RAMAIAH UNIVERSITY OF APPLIED SCIENCES

M S Ramaiah University of Applied Sciences

Program Structure and Course Details

of

B.Tech (Automotive Engineering) Degree Programme

Program Code: 013

Batch: 2022 – 2026

Department of Automotive and Aeronautical Engineering
Faculty of Engineering and Technology
M S Ramaiah University of Applied Sciences

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

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Bangalore - 560 054

Dean
Faculty of Engineering and Technology
M.S. Ramaiah University of Applied Sciences
Bangalore-560058

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

University's Vision, Mission and Objectives

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

Vision

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

Mission

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

Objectives

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

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Programme Specifications: B. Tech. (Automotive Engineering)

Faculty	Engineering and Technology
Department	Automotive and Aeronautical Engineering
Programme Code	013
Programme Name	B. Tech. (Automotive Engineering)
Dean of the Faculty	Prof. Dilip Kumar Mahanty
Head of the Department	Dr. A. T. Sriram

1. **Title of the Award:** B.Tech. (Automotive 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:** 1-July-2022
7. **Date of Programme Approval by the Academic Council of MSRUAS:** 26-Sep-2022
8. **Next Review Date:** June 2026
9. **Programme Approving Regulating Body and Date of Approval:** All India Council for Technical Education, New Delhi, 30-Jun-2020
10. **Programme Accredited Body and Date of Accreditation:** Not Applicable
11. **Grade Awarded by the Accreditation Body:** Not Applicable
12. **Programme Accreditation Validity:** Not Applicable
13. **Programme Benchmark:** Not Applicable
14. **Rationale for the Programme**

Automotive engineering is one of the specialized disciplines of engineering. Designing and manufacturing of automotive components and system have been there world over for many centuries. Automotive Engineering is a specialized discipline, critical to the success of many enterprises. It plays a key role in energy, transportation, development of infrastructure and manufacturing of automotive vehicles.

Presently, automotive engineers are contributing in research and development pertaining to environmental, bio-fuel fields, electric vehicle, use of machine learning and artificial intelligence towards development of autonomous vehicle. Automotive engineers are responsible for selection and processing of eco-friendly materials, fuels and processes, design and fabrication of automotive components and systems to improve the quality of transportation.

The automotive engineering programme at Faculty of Engineering and Technology at RUAS has been developed by the members of the faculty based on interactions with various universities and industries in India and abroad.

The curriculum is outcome based and helps students to develop critical thinking abilities and imbibe relevant practical skills for a smooth transition from academics to real-lifework 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 student admitted to the programme in automotive engineering is given a strong foundation in real-life problem solving which quite are with many institutions is 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 transferrable skills gained through systematic, flexible and rigorous learning in the chosen academic domain.

16. Graduate Attributes (GAs)

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

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

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

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

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

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

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

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

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

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

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

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

17. Programme Outcomes (POs)

B.Tech. graduates will be able to:

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

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

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

PO-4. Apply the knowledge of laboratory techniques and research methods to solve complex engineering problems through experimental investigations, analysis and interpretation of results

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

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

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

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

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

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

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

PO-12. Recognize and engage in lifelong learning to adapt to changing needs and advancements in technology

18. Programme Goal

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

19. Program Educational Objectives (PEOs)

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

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

PEO-2. To enable students to design and develop the 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 successful career in industries and to engage in lifelong learning

20. Programme Specific Outcomes (PSOs)

At the end of the B.Tech. (Automotive Engineering) program, the graduate will be able to:

PSO-1. Apply the knowledge in automotive domain including Automotive Systems, Vehicle Dynamics, Automotive Structures , Vehicle Aerodynamics , Materials, Electronic Control and safety systems, Product Design, Electric and Hybrid Vehicles, Autonomous Systems, NVH and Automotive advanced technologies to develop efficient solutions for complex problems in automotive engineering and allied areas

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

PSO-3. Demonstrate ethics, leadership qualities, communication, entrepreneurial skills and involvement in lifelong learning for betterment of organisation, 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	AUC202A	Materials Science for Engineers	3	0	0	3	100
3	AUC203A	Elements of Automotive Systems and Autonomous Vehicle	3	0	0	3	100
4	AUC204A	Thermodynamics for Engineers	3	1	0	4	100
5	AUC205A	Fluid Mechanics and Machines	3	1	0	4	100
6	AUL206A	Automotive Systems Laboratory	0	0	2	1	50
7	AUL207A	Fluid Mechanics and Machines Laboratory	0	0	2	1	50
8	BTN101A	Environmental Studies	2	0	0	2	50
		Total	**17**	**3**	**4**	**22**	**650**
		Total number of contact hours per week	**24**				

Semester 4							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	MTF202A	Engineering Mathematics - 4	3	1	0	4	100
2	AUC212A	Strength of Materials	3	1	0	4	100
3	AUC213A	Manufacturing Processes for Automotive Systems	4	0	0	4	100
4	AUC214A	3D Modeling and Machine Drawing	1	0	4	3	100
5	AUC215A	Automotive Electrical and Electronic Systems	3	0	0	3	100
6	AUL216A	Materials and Testing Laboratory	0	0	2	1	50
7	AUL217A	Manufacturing Processes Laboratory	0	0	2	1	50
8	BAU201A	Innovation and Entrepreneurship	3	0	0	3	100
		Total	**17**	**2**	**8**	**23**	**700**
		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	AUC301A	Propulsion Systems for Electric and Hybrid Vehicle	4	0	0	4	100
2	AUC302A	Theory of Machines	3	1	0	4	100
3	AUC303A	Design of Automotive Components	3	1	0	4	100
4	AUC304A	Automotive Noise, Vibration and harshness	3	0	0	3	100
5	AUC305A	Artificial Intelligence and Machine Learning	3	1	0	4	100
6	AUC306A	Control System Engineering and Laboratory	3	0	2	4	100
7	AUL307A	Automotive Powertrain Laboratory	0	0	2	1	50
8	AUL308A	Kinematics and Dynamics Simulation Laboratory	0	0	2	1	50
		Total	**19**	**3**	**6**	**25**	**600**
		Total number of contact hours per week	**28**				

Semester 6							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	AUC311A	Vehicle Body Engineering and Crashworthiness	4	0	0	4	100
2	AUC312A	Finite Element Analysis	3	1	0	4	100
3	AUC313A	Vehicle Dynamics and Handling	3	1	0	4	100
4	AUC314A	Computational Intelligence in Automotive Applications	4	0	0	4	100
5	AUC315A	Engineering Economics	3	0	0	3	100
5	AUL316A	Vehicle Simulations Laboratory	0	0	2	1	50
6	AUL317A	CAE Laboratory	0	0	2	1	50
7	ASS311A	Seminar	0	0	2	1	50
8	AUE31XA	Professional Core Elective - 1	4	0	0	4	100
		Total	**21**	**2**	**6**	**26**	**750**
		Total number of contact hours per week	**29**				

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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	AUE41XA	Professional Core Elective - 2	4	0	0	4	100
2	AUE42XA	Professional Core Elective - 3	4	0	0	4	100
3	OEE41XA	Open Elective - 1	3	0	0	3	100
4	AUP401A AUI401A	I] Project Work - 1 II]Internship	0	0	12	6	200
		Total	**11**	**0**	**12**	**17**	**500**
		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	AUP402A	Project Work - 2	0	0	24	12	300
		Total	**0**	**0**	**24**	**12**	**300**
		Total Number of Contact Hours per week	**24**				

Professional Core Electives (PCE):						
	Stream ▸ Group ←	AI and ML for Autonomous Vehicles	Control Systems	Automotive Systems	Data Sciences and Analytics	Applied Mathematics
PCE-1 Sem. 6	Course Code	AUE311A	AUE312A	AAE313A/MEE314A	MTE401A	MTE02A
	Course Title	Autonomous Vehicles and Future Mobility	Automotive Control Systems	Light Weight and Novel Materials/ Additive Manufacturing	Probability and Statistics	Advanced Mathematics
PCE-2 Sem. 7	Course Code	AUE411A	AUE412A	AUE413A	CSE411A	MTE401A
	Course Title	Sensing and Control for Autonomous Vehicles	Robust Control Systems	Vehicle Aerodynamics and Styling	Data Sciences and Foundation	Optimization Techniques -1
PCE-3 Sem.7	Course Code	AUE421A	AUE422A	AUE423A	CSE431A	MTE403A/ MTE402A
	Course Title	Battery Management Algorithm for Electric Vehicle	Modelling, Dynamics and Control of Electrified Vehicles	Fatigue and Fracture Mechanics	Data Analytics	Advanced Numerical Methods/ Optimization Techniques -2

Note:

1. Students are required to select **One** Professional Core Elective Course in the 6th Semester, from PCE-1 Group.

2. Students are required to select **Two** Professional Core Elective Courses in the 7th Semester from the PCE-2 & PCE-3 Groups.

22. Open Elective Courses

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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.
Marks obtained CE and SEE components have a weightage of 60:40 (CE: 60% and SEE: 40%) in determining the final marks obtained by a student in a Course.

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

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25.2. Continuous Evaluation Policies

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

25.2.1 Theory Courses

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1			
CO-2			
CO-3			
CO-4			
CO-5			
CO-6			
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

- CE components should have a mix of term tests, quiz and assignments
- Two Tests (15 each), Two Assignments (20 marks). (One written and another to be MCQs)
- Course leaders to declare the assessment components before the commencement of the session and get approval from HoD and Dean

25.2.2 Laboratory Course

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

For Laboratory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Conduct of Experiments	Laboratory Report + Viva	Laboratory SEE
CO-1			
CO-2			
CO-3			
CO-4			
CO-5			
CO-6			
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document			

The subcomponents can be of any of the following types:

a) Laboratory / Clinical Work Record
b) Experiments
c) Computer Simulations
d) Creative Submission

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e) Virtual Labs
f) Viva / Oral Exam
g) Lab Manual Report
h) Any other (e.g. combinations)

Course leaders to declare the assessment components before the commencement of the session and get approval from HoD and Dean

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:

For Combined Courses (Theory + Laboratory)					
Focus of COs on each Component or Subcomponent of Evaluation					
Course Outcome	CE (Weightage: 60 %) Four components including one Lab component			SEE (Weightage: 25 %)	Lab (Weightage: 15 %)
	Tests (30 %)	Written Assignments+ Lab (20 %)	Assignment +Lab CE (10%)	Written exam	LSEE: SEE
CO-1					
CO-2					
CO-3					
CO-4					
CO-5					
CO-6					
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.					

- CE components should have a mix of term tests, quiz and assignments
- Two Tests (15 each), Two Assignments (20 marks). (One written and another to be MCQs)
- In case of courses where laboratory is combined with theory, laboratory components to be assessed in both CE and SEE
- Course leaders to declare the assessment components before the commencement of the session and get approval from HoD and Dean

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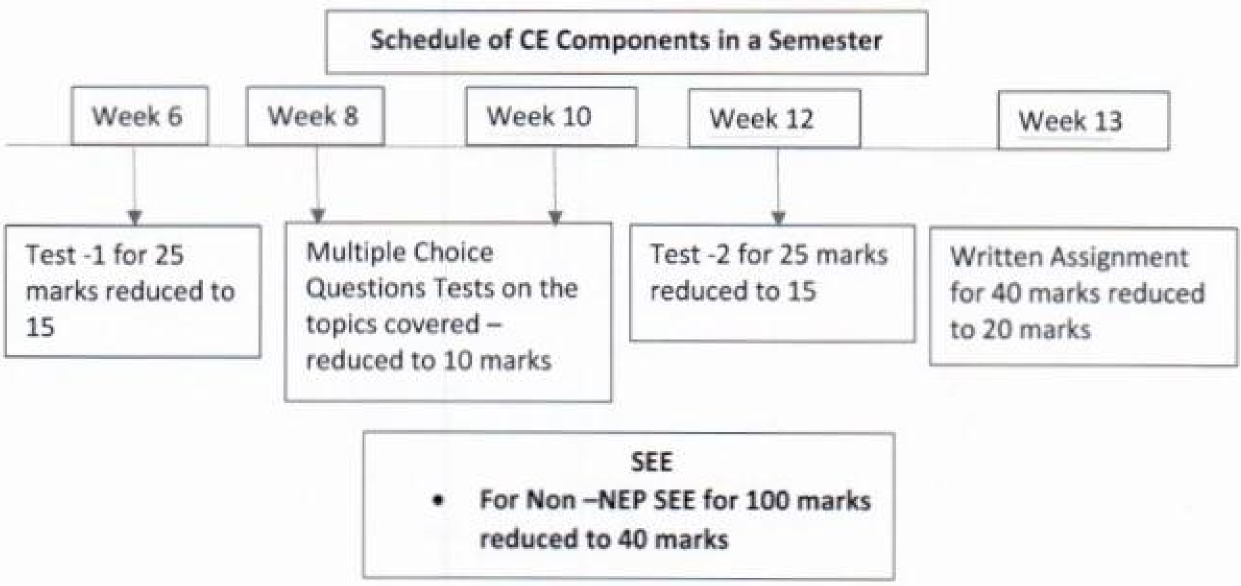
25.2.4 Ability Enhancement courses

For AECC Only		
Focus of COs on each Component or Subcomponent of Evaluation		
	Component 1: CE (60% Weightage)	Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests or Assignments	
CO-1		
CO-2		
CO-3		
CO-4		
CO-5		
CO-6		
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.		

- Course leaders to declare the assessment components before the commencement of the session and get approval from HoD and Dean



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

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27. Student Support for Learning

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

28. Quality Control Measures

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

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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						2			3	3	2
1	Engineering Physics and Laboratory	3	3	3	3	1	1	2		1	2			3	3	2
1	Engineering Mechanics	3	3	3										3		
1	Elements of Electronics Engineering and Laboratory	3	3			3					3			3	3	3
1	Engineering Drawing	3	2			2					1			3	2	1
1	Constitution, Human Rights and Law	2	2	3				3						3	3	
2	Engineering Mathematics -2	3	3	2	2	2					1			3	2	1
2	Engineering Chemistry and Laboratory	3	3	3	3		3	3		1	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	Material Science for Engineers	3	3	3			1	2	1	1	1			3	2	1
3	Elements of Automotive Systems and Autonomous Vehicle	3	3	3	2	2	1	1			1			3	2	1
3	Thermodynamics for Engineers	3	3		3		2		3	2	2			3	3	3
3	Fluid Mechanics and Machines	3	3	2	3	2	1	2	1	2	1	1	1	3	3	2
3	Automotive Systems Laboratory	3	3		3						1			3	3	1
3	Fluid Mechanics and Machines Laboratory	3	3		3		2		3	2	2			3	3	3
3	Environmental Studies	1					3		1					1	3	1
4	Engineering Mathematics - 4	3	3	2		2				1	1			3	2	1
4	Strength of Materials	3	3	3	2	3	2	3	1	2	2	2	2	3	3	2
4	Manufacturing Processes for Automotive Systems	3	3	3	1		1	1	2		1	1		3	1	2
4	3D Modeling and Machine Drawing	3	3	3	2	2					2			3	2	2
4	Automotive Electrical and Electronic Systems	3	3	3			2	2	1		1		1	3	2	1
4	Materials and Testing Laboratory	3	3		3		2		3	2	2			3	3	3
4	Manufacturing Processes Laboratory	3	3	3	3	3	3	2	2	2	1	1	2	3	3	2
4	Innovation and Entrepreneurship	1		1			1				1	3	1	1	3	2
5	Propulsion Systems for Electric and Hybrid Vehicle	3	3	3		2		2			1			3	2	1

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	Theory of Machines	3	3	3	1	3	2	2		2	2	3	2	3	3	3
5	Design of Automotive Components	3	3	3			3	3	2	2				3	3	3
5	Automotive Noise, Vibrations and Harshness	3	3	3	3	2			2	2				3	3	2
5	Artificial Intelligence and Machine Learning	3	3	3	1	3	2	2				1	1	3	3	1
5	Control System Engineering and Laboratory	3	3	3		2								3	2	
5	Automotive Powertrain Laboratory	3	3		3		2		3	2	2			3	3	3
5	Kinematics and Dynamics Simulation Laboratory	3	3	3	3	3		2			3	2	2	3	3	3
6	Vehicle Body Engineering and Crashworthiness	3	3	3			3							3	3	
6	Finite Element Analysis	3	3	3		3					1			3	3	1
6	Vehicle Dynamics and Handling	3	3	3	3	2	3	3	1	2	3	2	3	3	3	3
6	Computational Intelligence in Automotive Applications	3	3	3										3		
6	Engineering Economics	3	2			1					1	3	1	1		2
6	Vehicle Simulations Laboratory	3	3	3	3	3	2	3	2	2	3	3		3	3	3
6	CAE Laboratory	3	3	3		3					3			3	3	3
6	Seminar	3	3	3	2	2			2	2	3	1	1	3	2	3
6	Autonomous Vehicles and Future Mobility	3	3	3			2	2	2		2	1	1	3	2	2
6	Automotive Control Systems	3	3	1										3		
6	Light Weight and Novel Materials	3	3	3	2		1	1	1		1			3	2	1
6	Additive Manufacturing	3	3	3							1	1	1	3	3	1
6	Probability and Statistics	3	3	2	2						2			3	2	2
6	Advanced Mathematics	3	3	2	3						2			3	3	2
7	Sensing and Control for Autonomous Vehicles	3	3	1										3	2	
7	Robust Control Systems	3	3	1										3		
7	Vehicle Aerodynamics and Styling	3	3	3			3	3	3		3	2	2	3	3	3
7	Data Sciences and Foundation	2	1	3	2	2	2		1			1	2	3	2	2
7	Optimization Technqiues-1	3	3	3			1				2			3	1	2
7	Battery Management Algorithm for Electric Vehicle	3	3	3										3		
7	Modeling, Dynamics and Control of Electrified Vehicles	3	3	3			3	2					2	3	3	
7	Fatigue and Fracture Mechanics	3	3	1										3		
7	Data Analytics	2	1	3	2	2	2		1			1	2	3	2	2
7	Advanced Numerical Methods	3	3	2	2	2					2			3	2	2
7	Optimization Techniques-2	3	3	3			1					2		3	1	2
7	Project Work-1	3	3	3	3	3	3	2	1	3	3	3		3	3	3
7	Internship	3	3	3	3	3			2	2	3	2	2	3	3	3
8	Project Work-2	3	3	3	3	3	3	2	1	3	3	3		3	3	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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RAMAIAH UNIVERSITY OF APPLIED SCIENCES

Course Specifications

B.Tech. (Automotive Engineering) Degree Programme

Programme Code: 013

Faculty of Engineering and Technology

Batch 2022-202

Medha. 4/20

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

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.

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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	
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.

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

8. Achieving COs

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

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

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9. **Course Resources**

a. **Essential Reading**

1. 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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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
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

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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

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 functio

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.

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

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

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

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		02
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems		
3. Demonstration on a Computer		
Numeracy		13
1. Solving Numerical Problems	13	
Practical Work		30
1. Course Laboratory	30	
2. Computer Laboratory		
3. Engineering Workshop / Course Workshop / Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		00
1. Case Study Presentation		
2. Guest Lecture		
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions		
6. Discussing Possible Innovations		
Term Tests, Written Examination		10
Total Duration in Hours		85

7. Course Assessment and Reassessment

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The details of the components and subcomponents of course assessment 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.

For Combined Courses (Theory + Laboratory)					
Focus of COs on each Component or Subcomponent of Evaluation					
Course Outcome	CE (Weightage: 60 %) Four components including one Lab component			SEE (Weightage: 25 %)	Lab (Weightage: 15 %)
	Tests (30 %)	Written Assignments+ Lab (20 %)	Assignment +Lab CE (10%)	Written exam	LSEE: SEE
CO-1	x			x	
CO-2	x			x	
CO-3	x	x		x	
CO-4		x	x	x	
CO-5		X	x	x	x
CO-6					
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8 Achieving COs

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

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

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14.	Personal Management	Assignment, examination
15.	Leadership Skills	Effective management of learning, time management, achieving the learning

9. Course Resources

a. Essential Reading

1. Class Notes
2. Rajendran, V. (2011) Engineering Physics, TMH
3. Srinivasan M. R. (2011) Physics for Engineers, 3rd Ed, New Age International
4. Gyan Prakash, (2012) Experimental Physics,
5. Michael Sayer, Abhai Mansingh, (1999) Measurement, Instrumentation and Experiment Design in Physics and Engineering, PHI

b. Recommended Reading

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

c. Magazines and Journals

d. Websites

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

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

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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, centre of gravity for the structural members
CO-4. Apply the laws of statics and dynamics for the equilibrium analysis of rigid bodies with and without friction
CO-5. Apply energy methods in analyzing of static and dynamic aspects of engineering structures made of rigid bodies

4. Course Contents

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

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Bangalore-560054

Equivalent force - couple system; Resolution of forces, composition of forces; Numerical problems on moment of forces and couples, equivalent force and couples.

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

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

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

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

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

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

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

4/20

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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		0
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	30	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

7. Course Assessment and Reassessment

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

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

9. Course Resources

a. Essential Reading

1. Class notes
2. Satheesh Gopi (2010), Basic Civil Engineering, Dorling Kindersley (India) Pvt Ltd
3. R K Rajput (2011), A Text Book of Applied Mechanics, 3rd Edn, Laxmi Publications
4. Richard H. McCuen, Edna Z. Ezzell (2011), "Fundamentals of Civil Engineering: An Introduction to the ASCE Body of Knowledge", CRC press

b. Recommended Reading

1. S. S. Bhavikatti, K. G. Rajashekarappa (2004), Engineering Mechanics, New Age International
2. C. Lakshamanarao, J. Lakshinarashiman, Raju Sethuraman, Srinivasan M. Sivakumar (1993), Engineering Mechanics: Statics and Dynamics, PHI, New Delhi

c. Magazines and Journals

d. Websites

e. Other Electronic Resources

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

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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 analyse operation of standard analog / digital circuits for a given application
CO-5. Conduct experiments as per the standard procedures and tabulate/calculate/plot the measured values
CO-6. Interpret and compare with standard results, and draw conclusions and Write report as per the prescribed format

4. Course Contents

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

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

Unit 3 (Amplifiers): Differential amplifiers and their transfer characteristics, IC Op-Amps, their ideal and practical characteristics, Op-Amp in different modes as inverting amplifier, 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)		
	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															

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6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		33
Demonstrations		02
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		10
1. Solving Numerical Problems	10	
Practical Work		30
1. Course Laboratory	30	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**85**

7. Course Assessment and Reassessment

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

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3 and LSC4), COs are assessed as illustrated in the following Table.

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For Combined Courses (Theory + Laboratory)					
Focus of COs on each Component or Subcomponent of Evaluation					
Course Outcome	CE (Weightage: 60 %) Four components including one Lab component			SEE (Weightage: 25 %)	Lab (Weightage: 15 %)
	Tests (30 %)	Written Assignments+ Lab (20 %)	Assignment +Lab CE (10%)	Written exam	LSEE: SEE
CO-1	x			x	
CO-2	x			x	
CO-3	x	x		x	
CO-4		x		x	
CO-5			x	x	x
CO-6	x			x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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9. Course Resources

a. Essential Reading

1. Class Notes
2. Millman and Halkias, 2001, Integrated Electronics, Tata McGraw-Hill Education
3. Robert Boylestad and Louis Nashelsky, Electronic Devices and Circuit Theory, 7th Ed. Prentice Hall
4. Dale R. Patrick, 1989, Electricity and Electronics Laboratory, The Goodheart-willcox 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
3. Digital trainer kit
4. Discrete electronic components

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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

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

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

7. Course Assessment and Reassessment

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

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		**Component 2: SEE (40% Weightage)**
Subcomponent Type ▶	**Terms Tests**	**Assignments**	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
CO-6		x	x

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

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

b. Recommended Reading

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

c. Magazines and Journals

d. Websites

1. http://nptel.ac.in

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e. **Other Electronic Resources**

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

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.

