RAMAIAH UNIVERSITY OF APPLIED SCIENCES

M S Ramaiah University of Applied Sciences

Program Structure and Course Details

of

M. Tech. Aerospace Engineering Degree Programme

Program Code: 024

Batch: 2020 Onwards

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

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

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

Approved by the Academic Council at its 22nd ACM held on 23rd Oct 2020

Programme Specifications

M.Tech. Programme

Programme: Aerospace Engineering

Department: Automotive and Aeronautical Engineering

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Bangalore - 560 054

Faculty of Engineering and Technology

Ramaiah University of Applied Sciences

University House, New BEL Road, MSR Nagar, Bengaluru–560054

www.msruas.ac.in

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

Programme Specifications: M. Tech. (Aerospace Engineering)

Faculty	Engineering and Technology
Department	Aerospace Engineering
Programme Code	124
Programme Name	M.Tech. (Aerospace Engineering)
Dean of the Faculty	Prof. H. M. Rajashekara Swamy
Head of the Department	Prof. Raja R

1. **Title of the Award:** M.Tech. (Aerospace Engineering)
2. **Mode of Study:** Full-Time
3. **Awarding Institution /Body:** M. S. Ramaiah University of Applied Sciences, Bengaluru
4. **Joint Award:** Not Applicable
5. **Teaching Institution:** Faculty of Engineering and Technology, M. S. Ramaiah University of Applied Sciences, Bengaluru
6. **Date of Programme Specifications:** October 2020
7. **Date of Programme Approval by the Academic Council of MSRUAS:** 23-Oct-2020
8. **Next Review Date:** May 2022
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**

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The present global economic recession is showing signs of abating and India's growth story continues to hold promise. Demographically India is at a great advantage as close to half of the population are in the 14 to 35 years age group.

Aerospace sector in India has seen robust growth and most big OEMs and service sector giants can be found in here. India is home to government organisations like Defence Research and Development Organisation (DRDO), Aeronautical Development Agency (ADA), Council for Scientific and Industrial Research (CSIR), Hindustan Aeronautics Limited (HAL), and private enterprises like Boeing, Airbus, General Electric, Pratt and Whitney, SNECMA, Honeywell, Goodrich Aerospace.

Some are involved in Aerospace research and development, while others provide engineering services. Their already high annual average growth rate is likely to be boosted by the 'off-set' clause included by Government of India in all major aerospace transactions.

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High competitiveness in the airline sector has forced the manufacturers to not only continuously improve their product but also introduce cutting edge technology in their products. Aerospace industry traditionally has pushed technological boundaries in a bid to meet the ever increasing demand for faster, safer and cheaper travel. With the available experienced person power and infrastructure in the areas of fluid mechanics, structural engineering, propulsion, artificial intelligence and machine learning, the University will be able to support their requirement for advanced products.

To sustain the growth rate the organisations are in need of designers, analysts, developers, innovators, manufacturing, testing and marketing engineers as well as managers with a postgraduate degree in aerospace engineering. It is estimated that these organisations will require annually 500-600 such postgraduates for the next 5-6 years.

Aerosapce is a highly interdisciplinary programme where there is interaction between aerodynamicists, structural engineers, control system engineers, manufacturers and electronic engineers. In this situation, University gives an ideal platform for the students as they are exposed to different disciplines with artificial intelligence and machine learning, and thereby increase their breadth of knowledge in aerospace. The department is staffed with professors with extensive experience in national aerospace projects, excellent infrastructure and has developed a reputation amongst students, parents, industry and research sponsors.

The Faculty of Engineering and Technology plans for further development of Aerospace Engineering programme and compete with the best universities in the world and attract high quality graduates as well as teaching talent from all over the country and abroad.

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

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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)

M.Tech. graduates will be able to:

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

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

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

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

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

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

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

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

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

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

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

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

18. Programme Goal

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

19. Program Educational Objectives (PEOs)

The Programme educational objectives of the M.Tech. (Aerospace Engineering) Programme are:

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

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

PSO-1. Apply the knowledge and principles of aerospace design to conceptualize and develop efficient solutions to complex engineering problems through critical analysis

PSO-2. Design and develop sustainable aerospace design solutions to industry and societal requirements through applied research, concepts and techniques involving experimentation and usage of modern design and modelling tools

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

Sl. No	Course Code	Name of the Course	hours (h/W/S)			Credits	Max. Marks
			Theory	Tutorial	Practical		
1	20ASC501A	Applied Mathematics	4	0	0	4	100
2	20ASC502A	Aerodynamics	3	0	2	4	100
3	20ASC503A	Propulsion	3	0	0	3	100
4	20ASC504A	Aerospace Structures	3	1	0	4	100
5	20ASC505A	Flight Mechanics	3	0	0	3	100
6	20ASC506A	Computer Aided Engineering	3	0	2	4	100
7	20FET508A	Research Methodology and IPR	2	0	0	2	50
	20FET509A	Professional Communication	2	0	0	0	0
Total			23	1	4	**24**	**650**
Total Number of Contact Hours per Week			**29**	**Hours**			

SEMESTER 2

Sl. No	Course Code	Name of the Course	hours (h/W/S)			Credits	Max. Marks
			Theory	Tutorial	Practical		
1	20ASC507A	Artificial Intelligence and Machine Learning	4	0	0	4	100
2	20ASE5XXA	Professional Core Elective-1	4	0	0	4	100
3	20ASE5XXA	Professional Core Elective-2	4	0	0	4	100
4	20ASE5XXA	Professional Core Elective-3	4	0	0	4	100
5	20ASE5XXA	Professional Core Elective-4	4	0	0	4	100
6	20FET510A	Value Education	2	0	0	0	0
Total			22	0	0	**20**	**500**
Total Number of Contact Hours per Week			**22**	Hours			

SEMESTER 3

Sl. No	Course Code	Name of the Course	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	20ASP521A	Internship			8	4	100
2	20ASP522A	Group project			**16**	8	200
3	20ASP523A	Dissertation and Publication Phase-1					
Total					**24**	**12**	**300**
Total number of contact hours per week			**24 hours**				

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SEMESTER 4

Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	20ASP524A	Dissertation and Publication Phase-2			48	24	400
Total					**48**	**24**	**400**
Total number of contact hours per week			**48 hours**				

Professional Core Electives List					
Group ▼	Stream ▸	Aerodynamics	Propulsion	Structures	General
PCE-1	Course Code	20ASE511A	20ASE511A	20ASE512A	20ASE541A
	Course Title	Computational Fluid Dynamics	Computational Fluid Dynamics	Engineering Optimization	Stochastics Mechanics and Reliability
PCE-2	Course Code	20ASE512A	20ASE522A	20ASE531A	20ASE542A
	Course Title	Engineering Optimization	Design of Turbomachines	Fracture Mechanics and Fatigue	Aerospace Materials and Manufacturing Processes
PCE-3	Course Code	20ASE513A	20ASE523A	20ASE532A	20ASE543A
	Course Title	Hypersonic Flow	Combustion	Aircraft Structural Dynamics	Conceptual Design of Aerospace Vehicle
PCE-4	Course Code	20ASE514A	20ASE524A	20ASE533A	20ASE544A
	Course Title	Flight Dynamics and Orbital Mechanics	Launch Vehicle Design	Composite Structures	Unmanned Aerial Vehicle

Note:

1. Students are required any 4 professional core electives from the list. There is no restriction they should stick to one stream and stream is provided as an opportunity for students to choose particular

22. Course Delivery: As per the Timetable

23. 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

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24. Assessment and Grading

24.1. Components of Grading

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

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

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

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

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

24.2. Continuous Evaluation Policies

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

24.2.1 Theory Courses

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

Option 1 for a Theory Course:

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

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

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

After the four subcomponents are evaluated, the CE component marks are determined as:
CE Component Marks = (Total of the marks obtained in all the four subcomponents) ÷ 2

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

Option 2 for a Theory Course:

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

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

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

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

CE Component Marks = (Best of two Assignment Marks) + (Best of two Term-Test Marks)
Each Faculty Dean, in consultation with the heads of all departments in the Faculty and the Faculty Academic Registrar, decides whether Option 1 or Option 2 is adopted for each programme offered by the Faculty. He/she notifies the students about the option at the beginning of the semester.

24.2.2 Course Having a Combination of Theory and Laboratory

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

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

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

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

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

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

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

After the four subcomponents are evaluated, the CE component marks are determined as:
CE Component Marks = (Total of the marks obtained in all the four subcomponents) ÷ 2

25. 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

26. 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

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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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27. 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	Applied Mathematics	3	3	3	2	3		2		1	1	2	1	3	3	2
1	Aerodynamics	3	3	3	3	3		2			1	1	1	3	3	1
1	Propulsion	3	3	2	1	1					1			3	1	1
1	Aerospace Structures	3	3	3		1	2							3	2	
1	Flight Mechanics	3	3	3	2	2		2		1	2			3	2	2
1	Computer Aided Engineering	3	3	3		3		2	1			1	1	3	3	1
1	Research Methodology and IPR				3		3	3	3	2	3	3	1		3	3
1	Professional Communication					2					3				2	3
2	Artificial Intelligence and Machine Learning	3	3	3	3	3	2	3	2	2	2	3	2	3	3	3
2	Value Education	2						2	3	2			3	2	2	3
2	Computational Fluid Dynamics	3	3	3		3					2			3	3	2
2	Engineering Optimization	3	3	1										3		
2	Hypersonic Flow	3	3	2	3	2	1	1	1	3	3	2	2	3	3	3
2	Flight Dynamics and Orbital Mechanics	3	3	3	2	2		2		1	1			3	2	1
2	Design of Turbomachines	3	3	3	3	3	2	2	3	3	2	2	3	3	3	3
2	Combustion	3	3	3	2	3	2	1			2		1	3	3	2
2	Launch Vehicle Design	3	3	3	2	2		2		1	1			3	2	1
2	Fracture Mechanics and Fatigue	3	3	1										3		
2	Aircraft Structural Dynamics	3	3	3		1	2							3	2	
2	Composite Structures	3	3	1										3		
2	Stochastic Mechanics and Reliability	3	3	1										3		
2	Aerospace Materials and Manufacturing Processes	3	3	3	3	3	2	2	1	1	2	2	2	3	3	2
2	Conceptual Design of Aerospace Vehicle	3	3	3	2	2		2		1	2			3	2	2
2	Unmanned Aerial Vehicles	3	2	2			1	1	1	3	2	1	1	3	1	3
3	Internship	3	3	3	3	3	3	3	2	3	3	3	2	3	3	3
3	Group project	3	3	3	3	3	2	2	2	2	2	1	2	3	3	2
4	Dissertation and Publication	3	3	3	3	3	1	3	1	3	3	3	1	3	3	3

28. 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.

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29. 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.

