM, Tata McGraw-Hill

b. Publications Recommended Reading

1. Ibrahim Zeid and R. Sivasubramanian, (2008), CAD/CAM Theory and Practice, Tata McGraw-Hill

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2. Cornelius Leondes, (2000), Computer-Aided Design Engineering, and Manufacturing: Systems Techniques and Applications, (Volume 1-7), CRC Press
3. Kunwoo Lee, (1999), Principles of CAD/CAM/CAE Systems, Addison Wesley

c. Websites

1. http://www.nptel.com
2. www.autodesk.com
3. www.cadalyst.com

d. Other Electronic Resources

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

10. Course Organization

Course Code	ROE411A		
Course Title	CAE for Robotics 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 2024		

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Course Specifications: Statistical and Optimization Tools for Robotics

Course Title	Statistical and Optimization Tools for Robotics
Course Code	ROE412A
Course Type	Professional Core Elective
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with descriptive statistics, probability distributions, estimation and confidence intervals in the context of engineering problems. The analysis of variance and design of experiment taught to design the engineering problems. The concept of stochastic modeling for discrete and continuous Markov chains taught as an application for engineering problems. The major optimization techniques like linear and nonlinear optimization problems discuss to solve the engineering problems. This course also aims to solve engineering problems using statistical methods, stochastic process and optimization techniques using Matlab/Python.

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 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 basics of descriptive statistics, probability distributions and random number generations

CO-2. Determine the confidence intervals for population parameters and test for the statistical significance

CO-3. Design engineering problems using experimental designs and test for significance using ANOVA

CO-4. Apply discrete and continuous stochastic models for analyzing engineering problems

CO-5. Analyze the engineering problems using optimization techniques

4. Course Contents

Unit 1 (Basic Statistics): Introduction to descriptive statistics, Binomial, Poisson, Normal,

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Exponential, Weibul distributions and their applications in engineering, random number generation.

Unit 2 (Statistical Inference): Random sample and statistic, sampling distribution of statistic, introduction to estimation – point and interval estimation, maximum likelihood estimation, confidence intervals - mean, variance, proportion, difference of means and proportions, and significance using t, F and Chi-Square tests.

Unit 3 (ANOVA and design of experiments): Introduction to Analysis of variance (ANOVA) and design of experiments – Completely Randomized Design (CRD), Randomized Block Design (RBD) and Latin Square Design (LSD) and applications

Unit 4 (Probability and Stochastic Processes): Axiomatic definition of probability, conditional probability, Bayes' theorem (statement only) and applications; Introduction to stochastic modeling- definition, applications, stationarity-weak and strong stationary; nonstationary stochastic process with applications in engineering problems.

Unit 5 (Optimization Methods for Engineering Design): Introduction and overview of optimization problems include the notion of convergence and convexity; basics of constrained and unconstrained optimization; Linear programming problems – applications, formulation of LPP, graphical solution, simplex, Big-M, and two-phase methods; Constrained optimization – equality constrained problems, penalty function, Lagrange multipliers, introduction to nonlinear optimization problems and methods and inequality constrained optimization.

Unit 6 (Practical using MATLAB/Python):

1. Descriptive statistics, random number generation
2. Determining probabilities using probability distribution
3. MLE estimation and confidence interval construction
4. ANOVA and design of experiments
5. Linear programming problem – Simplex, Big-M and Two Phase methods
6. Quadratic programming problems
7. Integer programming problems
8. Dynamic programming problems
9. Stationary and non-stationary stochastic processes
10. Poisson process, Pure birth and death process

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		2		3									2	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		50
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		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. (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, 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	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	--

9. Course Resources

a. Essential Reading

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1. Class Notes
2. Ross, S. M. (2014). Introduction to probability and statistics for engineers and scientists. Academic Press.
3. Howard M. Taylor, Samuel Karlin (1998), An introduction to stochastic modelling, Gulf Professional Publishing.
4. Belegundu, A., & Chandrupatla, T. (2011). Optimization Concepts and Applications in Engineering (2nd ed.). Cambridge: Cambridge University Press.
5. Montgomery, D. C. (2017). Design and analysis of experiments. John wiley & sons.

b. Recommended Reading

1. Montgomery, D. C., & Runger, G. C. (2010). Applied statistics and probability for engineers. John Wiley & Sons.
2. Avriel, M., & Golany, B. (Eds.). (1996). Mathematical programming for industrial engineers (Vol. 20). CRC Press.