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															

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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		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.

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		**Component 2: SEE (40% Weightage)**
Subcomponent Type ▶	**Terms Tests**	**Assignments**	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x

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

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

8. Achieving COs

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

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

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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

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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

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

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

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7. Course Assessment and Reassessment

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

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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9. **Course Resources**

a. **Essential Reading**

5. Glyn James, 2016, Advanced Modern Engineering Mathematics, 4th edition, Pearson Dennis Zill, 2012,
6. A First Course in Differential Equations, 10th edition, Massachusetts, Brooks/Cole
7. Shepley Ross, 2007, Introduction to Ordinary Differential Equations, 4th edition, New York, John Wiley & sons

b. **Recommended Reading**

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

c. **Magazines and Journals**

d. **Websites**

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

e. **Other Electronic Resources**

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

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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 – electroless plating, thermosetting – thermoplastic polymers and dry corrosion - wet corrosion

CO-3. Discuss the reaction chemistry and stoichiometry of combustion of fuels, remedial measures to control oxides of nitrogen, sulphur and carbon, polymerization – methods, mechanism, preparation, properties and applications of some polymers, concepts of nano science and nanotechnology

CO-4. Identify the types of corrosion and methods to prevent corrosion, suitable polymers and nanocomposite materials for engineering applications

CO-5. Derive kinetic rate equations for various chemical systems and equation for electromotive force

CO-6. Analyze the suitability of polymers & composites for various applications and solve problems related to storage devices, chemical kinetics, electro chemistry, corrosion and metal finishing

CO-7. Plan the experimental set up, conduct experiments, calculate and plot the graphs to obtain results, and write a laboratory report as per the prescribed format

4. **Course Contents**

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

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

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

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

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

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

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

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

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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															

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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		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.

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For Combined Courses (Theory + Laboratory)					
Focus of COs on each Component or Subcomponent of Evaluation					
Course Outcome	CE (Weightage: 60 %) Four components including one Lab component			SEE (Weightage: 25 %)	Lab (Weightage: 15 %)
	Tests (30 %)	Written Assignments+ Lab (20 %)	Assignment +Lab CE (10%)	Written exam	LSEE: SEE
CO-1	x			x	
CO-2	x			x	
CO-3	x			x	
CO-4	x	x		x	
CO-5		x		x	
CO-6			x	x	
CO-7			x	x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.					

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

8. Achieving COs

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

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

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9. **Course Resources**

a. **Essential Reading**

1. Class Notes
2. Gadag, R.V. and Nityananda Shetty A., (2010), Engineering Chemistry, Second Edition, New Delhi, I.K. International Publishing House
3. O.G. Palanna, (2011), Engineering Chemistry, New Delhi, Tata McGraw Hill Education Pvt Ltd.
4. Gurudeep Raj, (2014), Advanced Physical Chemistry, Meerut-Uttar Pradesh, Krishnan Prakashana
5. Pradeep. T, (2012) "A Text Book of Nanoscience and Nanotechnology", New Delhi, Tata McGraw Hill Company Ltd.

b. **Recommended Reading**

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

c. **Magazines and Journals**

d. **Websites**

e. **Other Electronic Resources**

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

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Course Specifications: Elements of Mechanical Engineering and Workshop Practice

Course Title	Elements of Mechanical Engineering and Workshop Practice
Course Code	MEF104A
Course Type	Core Theory
Department	Applicable to all Programmes
Faculty	Engineering and Technology

1. Course Summary

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

2. Course Size and Credits

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

3. Course Outcomes (COs)

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

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

4. Course Contents

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

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

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Bangalore-560058

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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		
CO-4		3											3		
CO-5		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		40
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		20
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	30	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

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

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

1. Class Notes
2. 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

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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

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Course Specifications: Elements of Electrical Engineering and Laboratory

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

1. Course Summary

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

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:1
Total Hours of Interaction	75
Number of Weeks in a Semester	15
Department Responsible	Electrical Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. State and explain various laws of electric circuits, magnetic circuits and their significance, phasor diagrams for electrical elements

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

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

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

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

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

4. Course Contents

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

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

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

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

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

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

Unit 7 (Laboratory): List of Experiments

No.	Course Content for Laboratory
1	Verification of KVL and KCL for DC circuits
2	Verification of superposition theorem
3	Verification of Thevnin'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

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															

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6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	30	
Practical Work		30
1. Course Laboratory	20	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**85**

7. Course Assessment and Reassessment

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

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3 and LSC4), COs are assessed as illustrated in the following Table.

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For Combined Courses (Theory + Laboratory)					
Focus of COs on each Component or Subcomponent of Evaluation					
Course Outcome	CE (Weightage: 60 %) Four components including one Lab component			SEE (Weightage: 25 %)	Lab (Weightage: 15 %)
	Tests (30 %)	Written Assignments+ Lab (20 %)	Assignment +Lab CE (10%)	Written exam	LSEE: SEE
CO-1	x			x	
CO-2	x			x	
CO-3	x	x		x	
CO-4		x		x	
CO-5			x	x	x
CO-6	x	x	x	x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of 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. 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

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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															

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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		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.

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For Combined Courses (Theory + Laboratory)					
Focus of COs on each Component or Subcomponent of Evaluation					
Course Outcome	CE (Weightage: 60 %) Four components including one Lab component			SEE (Weightage: 25 %)	Lab (Weightage: 15 %)
	Tests (30 %)	Written Assignments+ Lab (20 %)	Assignment +Lab CE (10%)	Written exam	LSEE: SEE
CO-1	x			x	
CO-2	x			x	
CO-3	x	x		x	
CO-4			x	x	x
CO-5		x	x	x	x
CO-6		x	x	x	x

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

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of 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. Dromey, R. G., 1982, How to Solve It by Computer, New Delhi: Pearson Education.

b. Recommended Reading

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

c. Magazines and Journals

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

d. Websites

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

e. Other Electronic Resources

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

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		26-Sep-2022	
Next Course Specifications Review Date		June-2026	

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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

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															

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6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		20
Demonstrations		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		04
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	04	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		06
1. Case Study Presentation	02	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	02	
5. Group Discussions	02	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**40**

7. Course Assessment and Reassessment

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

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2), COs are assessed as illustrated in the following Table.
Focus of CO's on each Component or Subcomponent of Evaluation:

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		**Component 2: SEE (40% Weightage)**
Subcomponent Type ▶	**Terms Tests**	**Assignments**	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x

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Bangalore-560054

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

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

8. Achieving COs

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

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

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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

e. **Other Electronic Resources**

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

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Course Specifications: Engineering Mathematics - 3

Course Title	Engineering Mathematics - 3
Course Code	MTF201A
Course Type	Core Theory
Department	Automotive and Aeronautical 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

Registrar
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Bangalore-560058

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4. Course Contents

Unit 1 (Fourier Series and Fourier Transform): Periodic functions, Dirichlet's conditions for convergence of Fourier series, Fourier series for a periodic function of period T, half range 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															

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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		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		15
1. Course Laboratory		
2. Computer Laboratory	15	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

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

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

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Bangalore-560054

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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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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Course Specifications: Materials Science for Engineers

Course Title	Materials Science for Engineers
Course Code	AAC202A
Course Type	Core Theory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with introduction to engineering materials, their properties and applications. The students will develop an understanding of structure of metals, ceramics, polymers and composites. Students will be exposed to concepts of diffusion, strengthening mechanisms, characterization techniques, physical and mechanical properties of engineering materials like strength, hardness, fatigue, creep, corrosion etc. Application of phase diagrams, TTT diagrams and heat treatment methods in materials will be discussed.

2. Course Size and Credits:

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

3. Course Outcomes (COs)

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

CO-1. Explain different types of diffusion mechanisms, engineering materials and its properties.

CO-2. Describe phase diagrams and heat treatment processes of metals.

CO-3. Identify the different types of strengthening mechanisms and compositions in metals and alloys.

CO-4. Discuss the various types of defects in material and relate it to the material behavior.

CO-5. Assess the different properties of materials and characterization techniques.

CO-6. Analyse different methods for improving the properties of materials for specific requirements and applications

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4. Course Contents

Unit 1 (Introduction and Classification of materials): Automotive Materials, Advanced Materials, Future materials, Diffusion mechanisms, Steady and non-steady state diffusion, Factors that influence diffusion, Applications., Types of metals and alloys, Ferrous alloys – low carbon steels, medium carbon steels, high carbon steels, stainless steels, gray cast iron, ductile iron, white and malleable cast iron; Nonferrous alloys – aluminium alloys, copper alloys, magnesium alloys, zinc alloys, titanium, Superalloys.

Unit 2 (Strengthening Mechanisms and Phase Diagrams): Mechanisms of strengthening in metals, Recovery, recrystallization and grain growth; Equilibrium phase diagrams, Particle strengthening by precipitation, Iron-Iron carbide system, Phase transformations, Transformation rate effects and TTT diagrams, Microstructure and property changes in iron-carbon system.

Unit 3 (Heat Treatment): Annealing Processes, stress relief, normalising, hardening, tempering, austempering, surface hardening like case hardening, carburising, cyaniding, nitriding, induction hardening, hardenability, Jominy end-quench test, Precipitation hardening.

Unit 4 (Nonmetallic Materials): Ceramics: Ceramic Structures. Mechanical properties. Types and applications (optical and electrical) of ceramics; Polymers: Polymer types, Mechanical behaviour of polymers, Polymer applications and processing (injection moulding, extrusion, compression moulding) Composites - Classification and Types of composites. Properties, Processing and their Applications.

Unit 5: (Properties of Materials): Mechanical Properties of Metals: Elastic deformation, Plastic deformation, Interpretation of tensile stress-strain curves, Yield criteria and macroscopic aspects of plastic deformation, torsion tests; Concept of hardness tests: Introduction, Types of testing - Rockwell, Brinell and Vickers test; Fatigue and Fracture, SN curves, Ductile and brittle fracture, Impact fracture, Ductile brittle transition; Creep: Generalized creep behaviour, Stress and temperature effects

Unit 6: (Characterization Techniques and Corrosion of metals): Metallographic microscope, Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), X-ray diffraction (XRD); Electrochemical corrosion, passivity, prediction of corrosion, forms of corrosion, Prevention of corrosion – cathodic protection, coatings, corrosion prevention by alloying.

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	0	0
CO-2	3	3	2										3	0	0
CO-3	3	3											3	0	0
CO-4	3		3			1	1	1	1	1			3	1	1
CO-5	3	3	2			1							3	1	
CO-6	3	3	3				2		1	1			3	2	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		35
Demonstrations		05
1. Demonstration using Videos	05	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		0
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. (Aerospace Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

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For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4	x	x	x
CO-5		x	x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
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. W. D. Callister, 2010, Materials Science and Engineering: An Introduction, 8th Edition, Wiley Publications

b. Recommended Reading

1. H. Van Vlack, 2002, Elements of Materials Science and Engineering, 6th Edition, Addison-Wesley
2. V. Raghavan, 2004, Materials Science and Engineering: A First Course, 5th Edition, PHI
3. Donald R. Askeland, 2011, The Science and Engineering of Materials, 6th Edition, Chapman and Hall

c. Magazines and Journals

1. Materials Science and Engineering: A, B, C & R, Elsevier
2. Materials Research Bulletin
3. Journal of Materials Science, Springer
4. Materials Today Magazine

d. Websites

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

e. Other Electronic Resources

1. NPTEL Videos and Digital Library

Registrar
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Bangalore - 560 054

Dean
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Bangalore - 560058

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Course Specifications: Elements of Automotive Systems and Autonomous Vehicle

Course Title	Elements of Automotive Systems and Autonomous Vehicle
Course Code	AUC203A
Course Type	Core Theory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with automotive component, sub systems, autonomous vehicle systems and technologies. Students are taught to identify, understand functional requirements and functions of automotive components and systems such as engine, transmission, drive line, suspension, and chassis systems. Students will be able to identify and explain the function of automotive components and their subsystems.

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	Automotive and Aeronautical 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 need, functional requirements of automotive systems, types of layout, dimensions and safety systems in a vehicle.

CO-2. Explain construction and working principle of automotive engines, engine accessories and transmission systems.

CO-3. Explain the working of driveline, chassis systems and their components.

CO-4. Discuss the electrical and electronics systems and their applications.

CO-5. Discuss the importance and requirements of safety systems.

CO-6. Discuss and suggest the appropriate technologies required for a given application.

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

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

Dean - Academics
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4. Course Contents

Unit 1 (Introduction): Significance of course, Automotive Industry in India and abroad, Introduction to Vehicle systems and overview of autonomous vehicle, EV & HEV, Vehicle Layouts, Vehicle Dimensions, Chassis Types, Body Styles and Classification.

Unit 2 (Automotive Power Plants): Construction and working of Gasoline Engines, Diesel Engines, Fuel System, Intake System, Exhaust Systems, Cooling System and Lubrication System.

Unit 3 (Accessories): Introduction to Starting System, Charging System, Lighting System, Comfort and Convenience Systems.

Unit 4 (Driveline and Chassis) : Construction and working of Coupling Devices – Clutch & Torque Converter, Transmission Systems – Manual, Automatic and Automated Manual, Final Drive: Differential &Transaxle, Transfer case, Drive Shafts, U Joints & C V Joints, Wheels and Tyres.
Chassis Systems (Running):
Front Axle and Rear Axle Suspension System: Steering System: Rack & Pinion, Pitman Arm, Power Assisted Steering, Wheel geometry, Braking System: Service & Parking Brakes, Disc and Drum Brakes.

Unit 5 (Safety Systems): Introduction to Active and Passive Safety Systems such as ABS, TCS, ESP, Seat Belt, Airbags and Head Restraints.

Unit 6 (Autonomous Vehicle): Introduction to autonomous Vehicle, systems layout, components, advantages and limitations.

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

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

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Bangalore-560054

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		35
Demonstrations		05
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	03	
Numeracy		0
1. Solving Numerical Problems	0	
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. (Automotive Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

Registrar
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Bangalore - 560 054

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Bangalore-560058

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Bangalore-560054

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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Bangalore - 560 054

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Faculty of Engineering and Technology
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Bangalore 560058

Dean - Academics
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Bangalore-560054

9. Course Resources

a. **Essential Reading**

1. Course notes
2. Jack Erjavec, Rob Thompson, 2015, Automotive Technology: A System Approach, USA, Cengage Learning.

b. **Recommended Reading**

1. Halderman, James D; Mitchell, Chase D.,1999, Automotive Technology: Principles, Diagnosis and Service, 2nd Edition, USA: Prentice Hall
2. Robert Bosch GmbH, 2014, Automotive Hand Book, 9th edition, SAE
3. Hanky Sjafrie, 2019, Introduction to Self-Driving technology, CRC Press ,

c. **Magazines and Journals**

1. Automotive Engineering - SAE International
2. SAE Journals
3. OVERDRIVE
4. Auto Car India
5. Auto Today

d. **Websites**

1. https://www.SAE.org/
2. http://auto.howstuffworks.com/automobile.htm
3. https://www.youtube.com/channels/automotive
4. http://nptel.ac.in/

e. **Other Electronic Resources**

1. NPTEL Videos and Digital Library

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Course Specifications: Thermodynamics for Engineers

Course Title	Thermodynamics for Engineers
Course Code	AAC204A
Course Type	Core Theory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course intends to impart the knowledge of principles of classical thermodynamics. In this course, students are taught macroscopic and microscopic approach to thermodynamic systems and concept of thermodynamic equilibrium. Zeroth, first, second and third law of thermodynamics and their application for energy conversion are taught. Students will be able to differentiate between availability and available energy for energy conversion, identify different thermodynamic processes and relate their properties to estimate the work and heat interaction.

2. Course Size and Credits:

Number of Credits	4
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Automotive and Aeronautical 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 thermodynamic processes, laws, concepts of heat, work, and energy
CO 2. Derive and apply the laws of thermodynamics to thermodynamic systems
CO 3. Explain the merits, limitations and equivalence of laws of thermodynamics
CO 4. Compute the parameters for thermodynamics processes and systems
CO 5. Analyze thermodynamic cycles, mixture of gases using thermodynamic relations and draw conclusions
CO 6. Solve complex thermodynamic problems using various thermodynamic relations

4. Course Contents

Unit 1: Fundamental concepts: Overview of thermodynamics and its scope; continuum, microscopic and macroscopic approaches; thermodynamic systems (closed and open); thermodynamic properties and equilibrium, thermodynamic state diagrams, path and processes; zeroth law of thermodynamics, concept of temperature, temperature scales; concepts of heat and work, different modes of work.

Unit 2: First law of Thermodynamics: Concept of energy, various form of energy; internal energy, specific heat, enthalpy; first law of thermodynamics applied to elementary processes, closed system and control volumes, Steady Flow Energy Equation (SFEE) and its applications.

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Bangalore - 560 054

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Bangalore-560054

Unit 3: Second Law of Thermodynamics: Limitations of first law, concepts of heat engines and reversed heat engines, Kelvin-Planck and Clausius statements and their equivalence; reversible and irreversible processes; Carnot cycle, principles and theorems; thermodynamic temperature scale; Clausius inequality and concept of entropy; microscopic interpretation of entropy, principle of increase of entropy, T-s diagrams; second law analysis of control volume; availability and irreversibility; third law of thermodynamics. Properties of Pure Substances:

Unit 4: Thermodynamic properties of pure substances in solid, liquid and vapor phases; P-v-T behavior of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, ideal gas equation of state and van der Waals equation of state; law of corresponding states, compressibility factor and generalized compressibility chart.

Unit 5: Thermodynamic Cycles: Carnot cycle, ideal Rankine cycle, Rankine reheat and regenerative cycles, Otto cycle, air-standard Diesel cycle, dual cycle, Brayton cycle, vapor-compression refrigeration cycle.

Unit 6: Ideal Gas Mixtures: Dalton's and Amagat's laws, properties of ideal gas mixtures, air-water vapor mixtures and simple thermodynamic processes involving them; specific and relative humidity, dew point and wet bulb temperature, adiabatic saturation temperature, psychrometric chart.

Unit 7: Thermodynamic Relations: T-ds relations, Helmholtz and Gibbs functions, Gibbs relations, Maxwell relations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibility, Clapeyron and Clausius -Clapeyron equations.

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

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Bangalore-560058

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		2
1. Demonstration using Videos	0	
2. Demonstration using Physical Models / Systems	02	
3. Demonstration on a Computer	0	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		0
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		03
1. Case Study Presentation	02	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	01	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

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

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and 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	Assignments, Laboratory Demonstrations
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Class Room Interaction
13.	Information Management	Assignments, Examination
14.	Personal Management	Assignments
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. Nag, P .K, 2002, Basic and Applied Thermodynamics, 3rd Edition, Tata McGraw Hill

b. Recommended Reading

1. Roy, B. N, 2001, Fundamentals of Classical Statistical Thermodynamics, London, John Wiley.
2. Eastop, T.D. & McConkey. A, 2006, Applied Thermodynamics for Engineering Technologies, New Delhi, Pearson.
3. Sonntag. R. E, 2003, Fundamentals of Thermodynamics, John Wiley.
4. Nashcnokin, V. V, 1979, Engineering Thermodynamics and Heat Transfer, Moscow, MIR.
5. Cenegal Y.A. and Boles M.A, 2004, Thermodynamics an Engineering Approach, Tata McGraw Hill.
6. Van Wylen, G.J. and Sonntag, R.E, 2001, Fundamental of Classical Thermodynamics, Wiley Eastern
7. Moran, M. J. & Shapiro, H. N, 2006, Fundamentals of Engineering Thermodynamics, USA, John Wiley & Sons Inc.

c. Magazines and Journals

1. International Journal for Thermodynamics

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d. **Websites**
   1. www.nptel.ac.in

e. **Other Electronic Resources**
   1. NPTEL Videos and Digital Library

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Course Specifications: Fluid Mechanics and Machines

Course Title	Fluid Mechanics and Machines
Course Code	AAC205A
Course Type	Core Theory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This subject deals with the principles of fluid mechanics and machines. This subject facilitates the students to understand fluid properties and classify fluid flows and hydraulic machines. Basics of hydrostatics, kinematics and dynamics of fluid flow will be taught. Students are trained to use the principles of dimensional analysis to infer the non-dimensional parameters involved in a flow problem. Students will be able to solve practical fluid flow problems in flow through ducts, flow meters and hydraulic machines.

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	Automotive and Aeronautical Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Describe different types of fluid flows, fluid machines and principle of dimensional homogeneity

CO-2. Derive important fluid mechanics relations, governing equations, Bernoulli's equation, Euler equation and Euler turbine equation

CO-3. Explain the working principle of flow meters and fluid machines using the appropriate governing equations

CO-4. Apply Buckingham π-theorem for problems in fluid mechanics and fluid machines

CO-5. Solve practical fluid flow problems like flow through ducts/pipes, flow meters, pumps and turbines

CO-6. Select a suitable type of fluid machine for a given application

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4. Course Contents

Unit 1 (Introduction to Fluid Mechanics):
History and scope of Fluid Mechanics, Concept of a continuum, Distinction between solids & fluids, Distinction between liquids & gases. Properties of fluids, Units and dimensions, Viscosity. Classification of fluids and flows: Newtonian and non-Newtonian fluids, internal and external flows, steady and unsteady flows, uniform and non-uniform flows, incompressible and compressible flows, ideal and real flows, rotational and irrotational flows, laminar and turbulent flows

Unit 2 (Pressure Distribution in a Fluid and its Measurement):
Definition of pressure and pressure gradient, Pascal's law, Absolute and gauge pressures, Measurement of pressure, Simple and differential manometers, Mechanical pressure gauges

Unit 3 (Fluid Statics, Kinematics and Dynamics):
Hydrostatic forces on plane and curved surfaces, Centre of pressure, Archimedes principle, Buoyancy and stability. Fluid kinematics: Concept of scalar and vector fields, Lagrangian and Eulerian descriptions of fluid flow, Definition of path line, streamline, streak line and stream tube, Derivation of continuity equation, Definition of velocity potential, stream function, streamline and equipotential line, Relation between velocity potential and stream function, Laplace equation. Fluid dynamics: Derivation of Euler's equation and Bernoulli's equation, Application of Bernoulli's equation, Navier-Stokes equations

Unit 4 (Dimensional Analysis, Similarity and Flow Through Ducts):
Principle of dimensional homogeneity, Buckingham π-theorem, Non-dimensional parameters and their importance, Concept of model testing and similarity. Flow through ducts/pipes: Reynolds number regimes, Laminar and turbulent fully developed pipe flow, Friction factor, Moody chart

Unit 5 (Fluid Machines):
Introduction to Euler turbine equation, Classification – pumps and turbines, Classification of pumps, Centrifugal pump, Pump performance parameters, Classification of turbines, Turbine performance parameters, Reciprocating pump, Fluid coupling, Torque convertor, Turbocharger, Gear pump, Vane pump, Vacuum pump. Classification of fans and blowers, Performance characteristics, Fan laws, Applications of fans and blowers

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3		3	2		2	1		1	1	1	3	3	1
CO-2	3	3	2	3	2		2	1	2	1	1	1	3	3	2
CO-3	3	3	2	3	2	1	2	1	1		1		3	3	1
CO-4	2	3	1	3	2		2		1				3	3	1
CO-5	3	3	2	3	2	1	2	1	2		1	1	3	3	2
CO-6	3	3	2	3	2		1		2	1	1	1	3	3	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		40
Demonstrations		05
1. Demonstration using Videos	03	
2. Demonstration using Physical Models / Systems	02	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		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. (Aerospace Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		**Component 2: SEE (40% Weightage)**
Subcomponent Type ▶	**Terms Tests**	**Assignments**	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
CO-6		x	x

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

9. Course Resources

a. **Essential Reading**
   1. Course notes
   2. Bansal, R.K., 2010. A Textbook of Fluid Mechanics and Hydraulic Machines, 9th edn., New Delhi, Laxmi Publications
   3. White, F. M., 2008, Fluid Mechanics. 6th edn., New Delhi, Tata McGraw-Hill

b. **Recommended Reading**
   1. Fox, R.W., McDonald, A.T. and Pritchard, P.J., 2013, Fluid Mechanics. 8th edn., New Delhi, Wiley
   2. Cengel, Y.A. and Cimbala, J.M., 2010, Fluid Mechanics: Fundamentals and Applications (in SI Units), 2nd edn., New Delhi, Tata McGraw-Hill

c. **Magazines and Journals**
   1. Journal of Fluid Mechanics
   2. Physics of Fluids
   3. Journal of Aerospace Sciences and Technology

d. **Websites**
   1. www.e-fluids.com

e. **Other Electronic Resources**
   1. Homsy, G.M. (ed.), 2008, Multimedia Fluid Mechanics (DVD-ROM), 2nd edn. New Delhi, Cambridge University Press
   2. Electronic resources on the course area are available in MSRUAS library

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10. Course Organization

Course Code	ASC205A		
Course Title	Fluid Mechanics and Machines		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	+91-80-4906-5555
		E-mail:	hod.aae.et@msruas.ac.in
Course Specifications Approval Date		26-Sep-2022	
Next Course Specifications Review Date		June-2026	

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Course Specifications: Automotive Systems Laboratory

Course Title	Automotive Systems Laboratory
Course Code	AUL206A
Course Type	Laboratory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course provides knowledge and hands on practical exposure of automotive components, sub systems and technologies to students. The course facilitates the students to understand functionality of automotive components in practical by dismantling and assembly of vehicle sub systems and components.