30. Sports and Athletics

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

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RAMAIAH UNIVERSITY OF APPLIED SCIENCES

Course Specifications

M.Tech. (Aerospace Engineering) Degree Programme

Programme Code: 124

Faculty of Engineering and Technology

Batch 2020-2021

M.S. Ramaiah University of Applied Sciences Bangalore

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University's Vision, Mission and Objectives

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

Vision

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

Mission

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

Objectives

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

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Programme Outcomes (POs)

M.Tech. graduates will be able to:

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

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

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

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

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

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

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

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

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

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

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Program Educational Objectives (PEOs)

The Programme educational objectives of the M.Tech. (Aerospace Engineering) Programme are:

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

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

Programme Specific Outcomes (PSOs)

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

PSO-1. Apply the knowledge and principles of aerospace design to conceptualize and develop efficient solutions to complex engineering problems through critical analysis

PSO-2. Design and develop sustainable aerospace design solutions to industry and societal requirements through applied research, concepts and techniques involving experimentation and usage of modern design and modeling tools

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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Course Specifications: Applied Mathematics

Course Title	Applied Mathematics
Course Code	20ASC501A
Course Type	Core Theory
Department	Aerospace Engineering
Faculty	Engineering and Technology

1. Course Summary

The course introduces students to the concepts in complex variables, MATLAB programing and matrix algebra. Students are taught the concepts of algebraic to solve liner system equations, data modelling and numerical techniques. Students will be able to choose the required numerical schemes to solve ODE and PDE. Students will be able to develop and analyse the probabilistic models for different systems.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO 1** Discuss the concepts of complex variables, matrix algebra, data modelling, numerical techniques and probability theory
- **CO 2** Develop and implement mathematical models for data analysis
- **CO 3** Apply linear algebraic concepts to solve linear system of equations
- **CO 4** Analyse and evaluate different numerical schemes to solve ordinary and partial differential equations
- **CO 5** Develop and analyse probabilistic models for continuous and discrete systems

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4. Course Contents

UNIT 1 (Complex Variables): 3D representation of complex variables. Sets of points in the complex plane. Analytic functions – Continuity and Derivatives, Cauchy-Riemann equations and Harmonic functions. Elementary Functions, Mapping by Elementary functions – Linear transformations and Conformal mapping.

UNIT 2 (Linear Algebra): Vector spaces, Subspaces, Orthogonality, Eigen values and vectors, Diagonalization, Singular Value Decomposition, Solutions of Linear System of Equations – solutions of engineering problems using MATLAB

UNIT 3 (Data Modelling): Least squares, Linear and non-linear least square estimation, Errors of coefficients, Residues, Interpolation and polynomial approximation – Lagrange polynomial, Hermite and cubic spline interpolation; Solutions of engineering problems using MATLAB

UNIT 4 (Ordinary Differential Equations): First and second order linear differential equations, Solutions, Numerical differentiation and integration, Euler, Taylor, and Runge-Kutte methods, Error estimates in numerical schemes. Solutions of engineering problems using MATLAB

UNIT 5 (Partial Differential Equations): First and second order equations, Laplace operator, Fundamental solution, Wave and heat equations, Numerical solutions to elliptic, Hyperbolic and parabolic partial differential equations. Solutions of engineering problems using MATLAB

UNIT 6 (Probability & Statistics): Introduction to Statistics.. Data collection methods & pilot survey. Univariate, bivariate and multivariate data. Association between two variables: Correlation, regression and significance of R^2. Introduction to probability, probability as quantification of randomness. Conditional probability, multiplication rule and Bayes' Theorem. Applications of probability.

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	3		1
CO-2	3	3	3	2	2					1	1	1	3	2	2
CO-3	3	3	3		3		2		1	1	2	1	3	3	2
CO-4	3	3	3	2	3		2		1	1	2	1	3	3	2
CO-5	3	3	3	2	2					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		35
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		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 M.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.

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

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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) Strang, G. (2005) Linear Algebra and its Applications. 4th Edn. Cengage Learning
2) Ross, S. (2009) Introduction to Probability Models. 10th Edn. Academic Press
3) Coddington, E. A. (1989) An Introduction to Ordinary Differential Equations. Dover Publications
4) C. Ray Wile , (1998), Advanced Engineering Mathematics, Mc Graw Hill, Sixth Edn.
5) Mathews, J. H., and Fink, K. K. (2004) Numerical Methods using MATLAB. 4th Edn. Pearson
6) Folland, G. B. (1995) Introduction to Partial Differential Equations. 2nd Edn. Princeton University Press

b) Recommended Reading

1. Hoffman, K., and Kunze, R. (2010) Linear Algebra. 2nd Edn. Prentice Hall India
2. Burden, R. L., and Faires, J. D. (2010) Numerical Analysis. 9th Edn. Cengage Learning
3. Papoulis, A., and Pillai, S. U. (2002) Probability, Random Variables and Stochastic Processes. 4th Edn. McGraw-Hill

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c. **Magazines and Journals**
   1) https://www.journals.elsevier.com/applied-mathematics-and-computation

d. **Websites**
   1) https://www.siam.org/

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

10. Course Organization

Course Code	20ASC501A	
Course Title	Applied Mathematics	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-80-4906-5555
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	23-Oct-2020	
Next Course Specifications Review Date	May-2022	

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Course Specifications: Aerodynamics

Course Title	Aerodynamics
Course Code	20ASC502A
Course Type	Core Theory with Laboratory
Department	Aerospace Engineering
Faculty	Engineering and Technology

1. Course Summary

This Course intends to impart concepts of aerodynamics and computational techniques to solve problems in aircraft aerodynamics. The students are taught panel codes and viscous codes to compute appropriate aerodynamic characteristics of interest in aircraft design. Students will be able to plan and execute tests on models in a wind tunnel. They will be able to solve practical aerodynamic problems computationally and experimentally and critically evaluate the results.

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	Aerospace 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 role of aerodynamics in aircraft design.

CO-2. Discuss the geometric features of airfoils, wings, and airplanes and their influence on aerodynamic performance.

CO-3. Apply thin airfoil theory, lifting line theory, panel methods, vortex lattice method and CFD to determine the performance characteristics of airfoils, wings and non-lifting bodies.

CO-4. Plan and perform experiments on appropriate models in a low speed wind tunnel.

CO-5. Evaluate the results from computations and wind tunnel tests.

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4. Course Contents

Unit 1 (Introduction to Aerodynamics): Introduction to inviscid and viscous flows, compressible and incompressible flows, rotational and irrotational flows, laminar and turbulent flows and their role in the selection of appropriate computational method and experimental testing.

Unit 2 (Potential Flow Theory): Potential flow theory, airfoil theory, symmetrical and cambered airfoil, flapped airfoil, pressure distribution on airfoils.

Unit 3 (Wing Theory): Wing theory, lifting line theory, horseshoe vortex, downwash and induced drag, elliptical lift distribution, twisted wing.

Unit 4 (Compressible Aerodynamics): Elements of compressible aerodynamics, isentropic flow, normal and oblique shock waves, Prandtl-Meyer expansion.

Unit 5 (Computational Aerodynamics): Elements of computational aerodynamics, panel method, vortex lattice method.

(Practical/Laboratory Content): MATLAB, Javafoil, Fluent, Wind Tunnel Testing

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3								1		1	3		1
CO-2	3	3								1		1	3		1
CO-3	3	3	3		3		2						3	3	
CO-4	3	3	3	3						1	1	1	3	3	1
CO-5	2	3	3	2	2					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	15	
Practical Work		30
1. Course Laboratory	05	
2. Computer Laboratory	25	
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 M.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.

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

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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. Houghton, E. L., Carpenter, P. W., Collicott, S. H. and Valentine, D. T. (2013) Aerodynamics for Engineering Students, Sixth Edition, MA, Elsevier.

b. Recommended Reading

1. Anderson, J. D. (2017) Fundamentals of Aerodynamics, Sixth Edition, New York, McGraw-Hill.
2. Kuethe, A. M. and Chow, C-Y. (1998) Foundations of Aerodynamics, Fifth Edition, New Delhi, Wiley India.
3. Bertin, J. J. and Cummings, R. M. (2014) Aerodynamics for Engineers, Sixth Edition, Harlow, Pearson.
4. Barlow, J. B., Rae, W. H. Jr. and Pope, A. (1999) Low Speed Wind Tunnel Testing, Third Edition, New Delhi, Wiley India.

c. Magazines and Journals

1. AIAA Journal
2. Journal of Aerospace Sciences and Technologies

d. Websites

1. www.dept.aoe.vt.edu/~mason/Mason_f/CAtxtTop.html
2. http://soliton.ae.gatech.edu/people/lsankar/AE2020/

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e. **Other Electronic Resources**

1. NPTEL Videos and Digital Library

10. Course Organization

Course Code	20ASC502A	
Course Title	Aerodynamics	
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	23-Oct-2020	
Next Course Specifications Review Date	May-2022	

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Course Specifications: Propulsion

Course Title	Propulsion
Course Code	20ASC503A
Course Type	Core Theory
Department	Aerospace Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to introduce fundamental concepts of aerospace propulsion systems which includes both gas turbines and rockets. The students are empowered to demonstrate an understanding of basic concepts and the ability to apply it to a propulsion system performance. This course enables students to classify and identify the requirements of propulsion systems. They are also introduced to different techniques of performance enhancement in propulsion engines.

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	Aerospace 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 constructional features, functioning and application of various propulsion engines.

CO-2. Perform aero-thermodynamic analysis of propulsion engines.

CO-3. Estimate the performance of propulsion engine components.

CO-4. Analyse the requirements of matching of the propulsion engine components.

CO-5. Suggest a propulsion system and performance enhancement techniques for an application.

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4. Course Contents

Unit 1 (Introduction to Air-breathing Engines and Rockets): Brief history of gas turbine and rocket propulsion development; Classification of aerospace propulsion systems; Overview of air-breathing (Piston, Turboprop, Turbojet, Turbofan Engines, Ramjet, Scramjet, Pulsejet and pulse detonation) and rocket engine configurations, functional requirements of major components and subsystems of various engines.

Unit 2 (Elements of Aerothermochemistry): Review of governing equations for fluid flow, Control volumes and thrust equation; First and second laws of thermodynamics, thermodynamic processes; Isentropic relations, flow through nozzle; Normal and oblique shocks. Reacting System: Ideal gas mixture, stoichiometry, heat of formation and reaction, Adiabatic Flame Temperature (AFT). Introduction to chemical equilibrium and chemical kinetics.

Unit 3 (Air-breathing Engines): Thermodynamic cycle analysis and performance estimation of various air-breathing engines. Analysis and design consideration of non-rotating parts - inlets, combustors and nozzles.

Unit 4 (Compressor and Turbine): Euler turbomachinery equations, basic concepts; Axial compressor and turbine design-point analysis, Centrifugal compressor/pumps design-point analysis; Compressor/ turbine maps, engine component matching.

Unit 5 (Rocket Performance): Performance parameters; The rocket equation, Staging, Space and launch mission.

Unit 6 (Chemical Rockets): Propellants and combustion, Solid propellant rocket, grain configuration, burn rate, Liquid propellant rockets, combustion chamber and combustor heat transfer, feed systems, turbo-pumps, Nozzle, types and gas expansion. Hybrid propellent rockets, construction and combustion process. Combustion instability in rocket motors.

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	1	1	1									3	1	
CO-2	3	3	1	1	1								3	1	
CO-3	3	3	1	1	1								3	1	
CO-4	3	3	2	1	1					1			3	1	1
CO-5	3	2	2	1	1								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		30
Demonstrations		03
1. Demonstration using Videos	01	
2. Demonstration using Physical Models / Systems	02	
3. Demonstration on a Computer	00	
Numeracy		12
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		**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 M. 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.