c. Magazines and Journals

1. Montgomery, D. C., & Runger, G. C. (2010). Applied statistics and probability for engineers. John Wiley & Sons.
2. Avriel, M., & Golany, B. (Eds.). (1996). Mathematical programming for industrial engineers (Vol. 20). CRC Press.

d. Websites

1. https://nptel.ac.in/
2. https://swayam.gov.in/

e. Other Electronic Resources

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

10. Course Organization

Course Code	ROE412A	
Course Title	Statistical and Optimization Tools for Robotics	
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 2024	

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Course Specifications: Probability and Statistics

Course Title	Probability and Statistics
Course Code	MTE301A
Course Type	Professional Core Elective
Department	Mechanical and Manufacturing 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. (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, 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="3">MTE301A</td></tr>
<tr><td>Course Title</td><td colspan="3">Probability and Statistics</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">080 4906 5555</td></tr>
<tr><td>E-mail:</td><td colspan="2">hod.mt.mp@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-2024</td></tr>
</table>

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Course Specifications: Advanced Mathematics

Course Title	Advanced Mathematics
Course Code	MTE302A
Course Type	Professional Core Elective
Department	Mechanical and Manufacturing 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
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

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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. (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, 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	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

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a. Essential Reading

1. Class Notes
2. Barrett O' Neil, 1966, Elementary Differential Geometry, Academic Press, New York and London
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	MTE302A	
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-2024	

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Course Specifications: Industrial Robotics and Automation

Course Title	Industrial Robotics and Automation
Course Code	ROE421A
Course Type	Professional Core Elective
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

This Course deals with industrial robotics and automation technologies adopted in industries. The need for robotic process automation systems and its role in operation excellence will be explained. The applications of robots in inspection and assembly system will be explained. The Development of robotic work cell procedure will be taught to students.

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 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. Explicate the role of robotics and automation in industrial applications
CO-2. Describe the applications of robots in various industrial application
CO-3. Identify the right Robot for a given industrial application
CO-4. Explicate End effector design for typical applications
CO-5. Illustrate robotic cell development procedure for given industrial applications

4. Course Contents

Unit 1 (Introduction): Types of industrial robots, Load handling capacity, general considerations in Robotic material handling, material transfer, machine loading and unloading, CNC machine tool loading, Robot centered cell. Factors influencing the choice of a robot, robot performance testing, economics of robotization, Impact of robot on industry and society. Application of Robots in continuous arc welding, Spot welding, Spray painting, assembly operation, cleaning, robot for underwater applications.

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Unit 2 (Robots for Assembly Systems and Line Balancing): The Assembly Process, Assembly Systems, Manual Assembly Lines, The Line Balancing Problem, Methods of Line Balancing, Computerized Line Balancing Methods, Other ways to improve the Line Balancing, Flexible Manual Assembly Lines.

Automated Assembly Systems - Design for Automated Assembly, Types of Automated Assembly Systems, Vibratory bowl feeder and Non-vibratory bowl feeder, Part Orienting Systems, Feed tracks, Escapements and part placing mechanism, Analysis of Multi-station Assembly Machines, Analysis of a Single Station Assembly Machine.

Unit 3 (Robots for Inspection): Introduction to quality, need for inspection and quality control, Modes of inspection: Accuracy testing of machine tools, Part/Product inspection, Process quality control, Limitations of manual inspection methods. Robotic vision systems, image representation, object recognition and categorization, depth measurement, image data compression, visual inspection, software considerations.

Unit 4 (End Effectors): Gripper force analysis and gripper design for typical applications, design of multiple degrees of freedom, active and passive grippers.

Unit 5 (Robotic work cell): Phases in robotic cell design, design and economic considerations. Development of manual task map and robot task map, comparison of manual and robot task map and selection from alternate robotic cell solutions.