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	Automotive and Aeronautical Engineering
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Identify automotive engine, transmission, drive line and chassis components.

CO-2. Describe the functionalities of engine, transmission, driveline and chassis system components.

CO-3. Perform dismantle and assembly of automotive engine and its subsystem.

CO-4. Perform dismantle and assembly of driveline systems.

CO-5. Perform dismantle and assembly of disc and drum brake systems.

CO-6. Write laboratory report as prescribed format

4. Course Contents

Sl. No	Name of the Experiments
1	Identification and study of Automotive Power plants components
2	Identification and study of Cooling System, Lubrication System components
3	Identification and study of Clutch and Torque Converter, Transmission, Differential components
4	Identification and study of Drive Shafts, U Joints and C V Joints, Wheels and Tyres
5	Identification and study of Braking System components
6	Identification and study of Suspension and Steering Systems
7	Dismantle and Assembly exercise on single cylinder engine, and measurement of dimensions
8	Dismantle and Assembly exercise on multi cylinder engine
9	Dismantle and Assembly exercise on transmission and driveline components, and measurement.
10	Dismantle and Assembly exercise on drum and disc brake assembly

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3											3	0	
CO-2	3	3		3									3	2	
CO-3	3	3		3									3	2	
CO-4	3	3		3									3	2	
CO-5	3	3		3									3	2	
CO-6	3	3		2					1					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		0
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	0	
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		0
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	
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. (Automotive Engineering) Programme. The procedure to determine the final course marks is also presented in the

Programme Specifications document.

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

For Laboratory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Conduct of Experiments	Laboratory Report + Viva	Laboratory SEE
CO-1	x		x
CO-2	x	x	x
CO-3	x		x
CO-4	x		x
CO-5	x		x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	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 Manual
10.	Verbal Communication Skills	Viva Voce
11.	Presentation Skills	Laboratory Report
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. Lab Manual
   2. Jack Erjavec, Rob Thompson, 2015, Automotive Technology: A System Approach, USA, 2nd edition, Cengage Learning

b. **Recommended Reading**
   1. Robert Bosch GmbH, 2014, Automotive Hand Book, 9th edition, SAE
   2. Halderman, James D., Mitchell, Chase D, 1999, Automotive Technology: Principles, Diagnosis and Service, New Jersey, 2nd Edition, Prentice Hall

c. **Magazines and Journals**
   1. SAE Journals
   2. OverDrive
   3. AUTOCAR
   4. Auto Today

d. **Websites**
   1. http://magazine.sae.org
   2. http://auto.howstuffworks.com/automobile.html
   3. https://www.youtube.com/channels/automotive

e. **Other Electronic Resources**
   1. NPTEL Videos and Digital Library

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Course Specifications: Fluid Mechanics and Machines Laboratory

Course Title	Fluid Mechanics and Machines Laboratory
Course Code	AUL207A
Course Type	Laboratory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with the experimental aspects of fluid mechanics and fluid machines. This course facilitates students to plan and execute flow measurements from first principles using notches, venturimeter, orifice meter etc. In addition, viscosity of fluids and losses in flow through pipes and conduits will be determined as per standards. Students are trained to conduct the experiment on test rigs of hydraulic turbines and pumps, to measure and record the experimental data, plot performance curves, and interpret the results.

2. Course Size and Credits:

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

3. Course Outcomes (COs)

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

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

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4. Course Contents

Sl. No	Name of the Experiment
1	Estimation of uncertainty in experimental measurements
2	Measurement of viscosity of fluids using viscometers
3	Determination of velocity using Pitot-static probe and static pressure measurements
4	Determination of friction coefficient in pipes of different diameters
5	Determination of major losses and minor losses in flow through pipes and fitting
6	Calibration of flow measuring devices: a) Orifice plate b) Venturimeter c) Convergent Nozzle
7	Determination of performance characteristics like head vs. discharge and efficiency of centrifugal blower
8	Determination of constant head and constant speed performance characteristics like head vs. discharge, power output and efficiency of Francis turbine and Kaplan turbine
9	Determination of performance characteristics like head vs. discharge and efficiency of centrifugal pump
10	Determination of performance characteristics like total head vs. discharge and efficiency of Gear Pump, Vane Pump, Diaphragm pump
11	Determination of performance characteristics like torque vs. speed ratio and efficiency of Torque Convertor, demonstration of turbocharger

5. Course Map (CO-PO-PSO Map

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3		2									3	2	
CO-2	3	3		3				3	2				3	3	3
CO-3	3	3		3									3	3	
CO-4	3	3		3		2							3	3	
CO-5	3	3		3						2			3	3	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		0
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	0	
Practical Work		30
1. Course Laboratory	30	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		0
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	
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. (Automotive Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

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For Laboratory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Conduct of Experiments	Laboratory Report + Viva	Laboratory SEE
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document			

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 Manual
10.	Verbal Communication Skills	Viva Voce
11.	Presentation Skills	Laboratory Report
12.	Behavioral Skills	--
13.	Information Management	Laboratory Manual
14.	Personal Management	--
15.	Leadership Skills	Laboratory Work

9. Course Resources

a. Essential Reading

1. Laboratory Manuals
2. Rathakrishnan, E, 2007, Instrumentation, Measurements and Experiments in Fluids, New Delhi, CRC Press
3. Yahya, S.M, 2017, Turbines, Compressors and Fans, 4th edn., New Delhi, Tata-McGraw Hill
4. Kadambi, V. and Prasad, M, 2011, An Introduction to Energy Conversion, Volume III – Turbomachinery, New Delhi, New Age

b. Recommended Reading

1. White, F. M, 2008, Fluid Mechanics. 6th edn. New Delhi, Tata McGraw-Hill
2. Holman, J. P, 2000, Experimental Methods for Engineers. 7th edn., New Delhi, Tata McGraw-Hill
3. Tavoularis, S, 2009, Measurement in Fluid Mechanics, Cambridge, Cambridge University Press
4. Round G.F, 2004, Incompressible Flow Turbomachines, Burlington, Butterworth-Heinemann.
5. Dixon S.L. and Hall, C.A, 2014, Fluid Mechanics and Thermodynamics of Turbomachinery, 7th edn., New Delhi, Butterworth-Heinemann.

c. Magazines and Journals

1. Experiments in Fluids
2. Physics of Fluids

d. Websites

1. www.e-fluids.com

e. Other Electronic Resources

1. NPTEL Videos and Digital Library
2. Homsy, G. M. (ed.), 2008, Multimedia Fluid Mechanics (DVD-ROM). 2ndedn., New Delhi, Cambridge University Press

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Course Specifications: Environmental Studies

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

1. Course Summary

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

2. Course Size and Credits:

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

3. Course Outcomes (COs)

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

- **CO-1.** Illustrate the multidisciplinary nature of environmental studies and recognize the need for public awareness
- **CO-2.** Explain the various natural resources and their associated problems, ecosystem, and environmental pollution
- **CO-3.** Analyse the concept of ecosystem and classify various types
- **CO-4.** Compare biodiversity at local, national and global levels
- **CO-5.** Discuss various social issues pertaining to environment including sustainable development and energy issues

4. Course Contents

Unit 1: Natural resources:

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

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logging, salinity. **Energy resources:** Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. **Land resources:** Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

Unit 2: Ecosystems:

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

Unit 3: Biodiversity and its conservation:

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

Unit 5: Environmental Pollution:

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

Unit 6: Social Issues and the Environment:

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

Unit 7: Environmental ethics:

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

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

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

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		22
Demonstrations		05
1. Demonstration using Videos	05	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		03
1. Case Study Presentation	03	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**40**

7. Course Assessment and Reassessment

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

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

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Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

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

8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

1. Class notes
2. Bharucha, E., 2004, Environmental Studies, New Delhi, University Grants Commission Ahluwalia, V.K., 2013,
3. Environmental Studies: Basic concepts, The Energy and Resources Institute (TERI).

b. Recommended Reading

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

c. Magazines and Journals

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

d. Websites

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

e. Other Electronic Resources

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

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Course Specifications: Additional Mathematics - 1

Course Title	Additional Mathematics - 1
Course Code	MTB103A
Course Type	Ability Enhancement Compulsory Course
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

The course introduces students to the basic concepts in real analysis, MATLAB programing and matrix algebra. Students are taught the concepts of limits, continuity, differentiation, series expansion for the functions of one and two variable, indefinite and definite integrals of single real variable functions. Basic concepts of vectors with necessary properties and operations are taught. The mathematical operations in Matrix theory, Eigen value and Eigen vector, Inversion and diagonalization of matrix and matrix solution for linear system of equations and implementation of the same using MATLAB are discussed in this course.

2. Course Size and Credits:

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	2:1:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. State and explain the important theorems and solve simple mathematical problems in one variable calculus and vector algebra

CO-2. State theorems and solve simple problems in two variable calculus

CO-3. Solve complex real world problems associated with one and two real analysis

CO-4. Illustrate fundamentals of MATLAB programming and write simple programs

CO-5. Solve complex mathematical problems associated with linear algebra and compare the results with that of solutions obtained using MATLAB

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4. Course Contents

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

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

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

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

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

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

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

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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		15
1. Course Laboratory	00	
2. Computer Laboratory	15	
3. Engineering Workshop / Course/Workshop	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. (Electronics and Communication Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

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For AECC Only		
Focus of COs on each Component or Subcomponent of Evaluation		
	Component 1: CE (50% Weightage)	Component 2: SEE (50% Weightage)
Subcomponent Type ▶	Terms Tests or Assignments	
CO-1	x	x
CO-2	x	x
CO-3	x	x
CO-4	x	x
CO-5	x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.		

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

3. James Stewart, 2015, Calculus: Early Transcendentals, 8th edition, Boston, Cengage Learning
4. Steven Leon, 2014, Linear Algebra with Application, 9th edition, New Jersey,

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Pearson

5. Rudra Pratap, 2013, Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers, New York, Oxford University Press

b. Recommended Reading

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

c. Magazines and Journals

1. International Journal for Mathematics

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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Course Specifications: Engineering Mathematics - 4

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

1. Course Summary

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

2. Course Size and Credits:

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

3. Course Outcomes (COs)

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

CO-1. Define and explain the concepts of correlation, regression, random variables, probability distribution, partial differential equations and complex analysis

CO-2. State theorems and solve simple problems in partial differential equations, complex analysis , probability , probability distributions

CO-3. Apply numerical methods to solve ordinary and partial differential equations using MATLAB

CO-4. Solve complex engineering problems associated with numerical methods using MATLAB

CO-5. Analyze real world problems associated with probability, probability distributions, partial differential equations and complex analysis

CO-6. Construct the Bar chart, pie chart, Histogram , Box-plot and fitting of curves by using MATLAB

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4. Course Contents

Unit 1 (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 2 (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 3 (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 4 (Correlation and Regression): Review of statistics. Contingency, correlation and regression Curve fitting: Least squares method - polynomial, exponential and power fit.

Unit 5 (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 6 (Finite Difference Method): Finite differences, explicit methods for one dimensional heat and wave equations, stability conditions. Implicit method for one dimensional heat equation. Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain.

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

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

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

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

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

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For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

8. Dennis Zill and Patrick Shanahan, 2013, Complex Analysis, 3rd edition, Jones and Bartlett
9. Richard Burden and Douglas Faires, 2017, Numerical Analysis, 9th edition, Massachusetts, Brooks/Cole
10. Erwin Kreyszig, 2015, Advanced Engineering Mathematics, 10th edition,

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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
3.

e. Other Electronic Resources

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

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Course Specifications: Strength of Materials

Course Title	Strength of Materials
Course Code	AAC212A
Course Type	Core Theory
Department	Automotive and Aeronautical 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 will be able to analyze the response of the simple structural components with applied forces and boundary conditions.

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	Automotive and Aeronautical 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 types of stresses and strain, stress-strain relationship, strain energy, theories of failure, elastic constants and their relations.

CO-2. Explain various methodologies to determine reaction forces, deformation, stress, strain, strain energy on various structures such as rod, bar, beam for different types of loading and buckling load on columns.

CO-3. Solve simple numerical problems to compute the deformation, stress, strain for various structures with different loading and buckling load on columns.

CO-4. Calculate dimensions of structural members including bars and beams using appropriate method and stress distribution in thick and thin cylinders.

CO-5. Draw SFD and BMD for different beams subjected to different loads and couples.

CO-6. Calculate deformation, stress, strain for given aerospace component and draw BMD, SFD with appropriate assumption.

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4. Course Contents

Unit 1 (Stress and Strain):
Introduction, Hooke's law, Calculation of stresses in straight, Stepped and tapered sections, Composite sections, Stresses due to temperature change, Shear stress and strain, Lateral strain and Poisson's ratio, Generalized Hooke's law, Bulk modulus, Relationship between elastic constants.

Unit 2 (Analysis of Stress and Strain):
Plane stress, Stresses on inclined planes, Principal stresses and maximum shear stress, Principal angles, Shear stresses on principal planes, Maximum shear tress, Mohr circle for plane stress conditions. Cylinders: Thin cylinder, Hoop's stress, maximum shear stress, circumferential and longitudinal strains. Thick cylinders: Lames equations.

Unit 3 (Shear Forces and Bending Moments):
Type of beams, Loads and reactions, Relationship between loads, shear forces and bending moments, Shear force and bending moments of cantilever beams, Pin support and roller supported beams subjected to concentrated loads and uniformly distributed constant / varying loads.

Unit 4 (Stress in Beams):
Pure bending, Curvature of a beam, Longitudinal strains in beams, Normal stresses in Beams with Rectangular, circular, 'I' and 'T' cross sections, Flexure Formula, Bending Stresses, and Deflection of beams (Curvature).

Unit 5 (Torsion):
Circular solid and hallow shafts, Torsional moment of resistance, Power transmission of straight and stepped shafts, Twist in shaft sections, Thin tubular sections, Thin walled sections

Unit 6 (Columns):
Buckling and stability, Critical load, Columns with pinned ends, Columns with other support conditions, Effective length of columns, Secant formula for columns.

Unit 7 (Strain Energy):
Castigliano's theorem I and II, Load deformation diagram, Strain energy due to normal stresses, Shear stresses, Modulus of resilience, Strain energy due to bending and torsion. Theories of Failure: Maximum Principal stress theory, Maximum shear stress theory.

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	3	2	3	1	2				1	2	3	3	2
CO-2	3	3	3	2	3	1	2		2	2	2	2	3	3	2
CO-3	3	3	3	2	3	2	3	1	1		1	1	3	3	1
CO-4	3	3	3	2	3	2	3				2	1	3	3	2
CO-5	3	3	3	2	3	1	2				1	1	3	3	1
CO-6	3	3	3	2	3	2	3	1	2	2	1	1	3	3	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		35
Demonstrations		5
1. Demonstration using Videos	5	
2. Demonstration using Physical Models / Systems	0	
3. Demonstration on a Computer	0	
Numeracy		20
1. Solving Numerical Problems	20	
Practical Work		0
1. Course Laboratory	0	
2. Computer Laboratory	0	
3. Engineering Workshop / Course Workshop	0	
4. Clinical Laboratory	0	
5. Hospital	0	
6. Model Studio	0	
Others		0
1. Case Study Presentation	0	
2. Guest Lecture	0	
3. Industry / Field Visit	0	
4. Brain Storming Sessions	0	
5. Group Discussions	0	
6. Discussing Possible Innovations	0	
Term Tests, Laboratory Examination / Written Examination, Presentations		10
Total Duration in Hours		**70**

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

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

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For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4	x	x	x
CO-5		x	x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications 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	How imparted during the course
1.	Knowledge	Class Room Lectures, Assignments
2.	Understanding	Class Room Lectures, Assignments
3.	Critical Skills	Class Room Lectures, Assignments
4.	Analytical Skills	Class Room Lectures, Assignments
5.	Problem Solving Skills	Class Room Lectures, Assignments
6.	Practical Skills	Assignments, Laboratory Demonstrations
7.	Group Work	Assignments
8.	Self-Learning	Assignments
9.	Written Communication Skills	Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Class Room Interaction
13.	Information Management	Assignments, Examination
14.	Personal Management	Assignments
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. S. Timoshenko, 1986, Strength of materials, New Delhi, CBS
3. James M Gere, 2003, Strength of materials, New Delhi, Tata McGraw Hill

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b. Recommended Reading

1. J.P. Den Hartog, 1961, Strength of materials, Dover Publications
2. Ferdinand Beer and Russell Johnston, 2003, Mechanics of Materials, TMH
3. T.H.G Megson, 2007, Introduction to Aircraft Structural Analysis, Butterworth-Heinemann Publications,

c. Websites

http://nptel.ac.in/courses/112107147/

d. Other Electronic Resources

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

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Course Specifications: Manufacturing Processes for Automotive Systems

Course Title	Manufacturing Processes for Automotive Systems
Course Code	AUC213A
Course Type	Core Theory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with different manufacturing processes used in automotive industries. The student will gain knowledge about the principles, procedure and applications of different primary shaping processes like casting, forming operations, additive manufacturing, and secondary operations like material removal processes and joining technologies. Students are taught need, principle and application of modern machining processes, CNC machining.

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	Automotive and Aeronautical 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 casting, forming, additive manufacturing, machining, and joining processes.

CO-2. Explain the principle of operation and equipment required for different casting, forming, additive manufacturing, machining and joining techniques.

CO-3. Calculate power requirements for forging and cutting forces.

CO-4. Explain design guidelines and features in components for different processes.

CO-5. Examine the need and suitability of non-conventional machining and CNC machining processes

CO-6. Select suitable casting, forming, additive manufacturing, machining and joining process to meet the design requirement of the component.

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4. Course Contents

Unit 1 (Introduction to Manufacturing Processes and Casting): Classification, primary and secondary processes, characteristics, influence of manufacturing processes on mechanical properties, Introduction to casting, advantages, limitation and applications of casting processes, classification, Sand casting and molding practices: Molding sand characteristics and properties, Patterns, Types of furnaces, Shell mold casting, investment casting, gravity die casting, pressure die casting, centrifugal casting, Foundry defects, Feed (Sprue, runner, gate) system, Casting design guidelines.

Unit 2 (Metal Forming Process): Introduction, classification, advantages, limitations and applications of forming processes, Hot working and cold working, plastic deformation of metallic materials; Rolling: Principle and types, rolling load, effect of friction; Forging: Principle, types, characteristics of forged products, forging load, die design, forging defects. Extrusion and drawing: Principle, types, extrusion equipment, wire, rod and tube drawing, extrusion defects. Sheet metal operations: Principle and stages of sheet metal fabrication, drawing, stretch forming, embossing and coining, defects in sheet formed products, Numerical on punching, blanking and deep drawing operations; Additive manufacturing process: Introduction, classification and applications for metal, ceramics and polymer, Aerospace Applications.

Unit 3 (Joining): Introduction to types of joining, classification of joining processes. Welding: Principles, types and applications of welding: Arc welding, gas metal arc welding, tungsten arc welding, Resistance welding, advanced welding, friction etc. Heat affected Zone, Welding defects and welding design. Brazing, Braze welding and soldering: principle and types, application.

Unit 4 (Material Removal Operations): Principles of metal cutting: chip formation, cutting tool geometry, metal cutting mechanics, cutting force calculation, aspects of cutting tool like cutting materials, life and wear, cutting fluid; Machine tools: Classification of machine tools, basic elements of machine tools, Turning machines and operations: Features of center lathe, specifications of lathes, lathe tools and work holding devices, lathe attachments, lathe operations, machining time and power estimation, Capstan and Turret lathe, automatic lathes; Milling machines and operations: Types of milling machines, milling operations, milling cutters, milling fixture, machining time estimation, Drilling, boring and tapping machines and operations: types and mechanisms, Grinding machines and abrasive based operations, types of grinding machines, honing, lapping and super finishing, Miscellaneous machine tools and operations: Like broaching, sawing etc.

Unit 5 (Nonconventional Machining Processes): Need and classification of NCM processes, types of NCM, CNC machine tools: Introduction to numerical control, computer numerical control, direct/distributed numerical control, classification of CNC machines, features of CNC machine tools, manual part programming methods, computer aided part programming; Non-Destructive Techniques: Types, working principles, applications.