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

1. Course notes
2. El-Sayed, A. F. (2016). Fundamentals of aircraft and rocket propulsion, London, Springer.
3. Sutton. G.P, (2012). Rocket Propulsion Elements, New York, John Wiley and Sons Inc.
4. Mukunda. H. S, (2004). Understanding Aerospace Chemical Propulsion, Interline Publishing India Ltd.
5. Saeed Farookhi (2008). Aircraft Propulsion, John Wiley & Sons, NY.

b. Recommended Reading

1. Mattingley. J.D. (2006). Elements of propulsion: gas turbines and rockets, U.S., AIAA.
2. Hill, P.G., & Peterson. C.R (1999). Mechanics and thermodynamics of propulsion, India, Addison Wesley, New Delhi.
3. Segal. C., (2011). The Scramjet Engine: Processes and Characteristics, Cambridge University Press.
4. Turner. J. L. (2005). Rocket and Spacecraft Propulsion, U.K. Praxis Publishing.
5. Humble, R. W, Henry, G. N. & Larson. W. J. (1995). Space Propulsion Analysis and Design, McGraw-Hill

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6. El-Sayed, A. F. (2017). Aircraft Propulsion and Gas Turbine Engines, second edition, CRC Press.
7. Cumpsty, N. (2003) Simple Guide to the Aerodynamic and Thermodynamic Design and Performance of Jet Engines, Cambridge University Press.

c. Magazines and Journals

1. Propulsion and Power Research, Elsevier.
2. Journal of Propulsion and Power, AIAA.

d. Websites

1. https://www.jpl.nasa.gov/
2. https://ocw.mit.edu/courses/aeronautics-and-astronautics/
3. http://spl.mit.edu/
4. http://nptel.ac.in/

e. Other Electronic Resources

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

10. Course Organization

Course Code	20ASC503A		
Course Title	Propulsion		
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		23-Oct-2020	
Next Course Specifications Review Date		May-2022	

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Course Specifications: Aerospace Structures

Course Title	Aerospace Structures
Course Code	20ASC504A
Course Type	Core Theory
Department	Aerospace Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to give the student a good understanding of the design rationale in thin-walled aerospace structural forms as well as the approaches and methodologies for designing such structural forms. Solution methodologies drawn from strength of materials, theory of elasticity and energy methods will be used to design and analyze structural components. Students will learn concepts of structural dynamics and elastic stability as well as aero-elastic phenomena like aileron reversal, wing divergence and flutter. Finite element analyses of stability and dynamic characteristics of laminated composite plates and shells will also be demonstrated, with selected case studies in design optimization.

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	Aerospace 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. Elucidate with reasons the rationale governing forms of typical aerospace structures; identify sources of loads on typical aerospace structures

CO-2. Analyse structural layouts to assess the adequacy of design under the prescribed functional and operational loads

CO-3. Apply knowledge of strength of materials and engineering mechanics to design, model, simulate and analyse components/systems of generic aerospace structural components such as slender beams and frames

CO-4. Analyse dynamic responses of aircraft structural components by analytical (energy) methods and interpret the responses for design needs

CO-5. Develop designs for structures of laminated composite construction and analyze by finite element methods.

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4. Course Contents

Unit 1 (Overview): Structural Forms and Load Paths: why and where of 1D, 2D and 3D forms; Sources of loads in aircraft, rotary wing, launch vehicles, satellite structures

Unit 2 (Analytical Methods): Theory of Thin- Walled Structures: Deformation – kinematic modelling, including beams, plates, and shells; energy methods

Unit 3 (Structural Dynamics): Structural Vibration: Single DOF system- natural frequency, damped free response, harmonic, periodic and arbitrary excitation, resonance and transmissibility; Multi-DOF systems- eigenvalues and eigenvectors, Rayleigh damping

Unit 4 (Composite Structures): Analytical modelling of laminated composite plates and shells. Numerical solutions for buckling and modal characteristics of composite plates and shells. Laminate Composites, [A], [B], [D] Matrices; Design and analysis of composite structures. FE solutions for buckling of composite plates and shells.

Unit 5 (Aeroelasticity and Design): Aero-elasticity phenomena in aircraft- Wing divergence and Flutter; Case studies in design optimization

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1						2								2	
CO-2	3	3			1								3	1	
CO-3	3	3			1								3	1	
CO-4	3	3			1								3	1	
CO-5	3	2	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		40
Demonstrations		05
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	03	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
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. Brainstorming 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 M.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.

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

9. Course Resources

a. **Essential Reading**
   1. Class notes
   2. T. H. G. Megson, 2007, Aircraft Structures for Engineering Students, Third Edition, Elsevier.

b. **Recommended Reading**
   1. W.T. Thomson, 1990, Mechanical Vibration, 8th ed., Prentice Hall.
   2. J. N, Reddy, 2003, Mechanics of Composite Plates and Shells, CRC Press.

c. **Magazines and Journals**
   1. Journal of Aircraft
   2. Composite Structures
   3. Flight International
   4. Journal of Spacecraft and Rockets.

d. **Websites**
   1. MIT OCW lectures and videos

e. **Other Electronic Resources**
   1. YouTube videos on Aircraft Landing, Cross- winds, Crashes, Engine Failures, Satellite Construction, Launch Videos.

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10.Course Organization

Course Code	20ASC504A		
Course Title	Aerospace Structures		
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		23-Oct-2020	
Next Course Specifications Review Date		May-2022	

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Course Specifications: Flight Mechanics

Course Title	Flight Mechanics
Course Code	20ASC505A
Course Type	Core Theory
Department	Aerospace Engineering
Faculty	Engineering and Technology

1. Course Summary

This course intends to prepare students for evaluating the performance, stability and control parameters of an airplanes and launch vehicles. Students are taught basics of steady and accelerated performance evaluation, static stability and control for longitudinal, lateral and directional modes. Students are taught dynamical equations governing the motion of airplanes and launch vehicles in space. They are trained to solve linearized equations of motion and compute stability margins.

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	Aerospace 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 influence of aerodynamic characteristics, weight, engine performance and flight altitude on the performance of aircraft and launch vehicles

CO-2. Distinguish performance requirements between different class of aircraft and launch vehicles.

CO-3. Analyse and evaluate aeroplane performance for different phases of flight: level flight, turning, gliding, climb, take-off and landing.

CO-4. Critically evaluate the stability derivatives and establish flight boundaries such as range and endurance, payload-range, V-n diagram and turn

CO-5. Compute short period and long period longitudinal modes.

CO-6. Calculate launch vehicle trajectories and optimal staging for payload requirements.

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4. Course Contents

Unit 1 (Level Flight): Governing equations, ceiling conditions, range, endurance, best (maximum) range with and without a specified airspeed, and maximum endurance

Unit 2 (Accelerated Flight): Take-off and landing, climbing and unpowered (gliding) flight, most economical climb, steepest and fastest climb, cruise-climb and stepped-altitude flight.
Turning flight: Turning flight in general, maximum load factor and bank angle, fastest and tightest turn, sustained and attained turn rates, V-n Diagram

Unit 3 (Stability and Control): Static equilibrium and trim, wing location, CG travel

Unit 4 (Longitudinal Static Stability): Neutral Point (stick fixed and free), hinge moments, elevator sizing.

Unit 5 (Directional and Roll Static Stability): lateral and directional stability coupling between the two, sizing of controls surfaces.

Unit 6 (Rockets): Rocket launch trajectories without and with drag, gravity turn, and optimal staging

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		2	2		2		1	1			3	2	1
CO-5	3	3	3		2					2			3	2	2
CO-6	3	3	2		2		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		0
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		10
1. Solving Numerical Problems	10	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop	00	
4. Clinical Laboratory	00	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 M.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.

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

1. Anderson, J. D. (1999) Aircraft Performance and Design, New Delhi, McGraw-Hill
2. Nelson, R. C. (2007) Flight Stability and Automatic Control, Second Edition, New Delhi, McGraw Hill
3. Martin J. L. Turner (2008) Rocket and Spacecraft Propulsion : Principles, Practice and New Developments (Third Edition), Springer, Praxis Publications
4. Class Notes

b. Recommended Reading

1. Russel, J. B. (2003) Performance and Stability of Aircraft, Oxford, Butterworth-Heinemann
2. Etkin, B. and Reid, L. D. (1996) Dynamics of Flight – Stability and Control, Third Edition, New York, Wiley
3. Cook, M. V. (2007) Flight Dynamics Principles, Second Edition, Oxford, Butterworth-Heinemann

c. Magazines and Journals

1. AIAA
2. Journal of Aircraft

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d. **Websites**
   1. MIT OCW lectures and video

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

10. Course Organization

Course Code	20ASC505A		
Course Title	Flight Mechanics		
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		23-Oct-2020	
Next Course Specifications Review Date		May-2022	

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Course Specifications: Computer Aided Engineering

Course Title	Computer Aided Engineering
Course Code	20ASC506A
Course Type	Core Theory with Laboratory
Department	Aerospace engineering
Faculty	Engineering and Technology

1. Course Summary

This course is aimed at preparing students to use CAE concepts to develop geometric model of engineering components for analyzing structural behavior under different conditions so that the design can be refined and optimized. The students will be taught advanced geometric modelling techniques; data exchange formats to use CAD model for downstream applications, reverse engineering method to generate engineering data. The principles of finite element modelling, problem solving approaches using finite element methodology to solve linear, non-linear, dynamic and thermal problems will be explained. The student will also be trained to use CAE tools like MSC Nastran / MSC Patran for specific practical problems and Rapid prototyping technique to build prototype models.

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	Aerospace 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. Discuss the need and usage of CAE tools in product development cycle.
CO-2. Create geometrical models of complex engineering components and assemblies.
CO-3. Formulate 1-D, 2-D and 3-D elements for finite element modelling.
CO-4. Synthesize finite element models and solve linear, non-linear, dynamic and thermal problems as applied to engineering components/systems.
CO-5. Analyze for design requirements and redesign the given component.
CO-6. Use CAE tools like CATIA/UG, HYPERMESH and ANSYS and operate 3D scanner

4. Course Contents

Unit 1 (CAE Systems): introduction to CAD/CAM/CAE systems, the role of CAE in product development cycle, CAD system environment, Introduction to PDM systems, CAD/CAM/CAE integration

Unit 2 (Geometric modeling): Co-ordinate systems in CAD environment, transformation features, solid modeling and assembly modeling techniques, advanced curve and surface generation techniques, surface curvature analysis, Data exchange in CAE and Neutral file formats, Reverse Engineering methods- data generation techniques, contact and non-contact type scanning, Rapid prototyping techniques for product development

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Unit 3 (Introduction to Finite Element Methodology): Use of engineering analysis for solution of complex problems, Mathematical model approach and its limitations, Numerical solution approaches, Finite element approach, Element stiffness, Different approaches for element formulation, Use of energy approach for element formulation, Local, global stiffness, Shape functions and natural coordinates, Gauss Quadrature, 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

Unit 4 (FEM for Linear Static Structural Problems): 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,.

Unit 5 (Application to Thermal and Dynamic analysis): Extension of FE methodology for structures to thermal problems, "Loads" and boundary conditions for thermal problems, Sources and types of non-linearity, techniques for solving non-linear problems, Static versus Dynamic analysis – loads and response, Dynamics and methodologies for dynamic problems

Unit 6 (Practical/Laboratory content): CATIA/UG-NX, MSC Nastran / MSC Patran software will be used for geometric modeling, finite element modeling and solving of complex linear, non-linear, thermal and dynamic 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		3								3	3	
CO-2	3	3	3		3		2	1			1	1	3	3	1
CO-3	3	3											3		
CO-4	3	3	1		2								3	2	
CO-5	3	3	1		2								3	2	
CO-6	3	3	1		3		2	1			1	1	3	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		25
Demonstrations		0
1. Demonstration using Videos	0	
2. Demonstration using Physical Models / Systems	0	
3. Demonstration on a Computer	0	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		30
1. Course Laboratory	30	
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		85

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Tech. (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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Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ▶	SC1	SC2	SC3	SC4	
Subcomponent Type ▶	Term Test 1	Term Test 2	Assignment 1	Tool Test	100 Marks
Maximum Marks ▶	25	25	25	25	
CO-1	×				×
CO-2	×		×		×
CO-3		×			×
CO-4		×	×		×
CO-5		×			×
CO-6				×	×
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