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		50
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		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. (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, 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	X	X
CO-4			X	X	X

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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. Class Notes
2. Gupta.A.K, Arora. S. K., "Industrial Automation and Robotics", University Science Press, 2009.
3. Deb S R, "Robotics Technology and Flexible Automation", Tata McGraw Hill, New Delhi, 1994.
4. James A Rehg, "Introduction to Robotics in CIM Systems", Prentice Hall of India, 2002.

b. Publications Recommended Reading

1. Mikell P. Groover (2008) Automation, Production Systems and Computerintegrated manufacturing, PHI Learning Private Ltd,
2. Richard. K. Miller, "Industrial Robot Handbook", Springer, 2013.
3. Cotsaftis, Vernadat, "Advances in Factories of the Future, CIM and

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Robotics",	Elsevier, 2013.

c. **Magazines and Journals**
   1. Industrial Robot, international journal of robotics research and application, Emerald Publishers
   2. International Journal of Automation and Control (IJAAC) Inderscience Publishers

d. **Websites**
   1. Leanrobotics.org
   2. www.automation.com
   3. www.new.abb.com
   4. www.fanucindia.com

e. **Other Electronic Resources**
   1. Electronic resources on the subject area are available in RUAS library

10. Course Organization

Course Code	ROE421A	
Course Title	Industrial Robotics 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 2024	

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Course Specifications: Multi-agent Systems for Robotics

Course Title	Multi-agent Systems for Robotics
Course Code	ROE422A
Course Type	Professional Core Elective
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

Students shall be taught the role of Agents and Multi-Agent Systems in various fields like distributed and cooperative robotics. Multiagent robotic systems have benefited from distinct fields such as social science, life science and engineering. An agent is a computational system that tries to fulfill a set of goals in a complex dynamic environment, an agent can take many different forms. A multirobot system is to enable individual robots to automatically program task handling behaviors, collaborate, adapt to the dynamic changes in their task environments. Students are able to learn and develop group behavior learning, evolution and adoption. The course aim is to understand the real-world challenges, approaches, model and techniques to develop multiagent robot 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	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 fundamental concepts of Agents, Multi-Agent Systems and Multi Agent Robotics
- **CO-2.** Discuss Behavior-Based Robotics, Collective Robotics, Evolutionary Robotics approaches and related issues
- **CO-3.** Discuss learning, evolution and adoption techniques for multiagent systems
- **CO-4.** Design learning models, methods and tools relevant for multi-agent systems
- **CO-5.** Apply concepts and tools relevant for multi-agent systems
- **CO-6.** Develop case studies on learning, adoption and self-organization

4. Course Contents

Unit 1 (Introduction): Agents and Multi-Agent Systems, Multi Agent Robotics, Cooperation,

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Learning, Evolution and Adaptation, Design of Multi-Robot Control.

Unit 2 (Approaches): Behavior-Based Robotics, Collective Robotics, Evolutionary Robotics, Inspiration from Biology and Sociology.

Unit 3 (Model and Techniques): Reinforcement Learning, Genetic Algorithms, Artificial Life, Artificial Immune System, Probabilistic Modelling, Multi Robot Planning and Coordination, Outstanding Issues.

Unit 4 (Humanoids): Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditory orientation control, Facial expression, Hands and manipulation, Sound and speech generation, Motion capture/Learning from demonstration, Human activity recognition using vision, touch, sound, Vision, Tactile Sensing, Models of emotion and motivation. Performance, Interaction, Safety and robustness, Applications.

Unit 5 (Case Studies in Learning): Multi Agent Reinforcement Learning Techniques, Results, Matters, Evolutionary Multi Agent Reinforcement Learning.
Case Studies in Adaptation: Coordinated Maneuvers in a Dual Agent System, Collective Behavior.
Case Studies in Self Organization: Multi agent Self Organization, Evolutionary Multi agent Self Organization.

Unit 6 (Exploration Tools): Tool box for Multi Agent Reinforcement Learning, Evolutionary Multi Agent Reinforcement Learning, Evolutionary Collective Behavior Implementation, Multi Agent Self Organization and 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	2	3											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		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		10
1. Solving Numerical Problems	10	
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		05
1. Case Study Presentation	05	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	03	
6. Discussing Possible Innovations	02	
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. (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, 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			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.