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	1		1	1	2		1			3	1	2
CO-2	3	1	3										3	0	0
CO-3	3	2	3	1									3	1	0
CO-4	3	3	3	1		1	1	2		1	1		3	1	2
CO-5	3	2	3	1		1				1			3	1	1
CO-6	3	3	3	1		1		2		1			3	1	2
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		05
1. Demonstration using Videos	05	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		05
1. Solving Numerical Problems	05	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop	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. (Automotive Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

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For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4	x	x	x
CO-5		x	x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
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. P. N. Rao, 2003, Manufacturing Technology, Foundry, Forming and Welding, TMH

b. **Recommended Reading**

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1. Serope Kalpakjian and S. R. Schmid, 2003, Manufacturing Engineering and Technology, Pearson Education
2. Paul Degarmo E. and Black Jt., 2004, Materials and Processes In Manufacturing, JWS
3. Peter Beeley, 2001, Foundry Technology, Butterworth-Heinemann
4. G. Davies, 2003, Materials for Automobile Bodies, Butterworth-Heinemann Publications
5. Amitabha Ghosh and Asok Kumar Mallik , 1994, Manufacturing Science, EWP.
6. M C Shaw, 2005, Metal cutting- Principles and Practices, Cambridge University Press
7. Hassan Abdel-Gawad El-Hofy, 2005, Advanced Machining Processes: Nontraditional and Hybrid Machining Processes, McGraw-Hill.

c. Magazines and Journals

1. Journal of Materials Processing Technology, Formerly: Journal of Mechanical Working Technology, Elsevier
2. Journal of Manufacturing Processes, Society of Manufacturing Engineers, ELSEVIER
3. Efficient Manufacturing

d. Websites

1. https://www.SAE.org/
2. http://nptel.ac.in/
3. http://www.efoundry.iitb.ac.in
4. http://www.foseco.com

e. Other Electronic Resources

1. NPTEL Videos and Digital Library

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Course Specifications: 3D Modeling and Machine Drawing

Course Title	3D Modeling and Machine Drawing
Course Code	AAC214A
Course Type	Core Theory and Laboratory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to give exposure to the students to use the concepts of computer aided design to develop wireframe, surface and solid models; feature based geometric models and parametric models of mechanical components. Students will be taught the guidelines and rules of drawing to create orthographic views of components and assembly of engineering components, IC engine components, fasteners and transmission system components. Students will also be trained to use CAD tool to develop geometric models of mechanical components and industry standard drawings.

2. Course Size and Credits:

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	1:0:2
Total Hours of Interaction	75
Number of Weeks in a Semester	15
Department Responsible	Automotive and Aeronautical 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 role of CAD in product development cycle.

CO-2. Apply geometric modeling techniques to build complex geometric models and assemblies of Mechanical components.

CO-3. Use drawing standards and principles, symbolic representation of mechanical components, sign conventions, sectional views, and bill of material for developing machine drawings.

CO-4. Create representative drawings of riveted joint, welded joints, pipe joints, bearings, couplings and fasteners, transmission system components.

CO-5. Create 3D assembly models and draw 2D detailed drawings with sectional details wherever required and prepare BOM for IC engine, transmission system, aircraft components, machine tool with components.

CO-6. Read and interpret the industrial drawing which includes limits-fits-tolerance information, datum references, GD & T symbols, surface roughness.

4. Course Contents

Unit 1

Computer Aided Design and Geometric modeling: Product development cycle, Engineering design, Computer Aided Design, CAD environment, CAD software and Hardware CAD coordinate system, geometric transformation, Geometric modeling- Wireframe modeling, surface modeling and solid modeling

Advanced Geometric modeling techniques:

Parametric modeling, Feature based geometric modeling, Assembly modeling and interference analysis, Synthetic curves and surfaces, Computer aided drawing, CAD neutral file formats

Unit 2

Engineering Drawing Basics:

Orthographic views, Sections of solid, Isometric views, Drawing standards, Drawing sheet layout, Line types, dimensioning methods and systems, Good drawing practices.

Unit 3

Mechanical components:

Engineering materials drawing conventions& symbols, Riveted joint, welded joints, pipe joints, Bearings, Couplings and fasteners, Transmission system components: Clutches, Gears, pulleys and chain sprockets

Assembly drawings:

IC engine components: Piston, cylinder, connecting rod, crank shaft, flywheel, Fuel Injection system components. Aircraft components: Aircraft wing with different airfoils, landing gear, Fuselage, Gas turbine, seating layout in fuselage

Unit 4

Reading and interpretation of industrial drawing:

Geometric dimensioning and tolerance, IT standards for tolerance, Surface roughness symbol, Bill of materials

Unit 5:

Geometric Modelling of Automotive Components:

Use industry standard CAD software to develop CAD models and detailed drawings of Automotive and Aerospace components.

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

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

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

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6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		20
Demonstrations		10
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	05	
3. Demonstration on a Computer	05	
Numeracy		0
1. Solving Numerical Problems	0	
Practical Work		45
1. Course Laboratory	00	
2. Computer Laboratory	45	
3. Engineering Workshop / Course/Workshop	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. (Automotive Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

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For Combined Courses (Theory + Laboratory)					
Focus of COs on each Component or Subcomponent of Evaluation					
Course Outcome	CE (Weightage: 60 %) Four components including one Lab component			SEE (Weightage: 25 %)	Lab (Weightage: 15 %)
	Tests (30 %)	Written Assignments+ Lab (20 %)	Assignment +Lab CE (10%)	Written exam	LSEE: SEE
CO-1	x	x	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	x	x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of 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. Ibrahim Zeid,1991, CAD/CAM Theory and Practice, Tata McGraw-Hill Education,
3. K R Gopalakrishna, 2012, Machine Drawing, Subhas Publications, Bangalore
4. R.B. Gupta,1995, Automobile drawing, 2st Edition, Sathyprakashan

b. Recommended Reading

1. M. Siddeshwara, P. Kamaiah, V.S. Sastry, 2007, Machine Drawing, Tata McGraw-Hill
2. K.L. Narayana, P. Kanaiah, K. Venkatat Reddy,2006, Machine Drawing, New Age International Publication
3. N.D. Bhatt, 2014, Machine Drawing, 49th Edition, Charotar Publishing House Pvt. Ltd

c. Magazines and Journals

1. Journal for Machine Design and Assembly

d. Websites

1. http://nptel.ac.in/syllabus/syllabus_pdf/112106075.pdf

e. Other Electronic Resources

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

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Course Specifications: Automotive Electrical and Electronic Systems

Course Title	Automotive Electrical and Electronic Systems
Course Code	AUC215A
Course Type	Core Theory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to impart knowledge on basic principles and applications of automotive electrical and electronic systems. Students are taught underlying principles of construction, working and limitations of automotive electrical and electronic systems. The students are taught the process of fault diagnostics and repairs. Students are also exposed to the developments in automotive technologies using electronic control.

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	Automotive and Aeronautical 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 need, requirements, features of various automotive electronic systems, OBD, HVAC, electric and hybrid electric vehicle.

CO-2. Explain the working principle of various sensors, actuators, HVAC and communication networks used in automotive applications.

CO-3. Discuss the functions of electronic control units in various applications such as Starting system, EMS, lighting systems, chassis electronics systems.

CO-4. Discuss types of EVs and HEVs and compare their advantages and disadvantages.

CO-5. Discuss recent and future trends in electronic systems in automotive applications.

CO-6. Suggest configuration of an electronically controlled system for a given automotive application.

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4. Course Contents

Unit 1 (Introduction to Automotive Electrical Systems): Automotive Electrical Systems, Electrical Controls, Switches and Connecters, Symbols and Circuit Diagrams.

Unit 2 Charging, Starting and Ignition Systems): Battery - Construction, Rating, Maintenance and Charging, testing. Charging Systems: Requirements of Charging System, Principles, Alternators and Charging Circuit. Starting Systems: Requirements of Starting Systems, Starter Motors and Circuits, Types of Starter Motors. Ignition Systems: Ignition Fundamentals, Conventional ignition systems, main components, Electronic Ignition systems.

Unit 3 (Engine Management System): Introduction to automotive sensors, Types of Sensors and their Applications, Types of Actuators and their Applications. Introduction to Engine Management System, Functions of EMS - Fuel and Ignition Control, Exhaust Emission Control, Other Functions of EMS. Introduction to CRDI and GDI Technologies. OBD & OBD Scanners.

Unit 4 (Automotive Lighting, Comfort, Convenient and Safety Systems): Lighting Fundamentals, Lighting Circuits, Faults & Diagnostics, Advanced Lighting Technologies, Gauges and controls, Visual Displays, Driver Information. Advanced Instrumentation Technologies.
Auxiliary Systems, Comfort and Safety Systems: Wind Screen Wipers & Washers, Power Windows, Signaling Circuits, Horns etc. Power Seats, Mirrors, Sun Roof, Central Locking, Cruise Control and ACC, In Vehicle Multimedia, Air Bags, Belt Tensioners, TPMS etc. Advanced Technologies

Unit 5 (Modern Chassis Systems and In-Vehicle Networking): Anti-Lock Braking Systems, Traction Control Systems, Active Suspension Systems, Electrical Power Steering Systems, Automatic Transmissions and control. In-vehicle Networking: Need for in-vehicle networking, overview of common vehicle networking protocols. Typical applications

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	3	3											3		
CO-3	3	3			1								3	1	
CO-4	3	3	2	2	2		2			1			3	2	1
CO-5	3	3	2	2		2	2						3	2	
CO-6	3	3	3		2	2		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		35
Demonstrations		05
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	03	
Numeracy		0
1. Solving Numerical Problems	0	
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. (Automotive Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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9. **Course Resources**

a. **Essential Reading**

1 Course notes

2 Tom Denton (2004) Automobile Electrical and Electronics Systems, USA, SAE Inc

3 James D Halderman, Chasey D. Mitchell, Jr. (2005) Automotive Electricity and Electronics, Ohio, Pearson Prentice Hall.

b. **Recommended Reading**

1 Robert Bosch (2007) Automotive Electrics Automotive Electronics Systems and Components, England, John Wiley & Sons Ltd.

2 Willam H Crouse and Donald L Anglin (2005) Automotive Mechanics, New Delhi, Tata McGraw-Hill.

c. **Magazines and Journals**

1 Automotive Engineering - SAE International

2 ATZ Technology (International Federation of Automotive Engineering Societies)

d. **Websites**

1 https://www.SAE.org/

2 http://nptel.ac.in/

e. **Other Electronic Resources**

1 NPTEL Videos and Digital Library

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Course Specifications: Materials and Testing Laboratory

Course Title	Materials and Testing Laboratory
Course Code	AUL216A
Course Type	Laboratory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

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

2. Course Size and Credits:

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

3. Course Outcomes (COs)

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

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

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4. Course Contents

Sl. No	Name of the Experiment
1	Conduct heat treatment processes such as Annealing, Normalizing, Hardening and Tempering for Medium Carbon
2	Microstructure analysis of heat treated MCS and untreated low carbon steel
3	Conduct Rockewell and Brinell hardness test on heat treated ferrous (MCS) and non-ferrous (Al) materials to determine hardness number.
4	Conduct Charpy impact test to determine the ductile to brittle transition temperature and energy absorbed by the specimens.
5	Conduct Izod impact test to determine the energy absorbed by ferrous and non-ferrous specimen (Al)
6	Conduct the Tensile test to determine mechanical properties of ferrous and non-ferrous
7	Conduct compression test on ductile (Aluminum) and brittle (Cast iron) materials to determine compressive strength.
8	Conduct single and double shear test to determine shear strength of given material
9	Conduct the test to determine the creep rate of given specimen
10	Demonstration on Photoelasticity method to illustrate contours of distribution of stress

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	1	3	2			2	3	3	2	1	3	3	3
CO-2	3	3	3	3	3			2	3	3	2	1	3	3	3
CO-3	3	3	3	3	3	3		2	2	3	2	2	3	3	3
CO-4	3	3	3	3	3	3		2	2	3	3	2	3	3	3
CO-5	3	3	3	3						3			3	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		0
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	0	
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		0
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	
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. (Automotive Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

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For Laboratory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Conduct of Experiments	Laboratory Report + Viva	Laboratory SEE
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	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 Manual
10.	Verbal Communication Skills	Viva Voce
11.	Presentation Skills	Laboratory Report
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. C. Suryanarayana, 2011, Experimental Techniques in Materials and Mechanics, CRC Press
3. A. K. Bhargava and C. P. Sharma, 2011, Mechanical Behaviour and Testing of Materials, Prentice Hall India

b. Recommended Reading

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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

e. Other Electronic Resources

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

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Course Specifications: Manufacturing Process Laboratory

Course Title	Manufacturing Process Laboratory
Course Code	AUL217A
Course Type	Laboratory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This laboratory deals with practice of foundry and forging, machine tools and CNC operations. Foundry sand tests for determining the strength, permeability, fineness and other relevant properties significant to casting process will be carried out. Students will be taught sand moulding, hot forging operations. Students will be equipped with basic knowledge, constructional features and operations of various machines like lathe, milling, drilling, grinding and various CNC turning and milling operations, tool and work holders for CNC machines, robot programming and operation. In addition, student will be trained to set up the work piece and cutting tool for CNC turning and milling operations.

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	Automotive and Aeronautical Engineering
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Identify forging and foundry tools, machine tools, cutting tools and accessories for turning, milling, drilling, sawing and grinding.

CO-2. Test for moulding sand properties and recommend suitable composition

CO-3. Prepare sand mould cavity, melt and pour the casting and perform forging operations.

CO-4. Operate the machine tools and perform machining operations like turning, milling, gear cutting, drilling and grinding

CO-5. Perform turning and machining operations on CNC turn center and machining center

CO-6. Write laboratory report as per the prescribed format.

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4. Course Contents

Sl. No	Name of the Experiment
1	**Foundry Sand Testing**: Strength tests: Compression and shear tests on green sand specimen, compression, Shear,bending and tensile tests on resin bonded sand specimensClay content test,Mo isture content test,Permeability test on green and resin bonded sand specimens Colla psibility / friability test, Grain fineness test.
2	**SandMoulding**:.Preparing green sand moulding based on single piece and multiple piece patterns. **Die casting**: Demo on melting of Aluminum alloys and pouring melt treatment like degasification, grain refinement and Demonstration of gravity die casting.
3	**Forging**: Demo on manual hot forging operations in mild steel specimen and Demo on Injection moulding.
4	**Lathe Machine Operations**: Facing, plain turning, step turning, taper turning, thread cutting, boring Machine the work piece to the given dimensions using lathe, Measure the shear angle for the given conditions, Measure the cutting forces for the given cutting conditions. Demo on Non-destructive testing.
5	**Milling Machine Operations**: Face Mill, Pocketing, end milling and straddle milling, Gear cutting using milling machine and indexing table, Machine a given hexagonal surface/T-slot in a given work piece using milling machine
6	**CNC Machining:** Turning: Demonstrations of various operations on a CNC turning center. Demonstration of milling operations on a CNC machining center
7	**Drilling and Grinding Operations**: Drilling holes using standard drill bits, reaming and tapping, surface and cylindrical grinding operations

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	1	3	1				2	2	3	3	3	3
CO-2	3	3	3	3	3	2	2	1	3		2	3	3	3	3
CO-3	3	3	3	3	3	2		2	3		2	1	3	3	3
CO-4	3	3	3	1	3	3	2	2	3		2	1	3	3	3
CO-5	3	3	3	1	3	3	2	2	3		2	1	3	3	3
CO-6	3	3			2					2			3	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		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. (Automotive Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

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For Laboratory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Conduct of Experiments	Laboratory Report + Viva	Laboratory SEE
CO-1	x	x	x
CO-2	x		x
CO-3	x		x
CO-4	x		x
CO-5	x		x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	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 Manual
10.	Verbal Communication Skills	Viva Voce
11.	Presentation Skills	Laboratory Report
12.	Behavioral Skills	--
13.	Information Management	Laboratory Manual
14.	Personal Management	--
15.	Leadership Skills	Laboratory Work

9. Course Resources

a. Essential Reading

1. Class Notes
2. Heine, Loper and Rosenthal (2008) Principles of Metal Casting, McGraw-Hill
3. P N Rao (2003) Manufacturing Technology, Foundry forming and welding, 2nd e dition, TMH
4. Hofy (2005) Advanced Machining Process: Nontraditional and Hybrid

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Machining Processes, McGraw-Hill Publication

b. Recommended Reading

1. Serope Kalpakjian and S. R. Schmid (2003) Manufacturing Engineering and Technology, Pearson Education
2. John G. Lenard (2002) Metal Forming Science and Practice, Elsevier
3. Amitabha Ghosh and Asok Kumar Mallik (1994) Manufacturing Science, EWP, New Delhi
4. Production Technology (1997) HMT, TMH
5. E. Paul DeGarmo (2005) Materials and Processes in Manufacturing, Mc Millan Publication, Eastern Economy edition
6. Trent, E.M. and P.K. Wright (2000) Metal Cutting, Butterworth-Heinemann
7. M C Shaw (2005) Metal cutting- Principles and Practices, Cambridge University Press
8. V K Jain (2002) Advanced Manufacturing Processes, Allied Publishers Pvt. Ltd.

c. Magazines and Journals

1. Journal of Materials Processing Technology, Formerly: Journal of Mechanical W orking Technology, Elsevier
2. Journal of Manufacturing Processes, Society of Manufacturing Engineers, Elsevi er
3. International Journal of Machine Tools and Manufacture: Design, Research and Application, Elsevier
4. International Journal of Precision Engineering and Manufacturing

d. Websites

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

e. Other Electronic Resources

1. Digital electronics resources available in RUAS Library

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Course Specifications: Innovation and Entrepreneurship

Course Title	Innovation and Entrepreneurship
Course Code	BAU201A
Course Type	Core Theory Course
Department	Management Studies
Faculty	Management and Commerce

1. Course Summary

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

2. Course Size and Credits:

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	1:1:1
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Respective Department of the Faculty
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

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

Course Contents

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

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Unit 2:

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

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, 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
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	

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Bangalore-560054

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.

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		**Component 2: SEE (40% Weightage)**
Subcomponent Type ▶	**Terms Tests**	**Assignments**	
CO-1	x		x
CO-2	x		x
CO-3	x	x	x
CO-4		x	x
CO-5		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, 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

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		presentation
6.	Practical Skills	Assignment
7.	Group Work	Case study Presentation
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	Case study and group discussions
11.	Presentation Skills	Case study and group discussions
12.	Behavioral Skills	Group discussions
13.	Information Management	Assignment
14.	Personal Management	Assignment and Group Discussion
15.	Leadership Skills	Group discussions and Case study

8. Course Resources

a. Essential Reading

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

b. Recommended Reading

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

c. Magazines and Journals

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

d. Websites

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

e. Other Electronic Resources

NA

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Course Specifications: Additional Mathematics - 2

Course Title	Additional Mathematics - 2
Course Code	MTB104A
Course Type	Ability Enhancement Compulsory
Department	Automotive and Aeronautical 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															

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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		15
1. Course Laboratory	00	
2. Computer Laboratory	15	
3. Engineering Workshop / Course/Workshop	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. (Electronics and Communication Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

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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 Type ▶	Terms Tests or Assignments	
CO-1	x	x
CO-2	x	x
CO-3	x	x
CO-4	x	x
CO-5	x	x
CO-6	x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.		

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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9. Course Resources

a. Essential Reading

1. 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

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

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Course Specifications: Propulsion Systems for Electric and Hybrid Vehicle

Course Title	Propulsion Systems for Electric and Hybrid Vehicle
Course Code	AUC301A
Course Type	Core Theory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course intends to impart the concepts of electric and hybrid vehicle. Students will be taught concepts, working of types of electric and Hybrid Vehicle. Students will also be taught about IC engine as it is one of the propulsion system used in IC engine and its subsystems. Students will be able to discuss about the electric vehicle performance for different applications.

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	Automotive and Aeronautical 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 types, concepts and working of hybrid and electric vehicles propulsion systems, alternate energy storage

CO-2. Explain the parameters influencing selection of IC engine, Electric motors for electric and hybrid vehicle

CO-3. Discuss the control strategy for hybrid and electric vehicle

CO-4. Discuss the emission formation, methods for controlling emission in IC engine and latest trends in Hybrid Vehicle engine management

CO-5. Solve simple problems IC engine performance and electric motors capacity

CO-6. Suggest the propulsion system for given specific requirements

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

4. Course Contents

Unit 1 (Introduction to Electric and Hybrid Vehicles): Types, working, layout and classifications, vehicle architecture

Unit 2 (Gas Power Cycles): Review of Air standard cycles; Fuel- air cycles; efficiencies and mean effective pressures, Comparison between air standard and fuel-air cycles; Comparison between air standard, fuel-air and real cycles for SI and CI engines; Difference between fuel-air and real cycles.

Unit 3 (IC Engine): SI and CI engines components and their requirement; inlet and exhaust systems; Fuel injection- Fuel injectors and mixture formation, Ignition- Ignition energy; Combustion in SI and CI engine; Abnormal combustion-Knocking, Knock Control, Injection control in diesel engines to control knock, Octane and Cetane Numbers- Combustion chambers; Engine cooling, lubrication, turbo charging; Engine performance and testing.

Unit 4 (Battery Storage and Electric Motor): Battery Energy Storage: Battery basics, Parameters, Battery Modeling, Thermal management of battery, Battery Pack Management.
Electric Motor and Drives: DC Machines, Three Phase AC Machines, PM Machines, Switched Reluctance Machines, AC and DC drives, SRM Drives, Control of AC Machines.

Unit 5 (Emission formation in Hybrid and Electric Vehicle): Hydrocarbons, CO, NOx, intermediate compound formation, pollutant formation on incomplete combustion, effects of design and operating variables on emission formation in SI and CI engines, Emission effects on health and environment, Emission inventory, ambient air quality monitoring, Emission controlling methods.

Unit 6 (Hybrid Vehicle Control Strategy): Vehicle Supervisory Controller, Mode selection strategy, Series- Parallel 2x2 hybrid modes, Modal control strategies.

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3								1			3		1
CO-2	3	3			1		2			1			3	2	1
CO-3	3	3			2					1			3	2	1
CO-4			3				2			1			3	2	1
CO-5			3		1		1						3	1	
CO-6	3		3		1		1							1	
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		35
Demonstrations		05
1.Demonstration using Videos	03	
2. Demonstration using Physical Models / Systems	02	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		05
1. Case Study Presentation	02	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	03	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

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

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		**Component 2: SEE (40% Weightage)**
Subcomponent Type ▶	**Terms Tests**	**Assignments**	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4	x	x	x
CO-5	x	x	x
CO-6		x	x

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	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	Assignment, Laboratory Demonstrations
7.	Group Work	Assignment
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Class Room Interaction
13.	Information Management	Assignment, Examination
14.	Personal Management	Assignments
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. Husain, I., (2013), Electric and Hybrid Vehicle. CRC Press.
3. Stone, R., (2012), Introduction to Internal Combustion Engine, 4th Edition, Palgrave Macmillan
4. Heywood, J. H., (1988), Internal Combustion Engine Fundamentals, McGraw Hill education.

b. Recommended Reading

1. Cenegal Y. A. and Boles M. A., (2004), Thermodynamics an Engineering Approach, Tata

McGraw Hill

2. Chris MI and Masrur, A., (2010), Hybrid Electric Vehicle, Wiley
3. Ramalingam K. K., (2007), Internal Combustion Engines, 3rd Edition, SciTech Publications

c. Magazines and Journals

1. SAE International Journal of Fuels and Lubricants
2. SAE International Journal of Engines

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d. Websites

1. www.engr.colostate.edu/~allan/heat_trans/page1/page1.html

e. Other Electronic Resources

1. NPTEL Videos and Digital Library

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Course Specifications: Theory of Machines and Mechanism

Course Title	Theory of Machines and Mechanisms
Course Code	ASC302A
Course Type	Core Theory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to prepare the students to perform the kinematic and dynamic analysis of planar mechanisms and accomplish the desired motion. The students are taught to apply concepts for machine dynamics, dynamic effects on performance accuracy, stability and efficiency of machines. Students are also taught the effect of unbalanced masses in reciprocating and rotating machinery. Students will be able to choose the appropriate mechanism for a given engineering application.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Automotive and Aeronautical 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 commonly used planar, spatial mechanisms and illustrate various constraints
- **CO-2.** Explain various principles used for kinematic and dynamic analysis of machines, and construction of cam profiles for desired motion
- **CO-3.** Solve simple problems to calculate the inertia forces at various joints, balancing force, gyroscopic forces using analytical and graphical methods
- **CO-4.** Analyze mechanisms for kinematic and dynamic properties like displacement, velocity, acceleration, force and torque
- **CO-5.** Perform static and dynamic balancing of rotating and reciprocating masses and assess the influence of gyroscopic effect
- **CO-6.** Solve complex problems to calculate inertia forces at various joints, balancing force and gyroscopic forces using appropriate method for a given application

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4. Course Contents

Unit 1 (Introduction of Mechanisms and Machines):

Concepts of Kinematics and Dynamics, Mechanisms and Machines, Planar and Spatial Mechanisms, Kinematic Pairs, Kinematic Chains, Kinematic Diagrams, Kinematic Inversion, Four bar chain and Slider Crank Mechanisms and their Inversions, Degrees of Freedom, Mobility and range of movement - Kutzbach and Grubler's criterion, Number Synthesis, Grashoff's criterion, D'Alembert principle and inertia forces

Unit 2 (Analysis of Mechanisms):

Position analysis (Analytical Techniques): Loop closure (Vector Loop) representation of linkages, Position analysis of four bar, slider crank and inverted slider crank mechanisms, coupler curves, demonstration of mechanisms using MSc Adams.