1. Class Notes
2. Chandraputla, T. R. and Ashok D. Belegundu. (2001) Introduction to Finite Elements in Engineering, 2nd Edition, Prentice-Hall of India, New Delhi
3. Ibrahim Zeid and R Sivasubramanian. (2008) CAD/CAM Theory and Practice, TMH

b. Recommended Reading

1. Zeid I., (2005), "Mastering CAD/CAM", McGraw-Hill ISBN
2. K.J. Bathe. (2008) Finite Element Procedures, Prentice-Hall India Pvt. Ltd., New Delhi
3. Emad Abouel Nasr, Ali K. Kamrani (2007), Computer-Based Design and Manufacturing - An Information-Based Approach, Springer Publication, ISBN: 0- 387-23323-7
4. Robert D. Cook, David S. Malkus, Michael E. Plesha and Robert J. Witt. (2001) Concepts and Applications of Finite Element Analysis, 4th Edition, John Wiley & Sons.
5. J.N. Reddy. (1993) An Introduction to the Finite Element Method, 2nd Edition, McGraw- Hill International Editions
6. W.T. Thomson. (1996) Theory of Vibrations with Applications, Nelson Thornes Ltd
7. O. C. Zienkiewicz, R. L. Taylor and J.Z. Zhu. (2005) The Finite Element Method: Its Basis and Fundamentals, 6th edition, Butterworth-Heinemann

c. Journal and Magazines

1. Flight
2. SAE Aerospace Journals

d. Websites

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

e. Other Electronic Resources

10. Course Organization

Course Code	20ASC506A	
Course Title	Computer Aided Engineering	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	**Phone:**	080-49065555
	E-mail:	hod.aae.et@msruas.ac.in
Course Specifications Approval Date	23-Oct-2020	
Next Course Specifications Review Date	May-2022	

Course Specifications: Research Methodology and IPR

Course Title	Research Methodology and IPR
Course Code	20FET508A
Course Type	Ability Enhancement Compulsory Course
Department	Aerospace Engineering
Faculty	Engineering and Technology

1. Course Summary

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

2. Course Size and Credits:

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

3. Course Outcomes (COs)

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

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

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

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

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

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4. Course Contents

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

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

Unit 3 (Out of the Box Thinking and Systematic Approach in Research): Transformation to Impossible Thinking, Convergent and Divergent Thinking, Generation, Evaluation and Selection of Ideas, Critical Thinking
Literature Review: Importance of Literature Review, Constituents of Good Literature Review, Strategies for Literature Search, Referencing, Paraphrasing, and Summarizing Academic Standards and Ethics
Research Proposal: Structure of a Good Research Proposal, Getting Started, Tips for Compilation of Good Research Proposal.

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

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

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

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

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

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6. Course Teaching and Learning Methods

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

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.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, or SC3), COs are assessed as illustrated in the following Table.

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

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

b. Recommended Reading

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

c. Magazines and Journals

1. https://www.tandfonline.com/toc/tsrm20/current

d. Websites

1. https://www.open.edu/openlearn/money-management/understanding-different-research-perspectives/content-section-8

e. Other Electronic Resources

1. NPTEL Videos and Digital Library

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10. Course Organization

Course Code	20FET508A	
Course Title	Research Methodology and IPR	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-80-4906-5555
	E-mail:	hod.aae.et@msruas.ac.in
Course Specifications Approval Date	23-Oct-2020	
Next Course Specifications Review Date	May-2022	

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Course Specifications: Professional Communication

Course Title	Professional Communication
Course Code	20FET509A
Course Type	Ability Enhancement Compulsory Course
Department	Aerospace Engineering
Faculty	Engineering and Technology

1. Course Summary

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

2. Course Size and Credits:

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

3. Course Outcomes (COs)

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

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

4. Course Contents

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

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

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

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

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

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

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		09
Demonstrations		0
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		0
1. Solving Numerical Problems	00	
Practical Work		
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
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	00	
5. Group Discussions	04	
6. Discussing Possible Innovations	00	
In-class assessments, Term Tests, Laboratory Examination/Written Examination, Presentations		3
Total Duration in Hours		**18**

Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Tech. (Aerospace 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, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

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

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

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

Course reassessment policies are presented in the Academic Regulations document.

Achieving COs

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

S No	Curriculum an Capabilities Skills	o imparte uring 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	--

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9. Course Resources

a. Essential Reading

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

b. Recommended Reading

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

c. Magazines and Journals

d. Websites

1. www.myenglishpages.com

e. Other Electronic Resources

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

10. Course Organization

Course Code	20FET509A	
Course Title	Professional Communication	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-80-453666666
	E-mail:	director.tsld@msruas.ac.in
Course Specifications Approval Date	23-Oct-2020	
Next Course Specifications Review Date	May-2022	

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Course Specifications: Artificial Intelligence and Machine Learning

Course Title	Artificial Intelligence and Machine Learning
Course Code	20ASC507A
Course Type	Core Theory
Department	Aerospace 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 aerospace vehicles such UAVs 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)	4:0:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Aerospace Engineering / Computer Science
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 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. Discuss the principles of localization, tracking and control with a focus on examples from Autonomous Vehicle /Self-driving cars

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 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	1		2							3	2	
CO-2	3	3	3	2		2							3	2	
CO-3	3	3	3	3	3		3	2	2		3	1	3	3	3
CO-4	3	3	3	3	3	1	2		2	2	2		3	3	2
CO-5	3	3	3	2		2					3	2	3	2	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		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 / 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 M.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.

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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1. International Journal for Machine learning

d. Websites

1. www.ijml.com

e. Other Electronic Resources

1. NPTEL Videos and Digital Library

10. Course Organization

Course Code	20ASC507A	
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	23-Oct-2020	
Next Course Specifications Review Date	May-2022	

Faculty of Engineering and Technology

Course Specifications: Value Education

Course Title	Value Education
Course Code	20FET510A
Course Type	Ability Enhanced Compulsory Course
Department	Aerospace Engineering
Faculty	Engineering and Technology

1. Course Summary

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

2. Course Size and Credits:

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

3. Course Outcomes (COs)

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

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

4. Course Contents

Unit 1 (Communication – Values, Ethics and Judgements): Values, Ethics and Self-Development; Awareness of self-destructive habits, Power of faith, Positive Thinking Value judgements – Stereotypes, prejudices and biases

Unit 2 (Communication – Sense of Duty): Sense of duty, Self-reliance, Confidence, Concentration, Discipline, Honesty, Truthfulness. National Unity, Patriotism, Love for nature

Unit 3 (Communication – Character Development): Universal brotherhood and religious tolerance. Character and Competence –Rational Thinking vs Blind faith

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

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

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		09
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		
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		06
1. Case Study Presentation	02	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	04	
6. Discussing Possible Innovations	00	
In-class assessments, Term Tests, Laboratory Examination/Written Examination, Presentations		03
Total Duration in Hours		**18**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Tech (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.

Focus of CO's on each Component or Subcomponent of Evaluation:		
	Component 1: CE (100% Weightage)	Component 2: SEE (0% Weightage)
Subcomponent▶↓	SC1	
Subcomponent Type ▶↓	In-Class Assessment	0 Marks
Maximum Marks▶↓	25	
CO-1	X	
CO-2	X	

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

Course reassessment policies are presented in the Academic Regulations document.

. 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	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
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	Assignment
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

b. Recommended Reading

c. Magazines and Journals

d. Websites

e. Other Electronic Resources

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

10. Course Organization

Course Code	20FET510A	
Course Title	Value Education	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-80-453666666
	E-mail:	director.tsld@msruas.ac.in
Course Specifications Approval Date	23-Oct-2020	
Next Course Specifications Review Date	May-2022	

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Course Specifications: Computational Fluid Dynamics

Course Title	Computational Fluid Dynamics
Course Code	20ASE511A
Course Type	Professional Core Elective
Department	Aerospace Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is aimed to impart concepts of fluid mechanics, computational methods and the use of CFD techniques to solve practical engineering problems. The students are taught the fundamentals of external and internal flows, nature of the governing equations, elements of computational methods and numerical solution to simple problems in fluid mechanics and heat transfer. The students are taught the basics of CFD and trained to use CFD software tool for solving flow problems. Students will be able to model a flow problem and derive discretized equations. They will be able to solve practical problems and critically evaluate the results.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Aerospace 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. Review different types of fluid flow, PDEs and identify the governing equations.

CO-2. Discretize the given equation, analyze the equation for stability and perform computation to solve simple problems.

CO-3. Identify appropriate algorithms, turbulence model, boundary conditions for numerical simulations of fluid flow.

CO-4. Perform CFD simulations with the use of commercial software including discretization, incorporating various models and methods.

CO-5. Analyze the results by plotting various quantities of interest, understanding physics of the flow and critically evaluate the results.

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4. Course Contents

Unit 1 (Introduction to Fluid Mechanics and Governing Equations): Basics of fluid mechanics and partial differential equations, governing equation for fluid dynamics – integral and differential form, method of deriving the equation, nature and physical meaning of various terms, assumptions used in different kind of flows and reducing the governing equations for incompressible, inviscid and ideal fluid flow. Physical meaning and mathematical behavior of various simplified equation.

Unit 2 (Finite Difference Method): Partial differential equations, Classification of PDEs, introduction to finite difference method and use of Taylor series to obtain difference equation.

Unit 3 (Solution to Advection Equation with FDM): 1-D linear advection equation as example for hyperbolic type of PDE Discretization, explicit method, stability of the scheme and CFL number, forward , backward and central differencing and concept of upwind method. Numerical solution to the equation for smooth and discontinuous initial data. Numerical errors, presence of wiggles, higher order methods, artificial diffusion.

Unit 4 (Solution to Diffusion Equation with FDM): 1-D unsteady heat conduction equation as example for parabolic equation and 2D steady state equation for elliptic equation, coding and analysis. Example of simple problems from aerodynamics.

Unit 5 (Finite Volume Method): Principles behind FVM, relative merits and demerits, numerical requirements, examples with advection-diffusion equation, higher order methods, flux limiters.

Unit 6 (Computational Fluid Dynamics and Use of Software to Solve Practical Problems): Introduction to CFD solvers, grid generation, finite volume approach, steady state and transient computations, pressure based methods, pressure velocity coupling, density based methods, estimation of fluxes, boundary conditions, initial conditions, time stepping, convergence, grid study, post processing the data, validation and verification.

(Practical/Laboratory Content): MATLAB programming and solution to 1-D and 2-D problems, CFD software, introduction to grid generation and CFD simulations.

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

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		05
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	05	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		20
1. Course Laboratory	00	
2. Computer Laboratory	20	
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	03	
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 M.Tech. (Aerospace 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, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				**Component 2: SEE (50% Weightage)**
Subcomponent ▶	**SC1**	**SC2**	**SC3**	**SC4**	
Subcomponent Type ▶	**Term Test1**	**Term Test 2**	**Assignment 1**	**Assignment 2**	**100 Marks**
Maximum Marks ▶	**25**	**25**	**25**	**25**	
CO-1	×	×	×	×	×
CO-2	×	×	×	×	×
CO-3	×	×	×	×	×
CO-4			×	×	
CO-5	×	×	×	×	×
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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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. Anderson Jr., J. D. (1995) Computational Fluid Dynamics - The Basics with Applications, McGraw-Hill, Inc.

b. Recommended Reading

1. Tannehill, J. C., Anderson, D. A., and Pletcher, R. H. (1997) Computational Fluid Mechanics and Heat Transfer, Taylor & Francis.
2. Patankar, S. V. (1980) Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing, New York.
3. Versteeg, H. K., and Malalasekara, W. (2008) An Introduction to Computational Fluid Dynamics: The Finite Volume Method, 2nd edn. Prentice Hall India, New Delhi.
4. Moin, P. (2010) Fundamentals of Engineering Numerical Analysis, 2nd edn. Cambridge University Press, New Delhi.

c. Magazines and Journals

1. Journal of Fluid Mechanics
2. Physics of Fluids
3. Journal of Aerospace Sciences and Technology

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4. Theoretical and Computational Fluid Dynamics
5. International Journal of Computational Fluid Dynamics
6. International Journal for Numerical Methods in Fluids

d. Websites

1. www.e-fluids.com
2. www.cfd-online.com

e. Other Electronic Resources

1. NPTEL Videos and Digital Library

10. Course Organization

Course Code	20ASE511A	
Course Title	Computational Fluid Dynamics	
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	23-Oct-2020	
Next Course Specifications Review Date	May-2022	

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Course Specifications: Engineering Optimization

Course Title	Engineering Optimization
Course Code	20ASE512A
Course Type	Professional Core Elective
Department	Aerospace engineering
Faculty	Engineering and Technology

1. Course Summary

This course will enable students to acquire an understanding of Optimization concepts in engineering system designs and the applications of Optimization algorithms. Students are taught theories and concepts from the viewpoint of the application of Optimization methods in engineering systems. Students are also taught the concepts employed in the development of classical Optimization methods and meta-heuristic Optimization approaches. Students will be able to develop computer based skills in implementing optimization algorithms to solve engineering problems.