8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

1. Class Notes
2. Multi Agent Robotic Systems", Jiming Liu, Jianbung Wu, CRC Press.

b. Recommended Reading

1. "Multiagent Systems: A Modern Approach to Distributed Artificial

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Intelligence." Gerhard Weiss (Ed.), MIT Press, 1999.
2. "An Introduction to Multiagent Systems", M. Wooldridge. John Wiley and Sons Ltd
3. "Reasoning about Rational Agents" M. Wooldrige, The MIT Press, 2000 4. "Readings in Agents" M. Huhns & M. Singh (Eds.), Morgan Kaufmann, 1998.
5. "Multi-Agent Systems", J. Ferber, Addison-Wesley, 1999

c. Magazines and Journals
1. IEEE Big Data Mining and Analytics
2. IEEE Transactions on Knowledge and Data Engineering
3. Analytics magazine from INFORMS

d. Websites
1. http://www.multiagent.com
2. http://www.agentlink.org
3. http://agents.umbc.edu/
4. http://www.ece.arizona.edu/~rinda/compareagents.html
5. http://www.agentbuilder.com/AgentTools/

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

10. Course Organization

Course Code	ROE422A		
Course Title	Multi-agent Systems for Robotics		
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 2024		

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Course Specifications: Data Sciences Foundation

Course Title	Data Sciences Foundation
Course Code	CSE411A
Course Type	Professional Core Elective
Department	Mechanical and Manufacturing 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 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		

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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

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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. (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, 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. KD Nuggets: Data Sets for Data Mining and Data Science, www.kdnuggets.com/datasets/index.htm
2. Quora: www.quora.com

10.Course Organization

Course Code	CSE411A	
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-2024	

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Course Specifications: Optimization Techniques – 1

Course Title	Optimization Techniques – 1
Course Code	MTE401A
Course Type	Professional Core Elective
Department	Mechanical and Manufacturing 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	

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. (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, 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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Course Code	MTE401A		
Course Title	Optimization Techniques – 1		
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-2024		

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Course Specifications: Project Work - 1

Course Title	Project Work -1
Course Code	ROP401A
Course Type	Project
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to give students an experience of identifying an engineering problem, conceptualize 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 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. Recognize the need for developing a new or improving an existing engineering product/system through an organized survey of literature
CO-2. Define engineering designspecifications.
CO-3. Design, model, solve analyze 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 technicalreport.

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

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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. (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 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	ROP401A	
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-2024	

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Course Specifications: Internship

Course Title	Internship
Course Code	ROI401A
Course Type	Internship
Department	Mechanical and Manufacturing 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 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. 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

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- 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. (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 (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	ROI401A		
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-2024	

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Course Specifications: Autonomous Robots

Course Title	Autonomous Robots
Course Code	ROE431A
Course Type	Professional Core Elective
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with autonomous robotics and the concepts of robot cognition and perception. The course covers the principles of robot motion, forward and inverse kinematics of robotic arms and simple wheeled platforms, perception, error propagation, localization and simultaneous localization and mapping. Understand the concepts of path planning algorithms, and knowledge on the robot programming packages used in localization and mapping. The students shall design and illustrate the importance of the mechanism in designing intelligent, autonomous 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 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 introduction and working principles of autonomous robotic Systems
CO-2. Discuss the aspects of cognition, perception and Imaging Techniques used in Robotic Applications
CO-3. Discuss the various robot programming packages for display, tele-operation and other applications
CO-4. Develop algorithms for simultaneous localization and mapping based techniques and paradigms
CO-5. Analyze the various path planning techniques by briefing about the robot's environment and explaining about the programs

4. Course Contents

Unit 1 (Introduction): Autonomous robots, Robot types, Kinematics and dynamics, Robotic

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hardware, Construction material, Sensors Actuators, Processors.

Unit 2 (Cybernetic View of Robot Cognition & Perception): Introduction to the Model of Cognition, Visual Perception, Visual Recognition, Machine Learning, Soft Computing Tools and Robot Cognition.

Unit 3 (Map Building): Introduction, Constructing a 2D World Map, Data Structure for Map Building, Explanation of the Algorithm, An Illustration of Procedure Traverse Boundary, An Illustration of Procedure Map Building, Robot Simulation, Execution of the Map Building Program.

Unit 4 (Randomized Path Planning): Introduction, Representation of the Robot's Environment, Review of configuration spaces, Visibility Graphs, Voronoi diagrams, Potential Fields and Cell Decomposition, Planning with moving obstacles, Probabilistic Roadmaps, Rapidly exploring random trees, Execution of the Quad tree-Based Path Planner Program.