Velocity and Acceleration Analysis: Relative velocity method, Velocity and Acceleration Diagrams, Instantaneous Centre of Velocity, Coriolli's component of acceleration

Unit 3 (Cams and Followers):

Introduction: Classification of cams and followers, nomenclature, displacement diagrams of follower motion. Determine of basic dimensions and synthesis of cam profiles using graphical methods, cams with specified contours

Unit 4 (Force Analysis of Machinery):

Static Forces in Machines, force acting on links, static force analysis of mechanisms, dynamic force analysis of mechanisms, equivalent dynamical system, inertia forces in machines, engine force analysis

Unit 5: (Balancing of Machinery and Gyroscopic Effects):

Dynamics of Rotating Bodies, unbalance effects and balancing of inertia forces, balancing of rotating masses, balancing of several masses rotating in the same plane, balancing of several masses rotating in different planes, balancing of reciprocating masses, balancing techniques.

Gyroscopic Effects: Concept of gyroscopic action, typical examples on gyroscopic effect, gyro scopic stabilization, gyroscopic effect on airplanes

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

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		35
Demonstrations		07
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	02	
3. Demonstration on a Computer	03	
Numeracy		18
1. Solving Numerical Problems	15	
Practical Work		
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. (Aerospace Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		**Component 2: SEE (40% Weightage)**
Subcomponent Type ▶	**Terms Tests**	**Assignments**	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4	x	x	x
CO-5		x	x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

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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. R.L. Norton (2004), Design of Machinery, McGraw-Hill

b. **Recommended Reading**
   1. J.J Uicker, G.R. Pennock, J.E. Shigley (2003), Theory of Machines and Mechanisms, Oxford University Press
   2. Charles E. Wilson J. Peter Sadler (2003), Kinematics and Dynamics of Machinery, Prentice Hall
   3. David H. Myszka (2011), Mechanics of Machines, Pearson Education, 4th Edition

c. **Magazines and Journals**
   1. Mechanism and Machine Theory, Elsevier

d. **Websites**
   1. Appropriate website related to course

e. **Other Electronic Resources**
   1. NPTEL Videos and Digital Library

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Course Specifications: Design of Automotive Components

Course Title	Design of Automotive Components
Course Code	AUC303A
Course Type	Core Theory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is aimed at making the students to understand the design procedures for automotive components. Students are taught to design engine, transmission, driveline, brake, suspension and chassis components. Students will be able to design the above said components for a given class of vehicle.

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	Automotive and Aeronautical 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 design procedure for automotive components
- **CO-2.** Design engine components
- **CO-3.** Design transmission and driveline components
- **CO-4.** Design brakes and chassis component
- **CO-5.** Design leaf spring and coil spring
- **CO-6.** Perform the design of automotive components for a given class of vehicle

4. Course Contents

Unit 1 (Introduction to design procedure of automotive components): General procedure in machine design, design considerations, methodology for solving design of machine component problems, factor of safety, load analysis

Unit 2 (Design of engine): Design of Engine Components: Design of piston, piston rings, connecting rod, crankshaft, valves and camshaft

Unit 3 (Design of transmission and driveline components): Design of transmission components: Design of flywheel, clutch plate, pressure plate and gear teeth, gear box
Design of driveline components: Design of drive shaft, propeller shaft, bearing
Design of Joints: Knuckle and Cotter Joints, Keys, Chains, Belt

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Unit 4 (Design of brakes and chassis): Design of brakes: Energy equations, brake formulas, heat dissipation, design of drum brake and disc brakeDesign of chassis: Load cases, design considerations for chassis and chassis design

Unit 5 (Design of leaf spring and coil spring): Functions of spring, types of springs, spring materials, coil spring design, springs in series, springs in parallel, equivalent stiffness, coil spring design, leaf spring design

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	3	2
CO-2	3	3	3			3	3	2	2				3	3	2
CO-3	3	3	3			3	3	2	2				3	3	2
CO-4	3	3	3			3	3	2	2				3	3	2
CO-5	3	3	3			3	3	2	2				3	3	2
CO-6	3	3	3			3	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		16
Demonstrations		04
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	01	
3. Demonstration on a Computer	00	
Numeracy		40
1. Solving Numerical Problems	40	
Practical Work		
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**

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

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

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4	x	x	x
CO-5		x	x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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9. **Course Resources**

   a. **Essential Reading**
      1. Class Notes
      2. R. B. Gupta (2000), Auto Design, Satyaprakasan Publishers
      3. PSG College of Technology (2012), Design Data Hand Book , Kalaikathir Achchagam

   b. **Recommended Reading**
      1. Newton and Steeds (2004), Motor Vehicle, SAE Publishers
      2. Mahadevan, K ; Balaveera Reddy, K, Design Data Handbook, Edition 3
      3. Lingaiah K, Machine Design Data Handbook Vol I & II, Suman Publishers

   c. **Magazines and Journals**
      1. Mechanism and Machine Theory, Elsevier
      2. Automotive Engineering International
      3. International Journal of Vehicle Mechanics and Mobility, Taylor and Francis
      4. SAE Journals

   d. **Websites**
      1. www.sae.org

   e. **Other Electronic Resources**
      1. NPTEL Videos and Digital Library

10. **Course Organization**

Course Code	AUC303A		
Course Title	Design of Automotive Components		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	+91-80-4906-5555
		E-mail:	hod.aae.et@msruas.ac.in
Course Specifications Approval Date		26-Sep-2022	
Next Course Specifications Review Date		June-2026	

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Course Specifications: Automotive Noise, Vibration and Harshness

Course Title	Automotive Noise, Vibration and Harshness
Course Code	AUC304A
Course Type	Core Theory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with the application of FEM to analyze and conduct physical experiments related to noise and vibration. Students are taught experimental methods to analyze modal characteristics of automotive components and systems. Students will be able to perform analysis and physical tests using available tools and data acquisition system to extract modal characteristics for components and systems. Students also frequency and transient FE analysis including selection of materials, application of loads and boundary condition to validate the design of given structure / automotive components subjected to vibrations

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	Automotive and Aeronautical Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (CO)

After undergoing this course students will be able to:

CO 1	Describe sources of vibration, noise, harshness in vehicles, effect on occupants and NVH testing procedures
CO 2	Explain the methodologies to compute the various parameters such as displacement, velocity, acceleration, mode shapes for a given system
CO 3	Explain the concepts of signal and systems analysis in solving NVH issues
CO 4	Solve simple numerical problems to compute the parameters such as amplitude of displacement, velocity, acceleration and sound pressure level
CO 5	Discuss the influence of parameters on noise and vibration propagation in vehicles
CO 6	Suggest suitable test procedures to acquire NVH data for a given class of vehicles

4. Course Contents

Unit 1 (Introduction): Introduction to noise, vibration and harshness, source, path and receiver concepts, effects of vibration and noise on vehicle occupants, importance of Time domain and frequency domain.

Unit 2 (Measurement of Noise, Vibration): Measurement of amplitude of Displacement, Velocity, acceleration scale and their correlation, Pressure measurement and relation to decibel scale, A-weighted scaling.

Unit 3 (Natural Frequency and Mode shapes) Characteristics; Node, anti-Node, Mode Shape, Natural frequencies, Excitation frequencies or operating frequencies, Frequencies of Interest.

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Unit 4 (Single and Multi-degree of Freedom Systems) : Single Degree of Freedom (SDOF), Two-DOF, Multi-DOF systems- examples, governing system from maximum energy principle; solution for eigenvalues and eigenvectors; normal modes and transformation; modal participation.
Unit 5 (Signal and System Analysis): Concepts of Signal and System analysis in solving NVH related problems in automotive, frequency response function; transmissibility, absorption and isolation. NVH testing- instrumentation, data acquisition systems, signal processing. Demonstration of NVH data acquisition and processing in car, correlation between noise and vibration signals and case studies.

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	2											3		
CO-2	3	3	1	2									3	2	
CO-3	3	3		2									3	2	
CO-4	3	3											3		
CO-5	3	3	1										3		
CO-6	3	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		40
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		--
1. Course Laboratory	30	
2. Computer Laboratory	00	
3. Engineering Workshop / Course Workshop	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,		10
Total Duration in Hours		55

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7. Course Assessment and Reassessment

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

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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9. Course Resources

a. Essential Reading

1. Class notes
2. W.T. Thomson, Marie Dillon Dahleh, 2008, Theory of Vibration with Applications, 5th Edition, Pearson.
3. M. L. Munjal, Noise and vibration control. Vol. 3. World Scientific, 2013.

b. Recommended Reading

1. Leonard Meirovitch, 1986, Elements of Vibration Analysis, McGraw Hill
2. Matthew Harrison ,2004, Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles, U.S.A., SAE International
3. Xu Wang, 2010, Vehicle noise and vibration refinement, New York, CRC

c. Magazines and Journals

1. Journal of Sound and Vibration, Elsevier Publ.
2. SAE Journals

d. Websites

1. https://www.bksv.com
2. http://www.ni.com/en-in.html

e. Other Electronic Resources

1. NPTEL Videos and Digital Library

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Course Specifications: Artificial Intelligence and Machine Learning

Course Title	Artificial Intelligence and Machine Learning
Course Code	AAC305A
Course Type	Core Theory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

The course on Artificial Intelligence and Machine Learning deals with the principles of Artificial Intelligence and their applications to autonomous vehicles 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)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Automotive and Aeronautical 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 application of AI in autonomous vehicles; communicating, perceiving and acting

CO-5. Explain principles of localization, tracking and control with a focus on examples from Autonomous Vehicle /Self-driving cars

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4. Course Contents

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

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

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

Unit 4 (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 (Applications): Communicating, Perceiving and acting; Perception; Robotics: Robot Hardware, Robot Perception, Planning Movements, Robotic Software Architecture. Localization, tracking and control with a focus on examples from Robotics/Self-driving 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	3	3	3										3	1	
CO-2	3	3	3										3	2	
CO-3	3	3	3		3								3	3	
CO-4	3	3	3	1	3	2	2				1	1	3	3	1
CO-5	3	3	3	1		2						1	3	2	1
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	00	
3. Demonstration on a Computer	03	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop	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. (Automotive Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		**Component 2: SEE (40% Weightage)**
Subcomponent Type ▶	**Terms Tests**	**Assignments**	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

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 Stuart J.Russell, Peter Norvig(2015), Artificial Intelligence, A Modern Approach, 4th edition

b. **Recommended Reading**

1 Daniel Prokhorov, (2008), Computational Intelligence in Automotive Applications, Springer.

c. **Magazines and Journals**

1 IEEE journals for Machine learning and Artificial intelligence

d. **Websites**

1 www.jimr.com

e. **Other Electronic Resources**

1 NPTEL Videos and Digital Library

10. Course Organization

Course Code	AAC305A		
Course Title	Artificial Intelligence and Machine Learning		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	+91-80-4906-5555
		E-mail:	hod.aae.et@msruas.ac.in
Course Specifications Approval Date		26-Sep-2022	
Next Course Specifications Review Date		June-2026	

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Course Specifications: Control System Engineering and Laboratory

Course Title	Control System Engineering and Laboratory
Course Code	AAC306A
Course Type	Core Theory with Laboratory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

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

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:1
Total Hours of Interaction	75
Number of Weeks in a Semester	15
Department Responsible	Automotive and Aeronautical Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Explain the basic concepts of control system and associated terminologies
- **CO-2.** Develop mathematical models of mechanical systems and determine their transfer functions
- **CO-3.** Discuss time and frequency response analysis and stability of a system
- **CO-4.** Design controller for a system and analyse performance of the system
- **CO-5.** Perform stability analysis for a given system and interpret results
- **CO-6.** Apply control system techniques to a given application and analyse the response for suitability of design using standard software

4. Course Contents

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

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

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

Unit 4 (Stability Analysis): Characteristic equation, Necessary and sufficient conditions, Routh – Hurwitz criteria of stability. Stability analysis of closed loop systems using standard software tool.

Unit 5 (Controller Design): ON/OFF, proportional, integral, derivative, proportional integral, proportional integral derivative controllers their transfer function and physical examples. Design of P, PI and PID controllers for an automotive system using MATLAB.

Unit 6 (Root locus Method): Root locus plots and determination of time response specification and system gain stability Analysis of closed loop system using Root Locus method.

Unit 7 (Frequency Response Analysis): Introduction to Bode plots, sketching individual Bode components, Bode plots of complex transfer functions, Gain margin, Phase margin, Stability analysis.

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3												3		
CO-2	3	3	3										3		
CO-3	3	3											3		
CO-4	3	1	3		2								3		
CO-5	3	3			2								3	2	
CO-6	3	3	3		2								3	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		15
1. Solving Numerical Problems	15	
Practical Work		30
1. Course Laboratory	30	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**85**

7. Course Assessment and Reassessment

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

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

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For Combined Courses (Theory + Laboratory)					
Focus of COs on each Component or Subcomponent of Evaluation					
Course Outcome	CE (Weightage: 60 %) Four components including one Lab component			SEE (Weightage: 25 %)	Lab (Weightage: 15 %)
	Tests (30 %)	Written Assignments+ Lab (20 %)	Assignment +Lab CE (10%)	Written exam	LSEE: SEE
CO-1	x	x	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	x		x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
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 M. Gopal, 2002, Control Systems: Principles and Design, Tata McGraw-Hill Education

b. **Recommended Reading**

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

2 Katsuhiko Ogata, (2010), Modern Control Engineering, Prentice Hall

c. **Magazines and Journals**

1 International Journal of Control

2 IEEE Control Systems Magazine

d. **Websites**

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

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Course Specifications: Automotive Power Train Laboratory

Course Title	Automotive Power Train Laboratory
Course Code	AUL307A
Course Type	Laboratory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course imparts the knowledge of relationship between various thermodynamic properties and their effect on conversion of energy in practical. Students are trained on methods to determine fuel properties like flash point, fire point, carbon residue and calorific value. Students will be able to measure the heat transfer rate using conduction and convection principles. Students are trained to conduct the experiment, measure the properties and analyse the performance including heat balance for IC engine.

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	Automotive and Aeronautical Engineering
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Plan the experimental setup to achieve the stated aim

CO-2. Conduct experiments as per the standard procedures and tabulate the measured values

CO-3. Calculate the required parameters and plot the results

CO-4. Interpret, compare with standard results and draw conclusions.

CO-5. Write the laboratory report as per prescribed format.

4. Course Contents

Sl. NO	Name of the Experiment
1	Determination of fuel properties like flash and fire point, calorific value and carbon residue
2	Performance testing of IC engines- petrol or diesel
3	Performance testing of refrigeration
4	Construction of heat balance sheet for IC engines
5	Measurement of flame speed
6	Exhaust gas analysis using a gas analyser
7	Heat transfer through of metal rod/ composite walls
8	Heat transfer coefficient for natural/forced convection
9	Determination of effectiveness of cross-flow heat exchanger
10	Demonstration of Wankel engine

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

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

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		0
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	0	
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		0
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	
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. (Automotive Engineering) 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 and SC2), COs are assessed as illustrated in the following Table.

For Laboratory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Conduct of Experiments	Laboratory Report + Viva	Laboratory SEE
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	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 Report
12.	Behavioral Skills	--
13.	Information Management	Laboratory Report
14.	Personal Management	Laboratory Work
15.	Leadership Skills	---

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9. Course Resources

a. Essential Reading

1. Laboratory Manual
2. Cengel, Y.A. and Boles, M.A., (2011), Thermodynamics an engineering approach (SI units).Tata McGraw-Hill Education Pvt. Ltd.

b. Recommended Reading

1. Borgnakke, C. and Sonntag, R. E., (2010), Fundamentals of Thermodynamics. Wiley-India
2. Holman J. P., (2008), Heat transfer, McGraw-Hill, Inc.

c. Magazines and Journals

1. SAE Journals
2. AutoCar
3. OverDrive

d. Websites

e. Other Electronic Resources

1. NPTEL Videos and Digital Library

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Course Specifications: Kinematics and Dynamics Simulation Laboratory

Course Title	Kinematics and Dynamics Simulation Laboratory
Course Code	AUL308A
Course Type	Laboratory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

The course aim is to impart practical knowledge about kinematic and dynamic analysis of various mechanisms. Students are taught to develop joints, apply motions and forces using appropriate software. Students are trained to perform kinematic analysis to analyse the position, velocity and acceleration for mechanical linkages of different mechanisms for automotive applications. In addition dynamic analysis will be performed to evaluate the forces and torque at joints.

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	Automotive and Aeronautical 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. Construct mechanisms to perform kinematic and dynamic analysis.

CO-2. Perform kinematic analysis for the given mechanisms through Multi-Body Dynamics (MBD) simulation.

CO-3. Perform dynamic analysis of various mechanisms through MBD simulation.

CO-4. Analyse the results and draw conclusions.

CO-5. Write laboratory report as per the prescribed format.

4. Course Contents

Sl. No	Name of the Experiment
1	Introduction to kinematics and dynamic analysis, ADAMS/VIEW GUI
2	Modelling rigid bodies, adding joints, motions and forces, importing cad models to ADAMS software
3	Kinematic analysis of four bar mechanism, slider crank mechanism, quick return mechanism, scotch yoke mechanism, toggle mechanism, elliptic trammel mechanism, steering mechanism, watt's link mechanism, kinematic analysis of gears
4	Dynamic analysis of slider crank mechanism, excavator, CAM follower mechanism, spring mass damper system, rotating masses
5	Performing kinematic and dynamic analysis of mechanisms related to automotive applications

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

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	3	2	3		2			3	2	2	3	3	3
CO-2	3	3	3	2	3		2			3	2	2	3	3	3
CO-3	3	3	3	2	3		2			3	2	2	3	3	3
CO-4	3	3			3					3			3	3	3
CO-5										3			0	0	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		0
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	0	
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		0
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	
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. (Automotive Engineering) 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 and SC2), COs are assessed as illustrated in the following Table.

For Laboratory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Conduct of Experiments	Laboratory Report + Viva	Laboratory SEE
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	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 Manual
10.	Verbal Communication Skills	Viva Voce
11.	Presentation Skills	Laboratory Report
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. R. L. Norton (2004), Design of Machinery, McGraw-Hill Hill International

b. **Recommended Reading**
   1. K. J. Waldron and G. L. Kinzel, 1999, Kinematics, dynamics and design of machinery, John-Wiley and Sons.
   2. Charles E. Wilson and J. Peter Sadler, 2003, Kinematics and Dynamics of Machinery, 3rd edition, Prentice Hall.

c. **Magazines and Journals**
   1. Journal of Mechanisms, Elsevier
   2. Mechanism and Machine Theory, Elsevier

d. **Websites**
   1. www.mscsoftware.com

e. **Other Electronic Resources**
   1. NPTEL Videos and Digital Library

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Course Specifications: Vehicle Body Engineering and Crashworthiness

Course Title	Vehicle Body Engineering and Crashworthiness
Course Code	AUC311A
Course Type	Core Theory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with vehicle body engineering and safety systems available in automotive vehicle. This course facilitates the students to understand the various aspects of vehicle body components, design, manufacturing and assembly of components to build the body of vehicles. Students are also taught the various safety systems in automotive vehicle such as seatbelts, Airbag, ABS and TCS, and their importance to protect the occupants in vehicle. Students will be able to design the body of the vehicle by adopting appropriate method.

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	Automotive and Aeronautical 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 types of body structures, aerodynamics design aspects, driver seat, safety systems used in different Vehicles.

CO-2. Explain the influence of geometric modifications and add on devices to improve the aerodynamic performance of road vehicles.

CO-3. Explain the concept generation through Gemba study, ideation sketches and style boards in vehicle body design process.

CO-4. Discuss the effect of body design on performance and safety of the vehicle and driver visibility on vehicle Safety.

CO-5. Develop geometric models, detailed design, mock up models and visualize the vehicle concepts.

CO-6. Select the vehicle body construction and design process for a given specification of vehicle.

4. Course Contents

Unit 1 (Car Body and Bus Body Details): Types of Car body - Saloon, convertibles, Limousine, Estate Van, Racing and Sports car —Car body construction-Various panels in car bodies, Design aspects of Car body – Construction method. Types of bus body: based on capacity, distance travelled and based on construction.– Bus body lay out for various types, Types of metal sections used – Regulations – Constructional details: Conventional and integral.

Visibility regulations, driver's visibility, improvement in visibility and tests for visibility. Driver seat design.

Unit 2 (Commercial and Off-Road Vehicle): Types of commercial vehicle bodies - Light commercial vehicle body. Construction details of commercial vehicle body - Flat platform body, Trailer, Tipper body and Tanker body – Dimensions of driver's seat in relation to controls – Drivers cab design – Regulations.

Body Materials, Trim, Mechanisms and Body Repair: Types of materials used in body construction-Steel sheet, timber, plastics, GRP, properties of materials. Body trim items-body mechanisms. Corrosion: Anticorrosion methods, Modern painting process procedure-paint problems.