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	Aerospace 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 theory and concept of Optimization techniques to engineering systems design

CO-2. Explain classical unconstrained and constrained Optimization methods

CO-3. Explain the modern methods of Optimization and their applications such as genetic algorithm, simulated annealing, particle swarm Optimization

CO-4. Solve simple numerical problems in engineering Optimization

CO-5. Apply numerical techniques to complete the design of engineering systems for optimum performances

CO-6. Develop computer programs to implement and analyze Optimization approaches in the aerospace engineering context

4. Course Contents

Unit 1 (Engineering Optimization): Introduction, engineering Optimization examples, and Mathematical foundations: Review: differential equations, matrix algebra.

Unit 2 (Classical Optimization): Unconstrained, constrained, gradient-based Optimization, linear programming, Simplex method, Lagrange multiplier, Karush-Kuhn-Tucker condition.

Unit 3 (Optimal control): Calculus of variations, Optimal control theory, Optimal Criteria Methods, Optimization application in the designs for mechanical, manufacturing and robotic systems.

Unit 4 (Modern Methods of Optimization): Markov chain, genetic algorithms, Simulated annealing, ant colony algorithms, Bee swarm algorithm, particle swarm Optimization, Harmony search, firefly algorithm, Weighted sum, utility functions, Pareto front

Unit 5 (Practical Aspects of Optimization): Reduction of Size of an Optimization Problem, Surrogate models their construction and use, Fast Reanalysis Techniques, Derivatives of Static Displacements and Stresses, Eigen value and Eigen vector, Transient Response, Multilevel Optimization, Multi-objective Optimization.

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	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		
CO-6	3	3	1										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		0
1. Demonstration using Videos	0	
2. Demonstration using Physical Models / Systems	0	
3. Demonstration on a Computer	0	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		0
1. Course Laboratory	0	
2. Computer Laboratory	0	
3. Engineering Workshop / Course Workshop / Kitchen	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 M.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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Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ▶	SC1	SC2	SC3	SC4	
Subcomponent Type ▶	Term Test 1	Term Test 2	Assignment 1	Assignment 2	100 Marks
Maximum Marks ▶	25	25	25	25	
CO-1	×				×
CO-2	×				×
CO-3	×	×	×	×	×
CO-4		×			×
CO-5		×	×		×
CO-6				×	×
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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9. Course Resources

a. Essential Reading

1. Achille Messac, 2015, Optimization in Practice with MATLAB for Engineering Students and Professionals, Cambridge University Press
2. K.Deb, 2012, Optimization for Engineering Design: Algorithm and Design, PHI
3. S.S. Rao, 2009, Engineering Optimization: Theory and Practice, John Wiley & Sons

b. Recommended Reading

1. X.S. Yang, 2010, Engineering Optimization: An Introduction with Metaheuristic Applications, John Wiley & Sons
2. P. Venkataraman, 2009, Applied Optimization with MATLAB Programming, John Wiley & Sons.

c. Websites

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

d. Other Electronic Resources

1. Digital electronic resources available in RUAS library

10. Course Organization

Course Code	20ASE512A	
Course Title	Engineering Optimization	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	**Phone:**	080-49065555
	E-mail:	hod.aae.et@msruas.ac.in
Course Specifications Approval Date	23-Oct-2020	
Next Course Specifications Review Date	May-2022	

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Course Specifications: Hypersonic Flow

Course Title	Hypersonic Flow
Course Code	20ASE513A
Course Type	Professional Core Elective
Department	Aerospace Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is focused on basic theoretical aspects of hypersonic flows. Topics include the description of the hypersonic environment, inviscid and viscous hypersonic flows, hypersonic laminar boundary layers, rarefied gas, and thermo-chemical concepts in hypersonic flow domain.

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	Aerospace Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Identify the fundamental features of hypersonic flows, and how these differ from other flows
- **CO-2.** Classify hypersonic vehicles and describe their requirements
- **CO-3.** Explain the importance and influence of rarefied gas dynamics and real-gas effects in high temperature flows
- **CO-4.** Identify the physical mechanisms causing aerodynamic heating of high speed vehicles
- **CO-5.** Analyse how the above influence the design of hypersonic vehicles
- **CO-6.** Apply appropriate computational methods to high speed and/or high temperature flows

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4. Course Contents

Unit 1 (Introduction to Hypersonic Flow): Review of compressible flow and identify the differences between Supersonic and hypersonic flows. Classification of hypersonic applications: Re-entry spacecraft, Inter-Continental Ballistic Missiles (ICBM), hypersonic cruise aircrafts. Flight conditions leading to hypersonic flow phenomena.

Unit 2 (Inviscid Hypersonic Flow): Inviscid hypersonic flows. Hypersonic limit relations for shock waves. Newtonian theory and modification. The role of the density ratio in hypersonic flow. The combined limit of high Mach numbers and large density ratios. Mach-number independence principle. The shock standoff distance from blunted bodies. Shock layer and entropy layer.

Unit 3 (Viscous Hypersonic Flow): Viscous hypersonic flows. The role of flight altitude. Boundary-layer transition phenomenology: Endo-atmospheric and trans-atmospheric hypersonic vehicles. Non-continuum effects. Compressible laminar boundary layers. Recovery factor, Aerodynamic heating.

Unit 4 (High Temperature Effects): High temperature effects, thermo-chemical effects, air dissociation, ionization, and vibrational excitation. Chemical and vibrational non-equilibrium effects. Impact of the above on design of vehicle.

Unit 5 (Computational Methods for Hypersonic Flow): Computational methods appropriate for low density and reacting flow systems. Zones where continuum and inert gas approximations are acceptable and classical CFD tools maybe used. Basics of multi-species simulation (temperature effect) and Direct Simulation Mote Carlo (DSMC) techniques for large Knudson number domains.

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			1	1	3	3	2	2	3	3	3
CO-2	3	2	2	2	1	1		1	2	2	1	1	3	2	2
CO-3	2	2	1	2	1	1			1				2	2	1
CO-4	3	2	2	2	2	1	1		1		1		3	2	1
CO-5	3	2	1	2	2	1	1		1	1	1	1	3	2	1
CO-6	2	2	1	2	2								2	2	0
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		00
1. Solving Numerical Problems	00	
Practical Work		12
1. Course Laboratory	00	
2. Computer Laboratory	12	
3. Engineering Workshop / Course/Workshop	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		03
1. Case Study Presentation	03	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B.Tech. (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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Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ▶	SC1	SC2	SC3	SC4	
Subcomponent Type ▶	Term Test 1	Term Test 2	Assignment 1	Assignment 2	100 Marks
Maximum Marks ▶	25	25	25	25	
CO-1	×		×		×
CO-2	×		×	×	×
CO-3	×	×	×		×
CO-4		×	×	×	×
CO-5		×		×	×
CO-6		×		×	×
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

1. Course notes
2. Anderson JD Jr, 2006,"Hypersonic and High Temperature Gas Dynamics". Second edition, AIAA Education Series
3. John J. Bertin, 1994, "Hypersonic Aerothermodynamics". Third edition, AIAA Education Series

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b. Recommended Reading

1. Maurice Rasmussen, 1994, Hypersonic Flow, Wiley and Sons
2. H.W. Liepmann & A. Roshko, 2007, Elements of Gasdynamics, Dover Books on Aeronautical Engineering

c. Magazines and Journals

1. Journal of Fluid Mechanics
2. Physics of Fluids
3. Journal of Spacecraft and Rockets
4. Journal of Aerospace Sciences and Technology

d. Websites

e. Other Electronic Resources

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

10. Course Organization

Course Code	20ASE513A	
Course Title	Hypersonic Flow	
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	23-Oct-2020	
Next Course Specifications Review Date	May-2022	

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Course Specifications: Flight Dynamics and Orbital Mechanics

Course Title	Flight Dynamics and Orbital Mechanics
Course Code	20ASE514A
Course Type	Professional Core Elective
Department	Aerospace Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this Course is to prepare the students to study and critically evaluate the dynamics of a rigid aircraft and satellites. Equations of motion for Six Degrees of Freedom (6DOF) are derived for different axes of reference and their approximations highlighted. Specific cases of Longitudinal, Lateral and Directional modes of response are described. Time and frequency domain solution methods are dealt with in detail. Basics of orbital mechanics and satellite attitude dynamics are dealt with. Solutions to a few special cases are simulated in MATLAB.

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	Aerospace 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 various axes of reference used in describing dynamics of aircraft flight and discuss the complexities of Six Degrees of Freedom (6DOF) equations.

CO-2. Identify short and long period oscillations seen in Longitudinal, lateral and directional modes and propose remedies.

CO-3. Discuss different types of satellite orbits and laws governing them.

CO-4. Identify and analyse different types of satellite attitude control.

CO-5. Use MATLAB and similar software to simulate dynamic responses, and identify critical modes.

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4. Course Contents

Unit 1 (Review of Stability and Control): Static equilibrium and trim, wing location, tail plane sizing, CG travel. Systems of axes and notation: Earth, body axes, Euler angles and transformations, rigid body approximation. Derivation of equations of motion in body axes.

Unit 2 (Equations of motion of a rigid aircraft in space): Linearization, flat earth simplifications. Decoupled equations. Solution techniques: State space approach, Matrix methods, Transfer function.

Unit 3 (Longitudinal Dynamics): Response modes of a typical Aircraft, short and long period oscillations. Lateral and Directional Dynamics: Response modes of a typical Aircraft, rolling, Dutch, spiral oscillations. Errors related to rigid aircraft assumption at high angles of attack or Mach number, flexible body and aileron reversal. Manoeuvrability: Stability derivatives, pitch-up, yaw divergence

Unit 4 (Fundamentals of Orbit Mechanics, Orbit Manoeuvres): Two-body motion, Circular, elliptic, hyperbolic, and parabolic orbits-Basic Orbital Elements, Ground trace In-Plane Orbit changes, Hohmann Transfer, Bi-elliptical Transfer, Plane Changes, Combined Manoeuvres, Propulsion for Manoeuvres.

Unit 6 (Satellite Attitude Dynamics): Torque free Axi-symmetric rigid body, Attitude Control for Spinning Spacecraft, Attitude Control for Non-spinning Spacecraft, The Yo-Yo Mechanism, Gravity gradient. Satellite, Dual Spin Spacecraft, Attitude Determination.