Unit 5 (Simultaneous Localization and Mapping (SLAM)): Problem Definition, Mathematical Basis, Examples: SLAM in Landmark Worlds, Taxonomy of the SLAM Problem, Extended Kalman filter, Graph-Based Optimization Techniques, Particle Methods Relation of Paradigms.

Unit 6 (Robot Programming Packages): Robot Parameter Display, Program for Bot Speak, Program for Sonar Reading Display, Program for Wandering Within the Workspace, Program for Tele-operation, A Complete Program for Autonomous Navigation.

Unit 7 (Imaging Geometry): Introduction – Necessity for 3D Reconstruction – Building Perception – Imaging Geometry – Global Representation – Transformation to Global Co-ordinate System.

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3												3		
CO-2		3			2								3	2	
CO-3					3									3	
CO-4			2		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		55
Demonstrations		05
1. Demonstration using Videos	05	

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2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**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. (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, 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	
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. Patnaik, Srikanta, "Robot Cognition and Navigation - An Experiment with Mobile Robots", Springer Verlag Berlin and Heidelberg, 2007.
3. Howie Choset, Kevin LynchSeth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, and Sebastian Thrun, "Principles of Robot Motion Theory, Algorithms, and Implementation", MIT Press, Cambridge, 2005.

b. Publications Recommended Reading

1. Sebastian Tharun, Wolfram Burgard, Dieter Fox, "Probabilistic Robotics", MIT Press, 2005.

2. Margaret E. Jefferies and Wai-Kiang Yeap, "Robotics and Cognitive Approaches to Spatial Mapping", Springer-Verlag Berlin Heidelberg 2008.
3. Hooman Somani," Cognitive Robotics", CRC Press, 2015.
4. Jared Kroff,"Cognitive Robotics: Intelligent Robotic Systems", Wilford Press, 2016.
5. Lidia Ogiela, Marek Ogiela, "Advances in Cognitive Information Systems", Springer, 2012.

c. Magazines and Journals

1. IEEE Journals and papers
2. ASME Journals

d. Websites

1. http://www.vernon.eu/wiki/Cognitive_Robotics_Resources

e. Other Electronic Resources

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

10. Course Organization

Course Code	ROE431A	
Course Title	Autonomous robots	
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 2024	

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Course Specifications: Systems Engineering

Course Title	Systems Engineering
Course Code	ROE432A
Course Type	Professional Core Elective
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

Systems engineering examines methods of specifying, designing, analyzing and testing Robotic systems. In this course, principles and processes of systems engineering are introduced and applied to the development of robotic devices. The focus is on robotic system engineered to perform complex behavior. Such systems embed computing elements, integrate sensors and actuators, operate in a reliable and robust fashion, and demand rigorous engineering from conception through production. The course is organized to engineer process of conceptualization, specification, design, and prototyping with consideration of verification and validation. Students completing this course will engineer a robotic system through its complete design.

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	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 engineering design, product lifecycles, various models and standards for robots
CO-2. Explain the role of system engineering methodologies in an orderly design process
CO-3. Identify and evaluate system and subsystem requirements and decompose system requirements into functions for robotic system
CO-4. Develop and verify the system to meet the requirements of a robotic System
CO-5. Release and maintain a robotic system

4. Course Contents

Unit 1 (Overview of the systems engineering domain): Definitions key to systems engineering; the system life cycle, and the product development life cycle. Phase gate approach to product

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development enabled by application of systems engineering principles. Concept Exploration and four types of systems requirements that must be extracted from the customer's statement of want and needs, Dual nature of validation, and its differences from verification.

Unit 2 (Requirement analysis): Requirements development, and how these relate to planning for systems integration, verification, and validation. "V-Model". Examples from the context of a Robotic System

Unit 3 (Functional analysis): Interface analysis, requirement allocation, traceability, and use of commercial tools to enable effective application of SE principles in an integrated team environment. Examples from the context of a Robotic System.

Unit 4 (Modeling, simulation, and systems analysis): Modeling, simulation, and systems analysis enable analysis of alternatives in concept exploration.
Applying specialty-engineering disciplines by the system engineer throughout the product development life cycle, and the system life cycle. Gaining practical experience in the use of reliability, system safety and human factors engineering.
Examining risk management concepts, techniques, and tools and their utility in the concept exploration phase, as well as carry-over utility into the later phases of the product development life cycle. Examples from the context of a Robotic System

Unit 5 (Exploring the technical management responsibilities): Technical management responsibilities and functions of the systems engineer applicable to the entire system and product development life cycles.
Examining the later stages of the product development life cycle after Concept Development and understand how knowledge development continues through the phases: preliminary design, detailed design, integration and test, system validation, full rate production.