Unit 3 (Safety Concepts and Crashworthiness): Introduction to Federal Motor Vehicle Safety Standards (FMVSS), BS Regulations, Crashworthiness, Active safety: driving safety, conditional safety, perceptibility safety, operating safety, passive safety: exterior safety, interior safety, deformation behaviour of vehicle body speed and acceleration characteristics of passenger compartment on impact. Safety and Warning Equipments in vehicle. Calculation of impact forces on driver with and without seat belts, Airbag working principle and simple numerical on airbag

Unit 4 (History of automotive aerodynamics and body design: Evolution of automobiles, automotive body development, borrowed shapes, era of streamlines, one volume body and bathtub body concepts, present and future trends in body design, Introduction to Vehicle exterior and body shapes: Aerodynamic body design approaches: conservative design and Robust design

Unit 5 (Aerodynamic forces and Moments: Aerodynamic Drag force, lift force and Side forces, aerodynamic coefficients, Aerodynamic moments, cross-wind sensitivity, pressure and velocity distribution around vehicle bodies, center of pressure, Factors affecting aerodynamic performance, Aerodynamic stability Aerodynamic design of Road vehicles: Aerodynamic body design for passenger cars, commercial vehicles, sports vehicles, motorcycles, slip streaming, car and caravan combinations, complete body optimization of vehicles, soiling effect in road vehicles, Aerodynamics and fuel consumption relationship

Unit 6 (Automotive body design and styling process): Detailed design of the concepts, tape drawing, package drawing, Geometric modeling, rendering, visualizations, model studios-physical models, clay modeling, color and trim, presentation, ergonomic consideration, Reverse engineering and 3d printing

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

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For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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9. Course Resources

a. Essential Reading

1. Course notes
2. Powloski, G J., 1998, Vehicle Body Engineering, Business Books Ltd.
3. Bernard, 2003, Road Vehicle Aerodynamics, 4th edition, SAE International
4. Julian Happian Smith, 2002, An Introduction to Modern Vehicle Design, Butterworth - Heinemann, Reed Educational and Professional Publishing Ltd
5. Automotive Hand Book. BOSCH

b. Recommended Reading

1. Sydney F page , 1956, Body Engineering, London, Chapman & Hall Ltd, London
2. Ulrich Seiffert, Lothar Wech, 2003, Automotive Safety Handbook, SAE International,
3. Braithwaite, J.B., 1997, Vehicle Body building and drawing, London, Heinemann Educational Books Ltd.
4. David Lewis, 1984, Pencil Drawing Techniques, Watson-Guptill Publications
5. Tumminelli, P., 2011, Car design Europe: myths, brands, people, teNeues.
6. Nigel Cross, 2008, Engineering Design Methods: Strategies for Product Design, Wiley

c. Magazines and Journals

1. SAE Journals
2. Over Drive
3. AUTOCAR
4. AutoToday

d. Websites

1. http://auto.howstuffworks.com/automobile.htm
2. www.carbodydesign.com
3. https://www.nhtsa.gov/staticfiles/rulemaking/pdf/FMVSS-QuickRefGuide-HS811439.pdf

e. Other Electronic Resources

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

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Course Specifications: Finite Elements Analysis

Course Title	Finite Elements Analysis
Course Code	AAC312A
Course Type	Core Theory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with theory and practice of finite element analysis for engineering applications. Students will be taught direct methods of formulating the finite element problem as well as more advanced techniques based on virtual work, variational methods, and weighted residual methods. Common 1D, 2D, and 3D elements are discussed in the context of structural and thermal analysis. Students will be able to choose the appropriate method of FEA for given engineering 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	Automotive and Aeronautical Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After undergoing this course students will be able to:

CO-1. Describe the need, requirements, element types, loads, boundary conditions, modeling procedure, and analysis type for performing FE analysis

CO-2. Explain the concepts of discretization, convergence requirements, analytical and numerical methods required to solve engineering problems using FE Analysis

CO-3. Derive governing equations, stiffness matrix using various methods for different types of elements.

CO-4. Solve simple numerical problems in structural and thermal applications using finite element methods

CO-5. Discuss the selection of elements, analysis, and boundary condition for given engineering application

CO-6. Perform FE analysis for given aerospace components and assess the results

4. Course Contents

Unit 1 (Introduction to Finite Element Analysis): Methods to solve engineering problems-Analytical, Numerical and experimental methods, FEA in Design and Analysis of a Component, need of numerical methods in engineering, Significance of FEM, Approximate Method vs. Exact Method, Principle of Minimum Potential Energy, Origin of FEM, Principle of FEM, Classification of FEM, Types of Analysis-Linear, Non Linear, static, dynamic, harmonic, thermal, CFD, Crash Analysis.

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Unit 2 (Review of Solid Mechanics): Degrees of Freedom, Rigid Body Motion, Discrete Structures, Continuum Structures, Material Properties, Stress and Strain at a Point, Equilibrium Equations, Generalised Hooke's law, Stress –Strain relations for plane stress and plan strain conditions, Strong form and weak form solutions, General Variational methods in elasticity problems, variational formulation in FEA, Rayleigh-Ritz Method, and Galerkin Method- Significance and Examples.

Unit 3 (FEM/FEA concepts): An overview of finite element methods and its applications, steps in FEM approach with examples, stiffness matrix properties, mesh generation algorithms: Methods/techniques for structured and unstructured mesh generation, use of symmetry, higher order elements versus refined mesh, element aspect ratio. Element stiffness, Different approaches for element formulation, Use of energy approach for element formulation, Local, global stiffness, Shape functions and natural coordinates, Gauss Quadrature, convergence requirements of shape functions, shape functions by Lagrange method, Linear and quadratic elements, 1D/2D/3D/Bending/Other special elements. Element selection (kind, type, size, order), Representation of geometry, Application of loads, Representation and application of boundary conditions, h-method and p-method of analysis.

Unit 4 (Linear Static Structural analysis): Basic structural (stiffness) problem, Discretized structural problem, FE approach for structural problem, Idealization, Terminology, Requirement for representation of stiffness of discrete structural components, Basic Strength of Materials and its importance in carrying out the FE analysis, iso parametric, sub parametric and super parametric element formulation, methods of handling boundary conditions- elimination approach and penalty method, application of FEM to bars and trusses.

Unit 5 (Dynamic Analysis): Static versus Dynamic analysis – loads and response, Dynamics and Vibration, Types of problems in dynamic analysis – Modal, Transient, Harmonic, Inclusion of dynamic forces in finite element methodology, Solution methodologies for dynamic problems, Time Integration.

Unit 6 (Thermal Analysis): Physics of heat transfer, Governing equations for heat transfer and structural problems, Extension of FE methodology for structures to thermal problems, "Loads" and boundary conditions for thermal 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											3		
CO-2	3	3											3		
CO-3	3	3											3		
CO-4	3	3	1										3		
CO-5	3	3	1										3	2	
CO-6	3	3	1										3	2	1
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		5
1. Demonstration using Videos	3	
2. Demonstration using Physical Models / Systems	0	
3. Demonstration on a Computer	2	
Numeracy		20
1. Solving Numerical Problems	20	
Practical Work		
1. Course Laboratory	0	
2. Computer Laboratory	0	
3. Engineering Workshop / Course Workshop	0	
4. Clinical Laboratory	0	
5. Hospital	0	
6. Model Studio	0	
Others		5
1. Case Study Presentation	5	
2. Guest Lecture	0	
3. Industry / Field Visit	0	
4. Brain Storming Sessions	0	
5. Group Discussions	0	
6. Discussing Possible Innovations	0	
Term Tests, Laboratory Examination / Written Examination, Presentations		10
Total Duration in Hours		70

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

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

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For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4	x	x	x
CO-5		x	x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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9. Course Resources

a) Essential Reading

1. Class Notes
2. Chandrupatla, T.R. and Ashok D. Belegundu, 2012, Introduction to Finite Elements in Engineering, New Delhi, PHI
3. Singeresu S. Rao, 2013, The Finite Element Method in Engineering, Butterworth-Heinemann
4. Huei-Huang Lee, 2018, Finite Element Simulations with ANSYS Workbench 18, SDC Publications

b) Recommended Reading

1. O.C. Zienkiewicz, 2005, The Finite Element Method, Tata McGraw-Hill
2. John O. Dow, 1999, A unified approach to FEM and Error Analysis Procedures, Academic Press
3. J.N. Reddy, 1993, An Introduction to the Finite Element Method, McGraw-Hill International Edition

c) Magazines and Journals

1. Finite Elements in Analysis and Design, Elsevier
2. International Journal of impact engineering, Elsevier
3. Computers and structures, Elsevier
4. Journal of Computational and Applied Mathematics, Elsevier

d) Websites

1. www.mece.ualberta.ca
2. http://myweb.ncku.edu.tw/~hhlee/Myweb_at_NCKU/ANSYS18.html
3. https://confluence.cornell.edu/display/SIMULATION/ANSYS+Learning+Modules
4. http://www.andrew.cmu.edu/course/24-ansys/problems.htm#Section1

e) Other Electronic Resources

1. http://nptel.ac.in/courses/112106135/
2. http://community.wvu.edu/~bpbettig/MAE456/

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Course Specifications: Vehicle Dynamics and Handling

Course Title	Vehicle Dynamics and Handling
Course Code	AUC313A
Course Type	Core Theory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with ground vehicle dynamic response and engineering methods required to achieve desired vehicle behaviour. The students will be taught the principles of longitudinal and lateral load transfer and their effect on vehicle behaviour. The underlying concepts and design methods for vehicle performance, ride and handling will be dealt in detail. The student will be able to test a ground vehicle on road to analyse performance, ride and handling behaviour of the vehicle.

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	Automotive and Aeronautical 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 vehicle dynamics metrics like performance, ride and handling
- **CO-2.** Explain various design parameters considered for achieving desired performance, ride and handling characteristics
- **CO-3.** Discuss suspension design requirements for achieving improved handling and ride characteristics
- **CO-4.** Solve problems related to load transfer, acceleration performance, braking performance, suspension system, steering system, Handling and Vehicle ride
- **CO-5.** Propose design requirements for enhanced performance, ride and handling
- **CO-6.** Instrument, Test the automotive systems and present the results for performance, ride and handling

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4. Course Contents

Unit 1 (Introduction to Vehicle Dynamics): Metrics of vehicle dynamics, terminologies, GG diagram, Forces acting on vehicle axles, longitudinal and lateral load transfer, estimating load on individual wheel, gradeability, Worked Example based on vehicle specifications and design calculations

Unit 2 (Acceleration and Braking Performance): Acceleration Performance: Ideal engine characteristics, Need for transmission system, Transmission design to improve acceleration performance, Effect of power to weight ratio on acceleration performance, Calculations on acceleration performance

Braking Performance: Braking fundamentals, deceleration, time to stop, stopping distance, brake types, brake fading, panic braking, braking force calculations, wheel locking, brake proportioning, antilock brakes, calculations related to braking system

Unit 3 (Vehicle Handling): Introduction to vehicle handling, Derivation of steer angle vs lateral acceleration, Significance of understeer gradient, Neutral steer, Understeer and Oversteer characteristics, Calculations related to vehicle handling, ESP

Unit 4 (Suspension and Steering System): Suspension system: Need for suspension, rigid axle suspension, Independent suspensions, Design requirements of a suspension system, Roll Centre, Roll Axis, Roll Moment, Roll Moment Distribution and Setting Roll Centre Height , Squat and dive and designing suspension linkages for anti-squat, anti-dive, anti-pitch, Calculations related to suspension system

Steering system: Ackermann principle for vehicle steering, Steering systems and steering errors, Steering geometries, camber, Toe, Caster, Steering axis inclination, scrub radius, Thrust angle, Steering system performance-central feel, steering returnability, steering ratio, steering effort, Calculations related to steering system

Unit 5 (Vehicle Ride): Excitation Sources, Ride Rate and Vehicle natural frequency, Damping coefficient and variable damping ratio, Quarter car models and response analysis, Vehicle pitch and roll analysis, Olley criteria, Calculation related to vehicle ride

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

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6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		06
1. Demonstration using Videos	04	
2. Demonstration using Physical Models / Systems	02	
3. Demonstration on a Computer	00	
Numeracy		24
1. Solving Numerical Problems	24	
Practical Work		
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. (Automotive Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		**Component 2: SEE (40% Weightage)**
Subcomponent Type ▶	**Terms Tests**	**Assignments**	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4	x	x	x
CO-5		x	x
CO-6		x	
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and 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. Thomas D. Gillespie (1992), Fundamentals of Vehicle Dynamics, SA

b. **Recommended Reading**
   1. W. Milliken and D. Milliken (1995), Race Car Vehicle Dynamics, SAE.
   2. Reza N Jazar (2007), Vehicle Dynamics, Theory and Applications, Springer

c. **Magazines and Journals**
   1. International Journal of Vehicle Mechanics and Mobility, Taylor and Francis
   2. International Journal of Vehicle Systems Modelling and Testing, Inderscience Publishers
   3. SAE Journals

d. **Websites**

e. **Other Electronic Resources**
   1. NPTEL Videos and Digital Library

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Course Specifications: Computational Intelligence in Automotive Applications

Course Title	Computational Intelligence in Automotive Applications
Course Code	AUC314A
Course Type	Core Theory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

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

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Automotive and Aeronautical 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 underlying concepts of fuzzy systems, evolutionary computation, swarm intelligence and artificial immune systems.

CO-2. Explain the various algorithms of computational intelligence.

CO-3. Compare and contrast the use of different Computational Intelligence techniques to achieve particular functionalities.

CO-4. Discuss the performance issues of CI algorithms.

CO-5. Suggest a typical Computational Intelligence algorithms for given automotive engineering application(s).

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4. Course Contents

Unit 1 (Introduction to CI): Pitfalls of traditional artificial intelligence, Definitions and nomenclature, Fundamental elements of Computational Intelligence(CI), A brief review of CI paradigms, Synergism in CI. Performance issues of CI algorithms and suitability of CI algorithms for desired functionalities.

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

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

Unit 4 (Swarm intelligence (SI)): Particle swarm optimization algorithm, bacterial foraging algorithm, artificial honeybee algorithm, ant colony optimization algorithm, recent trends in SI, variants and hybrids of SI algorithms, implementation considerations and applications such as driver work load estimation, visual monitoring of Driver attention, pedestrian safety , Engine control, AFR estimation

Unit 5 (Neural networks): Introduction, basic principles and structures, Perceptron, Madaline, back propagation, Recurrent back propagation, neural networks in automotive application

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		
CO-2	3	3	3										3		
CO-3	3	3	3										3		
CO-4	3	3	3										3		
CO-5	3	3	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		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		10
1. Course Laboratory	00	
2. Computer Laboratory	10	
3. Engineering Workshop / Course/Workshop	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. (Automotive Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		**Component 2: SEE (40% Weightage)**
Subcomponent Type ▶	**Terms Tests**	**Assignments**	
CO-1	x		x
CO-2	x		x
CO-3	x	x	x
CO-4		x	x
CO-5		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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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	Assignments, Laboratory Demonstrations
7.	Group Work	Assignments
8.	Self-Learning	Assignments
9.	Written Communication Skills	Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Class Room Interaction
13.	Information Management	Assignments, Examination
14.	Personal Management	Assignments
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course Notes
2. Engelbrecht, A. P. (2007). Computational intelligence: An introduction. Chichester, England, John Wiley & Sons
3. Eberhart, R. C. (2007). Computational Intelligence: Concepts to Implementations. San Francisco, CA, USA, Morgan Kaufmann Publishers Inc
4. Daniel Prokhorov, (2008), Computational Intelligence in Automotive Applications, Springer,

b. Recommended Reading

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

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c. **Magazines and Journals**
   1. IEEE journal for computational i219intelligence
   2. SAE Journals

d. **Websites**

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

e. **Other Electronic Resources**

1. NPTEL Course Materials

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Course Specifications: Engineering Economics

Course Title	Engineering Economics
Course Code	AAC315A
Course Type	Core Theory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with various aspects of engineering economics applicable to aerospace engineering. Students are taught to compute the cost required for production of aerospace components. Students are also taught about the importance of depreciation, maintenance and replacement cost related to economic life of an asset.

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	Automotive and Aeronautical 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 various costs, cash flow and cost estimation methods
- **CO-2.** Explain various factors in value engineering and depreciation methods
- **CO-3.** Discuss influence of interest rate, maintenance and replacement cost on economic life of an asset
- **CO-4.** Estimate the production cost for aerospace/automotive vehicle component
- **CO-5.** Compare the methods for evaluation of depreciation
- **CO-6.** Compute the total cost required for making the aerospace or automotive component / subsystem from concept to product

4. Course Contents

Unit 1 (Introduction to Economics):

Flow in an economy, Law of supply and demand, Concept of Engineering Economics –Engineering efficiency, Economic efficiency, Scope of engineering economics- Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis- V ratio, Elementary economic Analysis –Material selection for product Design selection for a product, Process planning.

Unit 2 (Value Engineering):

Make or buy decision, Value engineering – Function, aims and procedure. Interest formulae and their

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applications –Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor equal payment series capital recovery factor-Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods

Unit 3 (Cash Flow):

Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods.

Unit 4 (Replacement and Maintenance Analysis):

Introduction to replacement and maintenance analysis – Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset – capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely.

Unit 5 (Depreciation):

Introduction, Straight line method of depreciation, declining balance method of depreciation-Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation-Evaluation of public alternatives- introduction, Examples, Inflation adjusted decisions – procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset.

Unit 6 (Cost Estimation): Types of estimates – methods of estimates – data requirements and sources- collection of cost- allowances in estimation, Elements of cost. Estimation of material cost, labor cost and over heads, allocation of overheads, Calibration of hourly rates, tooling material and stock part costs. Cost estimation for aerospace components.

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3												3		
CO-2	3						1						3	1	
CO-3	3												3		2
CO-4		3									2		3		1
CO-5		3									2		3	1	1
CO-6		3									2		2	3	1
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		35
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		05
1. Solving Numerical Problems	05	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		05
1. Case Study Presentation	05	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B.Tech. (Mechanical Engineering) the Programme Specifications document.

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

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For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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Course Specifications: Vehicle Simulations Laboratory

Course Title	Vehicle Simulations Laboratory
Course Code	AUL316A
Course Type	Laboratory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to give exposure to the students on various virtual simulation techniques used during product development cycle of automobiles. The students will be trained to use commercially available software to evaluate vehicle dynamics response and aerodynamic response of cars and trucks. The students are also trained to create concept car sketches, build physical models and conduct physical experiments to evaluate the aerodynamic performance using wind tunnel test facilities. The students are given exposure to understand the procedure for conducting impact and crash simulations.

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	Automotive and Aeronautical 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. Generate concept car sketches, build physical model of car and understand the procedure for conducting impact and crash simulations.

CO-2. Build scaled mockup model through form exploration process using model making materials.

CO-3. Conduct the experiment on scaled model car to measure drag force, lift forces using low speed wind tunnel.

CO-4. Perform CFD simulation of external flow over different geometric shapes and car body for the evaluation of aerodynamic forces and moments.

CO-5. Evaluate performance, handling and ride characteristics of passenger car by performing vehicle dynamics simulations

CO-6. Write laboratory report as per the prescribed format.

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4. Course Contents

Sl. No.	Name of the Experiment
1	**Concept sketching and physical modeling**: Generate concept car sketches, Development of Physical model using model making materials
2	**CFD simulation**: Overview, exploring CFD pre processer and solver, CFD simulation on different geometric shapes and evaluation of aerodynamic forces and moments, Demonstration of CFD simulation of external flow over car body and evaluation of aerodynamic forces and moments
3	**Wind tunnel testing**: Study of Wind tunnel test setup and instrumentation, Aerodynamic performance test on scaled model car and measurement of drag force, lift force and their co-efficient using wind tunnel
4	**Evaluating Vehicle Dynamics using commercial available Software**: Virtual model creation, Evaluation of performance, handling and ride of passenger car and trucks using full vehicle analysis, suspension analysis and four poster analysis
5	**Impact simulation**: Demonstration of examples on impact and crash 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		2	3		1	2	2					3	2	2
CO-2	3			3			2	2	2		3		3	2	3
CO-3				3										3	3
CO-4		3	3		3	2	3		2				3	3	3
CO-5		3	3		3	2	3		2		3			3	
CO-6										3					3
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

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6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		0
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	0	
Practical Work		30
1. Course Laboratory	30	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		0
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	
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. (Automotive Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

For Laboratory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Conduct of Experiments	Laboratory Report + Viva	Laboratory SEE
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4	x	x	x
CO-5	x	x	x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and 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	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 Manual
10.	Verbal Communication Skills	Viva Voce
11.	Presentation Skills	Laboratory Report
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. Tony Lewin, Ryan Borroff (2011), How to Design Cars Like a Pro, Motorbooks
3. Bernard (2003), Road Vehicle Aerodynamics, 4th edition, SAE International
4. Barlow J. B., Rae, W. H. and Pope, A. (1999), Low-Speed Wind Tunnel Testing, 3rd edition, New Delhi, Wiley India
5. Michael Blundell, Damian Harty (2004), Multibody Systems Approach to Vehicle Dynamics, 1st edition, Elsevier Butterworth-Heinemannl

b. **Recommended Reading**
1. Joseph Katz. (1995), Race Car Aerodynamics, Robert Bentley Publishers.
2. Nigel Cross (2008), Engineering Design Methods: Strategies for Product Design, Wiley
3. Dorling Kinderslay (2011), Car – The definitive visual history of the automobile, 1st edition, DK publications

c. **Magazines and Journals**
1. Autocar India

d. **Websites**
1. www.mscsoftware.com
2. www.carbodydesign.com

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e. **Other Electronic Resources**
   1. NPTEL Videos and Digital Library

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Course Specifications: CAE Practices for Aerospace Applications

Course Title	CAE Laboratory
Course Code	AUL317A
Course Type	Laboratory
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with the application of FEM to analyse the mechanical properties of given structure using FEA tools. Students will be taught various FE analysis including selection of materials, application of loads and boundary condition to assess the design of given structure / aerospace components. Students will be able to validate the design by performing FE analysis using CAE tools such as MSC Natran / MSC Patran.

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	Automotive and Aeronautical 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. Understand the importance and basics of finite element modelling and analysis procedures.

CO-2. Perform the different kinds of analysis and apply the basic principles to find out the stress and other related parameters.

CO-3. Carry out dynamic analysis and finding natural frequencies for various boundary conditions and also analyze with forcing function.

CO-4. Interpret, compare with standard results and draw conclusions.

CO-5. Write the laboratory report as per prescribed format.

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4. Course Contents

Sl. No	Name of the Experiment
1	Stress Analysis in Bars of Constant Cross-sectional Area
2	Stress Analysis in Stepped Bar with various cross section
3	Analysis of different beams with different loading conditions
4	Analysis of 3D Truss and frames
5	Stress Analysis of a Rectangular Plate with a Circular Hole
6	Stress Analysis of a 3D model of an automotive component
7	Modal Analysis for Frequency Determination
8	Harmonic Analysis of Cantilever Beam
9	Dynamic Analysis of automotive vehicle components
10	Heat Transfer Analysis of Piston and Cylinder wall

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	3	3	3		3					1			3	3	1
CO-3	3	3	1		3					1			3	3	1
CO-4	3	3	3		1					1			3	1	1
CO-5					2					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		0
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	0	
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		0
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	
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. (Automotive Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

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For Laboratory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Conduct of Experiments	Laboratory Report + Viva	Laboratory SEE
CO-1	x	x	x
CO-2	x		x
CO-3	x		x
CO-4	x		x
CO-5		x	x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	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 Manual
10.	Verbal Communication Skills	Viva Voce
11.	Presentation Skills	Laboratory Report
12.	Behavioral Skills	--
13.	Information Management	Laboratory Manual
14.	Personal Management	--
15.	Leadership Skills	Laboratory Work

9. Course Resources

a. Essential Reading

1. Course notes
2. J.N. Reddy, 1993, An Introduction to the Finite Element Method, McGraw-Hill International Edition
3. Huei-Huang Lee, 2018, Finite Element Simulations with ANSYS Workbench 18, SDC Publications

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b. Recommended Reading

1. Robert Bosch (2007) Automotive Electrics Automotive Electronics Systems and Components, England, John Wiley & Sons Ltd.

c. Magazines and Journals

1. Finite Elements in Analysis and Design, Elsevier
2. International Journal of impact engineering, Elsevier
3. Computers and structures, Elsevier
4. Journal of Computational and Applied Mathematics, Elsevier

d. Websites

1. www.mscsoftware.com
2. http://nptel.ac.in/

e. Other Electronic Resources

1. NPTEL Videos and Digital Library

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Course Specifications: Seminar

Course Title	Seminar
Course Code	AUS311A
Course Type	Seminar
Department	Automotive and Aeronautical 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	Automotive and Aeronautical 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

Indicative list of topics:

Sl. No.	Name of the Topic
1	Food Security
2	Energy Crisis
3	National Water Management
4	Cyber-warfare
5	Genetically modified food
6	Technology innovation
7	Non-Proliferation Treaty (NPT)
8	MSME and National Economy
9	Right to Information (RTI) Act, Right to Educate (RTE)
10	FDI
11	Corporate Social Responsibility
12	Work Life Balance
13	Political Stability and National growth
14	Demography
15	Impact of Science and Technology on society

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	3	2	2			2	2	3	1	1	3	2	3
CO-2	3	3	3	2	2			2	2	3	1	1	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		0
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		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		30
1. Case Study Presentation	26	
2. Guest Lecture	00	
3. Industry / Field Visit	06	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		2
	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. (Automotive Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2), 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: Internship Report (SEE) (50% Weightage)
Subcomponent ▶	SC1	
Subcomponent Type ▶	Presentation	50
Maximum Marks ▶	50	
CO-1	× ×	×
CO-2	× ×	×
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. Jerry Weissman, Presenting to Win
2. Cliff Atkinson, Beyond Bullet Points
3. Bruce R. Gibrielle, Speaking Powerpoint
4. Garr Reynolds, Presentation Zen Design

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b. **Recommended Reading**
   1. Based on the topic choosen

c. **Magazines and Journals**
   1. Based on the topic choosen

d. **Websites**
   1. Based on the topic chosen

e. **Other Electronic Resources**
   1. Relevant resources available in RUAS Library

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Course Specifications: Autonomous Vehicles and Future Mobility

Course Title	Autonomous Vehicles and Future Mobility
Course Code	AUE311A
Course Type	Professional Core Elective
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with autonomous vehicle and future mobility technologies. The course facilitates the students to identify, understand working and functional requirements of autonomous vehicle and their sub systems along with control and performance. Students are taught various mobility technologies such as energy storage devices, limitation and future trends. Students will be able to select the appropriate autonomous vehicle for given requirements

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	Automotive and Aeronautical 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 need, requirements, configuration of autonomous vehicles, energy storage devices and their subsystems.