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		2	2		2		1	1			3	2	1
CO-5	3	3	3		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		0
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		10
1. Solving Numerical Problems	10	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		10
1. Case Study Presentation	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 are presented in the Programme Specifications document pertaining to the M.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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Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ▶	SC1	SC2	SC3	SC4	
Subcomponent Type ▶	Term Test 1	Term Test 2	Assignment	Term Project	100 Marks
Maximum Marks ▶	25	25	25	25	
CO-1	×				×
CO-2	×		x		×
CO-3	x		x	×	×
CO-4		x	×	x	×
CO-5		x	x	×	×
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of 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.	Behavioural Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Marcello R. Napolitano, (2012), Aircraft Dynamics: From Modelling to Simulation, John Wiley & Sons
2. Howard D. Curtis, (2014), Orbital Mechanics for Engineering Students, Third Edition, , Elsevier Ltd
3. Class Notes

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b. Recommended Reading

1. Etkin, B., and Reid, L. D., (1996), Dynamics of Flight: Stability and Control, 3rd Ed., John Wiley & Sons
2. Pamadi, B. N., Performance,(1998), Stability, Dynamics, and Control of Airplanes, AIAA Education Series, 1998

c. Magazines and Journals

1. AIAA
2. Journal of Aircraft

d. Websites

1. MIT OCW lectures and video

e. Other Electronic Resources

1. NPTEL Videos and Digital Library

10. Course Organization

Course Code	20ASE514A	
Course Title	Flight Dynamics and Orbital Mechanics	
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	23-Oct-2020	
Next Course Specifications Review Date	May-2022	

Course Specifications: Design of Turbomachines

Course Title	Design of Turbomachines
Course Code	20ASE522A
Course Type	Professional Core Elective
Department	Aerospace Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to introduce fundamental concepts and constructional features of various turbomachinery systems used in aircraft. Students are taught to carry out thermodynamic cycle analysis of gas turbines and to finalize the design parameters of each component. Students are taught to carryout performance analysis at design and off-design operating conditions by considering realistic flow effects. They are also introduced to performance enhancement techniques like flow control and design modification.

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	Aerospace 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 constructional features, functioning, aerodynamics losses and application of various turbomachines
- **CO-2.** Perform aero-thermodynamic analysis of a turbomachine
- **CO-3.** Select an appropriate loss correlation and cascade data for turbomachinery design
- **CO-4.** Analyse the performance map and off-design operation
- **CO-5.** Suggest a suitable turbomachine and performance enhancement techniques for an application.

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4. Course Contents

Unit 1 (Introduction): types of turbomachinery, Principle of Operation; Constructional Features and Application. Ideal versus non-ideal gases, Energy considerations and Steady Flow Energy Equation, Incompressible and Compressible aerodynamics.

Unit 2 (Euler turbine equation): Definitions of efficiency, Velocity triangles and stage performance parameters, Meanline analysis, Stage loading considerations and degree of reaction

Unit 3 (Axial Compressor):, Correlations for performance estimation at the design point: loss estimation. Approximate off-design performance: compressor map. Two-dimensional flow in turbomachinery, Spanwise flow effects, Simple radial equilibrium, Free vortex and forced-vortex analysis. Actuator disc concept. Application to blade-row interactions, Through-flow analysis: governing equations and computational implementation; role in design.

Unit 4 (Centrifugal compressor): Design considerations, slip factor, rotor vane sweep, Compressible effects. Significance of diffusers and performance map.

Unit 5 (Axial turbine): design considerations. Correlations for performance estimation at the design point: loss estimation. Blade loading considerations: very high loading for weight and blade-count reduction.
Effects of geometric and operational parameters (gaps, steps, relative wall motion and purge flow) on blade passage flows.

Unit 6 (Compressible flow effects): choking in turbomachinery blade rows; shock waves in transonic compressors and turbine; shock-induced boundary layer separation; transonic limit load in axial turbines. Effects of compressibility on losses and other flow aspects.

Unit 7 (Unsteady flows in turbomachinery): Fundamental role of unsteadiness. Significance of wake blade interaction. Approximate analysis of unsteady behaviour of compression systems: dynamic system. Instability (surge); factors affecting compressor surge.

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

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		35
Demonstrations		05
1. Demonstration using Videos	01	
2. Demonstration using Physical Models / Systems	01	
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		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 M.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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Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ▶	SC1	SC2	SC3	SC4	
Subcomponent Type ▶	Term Test 1	Term Test 2	Assignment	Field Study	100 Marks
Maximum Marks ▶	25	25	25	25	
CO-1	×	×			×
CO-2	×	×	×		×
CO-3			×	×	×
CO-4	×	×	×		×
CO-5				×	×
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	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. Dixon, S. L. (1998) Fluid Mechanics, Thermodynamics of Turbomachinery, Elsevier Butterworth–Heinemann publications.
3. Saravanamutto, H.I.H., Rogers, G.F.C. and Cohen H. (2003) Gas Turbine Theory, 5th Edition, Pearson Education, New Delhi

b. Recommended Reading

1. Farooki, S. (2008) Aircraft Propulsion, John Wiley & Sons, NY.
2. Shobeiri, M.T. (2008) Turbomachinery Performance and Flow Physics, Springer Verlag.
3. Walsh, P.P. and Fletcher, P. (2000) "Gas Turbine Performance", 1st Edition, ASME Publication, USA.
4. Lakshminarayana, B. (1996) Fluid Mechanics and Heat Transfer of Trubomachinery, John Wiley & Sons Inc
5. Yahya, S. M. (1995) Turbines Compressors and Fans, second edition, Tata McGraw-Hill Publishing Company Ltd.

c. Magazines and Journals

1. Flight

d. Websites

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

e. Other Electronic Resources

1. NPTEL Videos and Digital Library

10. Course Organization

Course Code	20ASE522A		
Course Title	Design of Turbomachines		
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	23-Oct-2020		
Next Course Specifications Review Date	May-2022		

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Course Specifications: Combustion

Course Title	Combustion
Course Code	20ASE523A
Course Type	Professional Core Elective
Department	Aerospace Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with combustion associated with air-breathing and rocket engines. The students are taught fundamentals of combustion and guidelines for combustor design through the governing equations, thermochemistry relations, concepts, simplified models and calculations. Students are introduced to use CFD tools to perform gas phase combustion simulations. The students will be able to perform combustor design calculations, analyse the given critical conditions and suggest suitable methods to work around or solve the problem.

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	Aerospace 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 fuel properties, combustion process associated with air-breathing and rocket engines.

CO-2. Perform thermo-chemical calculations.

CO-3. Develop simple mathematical models and analyse combustion phenomena.

CO-4. Perform combustor sizing calculations for gas turbine and rocket engines and analyse it for various operating conditions

CO-5. Simulate co-axial burner and explain the combustor aerodynamics

CO-6. Suggest suitable solution to the given critical problem from combustion fundamentals

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4. Course Contents

Unit 1 (Elements of Combustion and Devices): Solid, liquid and gaseous fuels, oxidisers, propellants; calorific or heating value. Introduction to combustion process in IC engines, gas turbine engines, Ramjet and Scramjet engines, pulse jet and Pulse Detonation Engine (PDE), solid, liquid and hybrid rocket engines.

Unit 2 (Thermodynamics and Chemical kinetics): Review of Governing Equations for Fluid Flow, Thermodynamic Process, Isentropic Relations, Flow through Nozzle, Normal and Oblique shocks. Reacting System: Ideal gas mixture, Stoichiometry, Heat of Formation and Reaction, Adiabatic Flame Temperature. Introduction to Chemical Equilibrium and Chemical Kinetics.

Unit 3 (Transport equations – analysis and simplifications): Governing equations: Mass, momentum, energy and species equations. Non-dimensional numbers and time scales. Concepts of conserved scalar and mixture fraction.
Modelling of reactors: Constant-pressure, Constant-volume, well-stirred and plug-flow reactor; assumptions and application.
Reactive gas dynamics: Rankine-Hugoniot relations, deflagration and detonation. Details of detonation - structure of detonation wave, supersonic combustion and stabilized detonation.

Unit 4 (Ignition, Premixed and Diffusion flames, Droplet Combustion and Extinction): Ignition, factors affecting ignition and flammability limits. Premixed flame: Thermal and diffusion theories of laminar premixed flame propagation and estimation of laminar flame speed. Diffusion flame: Structure of attached and lifted diffusion flames. Droplet combustion: Theory and assumption and estimation of droplet life. Flame extinction, critical diameter or quenching distance.

Unit 5 (Mathematical Modeling of Combustor, Design Aspects and CFD): 0-D/1-D models to represents gas turbine combustor – prediffuser, primary and secondary zones, combustor sizing; ramjet, scramjet and PDE. CFD of reacting flows: Modelling aspects and turbulence-chemistry interaction and CFD simulation.

Unit 6 (Rocket Propellants, Combustion and Thermo-Acoustic Instability): Solid, liquid and hybrid propellants, combustion process, burn rate and sizing of combustion chamber. Principles of thermo-acoustic instabilities and mitigation.

Unit 7 (Emissions and Alternative Fuels for Aeroengines): Solid, liquid and hybrid propellants, combustion process, burn rate and sizing of combustion chamber. Principles of thermo-acoustic instabilities and mitigation.

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	1	2	1								3	2	
CO-2	3	3			1								3	1	
CO-3	3	3	3		1								3	1	
CO-4	3	3	3	1						1			3	1	1
CO-5	3	3	3		3					2			3	3	2
CO-6	3	3	3		1	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		32
Demonstrations		06
1. Demonstration using Videos	01	
2. Demonstration using Physical Models / Systems	02	
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	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		02
1. Case Study Presentation	02	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. 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.

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

1. Course notes
2. El-Turns S.R. (2000). An Introduction to Combustion: Concepts and Applications, McGraw-Hill, New York.
3. Lefebvre A.H. and Ballal D. R. (2010). Gas Turbine Combustion: Alternative Fuels and Emissions, Third Edition, Taylor & Francis Group, CRC Press, Florida.
4. Mukunda, H. S, (2004). Understanding Aerospace Chemical Propulsion, Interline Publishing India Ltd.

b. Recommended Reading

1. Mukunda, H. S. (1990). Understanding Combustion, MacMillan India Ltd.
2. Mellor A. M. (1990). Design of Modern Turbine Combustors, Academic Press Limited.
3. Williams, F. A. (1985). Combustion Theory, Perseus Books Publishing, Massachusetts.
4. Segal. C., (2011). The Scramjet Engine: Processes and Characteristics, Cambridge University Press.
5. Mishra, D. P. (2017). Fundamentals of Rocket Propulsion, Taylor & Francis Group, CRC Press, Florida.

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c. **Magazines and Journals**

1. International Symposium on Combustion, Proceedings of The Combustion Institute.
2. Combustion and Flame, Elsvier
3. Combustion Theory and Modelling, Affiliated Journal of The Combustion Institute
4. Journal of Propulsion and Power, AIAA.

d. **Websites**

1. https://cefrc.princeton.edu/combustion-summer-school
2. https://www.ccss.eng.cam.ac.uk/
3. http://nptel.ac.in/

e. **Other Electronic Resources**

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

10. Course Organization

Course Code	20ASE523A	
Course Title	Combustion	
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	23-Oct-2020	
Next Course Specifications Review Date	May-2022	

Course Specifications: Launch Vehicle Design

Course Title	Launch Vehicle Design
Course Code	20ASE524A
Course Type	Professional Core Elective
Department	Aerospace Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is intended to provide basic knowledge and required design skills for initial sizing of vehicles for powered flight to orbit. Topics include propulsion, the launch environment, ascent to orbit, performance and optimization of single and multistage rockets, testing methods. Students will practice skills in engineering design, analysis, and problem solving by completing homework assignment. They will be able to solve practical aerodynamic problems computationally and experimentally and critically evaluate the results.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Aerospace Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Identify the types of space launch vehicles and missiles.

CO-2. Classify different propulsion systems Distinguish the solid and liquid propellant motors

CO-3. Classify different types of trajectories used for rockets and missiles

CO-4. Analyse launch vehicle dynamics and arrive at appropriate velocity increments

CO-5. Identify different types of rocket testing in order to evaluate launch vehicle performance.

CO-6. Calculate launch vehicle trajectories and optimal staging for payload requirements.

4. Course Contents

Unit 1 (Launch vehicles): Types and sizes of launch vehicles, Civilian allocations: sounding rockets, LEO, PSLV, GSLV. Military applications: Short range surface-to-surface, surface-to-air, air-to-air, long range MRBMs, ICBMs. Anti-aircraft, anti-tank, anti-ship missiles. Examples.