Unit 6 (Explore the ideas behind concurrent engineering): Explore the ideas behind concurrent engineering, design for six sigma and total quality development as they apply to the systems engineering roles, responsibilities, and the development of high-quality products in any market, industry or sector. Examples from the context of a Robotic System.

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3												3		
CO-2	3												3		
CO-3		3						2					3		2
CO-4	3	2											3		
CO-5	3	2											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		55
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		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	03	
6. Discussing Possible Innovations	02	
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. (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, 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**

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
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

a. Essential Reading

1. Class Notes

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2. Benjamin S. Blanchard and Wolter J. Fabrycky, 2006, Systems Engineering and Analysis, 5th ed., Prentice Hall International Series in Industrial and Systems Engineering, (Upper Saddle River, NJ),.ISBN-13: 978-0-13-221735-4

b. Recommended Reading

1. Altshuller, Genrich, Dana W. Clarke, Uri Fedozeev, and Steve Rodman. 40 Principles: TRIZ Keys to Innovation. Worcester, MA: Technical Innovation Center, Inc., 2005. ISBN: 9780964074057
2. Miller, John. QBQ! The Question Behind the Question: Practicing Personal Accountability at Work and in Life. East Rutherford, NJ: Putnam Publishing Group, 2004. ISBN: 9780399152337.

c. Magazines and Journals

1. IEEE IEEE Journals and papers

d. Websites

1. https://ocw.mit.edu/courses/engineering-systems-division/esd-33-systemsengineering-summer-2010/lecture-notes/

e. Other Electronic Resources

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

10. Course Organization

Course Code	ROE432A	
Course Title	Systems 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	23-Oct-2020	
Next Course Specifications Review Date	May 2024	

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*Course Specifications: **Data Analytics***

Course Title	Data Analytics
Course Code	CSE431A
Course Type	Professional Core Elective
Department	Mechanical and Manufacturing 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 application of Data Analytics in various application domains of computing is discussed. Knowledge Representation and modern Data Warehousing techniques and technologies are dealt in detail. Machine Learning and Data Mining methods are employed for Knowledge Discovery in textual and other forms of structured and unstructured data. Students are trained in the use of modern techniques and technologies to develop Data Analytics applications.

2. Course Size and Credits:

Number of Credits	04
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 and the 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, and Data 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 and Reporting: 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	3		
CO-5	2	1	3	2	2	2		1			1	2	3	2	2
CO-6	2	1	3	2	2	2		1			1	2	3	2	2
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		05
1. Demonstration using Videos	01	
2. Demonstration using Physical Models / Systems	00	

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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. (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, 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
CO-2	X				X

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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/yVlclRcAhxc
3. What can Business Analytics Do for You? http://youtu.be/uP89kaDU40c

10. Course Organization

Course Code	CSE431A		
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-2024	

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Course Specifications: Advanced Numerical Methods

Course Title	Advanced Numerical Methods
Course Code	MTE403A
Course Type	Professional Core Elective
Department	Mechanical and Manufacturing 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 elements methods to solve partial differential equations

4. Course Contents

Unit 1 (Linear Algebra): Eigenvalue computations. Power methods, Subspace iteration, Inverse iteration 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. (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, 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	MTE403A	
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-2024	

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Course Specifications: Optimization Techniques – 2

Course Title	Optimization Techniques – 2
Course Code	MTE402A
Course Type	Professional Core Elective
Department	Mechanical and Manufacturing 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	

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. (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, 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	MTE402A		
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-2024	

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Course Specifications: Project Work - 2

Course Title	Project Work -2
Course Code	ROP402A
Course Type	Project
Department	Mechanical and Manufacturing Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to give students an experience of identifying an engineering problem, conceptualize a solution, perform basic design calculations, model, solve, analyze and develop a prototype or 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 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	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	16
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. Recognize the need for developing a new or improving an existing engineering product/system through an organized survey of literature

CO-2. Define engineering design specifications.

CO-3. Design, model, solve analyze 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
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. (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 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
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	ROP402A		
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-2024		

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