CO-2. Explain autonomous driving algorithms, localization, perception, prediction and routing.

CO-3. Discuss the influence of various factors on autonomous vehicle selection, performance and future trends.

CO-4. Discuss the impact of autonomous vehicle on environment and society.

CO-5. Select the suitable configuration of autonomous vehicle for specified user requirements.

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4. Course Contents

Unit 1 (Autonomous vehicle and future mobility solutions): Introduction, historical background and evolution, Current global scenario, connected and automated vehicle deployment, Future mobility scenarios, Challenges, Limitations

Autonomous Vehicle : AV Types & Configuration: Pure Electric Vehicles, Hybrid Electric Vehicles, Plug in Hybrid Electric Vehicles, Autonomous driving client systems : Robot Operating Systems (ROS), Hardware Platform , Autonomous driving cloud platform.

Unit 2 (Energy Storage Devices): Need, Working and specifications of Batteries, Flywheels, Super capacitors

Unit 3 (Autonomous Driving): Technologies and Algorithms, Sensing, Perception, Object Recognition and tracking, action. Autonomous Vehicle Localization: Localization with GNSS, LiDAR and HD Maps, Visual odometry, Dead Reckoning and Wheel Odometry, Sensor Fusion.

Perception in Autonomous Driving: Introduction, datasets, detection, segmentation, Stereo, Optical Flow and Scene Flow, Tracking

Prediction and Routing: Planning and control, Traffic prediction, Lane level routing,

Decision, Planning and Control: Behavioral decisions, Motion Planning, Feedback control: Bicycle model, PID Control

Unit 4 (Demand Analysis and Willingness to use New Mobility Concepts): Demand-responsive transport, study design and approach, results.

Unit 5 (Stake holder engagement in mobility planning): Policies, incentives and innovative mobility concepts, the impact of various forms of flexible working on mobility and congestion estimated empirically. Public sector facilitation of cargo bike operation to improve the city logistics, Impact of electric vehicles on environment and society.

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			1	1	1		2	1	1	3	2	2
CO-2	3	3	3			2	2			2	1	1	3	2	2
CO-3	3	3	3			2	2						3	2	0
CO-4	3	3	3			2	2	2		1			3	2	3
CO-5	3	3	3					2		2	1	1	3	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		40
Demonstrations		05
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	03	
Numeracy		0
1. Solving Numerical Problems	0	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		15
1. Case Study Presentation	10	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	05	
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. (Automotive Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		**Component 2: SEE (40% Weightage)**
Subcomponent Type ▶	**Terms Tests**	**Assignments**	
CO-1	x		x
CO-2	x		x
CO-3	x	x	x
CO-4		x	x
CO-5		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

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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. Shahosan Lui et al, 2018, Creating Autonomous Vehicle System, Morgan and Claypool Publishers,
3. Pierluigi Coppla, Domokos E K., 2019, Autonomous Vehicle and Future Mobility, Elsevier

b. Recommended Reading

1. Seref Soylu, Electric Vehicles – The Benefits and Barriers, Croatia, InTech
2. Iqbal Husain (2003) Electric and Hybrid Vehicles: Design, New York Washington, D.C, CRC Press

c. Magazines and Journals

1. SAE Journals
2. CHARGED EVs
3. Autovolt
4. GREENFLEET

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d. Websites

1. https://www.sae.org
2. https://www. auto.howstuffworks.com/electriccar.htm
3. https://www.youtube.com/channels/electric vehicles

e. Other Electronic Resources

1. Digital electronic resources available in RUAS Library

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Course Specifications: Automotive Control Systems

Course Title	Automotive Control Systems
Course Code	AUE312A
Course Type	Professional Core Elective
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is designed to impart the concepts of control systems deployed in automotive vehicle. Student will be taught various control systems in automotive vehicle including Engine, drive line, suspension control. Students will be able to assess and analyze the influence of various parameter on the performance on control system in automotive vehicle.

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	Automotive and Aeronautical Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (CO)

After undergoing this course students will be able to:

CO 1	Describe the requirements, basic design process of automotive control system
CO 2	Explain the concepts of Powertrain control systems and factors influencing the performance
CO 3	Explain the control of hybrid vehicle and vehicle stability control systems
CO 4	Discuss the recent trends in intelligent transportation systems
CO 5	Discuss the control system for vehicle safety
CO 6	Develop the control systems for given automotive applications.

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4. Course Contents

Unit 1 (Introduction: Motivation, background and overview): Automotive Control System Design Process: Identifying the control requirements, Review of engine modeling, vehicle dynamics, human factors and driver modeling

Unit 2 (Powertrain Control Systems): Air Fuel Ratio Control, PI control of First order system with delay; Control of Spark timing: Knock control, Idle speed control, Transmission control: ETCS, Clutch control and AWD

Unit 3 (Control of Hybrid Vehicle): Series, Parallel, and Split configuration, Hybrid Vehicle control Hierarchy, Control concepts for Series, Parallel, Hybrid, Split Hybrid, Feedback based supervisory control for PHEVs

Unit 4 (Vehicle Control Systems): Cruise and Headway control, Autonomous Cruise Control (ACC), Antilock brake and traction control systems: Modeling, ABS and Traction control

Unit 5 (Vehicle Stability control): Linear vehicle model, Non-linear vehicle model and VSC Design principles; Four-wheel steering, Active Suspension: Optimal active suspension for SDOF and Two-DOF Models, Optimal active suspension with state estimation

Unit 6 (Intelligent Transport System): Advanced Traffic Management system, Advanced Traveler information systems, Advanced vehicle control systems, Preventing collisions: Active safety Technologies, Collision detection and avoidance, Longitudinal Motion control and Platoons, Automated steering and lateral control, Lane sensing

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3											3	2	
CO-2	3	3											3	2	
CO-3	3	3											3	2	
CO-4	3	3											3	2	
CO-5	3	3	1										3	2	
CO-6	3	3											3	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		40
Demonstrations		05
1. Demonstration using Videos	03	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	02	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination / Written Examination, Presentations		10
Total Duration in Hours		70

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

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

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For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	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	Assignment, Laboratory Demonstrations
7.	Group Work	Assignment
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Class Room Interaction
13.	Information Management	Assignment, Examination
14.	Personal Management	Assignments
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. A Galip Ulosy, Huei Peng, 2012, Automotive Control System, Cambridge University Press

b. Recommended Reading

3. Uwe Kniecke. Lara Neilson, 2005. Automotive Control Systems, Springer

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c. **Magazines and Journals**
   4. IEEE Journals
   5. SAE Journals

d. **Websites**
   1. www.sae.org

e. **Other Electronic Resources**
   1. NPTEL Videos and Digital Library

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Course Specifications: Lightweight and Novel Materials

Course Title	Light Weight and Novel Materials
Course Code	AUE313A
Course Type	Professional Elective Course
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with lightweight materials used in automotive industry to reduce the weight and thereby improve environmental protection. Students will gain knowledge about different structural and functional materials, their manufacturing process and joining strategies, nondestructive testing, used in automotive components/systems. Students will be able to select suitable materials and manufacturing process for the given application.

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	Automotive and Aeronautical 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 importance, need, principles, properties and usage of light weight metals, alloys, polymers and ceramics for automotive applications.

CO-2. Explain the concepts, properties and application of composite materials for automotive applications.

CO-3. Discuss the various functional materials used for sensors and actuators and smart structures.

CO-4. Evaluate different forming operations, joining strategies for lightweight materials.

CO-5. Discuss Non-Destructive Testing (NDT) techniques used for determining flaws / defects.

CO-6. Select suitable materials and manufacturing processes for given applications.

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4. Course Contents

Unit 1 (Introduction to Light Weight Materials): Strategies used for fuel efficiency; Categories of lightweight materials; Properties of materials; Ferrous and Nonferrous materials: Different strategies used for light weight steels, Advanced High strength steels, Maraging steel, Al, Mg, Ti and Super alloys: properties and applications, Inter-metallic.

Unit 2 (Ceramics, Polymers and rubbers): Types of ceramics and its uses; Properties of polymers and rubbers and its uses; Processing of Polymers and rubbers: Injection molding, extrusion, blow molding, compression molding, foam molding, calendaring, thermoforming; Ceramic processing like slip casting, gel casting, tape casting and powder metallurgy.

Unit 3 (Composites): Classification of composites; like Polymer Matrix Composites (PMCs), Metal Matrix composites (MMCs) and Ceramic Matrix Composites (CMCs), Properties and uses of composites; Advantages and drawbacks, Processing of composites.

Unit 4 (Functional and Smart Materials): Introduction to smart materials, Magneto and electrorheological materials, different type of sensor and actuator materials used in aircraft systems and their principles, advances in functional materials, smart materials.

Unit 5 (Non Destructive Testing (NDT): Introduction and requirement of NDT for aerospace systems; Principles and techniques involved in different NDTs like Liquid penetrant techniques, Magnetic Particle Inspection, eddy current, ultrasound, radiography, Advantages and limitations of different NDTs, Applications of NDT.

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	0	0
CO-2	3	2	3										3	0	0
CO-3	3	2	3										3	0	0
CO-4	3	3	3			1	1	1		1			3	1	1
CO-5	3	3	2	2									3	2	
CO-6	3	3	3				1	1		1			3	1	1
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		45
Demonstrations		10
1. Demonstration using Videos	10	
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	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. (Automotive Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		**Component 2: SEE (40% Weightage)**
Subcomponent Type ▶	**Terms Tests**	**Assignments**	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
CO-6		x	x

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
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. M. F. Ashby, H. Shercliffn and D. Cubon, 2007, Materials Engineering Science, Processing and Design, Butterworth Publications
3. Sendijarevic V., Klempner, D., 2004, Handbook of polymeric foams and foam technology, 2nd edition, Munich, Hanser

b. Recommended Reading

1. Serope Kalpakjian and S. R. Schmid, 2003, Manufacturing Engineering and Technology, Pearson Education
2. W. D. Callister, 2005, Materials Science and Engineering an Introduction, John Wiley & Sons

3. K. U. Krainer, 2006, Metal Matrix Composites, Wiley-VCH, VerlagGmbH and Co.
4. J. A. Brydson, 1999, Plastic Materials, Butterworth-Hein2mann

c. Magazines and Journals

1. Automotive Engineering - SAE International
2. Reinforced Plastics

d. Websites

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

e. Other Electronic Resources

1. NPTEL Videos and Digital Library

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Course Specifications: Additive Manufacturing

Course Title	Additive Manufacturing
Course Code	MEE314A
Course Type	Professional Core Elective
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

The course deals with Additive Manufacturing (AM) processes to development of engineering (aerospace, energy, automotive, medical, industry and consumer) products. The students are taught with the concept of AM, various AM technologies, selection of materials for AM, AM processes and their applications in various fields. The student will be able to understand the AM process plan, including building strategies and post-processing. Students are trained on geometric transformation techniques, stereolithography (STL) file manipulation for the AM component and test the program through simulation. Emphasis is given to AM processes, their significance and application areas. Fused Deposition Modelling (FDM) as an example of AM process will be demonstrated. Students will be also trained to carry out reverse engineering and rapid prototyping processes to develop the engineering components.

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	Automotive and Aeronautical 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 importance, principles, and applications of additive manufacturing
CO-2. Select and discuss suitable additive manufacturing process based on material and component features
CO-3. Suggest and explicate methods for enhancement of accuracy, surface finish and structural properties for a given component
CO-4. Outline design guidelines for additive manufacturing
CO-5. Create CAD model and generate STL file for a given component

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4. Course Contents

Unit 1 (Introduction to Additive Manufacturing): Overview, need and importance of additive manufacturing process in product development, materials for additive manufacturing technology
Design for AM: Motivation, DFMA concepts and objectives, AM unique capabilities, Exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers etc.

Unit 2 (Steps involved in designing for additive manufacturing): CAD model preparation, part orientation and support generation, model slicing and tool path generation.
Guidelines for process selection: Introduction, selection methods for a part, challenges of selection, example system for preliminary selection, production planning and control

Unit 3 (Classification of AM processes): Liquid polymer system, Discrete particle system, Molten material systems and Solid sheet system. Liquid based and solid based additive manufacturing systems: Working principle, process characteristics, surface finish, compatibility, advantages and applications of Stereolithographic Apparatus (SLA), Fused Deposition Modeling (FDM) and Laminated Object Manufacturing

Unit 4 (Powder based additive manufacturing systems): Working principle, process characteristics, surface finish, compatibility, advantages and applications of three dimensional printing, Laser Engineered Net Shaping (LENS), Electron Beam Melting (EBM)
Challenges in additive manufacturing: Errors in prototyping, Support material removal methods, curing procedure, accuracy and surface finish enhancement, assembly of components, machining strategy, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques

Unit 5 (Non Destructive Testing (NDT): Introduction and requirement of NDT for aerospace systems; Principles and techniques involved in different NDTs like Liquid penetrant techniques, Magnetic Particle Inspection, eddy current, ultrasound, radiography, Advantages and limitations of different NDTs, Applications of NDT

Unit 6 (Design for Additive Manufacturing): Part orientation; Removal of supports; Hollowing out parts; Manufacturing constraining features; Interlocking features; Reduction of part count in an assembly. Applications of additive manufacturing: Engineering and Original Equipment Manufacturer (OEMs), Biomedical applications- implants and prosthesis, Future direction in additive manufacturing, Case studies: Aerospace, Energy, Medical, Industry, Automotive and Consumer products

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

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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		10
1. Demonstration using Videos	10	
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. (Aerospace Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

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For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x	x	x
CO-4		x	x
CO-5		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
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. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2014

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b. Recommended Reading

1. Ian Gibson, "Software Solutions for Rapid Prototyping", Professional Engineering Publishing Limited, UK, 2002.
2. Chua Chee Kai, Leong Kah Fai, "Rapid Prototyping: Principles & Applications", World Scientific, 2003
3. Ali K. Kamrani, Emand Abouel Nasr, "Rapid Prototyping: Theory & Practice", Springer, 2006.
4. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer, 2001.

c. Magazines and Journals

1. Additive Manufacturing
2. Progress in Additive Manufacturing
3. 3D Printing and Additive Manufacturing

d. Websites

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

e. Other Electronic Resources

1. NPTEL Videos and Digital Library

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Course Specifications: Probability and Statistics

Course Title	Probability and Statistics
Course Code	MTE301A
Course Type	Professional Core Elective
Department	Automotive and Aeronautical 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

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4. Course Contents

Unit 1 (Random variables and Discrete Probability Distributions): Discrete and continuous. Definitions, illustrations and properties of random variables, univariate transformations with illustrations. Probability density function, cumulative distribution function, expected values, variance and their properties. 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															

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

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

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Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x	x	x
CO-4		x	x
CO-5		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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

b. **Recommended Reading**

5. Vijay K. Rohatgi, A. K. Md. Ehsanes Saleh, An Introduction to Probability and

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Statistics, Wiley
6. Harold J. Larson, Introduction to Probability Theory and Statistical Inference, John Wiley & Sons
7. Hogg, Tannis, Rao, 1997, Probability and Statistical Inference, 7h Edition Pearson Publication
8. Pradeep Kumar Sahu. Santi Ranjan Pal, Ajit Kumar Das, 2015, Estimation and inferential Statistics, Springer International Publishing A.G.
9. 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/

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Course Specifications: Advanced Mathematics

Course Title	Advanced Mathematics
Course Code	MTE302A
Course Type	Professional Core Elective
Department	Automotive and Aeronautical 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												

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

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

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For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x	x	x
CO-4		x	x
CO-5		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

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

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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/

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Course Specifications: Sensing and Control for Autonomous Vehicles

Course Title	Sensing and Control for Autonomous Vehicles
Course Code	AUE411A
Course Type	Professional Core Elective
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to impart knowledge on principles and applications of automotive sensors and control systems in autonomous vehicles. This course facilitates the students to identify, understand the working, functional requirements, applications of sensors, and control used in various systems. Students are taught interfacing of sensors and actuators to microcontrollers for development of electronic control systems and in-vehicle networking concepts.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
Total Hours of Interaction	60
Number of Weeks in a Semester	16
Department Responsible	Automotive and Aeronautical Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (CO)

After undergoing this course students will be able to:

CO-1	Describe the need for sensors and control, their role in autonomous Vehicle
CO-2	Explain the construction, working principle and applications of various types of sensors and actuators used in autonomous vehicles
CO-3	Explain the features of automotive microcontrollers and various interfacing techniques, networking protocols and their applications
CO-4	Discuss the features of Maps and Path Planning in autonomous vehicles
CO-5	Suggest electronically controlled system configuration for a given function in autonomous vehicles

4. Course Contents

Unit 1 (Introduction): Background in Autonomy in cars – Components of Autonomy: Sensor, Actuators, communication, Intelligence, Historical development, recent appearances in market. The Role of control in Autonomous Systems- Feedback: Speed control using Point Mass and Force Stopping, Swerving, Advanced Cruise Control, Steering control: Open Loop and Closed Loop commands, Polynomial Tracking, need of command sequencing

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Unit 2 (Sensor, Estimation and Sensor Fusion): Sensor Characteristics, Vehicle Internal State sensing: OEM Vehicle sensors, GPS, Inertial measurements, Magnetic Compass; External World Sensing: Radar, LIDAR, Image processing sensor,
Estimation: Introduction to Kalman Filter, Example: Vehicle Tracking, Crash Avoidance
Sensor Fusion: Vehicle localization, External environment sensing, Occupancy Maps and an off-Road Vehicle, Cluster Tracking and an On-Road Urban Vehicle
Situation Awareness: Structure of a Situation analysis module, Road and Lane Model Generation, Intersection Generation, Primitives.

Unit 3 (Microcontrollers): Microcontrollers used in automotive applications, specifications, features. Overview of architecture of a typical automotive microcontroller. Applications and selection criterion.

Unit 4 (Interfacing of Sensors and Actuators): Interfacing requirements of various types of sensors and actuators.
Control Applications, sensor selection, actuator selection, interfacing methods / techniques for typical sensors and actuators.
Overview of Control Application Development: Case Studies on control applications in engine, transmission and chassis systems. Body electronic applications. ACC, ABS, Steering control, Parking

Unit 5 (In-vehicle Networking): Need for in-vehicle networking, overview of common vehicle networking protocols. V2V, v2G, Communication Technologies, Typical applications.

Unit 6 (Maps): Map Databases : Raster Map Data, Vector Map Date, Utilizing Map Data
Path Planning : Path Planning in an Off-Road Environment, An Off-Road Grid based Path Planning algorithm, Other approaches,

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	2	0
CO-2	3	3											3	1	0
CO-3	3	3											3	2	0
CO-4	3	3											3	2	0
CO-5	3	3	1										3	2	
CO-6	3	2											3	2	0
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

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

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2. Computer Laboratory	00	
3. Engineering Workshop / Course Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		
1. Case Study Presentation	10	10
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 is presented in the Programme Specifications document pertaining to the B.Tech. (Automotive Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		**Component 2: SEE (40% Weightage)**
Subcomponent Type ▶	**Terms Tests**	**Assignments**	
CO-1	x		x
CO-2	x		x
CO-3	x	x	x
CO-4		x	x
CO-5		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

1. Class Notes,
2. Umit Ozuguner et al, 2011, Autonomous Ground Vehicles, London, Artech House
3. Robert Bosch GmbH., 2007, Bosch Automotive Electrics and Automotive Electronics, Plochingen, Germany, Springer Vieweg
4. A. Galip Ulsoy, Huei Peng, 2012, Automotive Control Systems, , New York Cambridge

b. Recommended Reading

1. Thor I Fossen et al, 2017, Sensing and Control for Autonomous Vehicles, Springer
2. Uwe Kiencke, Lars Nielsen, 2005, Automotive Control Systems for Engine, Driveline, and Vehicle, New York, Springer Berlin Heidelberg
3. Robert Bosch GmbH, 2014, Bosch Automotive Hand Book, 9th Edition, SAE
4. Ronald K Jurgen, 1999, Automotive Electronics Handbook , McGraw Hill

c. Magazines and Journals

6. SAE Journals
7. Overdrive
8. Autocar India
9. Auto Today

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d. Websites

1. http://magazine.sae.org
2. http://auto.howstuffworks.com/automobile.htm
3. https://www.youtube.com/channels/automotive

e. Other Electronic Resources

1. NPTEL Videos and Digital Library

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Course Specifications: Robust Control Systems

Course Title	Robust Control Systems
Course Code	AUE412A
Course Type	Professional Core Elective
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with modelling of uncertain systems, stabilization and performance requirements for robust design using H-techniques. In this course students are taught to design robust controllers for an automotive application. Students are taught to model, simulate and analyze robust control techniques using standard software tools.

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	Automotive and Aeronautical Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (CO)

After undergoing this course students will be able to:

CO 1 Describe norms, uncertainties and robustness measures
CO 2 Discuss the principles of stabilization, parametrization and H-design
CO 3 Develop robust design specifications for given system
CO 4 Evaluate the robust stability of the system using H-techniques
CO 5 Design robust controllers for automotive applications using standard software tool

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4. Course Contents

Unit 1 (Introduction): Vector norm, Signal norm, System norm, Modelling of Uncertain Systems - Unstructured uncertainties, Parametric uncertainty, Linear fractional transformation, Structured uncertainties

Unit 2 (Stabilization): Controller parametrization, Coprime factorization, Examples, Small gain theorem, Robust stabilization, Performance consideration, Structured singular value

Unit 3 (H-Design): Mixed sensitivity H-optimization, 2-DOF H-design, H-suboptimal solutions, Solution for normalized systems, Normalization transformation

Unit 4 (H-Loop Shaping Design): Robust stabilization against normalized coprime factor perturbations, Loop shaping design procedures (LSDP), Design example – Robust control of automotive cruise control system

Unit 5 (In-vehicle Networking): Need for in-vehicle networking, overview of common vehicle networking protocols, LIN, CAN, FlexRay, and Ethernet. V2V, V2G, Communication Technologies, Typical applications.