Unit 2 (Launch vehicle Propulsion): Solid Propellant Rocket Motor Systems: Solid Propellant rocket motors, principal features, applications. Solid propellants, types, composition, properties, performance. Propellant grain, desirable properties, grain configuration, preparation, loading, structural design of grain.
Liquid Propellant Rocket Motor Systems: Liquid propellants, types, composition, properties, performance. Propellant tanks, feed systems, pressurization, turbo-pumps, Propellant slosh, and propellant hammer valves, feed lines, injectors, starting and ignition. Engine cooling, support structure.

Unit 3 (Launch Vehicle Dynamics): Tsiolkovsky's rocket equation, range in the absence of gravity, vertical motion in the earth's gravitational field, inclined motion, flight path at constant pitch angle, motion in the atmosphere, the gravity turn – the culmination altitude, multi staging. Earth launch trajectories – vertical segment, the gravity turn, constant pitch trajectory, orbital injection. Actual launch vehicle trajectories, types. Examples, the Mu 3-S-II, Ariane, Pegasus launchers. Reusable launch vehicles, future launchers, launch assist technologies. Attitude Control Of Rockets And Missiles: Rocket Thrust Vector Control – Methods of Thrusts Vector Control for solid and liquid propulsion systems, thrust magnitude control, thrust termination; stage separation dynamics, separation techniques.

Unit 4 (Rocket Testing): Ground Testing and Flight Testing, Types of Tests facilities and safeguards, monitoring and control of toxic materials, instrumentation and data management. Ground Testing, Flight Testing, Trajectory monitoring, post -accident procedures. Description of a typical space launch vehicle launch procedure. Materials: Criteria for selection of materials for rockets and missiles, requirements for choice of materials for propellant tanks, liners, insulators, inhibitors, at cryogenic temperatures, requirements of materials at extremely high temperatures, requirements of materials for thermal protection and for pressure vessels.

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		2	2		2		1	1			3		1
CO-5	3	3	3		2					1			3	2	1
CO-6	3	3	2		2		2						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		0
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		10
1. Solving Numerical Problems	10	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		10
1. Case Study Presentation	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 are presented in the Programme Specifications document pertaining to the M.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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Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ▶	SC1	SC2	SC3	SC4	
Subcomponent Type ▶	Term Test 1	Term Test 2	Assignment	Term Project	100 Marks
Maximum Marks ▶	25	25	25	25	
CO-1	×				×
CO-2	×		x		×
CO-3	x		x	×	×
CO-4		x	×	x	×
CO-5		x	x	×	×
CO-6			×	x	×
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	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. Jerry Jon Sellers (2004) Understanding Space: An Introduction to Astronautics, 2nd Edition, McGraw-Hill, U.S.A.
2. George Paul Sutton and Oscar Biblarz (2010), Rocket Propulsion Elements, 8th Edition, John Wiley & Sons, INC
3. Class Notes

b. Recommended Reading

1. Michael D. Griffin , James R. French, (2004) Space Vehicle Design, 2nd Edition, AIAA Education Series
2. Martin J.L. Turner (2009) Rocket and Spacecraft Propulsion: Principles, Practice and New Developments, 3rd Edition, Springer
3. George Paul Sutton and Oscar Biblarz (2010), Rocket Propulsion Elements, 8th Edition, John Wiley & Sons, INC

c. Magazines and Journals

1. AIAA
2. Journal of Aircraft

d. Websites

1. MIT OCW lectures and video

e. Other Electronic Resources

1. NPTEL Videos and Digital Library

10. Course Organization

Course Code	20ASE524A	
Course Title	Launch Vehicle Design	
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	23-Oct-2020	
Next Course Specifications Review Date	May-2022	

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Course Specifications: Fatigue and Fracture Mechanics

Course Title	Fatigue and Fracture Mechanics
Course Code	20ASE531A
Course Type	Professional Core Elective
Department	Aerospace 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	Aerospace 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.

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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

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	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		
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		35
Demonstrations		5
1. Demonstration using Videos	2	
2. Demonstration using Physical Models / Systems	1	
3. Demonstration on a Computer	2	
Numeracy		20
1. Solving Numerical Problems	20	
Practical Work		0
1. Course Laboratory	0	
2. Computer Laboratory	0	
3. Engineering Workshop / Course Workshop / Kitchen	0	
4. Clinical Laboratory	0	
5. Hospital	0	
6. Model Studio	0	
Others		0
1. Case Study Presentation	0	
2. Guest Lecture	0	
3. Industry / Field Visit	0	
4. Brain Storming Sessions	0	
5. Group Discussions	0	
6. Discussing Possible Innovations	0	
Term Tests, Laboratory Examination / Written Examination, Presentations		10
Total Duration in Hours		70

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Tech. (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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Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ▶	SC1	SC2	SC3	SC4	
Subcomponent Type ▶	Term Test 1	Term Test 2	Assignment 1	Assignment 2	100 Marks
Maximum Marks ▶	25	25	25	25	
CO-1	×				×
CO-2	×				×
CO-3	×	×	×	×	×
CO-4		×			×
CO-5		×	×		×
CO-6				×	×
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

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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

1. http://apm.iitm.ac.in/smlab/kramesh/book_4.htm
2. http://engr.bd.psu.edu/ansysug/2007-11-20/WBEFatigue.pdf
3. http://www.ozeninc.com/default-aspii85/
4. https://caeai.com/sites/default/files/fatigue_in_ansys_0.pdf

e. Other Electronic Resources

1. Digital electronic resources available in RUAS library

10. Course Organization

Course Code	19ASE531A	
Course Title	Fatigue and Fracture Mechanics	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	**Phone:**	080-49065555
	E-mail:	hod.aae.et@msruas.ac.in
Course Specifications Approval Date	23-Oct-2020	
Next Course Specifications Review Date	May-2022	

◀◆▶

Course Specifications: Aircraft Structural Dynamics

Course Title	Aircraft Structural Dynamics
Course Code	20ASE532A
Course Type	Professional Core Elective
Department	Aerospace Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with the influence of structural dynamics on the response of aircraft structures. Students will be exposed to analytical methods for assessing characteristics such as modal frequencies and modes from lumped- parameter models. Beginning with the concept of natural frequency, the course will go on to cover transmissibility, isolation, shock- and periodic responses, all of which have a high influence on aerospace structure design. Throughout the course, MATLAB will be used for solutions. By doing this course, students will be able to usefully apply understanding of structural dynamics to aircraft design.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Aerospace 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. Determine natural frequencies and transient responses for SDOF models of aerospace structures

CO-2. Solve for the shock response, transmissibility and frequency response function of SDOF models.

CO-3. Solve for periodic response of SDOF models from Fourier decomposition.

CO-4. Build MDOF models to determine eigenvalues/ eigenvectors as well as frequency and transient responses.

CO-5. Identify sources of vibration in real- world aerospace systems and tune the associated structural design towards desired modal characteristics.

4. Course Contents

Unit 1 (Overview): Structural dynamics vs. rigid body dynamics, real- world examples: - aircraft structural dynamic loads induced from runways, engines, landing, cross- winds; spacecraft loads - launch vehicles, satellites, landers.

Unit 2 (Conservative single DOF systems): Conservative vs. non- conservative systems; Energy method; Concept of Degrees of freedom (DOF): - lumped- parameter models: - solution for a simple oscillating pendulum, spring- mass models in translation and rotation, natural frequencies of simple aerospace structures: beams supporting masses, shafts supporting rotors.

Unit 3 (Non- conservative single DOF systems): Viscous damping, Governing equation and solution for transient free response; Response to excitation: harmonic excitation: resonance concept; arbitrary excitation: convolution principle and Duhamel's integral for shock response; periodic excitation: Fourier decomposition; solutions using MATLAB.

Unit 4 (Multi- DOF systems): Governing system of equations for a 2- DOF model: eigenvalues and eigenvectors; orthogonality principle: principal coordinates, Rayleigh damping; Lagrange's equation and its applications

Unit 5 (Distributed parameter models): Vibration of beams and rods- assumed modes: natural frequencies and normal modes; Finite element solutions for frequencies of structural assemblies.

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			1								3	1	
CO-3	3	3			1								3	1	
CO-4	3	3			1								3	1	
CO-5	3	2	3		1								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		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	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. Brainstorming 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 M.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.

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

1. Class notes
2. W.T. Thomson, 1997, Vibration Theory and Applications, Prentice Hall Publ.
3. Leonard Meirovitch, 1986, Elements of Vibration Analysis, McGraw Hill Publ.

b. Recommended Reading

1. P. Srinivasan, 2000, Mechanical Vibration, TATA McGraw Hill Publishers.
2. S.P. Timoshenko et al, 1990, Vibration problems in Engineering, 5th ed., Wiley Inter science Publ.
3. W.M. Seto, 1964, Theory and Practice of Mechanical Vibrations, Schaum Publ.

c. Magazines and Journals

1. Journal of Sound and Vibration, Elsevier Publ.

d. Websites

1. MIT OCW lectures and videos

e. Other Electronic Resources

1. YouTube videos on Aircraft Landing, Cross- winds, Crashes, Engine Failures.

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10.Course Organization

Course Code	20ASE412A	
Course Title	Aircraft Structural Dynamics	
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	23-Oct-2020	
Next Course Specifications Review Date	May-2022	

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Course Specifications: Composite Structures

Course Title	Composite Structures
Course Code	20ASE533A
Course Type	Professional Core Elective
Department	Aerospace Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is aimed at giving a broad understanding of the mechanics of composite structures and their current applications in aerospace engineering. Beginning with an overview of composite forms and processing methods, the course will cover the theory and applications of laminated composite beams, plates and shells. Orthotropic and anisotropic constants will be derived for simple unidirectional plies. Concepts of plate and shell mechanics will be discussed for multiple layup sequences to point to the role of layup tailoring for load needs. Topics of strength, damage, characterization and non- destructive evaluation will be covered. MATLAB and FE analyses will be invoked throughout to compute solutions to example problems. On doing this course, students will be able to reliably apply their understanding to designing composite structures.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
Total Hours of Interaction	60
Number of Weeks in a Semester	16
Department Responsible	Aerospace 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 strengths and limitations of composite materials vis- a- vis metals, from property and processing aspects

CO-2. Compute the 'on- axes' and 'off- axes' stiffness constants of an orthotropic lamina and the A, B, D matrices of laminates for a given stacking sequence

CO-3. Calculate deformation and stresses in simple composite beam and plate structural components using MATLAB programs and draw conclusions from the solutions

CO-4. Compute modal and buckling eigenvalues of composite beam, plate and stiffened shell components using FEA tools and draw conclusions from the solutions

CO-5. Describe the test principles and methods of characterizing composite materials for elastic constants, as well as the NDE principles for composite structure damage detection and assessment.

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4. Course Contents

Unit 1 (Overview): Composite materials overview- how composite materials compare against metals, real- world applications; fabrication processes- hand layup, vacuum bagging, autoclaves and ovens, hot press curing

Unit 2 (Composite Forms): Micromechanics- mass and volume fractions, unidirectional moduli, fabric- reinforced composite materials- plain, twill and satin weave forms; examples

Unit 3 (Elasticity): Orthotropic and anisotropic media; Orthotropic lamina on- axes stress- strain relations, off- axes transformations and ply stiffness matrix, numerical examples with MATLAB

Unit 4 (Laminates): Composite laminates- A, B and D matrices, extension- shear, bending- shear and bending- twist couplings, using coupling to achieve 'tailored' structural behavior; numerical examples with MATLAB; Finite element analyses of composite structures- beams, plates and shells, demonstration problems; Failure of composite structures- Tsai- Hill and related theories; Damage modeling with FEA

Unit 5 (Testing and NDE): Testing of composite structures- test coupons, characterization of moduli by tensile test, 3- point bending, shear moduli by corner load test; non-destructive examination of composite structures- ultrasound, A- scan, B- scan and C- scans, test videos

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							0	2	0
CO-2	3	3			1								3	1	0
CO-3	3	3			1								3	1	0
CO-4	3	3			1								3	1	0
CO-5	3	2	3		1								3	1	0
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		10
1. Solving Numerical Problems	10	
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		0
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brainstorming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**60**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Tech. (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.