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	1										3		
CO-3	3	3	1										3		
CO-4	3	3	1										3		
CO-5	3	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		30
Demonstrations		05
1. Demonstration using Videos	05	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		20
1. Solving Numerical Problems	20	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	

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

7. Course Assessment and Reassessment

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

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		**Component 2: SEE (40% Weightage)**
Subcomponent Type ▶	**Terms Tests**	**Assignments**	
CO-1	x		x
CO-2	x		x
CO-3	x	x	x
CO-4		x	x
CO-5		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

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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	Class Room Lectures, Assignments
2.	Understanding	Class Room Lectures, Assignments
3.	Critical Skills	Class Room Lectures, Assignments
4.	Analytical Skills	Class Room Lectures, Assignments
5.	Problem Solving Skills	Class Room Lectures, Assignments
6.	Practical Skills	Assignments, Laboratory Demonstrations
7.	Group Work	Assignments
8.	Self-Learning	Assignments
9.	Written Communication Skills	Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Class Room Interaction
13.	Information Management	Assignments, Examination
14.	Personal Management	Assignments
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes,
2. I.R. Petersen, V.A. Ugrinovskii and A. V. Savkin, "Robust Control Design using H-infinity Methods", Springer, 2000

b. Recommended Reading

1. Kang-Zhi Lui,Yu Yao, V., 2016, Robust Control: Theory and Applications, John-Wiley Sons.
2. U, Mackenroth, 2004, Robust Control Systems: Theory and case Studies, Springer

c. Magazines and Journals

1. IEE Control System Magazine

d. Websites

e. Other Electronic Resources

1. NPTEL Videos and Digital Library

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Course Specifications: Vehicle Aerodynamics and Styling

Course Title	Vehicle Aerodynamics and Styling
Course Code	AUE413A
Course Type	Professional Core Elective
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to expose the students to use the principles of aerodynamics to design and develop streamlined aerodynamic body shapes for the road vehicles such as passenger cars, commercial vehicles, sports cars and bikes. Students will be taught the body design and styling process such as concept sketching, geometric modeling, digital rendering, and clay modeling and visualization methods. The student will also get exposure to wind-tunnel facility to evaluate the aerodynamic behavior of scaled models.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Automotive and Aeronautical Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Discuss the historical evolution of body shapes, present and future trends in body design of road vehicles, aerodynamic forces and moments acting on road vehicles.

CO-2. Apply systematic geometric modifications at the appropriate locations of body and use add on devices to improve the aerodynamic performance of road vehicles.

CO-3. Discuss the under-hood and in cabin airflow interactions for effective thermal management.

CO-4. Generate aerodynamic and aesthetically pleasing vehicle body shapes through Gemba study, ideation sketches and style boards and concept sketches.

CO-5. Develop geometric models, detailed design, mock up models and visualize the vehicle concepts.

CO-6. Analyze aerodynamic performance of vehicles using CFD solver and validate with the available test data.

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4. Course Contents

Unit 1 (History of automotive aerodynamics and body design Evolution): Automotive body development, borrowed shapes, era of streamlines, one volume body and bathtub body concepts, present and future trends in body design, Introduction to Vehicle exterior and body shapes: Aerodynamic body design approaches: conservative design and Robust design

Unit 2 (Aerodynamic forces and Moments): Factors affecting aerodynamic performance, Aerodynamic Drag force, lift force and Side forces, aerodynamic coefficients, Aerodynamic moments, cross-wind sensitivity, pressure and velocity distribution around vehicle bodies, center of pressure, Aerodynamic stability

Unit 3 (Aerodynamic design of Road vehicles): Aerodynamic body design for passenger cars, commercial vehicles, sports vehicles, motorcycles, slip streaming, car and caravan combinations, complete body optimization of vehicles, soiling effect in road vehicles, Aerodynamics and fuel consumption relationship

Unit 4 (Internal air-flow): Air flow through under hood compartment, passenger cabin air flow, under hood and passenger cabin thermal management, thermal comfort conditions for passenger, Automotive HVAC system, ASHRAE's standards

Unit 5 (Automotive Concept generation and image boards): Customer input, Gemba Study, Quality functional deployment. Product design specification, development of ideation sketches, Mood board, theme board, life style boards, bionic concepts, concept sketch creation, concept selection methods

Unit 6 (Automotive body design and styling process): Detailed design of the concepts, tape drawing, package drawing, Geometric modeling, rendering, visualizations, model studios-physical models, clay modeling, painting, presentation, ergonomic studies, Reverse engineering

Unit 7 (Aerodynamic performance test): External Aerodynamic simulation using CFD solvers, Aerodynamic road test, wind tunnel test, wind tunnel instrumentation and measuring devices. Determination of aerodynamic forces and moments, flow visualization 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										2	3		2
CO-2	3	3	2			3	3	3		3			3	3	3
CO-3	3	3	3			2	2	2		3		2	3	2	3
CO-4	3	3					2			3	2	1	3	3	3
CO-5	3	3								3			3	3	
CO-6		3								3			3	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		35
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	
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. (Automotive Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		**Component 2: SEE (40% Weightage)**
Subcomponent Type ▶	**Terms Tests**	**Assignments**	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
CO-6		x	x

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Bangalore-560058

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

Registrar
M.S.Ramaiah University of Applied Sciences
Bangalore - 560 054
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Bangalore-560054

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
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	Presentation
11.	Presentation Skills	Assignment
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. **Essential Reading**
   1. Class Notes
   2. Bernard, (2003) Road Vehicle Aerodynamics, 4th edition, SAE International
   3. Julian Happian Smith, An Introduction to Modern Vehicle Design, ButterworthHeinemann, Reed Educational and Professional Publishing Ltd, 2002

b. **Recommended Reading**
   1. Hucho W. H. (1998) Aerodynamics of Road Vehicles, 4th edition, SAE International
   2. Joseph Katz. (1995) Race Car Aerodynamics, Robert Bentley Publishers.

c. **Magazines and Journals**
   1. Automotive Engineering - SAE International
   2. ATZ Technology (International Federation of Automotive Engineering Societies)
   3. Autocar India
   4. Overdrive
   5. Automotive Engineering
   6. Top Gear

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d. Websites

1. http://www.Howautomotiveworks.com/
2. http://www.car-engineer.com/technology/
3. http://nptel.iitm.ac.in
4. http://chalmersautomotive.com/

e. Other Electronic Resources

1. Electronic resources on the course area are available on MSRUAS library
2. Videos from NTPEL
3. Discovery channel videos
4. History channel video

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Course Specifications: Data Sciences Foundation

Course Title	Data Sciences Foundation
Course Code	CSE411A
Course Type	Professional Core Elective
Department	Automotive and Aeronautical 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.

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Bangalore-560054

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

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

Faculty of Engineering and Technology
M.S. Ramaiah University of Applied Sciences
Bangalore-560058

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: Try-except block, Exception class and writing own exceptions. Filesystem and OS interface: File I/O, working with the filesystem, binary and text (Unicode) mode file data handling. Visualisation: Plotting 2D charts and plots, Surface 3D plots and Square Map plots using matplotlib and other plotting packages. Interactive visualisations: IPython notebooks, packages such as Bokeh.

Unit 3 (Libraries for Data Science Applications): Data modelling, processing and visualization packages/libraries: E.g., matplotlib and others, interactive visualisation packages, SQLAlchemy, NumPy, Pandas, SciPy, scikit-learn and statsmodels.

Unit 4 (Parallel Programming): Python support for parallel programming for data science tasks. CPU bound threads, GIL bottleneck and workarounds. Thread pooling. Process oriented parallelism: Multiprocessing communication support. Support for host based and distributed Inter Process Communication (IPC). Distributed computation: Distributed task queue, task scheduling, message transport brokers. Asynchronous operations: select, poll and epoll. Event loops. Coroutines and futures.

Unit 5 (Testing): Python Unit Testing module, Acceptance Testing of python software, Test Driven Development (TDD) and Behaviour Driven Development (BDD). Virtual environments for testing. Debugging and Python debugger, pdb.

Unit 6 (Advanced Python Programming): Functional Programming: Decorators, Context Managers, Generators and Iterators. Applications. zip and map. OO Programming: Magic methods, operator overloading, Collections, Python object model, Metaclasses, metaclass programming, inspection and other uses. Class Factories and run time attributes. Abstract Base Classes (ABCs) and protocol declaration.

Tutorials: Demonstrations and Case studies, Data Science Application design and scripting

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

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

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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		05
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	03	
Numeracy		20
1. Solving Numerical Problems	20	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		05
1. Case Study Presentation	03	
2. Guest Lecture	02	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
	Total Duration in Hours	**70**

7. Course Assessment and Reassessment

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

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

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For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	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
11.	Presentation Skills	--
12.	Behavioral Skills	Class Work, Tutorials
13.	Information Management	Assignments
14.	Personal Management	Assignments, Examinations
15.	Leadership Skills	--

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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

d. **Websites**

1. Python website: www.python.org
2. Data Science Central: www.datasciencecentral.com
3. Knowledge Discovery Nuggets: www.kdnuggets.com
4. Data Science Weekly: www.datascienceweekly.org

e. **Other Electronic Resources**

1. KDNuggets: Data Sets for Data Mining and Data Science, www.kdnuggets.com/datasets/index.html
2. Quora: www.quora.com

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Course Specifications: Optimization Techniques – 1

Course Title	Optimization Techniques – 1
Course Code	MTE401A
Course Type	Professional Core Elective
Department	Automotive and Aeronautical 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 Kuhn-Tucker 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 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

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

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x	x	x
CO-4		x	x
CO-5		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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9. **Course Resources**

a. **Essential Reading**
   1. 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

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Course Specifications: Battery Management Algorithm for Electric Vehicle

Course Title	Battery Management Algorithm for Electric Vehicle
Course Code	AUE421A
Course Type	Professional Core Elective
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with electric vehicle battery management and required algorithm for Battery Management System (BMS). Students will be taught underlying principles, theories of algorithm required for development of algorithm required for battery management in electric vehicle. Students will be able to develop, test and evaluate the algorithm for BMS.

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	Automotive and Aeronautical 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 need, requirements , methodologies, strategies of battery management System.

CO-2. Explain the various battery testing process and modeling of Battery.

CO-3. Explain the methods and procedure for Battery SOC and SOH estimation.

CO-4. Discuss the methods for Remaining Useful Life (RUL) prediction of Lithium Ion Batteries.

CO-5. Discuss the algorithm development processes for battery management using RNN.

CO-6. Develop algorithm to predict the life battery for the given specification.

4. Course Contents

Unit 1 (Overview of Battery and its management): Application requirements for batteries and Battery Management System (BMS) for different types of electric vehicles. Basic Functions of BMS, Topology of BMS, Development process of BMS.
Battery Test: Battery test platforms, Test Process, Test Data, Characteristics analysis of Battery

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Unit 2 (Modeling Theory of Lithium-Ion Batteries): Electrochemical Model, Equivalent Circuit Model, Fractional order Model : Introduction, Model Construction, Parameter Identification of Model , Case Study

Unit 3 (Battery SOC and SOH Estimation): SOC Estimation: Classification, Model based SOC Estimation Method, AEKF algorithm, HIF algorithm

SOH Estimation: Classification, Capacity estimation based on SOC estimation, Available capacity estimation method based on Response surface, SOH estimation based on ICA/DVA , Multi-timescale co-estimation of SOC and SOH.

Unit 4 (State Estimation of Battery System): Battery grouping analysis: Broom effect of battery pack, Battery pack in series and parallel, Performance analysis of typical Hybrid connected battery pack,

State Estimation of Battery Pack: Inconsistency analysis, Screening method, Quantitative methods of Inconsistency, Modeling of Battery pack, State estimation of pack based on selected cells

Unit 5 (SOP Prediction of batteries): Instantaneous SOC prediction methods, Continuous method, Joint estimation, SOP evaluation method, Remaining Useful Life prediction of Lithium Ion Batteries, Over view of RUL prediction, method, probability distribution, RUL prediction based on Box-cox transformation, based on ling Short-term memory recurrent Neural network : MSTM RNN, Prediction of LSTM RNN, Case Study. Low Temperature Heating and Optimal Charging Methods for Lithium Ion-Batteries: Classifications, AC heating Principles, Echelon AC Heating method, Battery optimal charging

Unit 6 (BM Algorithm): Development, Test and Evaluation: General Process of Algorithm development Model based V Development process, Rapid Prototype simulation test, HIL algorithm Test: System Composition, Algorithm Integration, testing and Evaluation, Vehicle experiment verification: Drum bench Test, Road Test,

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	2	2
CO-2	3	3	3										3	2	
CO-3	3	3	3										3	2	
CO-4	3	3	3										3	2	
CO-5	3	3	3										3	2	
CO-6	3	3	3										3	3	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		35
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	
3. Engineering Workshop / Course/Workshop	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. (Automotive Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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

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For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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9. **Course Resources**

   a. **Essential Reading**
      1. Course notes
      2. Rui Xeong, 2020, Battery management algorithm for Electric Vehicle, Springer

   b. **Recommended Reading**
      1. Rui Xeong, 2019, Advanced Battery Management Technologies for Electric Vehicle, Wiley

   c. **Magazines and Journals**
      1. SAE Journals
      2. https://www.mdpi.com/journal/wevj

   d. **Websites**
      1. www.infenion.com

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

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Course Specifications: Modeling, Dynamics and Control of Electrified Vehicles

Course Title	Modeling, Dynamics and Control of Electrified Vehicles
Course Code	AUE422A
Course Type	Professional Core Elective
Department	Automotive and Aeronautical Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with modeling, dynamics and control of electrified vehicle. The students will be taught the various principles of modeling of electric vehicle system to assess its performance of the EVs. Student also will be taught various control modeling approach of electric vehicle powertrain, brake blending, integration with smart grid and efficient energy management of battery used in electric vehicle.

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	Automotive and Aeronautical 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 need, requirements of Modeling, Control strategies of Electrified Vehicles (EVs)
- **CO-2.** Explain generalized dynamic control of EVs
- **CO-3.** Discuss various methods for state and parameter estimation of EVs
- **CO-4.** Discuss the modeling of fault tolerant control techniques for EVs
- **CO-5.** Discuss the transmission design and control of EVs
- **CO-6.** Estimate velocity, slip angle and other parameters for the given electric vehicle specifications

4. Course Contents

Unit 1 (Modeling, Evaluation, and state estimation of batteries): Introduction, battery modeling, Evaluation of Model accuracy, State Estimation
High Power Energy Storage System (HEES) and its application in series Hybrid Electric vehicle: Ultra capacitors, Modeling and application of HESS, Transmission Architecture and Topology design of EVS and HECS, Energy Management of HEVs

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Unit 2 (Generalized dynamic control of HEVs): Generalized Dynamic Models, Extended High Efficiency Area model, Typical applications .Transmission Design and Control of EVs: EVs equipped with IMT powertrain, problem formulation, Oscillator controller design, Simulation results. Brake-Bleeding control of EVs: Modeling, Regenerative Braking energy management strategy, Dynamic Brake-Blending Algorithm

Unit 3 (Dynamic Control of Evs): Modeling and control of EVs, Sensing and estimation, Active Safety Control, Riding energy efficiency control. Sate and Parameter Estimation of EVs: Velocity Estimation (Longitudinal and Total) , Slip angle estimation, Tire-Fore and Tire-Road Friction Co-efficient Estimation, Vehicle Mass and Road Slope – Estimation Method

Unit 4 (Modeling and Fault Tolerant control of Four wheel independent Drive EVs): Introduction, System modeling and Problem formulation, Fault Tolerant Tracking Controller Design, Simulation investigations.

Unit 5 (Integration of EVs with a Smart Grid and ISD): Introduction, Powertrain modeling, Formulation of Cost-Optimal control problem. Integrated System Design (ISD) and Energy movement of Plug-in Hybrid Vehicle: Power train modeling, Heuristic Scenarios, Emission mitigation via renewable energy integration, Optimal scenario with ISD and energy management

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3												3		
CO-2	3		3										3		
CO-3	3												3		
CO-4	3	3	3			3	2						3	2	
CO-5	3	3	3			3	2						3	3	
CO-6	3	3											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	01	
3. Demonstration on a Computer	02	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

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

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		**Component 2: SEE (40% Weightage)**
Subcomponent Type ▶	**Terms Tests**	**Assignments**	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
CO-6		x	x

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

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
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. HUI ZHANG, DONGPU CAO, HAIPING DU, 2018, Modeling, Dynamics and Control of Electrified Vehicle, Wood head Publishing

b. Recommended Reading

1. Louis Remeral Martinez, Miguel Delgado P., 2019, New Trends in Electric Vehicle Powertrain, IntechOpen Limited.

c. Magazines and Journals

1. SAE Journals - Elsevier
2. Autocar

d. Websites

e. Other Electronic Resources

1. NPTEL Videos and Digital Library

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Course Specifications: Fatigue and Fracture Mechanics

Course Title	Fatigue and Fracture Mechanics
Course Code	AUE423A
Course Type	Professional Core Elective
Department	Automotive and Aeronautical Engineering
Faculty	Faculty of Engineering and Technology

1. Course Summary

This course deals with the physical and the mathematical principles of fatigue and fracture mechanics. Students will be taught underlying principles, theories of fatigue and fracture mechanics, relationship between fatigue and crack propagation; the laws governing crack growth rate, and their application to assess the expected life of structure. Students will be able to predict the life of the given component with appropriate approach.

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	Automotive and Aeronautical Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After undergoing this course students will be able to:

CO-1. Describe the need, requirements, methodologies, strategies for fatigue based design of components and significance of fracture mechanics in design

CO-2. Explain the various fatigue theories and their application for prediction of life and fatigue

CO-3. Discuss methods and procedure of stress analysis of cracked components based on theory of fracture mechanics

CO-4. Solve simple fatigue problems based on fracture mechanics approach

CO-5. Apply different methods of fatigue analysis to design components against fatigue failure

CO-6. Estimate the life of a given component by adopting suitable methodology and validate the result with virtual simulation

4. Course Contents

Unit 1 (Overview of Fatigue): Fatigue phenomenon; loading patterns and characteristics; Overview on strategies in fatigue based design; Discussion on fatigue design criteria; Fatigue testing methodology and life prediction.

Unit 2 (Classic Fatigue Theory): Stress based fatigue theory (HCF): Wöhler-diagrams/SN-curves. Mean-stress effect. Haigh-diagram. Linear damage accumulation rules. Strain based fatigue theory (LCF). Basquin's, Coffin-Manson's and Morrow's equations. Ramberg-Osgood's equation. Cyclic plasticity- Neuber's rule

Unit 3 (Fracture Mechanics): Introduction-Significance of fracture mechanics design and displacement modes; Fracture parameters based on Linear Elastic Fracture Mechanics (LEFM) approach: Energy balance based approach and Stress (SIF, CSIF) based approach; Discussion on plane stress and plane strain conditions, thick plate and thin plate based on fracture mechanics point of view.

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Unit 4 (Stress field-based linear Fracture Mechanics): Stress intensity, fracture toughness. Applicability of linear Fracture Mechanics: Crack tip plasticity. Applicability criteria. Experimental determination of fracture toughness

Unit 5 (Fatigue Crack Growth): Paris' law. Cycle counting (Fatigue life), virtual crack growth modeling and its applications

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	2	2											3		
CO-2	3	3											3		
CO-3	3	3											3		
CO-4	3	3	1										3		
CO-5	3	3	1										3	2	
CO-6	3	3	1										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		5
1. Demonstration using Videos	2	
2. Demonstration using Physical Models / Systems	1	
3. Demonstration on a Computer	2	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		0
1. Course Laboratory	0	
2. Computer Laboratory	0	
3. Engineering Workshop / Course Workshop	0	
4. Clinical Laboratory	0	
5. Hospital	0	
6. Model Studio	0	
Others		0
1. Case Study Presentation	0	
2. Guest Lecture	0	
3. Industry / Field Visit	0	
4. Brain Storming Sessions	0	
5. Group Discussions	0	
6. Discussing Possible Innovations	0	
Term Tests, Laboratory Examination / Written Examination, Presentations		10
Total Duration in Hours		70

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

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x	x	x
CO-4	x	x	x
CO-5		x	x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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9. Course Resources

a. **Essential Reading**

1. Class notes
2. Anderson T L, 2005, Fracture Mechanics – Fundamentals and Application, Taylor and Francis Group
3. Simha K.R.Y, 2001, Fracture Mechanics for Modern Engineering Design, India, Universities Press

b. **Recommended Reading**

1. Prashant Kumar, 2009, Elements of Fracture Mechanics, New Delhi, Tata McGraw Hill
2. D. Broek, 1986, Elementary Engineering Fracture Mechanics, Dordrecht, Kluwer Academic Publishers
3. T Dahlberg, A Ekberg, 2009, Failure, Fracture, Fatigue - An Introduction, Lund, Student literature

c. **Magazines and Journals**

1. International Journal of Fatigue – Elsevier

d. **Websites**

2. http://apm.iitm.ac.in/smlab/kramesh/book_4.htm
3. http://engr.bd.psu.edu/ansysug/2007-11-20/WBEFatigue.pdf
4. http://www.ozeninc.com/default-aspii85/
5. https://caeai.com/sites/default/files/fatigue_in_ansys_0.pdf

e. **Other Electronic Resources**

1. Digital electronic resources available in RUAS Library

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Course Specifications: Data Analytics

Course Title	Data Analytics
Course Code	CSE431A
Course Type	Professional Core Elective
Department	Automotive and Aeronautical 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 mining.

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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 central tendency, 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	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

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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	01	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	03	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
	Total Duration in Hours	**70**

7. Course Assessment and Reassessment

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

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

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For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x		x
CO-4		x	x
CO-5		x	x
CO-6		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

Journal of Big Data, a Springer Open Journal

d. Websites

http://flowingdata.com/Abbott Analytics
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/yVIclRcAhxc
3. What can Business Analytics Do for You? http://youtu.be/uP89kaDU40c

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Course Specifications: Advanced Numerical Methods

Course Title	Advanced Numerical Methods
Course Code	MTE403A
Course Type	Professional Core Elective
Department	Automotive and Aeronautical 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 non-linear 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.

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

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**

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

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x	x	x
CO-4		x	x
CO-5		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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9. Course Resources

a. Essential Reading

1. 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

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Course Specifications: Optimization Techniques – 2

Course Title	Optimization Techniques – 2
Course Code	MTE402A
Course Type	Professional Core Elective
Department	Automotive and Aeronautical 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 integro-differential equations. This course focuses on optimization methods that are commonly used in modern statistical machine learning. The course will cover theory on calculus of variations such as vibrational problems involving fixed and moving boundaries. The course also introduces to linear search and algorithms like descent algorithms, Newton's method, conjugate direction methods, and quasi-Newton methods in the nonlinear case.

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

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

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Bangalore - 560 054

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**

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

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

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1	x		x
CO-2	x		x
CO-3	x	x	x
CO-4		x	x
CO-5		x	x
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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9. Course Resources

a. **Essential Reading**

1. 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

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