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

1. Class notes
2. Ever J Barbero (2013), Introduction to Composite Materials Design, CRC Press, Indian Edition
3. Jones R M. (1975), Mechanics of Composite Materials, Taylor and Francis.

b. Recommended Reading

1. Reddy J. N. (1997), Mechanics of Laminated Composite Plates- Theory and Analysis, CRC Press

c. Magazines and Journals

1. Composite Structures, Elsevier Publ.

d. Websites

1. Websites of ACMA, Boeing, Airbus, NASA

e. Other Electronic Resources

1. YouTube videos on Composites Manufacturing and Testing.

10. Course Organization

Course Code	20ASE533A		
Course Title	Composite Structures		
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	23-Oct-2020		
Next Course Specifications Review Date	May-2024		

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Course Specifications: Stochastic Mechanics and Reliability

Course Title	Stochastic Mechanics and Reliability
Course Code	20ASE541A
Course Type	Professional Core Elective
Department	Aerospace engineering
Faculty	Engineering and Technology

1. Course Summary

This course will enable students to acquire an understanding of probabilistic modelling and reliability analysis of an engineering system design. Students are taught theories and concepts of probability theory from the viewpoint of application in engineering systems. Students are also taught the concepts employed in the development of algorithms for reliability based engineering and simulation based approaches. Students will be able to develop computer based skills in implementing these probabilistic methods to solve engineering problems.

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	Aerospace 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 basics and concept of probability theory

CO-2. Explain concept of random variable, random field, Probability density functions, Cumulative distribution functions, correlation and covariance analysis

CO-3. Explain different functional relationships between response and random variables

CO-4. Elucidate the concept of risk and safety factor, fundamentals of reliability analysis and Simulation techniques

CO-5. Apply reliability methods to solve simple numerical examples

CO-6. Develop computer programs to implement probabilistic methods in the aerospace engineering context

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4. Course Contents

Unit 1 (Probability basics): definitions, set theory, axioms of probability, multiplication rule, Bayes' theorem

Unit 2 (Characteristics of probability description) : Analytical models to quantify randomness - Random variable : continuous and discrete, Probability density functions, Cumulative distribution functions, Dispersion measures, Random fields, concept of correlation and covariance, multivariate distributions

Unit 3 (Randomness in response variables): Functional relationship between response and random variables – linear, nonlinear; response as a function of random variables – single, multiple; Regression analysis

Unit 4 (Reliability analysis): Concept of risk and safety factor, fundamentals of reliability analysis – First order reliability methods, second order reliability methods

Unit 5 (Simulation Techniques): Monte Carlo methods, Introduction to stochastic finite element approach, random field discretization techniques, Matlab based implementation

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											3		
CO-5	3	3	1										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		0
1. Demonstration using Videos	0	
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 / Kitchen	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 M.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.

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

1. Halder A., Mahadevan, S., Probability, Reliability and Statistical Methods in Engineering Design, Wiley (2000)
2. Seung-Kyum Choi, Ramana V. Grandhi and Robert A. Canfield Reliability-based Structural Design (2006)

b. Recommended Reading

1. Ghanem, R. G., Spanos, P. D., Stochastic Finite Elements: A Spectral Approach, Springer (1991)
2. Melchers, R. E., Structural Reliability Analysis and Prediction, Wiley (1999)
3. Isaac Elishakoff, Probabilistic Theory of Structures, (1983)

c. Magazines and Journals

1. Journal for Reliability

d. Websites

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

e. Other Electronic Resources

10. Course Organization

Course Code	20ASE541A	
Course Title	Stochastic Mechanics and Reliability	
Course Leader/s Name	As per Time - table	
Course Leader Contact Details	**Phone:**	080-49065555
	E-mail:	hod.aae.et@msruas.ac.in
Course Specifications Approval Date	23-Oct-2020	
Next Course Specifications Review Date	May -2022	

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

Course Specifications: Aerospace Materials and Manufacturing Processes

Course Title	Aerospace Materials and Manufacturing Processes
Course Code	20AUC542A
Course Type	Professional Core Elective
Department	Aerospace Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with critical evaluation of materials and manufacturing processes, and selection of appropriate materials and processes for aerospace applications. The course will impart knowledge about different classes of materials, advanced materials, high temperature materials, advanced manufacturing processes, structure-property-processing correlation, matching manufacturing processes and materials, corrosion and its prevention, coating techniques, Non Destructive Testing (NDT) and failure analysis of materials. The students will be trained in selection of materials and manufacturing techniques for different aerospace systems using database.

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	Aerospace 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 different types of materials, properties, processes and type of heat treatments given for aerospace components.

CO-2. Identify materials and manufacturing processes used for aerospace systems.

CO-3. Review different types corrosion, coatings and Non-Destructive Testing used for aerospace components.

CO-4. Analyse functional requirements of components and suggest suitable material and manufacturing processes for the same.

CO-5. Analyse component failures and suggest remedies in terms of materials and processes.

CO-6. Use appropriate database tools to select suitable combination of materials and manufacturing process for a specified application.

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4. Course Contents

Unit 1 (Aerospace components and materials): Component categories, property evaluation of materials for different components, classification of materials, factors influencing selection of materials; Metallic materials for aerospace applications: Metallurgical principles used for strengthening metals and alloys, Properties and application of ferrous and non- ferrous alloys, different lightweight metals and alloys, Property requirement for high temperature materials, high temperature alloys like super alloys, intermetallics, heat treatment processes for alloys, analysis of merits and demerits of metallic materials for aerospace and turbomachinery applications with case studies; Non-metallic materials in aerospace applications: Properties of polymers, Thermo plastic and thermoset usage based on the functionality requirement, **Ceramic materials:** Properties and applications in aerospace applications, Advantages and limitations of non-metallic materials for aerospace applications and remedies to overcome these

Unit 2 (Advanced manufacturing processes for metallic and nonmetallic materials): Advanced casting methods, forging, superplastic forming, directional solidification, single crystal blade fabrication, Powder metallurgy, Gel casting, Additive manufacturing;
Non- conventional machining: Principles and application of advanced machining technology like ultrasonic machining, water jet cutting, electrochemical processing, laser cutting etc.
Joining technologies: TIG and MIG welding, mechanical fastening, advanced techniques like plasma technique, laser welding, adhesive joining etc., joining of dissimilar materials

Unit 3 (Composite materials and processing for Aerospace applications): Classification and properties of composite materials, Polymer Matrix Composites (PMC), Metal Matrix Composites (MMC) and Ceramic Matrix Composites (CMC), Foam based materials, advantages and disadvantages of composite materials for aerospace applications with case studies;
Processing of PMC, MMC, CMC: Laminate structures, hand layup, filament winding, resin transfer moulding, squeeze casting, gas pressure infiltration, Chemical Vapor Infiltration etc.

Unit 4 (Corrosion, Coatings and Failure Analysis): Corrosion observed in aerospace components and its prevention; **Coating:** Significance of coating for aerospace components, Thermal Barrier Coatings (TBCs), Stealth technology, Coating techniques like thermal deposition, laser, PVD, CVD etc.
Non Destructive Testing (NDT) techniques and Failure analysis: Different types of NDT techniques and their application for aircraft applications, case studies on failure analysis of components/systems

Unit 5 (Selection of materials and manufacturing processes): Identification of materials and manufacturing processes for aerospace components/systems, Correlation of functionality of the component with material properties, derivation of performance index based on functionality of the component, selection of materials and manufacturing based on functionality, manufacturing feasibility, adoption of suitable joining technique, Use of database tools for selection of materials and manufacturing

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

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	1	1			1	1			1	1	3	2	1
CO-2	3	3	3	3	1		1	1	1	1	2	2	3	3	2
CO-3	2	3	3	3	2	2		1	1		2		3	2	2
CO-4	2	3	3	3	2	1	2	1	1	1	1	2	3	3	2
CO-5	2	3	3	3	1	2	2		1	2		1	3	3	2
CO-6	2	2	1	3	3		1			1	1	1	2	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		45
Demonstrations		06
1. Demonstration using Videos	03	
2. Demonstration using Physical Models / Systems	03	
3. Demonstration on a Computer		
Numeracy		0
1. Solving Numerical Problems	0	
Practical Work		06
1. Course Laboratory	00	
2. Computer Laboratory	06	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		03
1. Case Study Presentation	03	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Tech. (Aerospace 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, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

1. Course notes
2. M. F. Ashby and H. Shercliff, D. Cubon, (2007) Materials Engineering Science, Processing and Design, Butterworth Publications
3. Serope Kalpakjian and Steven R. Schmid. (2004) Manufacturing Processes for Engineering Materials, Pearson Education

b. Recommended Reading

1. George F. Titteron. (2010) Aircarft Materials and Processes, 5th edition, Pitman Publishers Ltd.
2. K. U. Krainer. (2006) Metal Matrix Composites, Wiley-VCH, VerlagGmbH and Co.
3. G. W. Meetham and M. H. Van de Voorde. (2006) Materials for High Temperature Engineering Applications, Springer
4. M. P. Groover. (2005), Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 2nd Edition, John Wiley & Sons
5. W. D. Callister. (2005) Materials Science and Engineering an Introduction, 6th Edition, John Wiley & Sons

c. Magazines and Journals

1. SAE International
2. Composite Structures
3. Materials Today

d. Websites

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

e. Other Electronic Resources

1. NPTEL Videos and Digital Library

10. Course Organization

Course Code	20ASE542A	
Course Title	Aerospace Materials and Manufacturing Processes	
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	23-Oct-2020	
Next Course Specifications Review Date	May-2022	

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Course Specifications: Conceptual Design of Aerospace Vehicles

Course Title	Conceptual Design of Aerospace Vehicles
Course Code	20ASE543A
Course Type	Professional Core Elective
Department	Aerospace Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is intended to provide basic knowledge and required design skills for initial sizing of vehicles for powered flight to orbit. Topics include propulsion, the launch environment, ascent to orbit, performance and optimization of single and multistage rockets, testing methods. Students will practice skills in engineering design, analysis, and problem solving by completing homework assignment. They will be able to solve practical aerodynamic problems computationally and experimentally and critically evaluate the results.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Aerospace Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Identify and describe requirements for different classes of aerospace vehicles

CO-2. Contrast and explain the design requirements obtained based on fundamental principles and historical data

CO-3. Evaluate the design specifications and then critically arrive at an aerospace vehicle design that is likely to meet the requirements

CO-4. Analyse the various constraints coming from specifications and choose key parameters (total weight, wing plan form, thrust/power required etc.)

CO-5. Calculate and compare performance and stability characteristics against design goals and make necessary changes to choices already made and generate a layout.

CO-6. Analyse design issues for aerodynamics, propulsion, structure, weights, stability, cost, and performance, and then calculate range or sizing the design to a specified mission.

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4. Course Contents

Unit 1 (Overview of the design process and design requirements): Mission analysis and start of design by analysing and grouping the requirements as 'must have' and 'good to have'. Initial maximum take-off weight estimation based on payload, range and endurance requirements.

Unit 2 (Loading and Constraint Diagram): Energy balance (potential and kinetic) during different flight conditions are derived and used to cast some of the requirements as constraints for the choice of wing loading (W/S) and thrust loading (T/W). Computation and plotting of 'Constraint Diagram' and choice of appropriate (T/W) and (W/S) for mission requirements. Preliminary design of wing (planform, aerofoils, twist) is followed by sizing of tail geometry. Initial aerodynamic behaviour is verified using low-fidelity codes such as OpenVSP and SAUVE.

Unit 3 (Propulsion Systems) : Different propulsion systems are explored and depending on overall performance requirements, choice of a propulsion unit and its location is made. Matching of subsystems viz., Intake and nozzle are discussed.

Unit 4 (Steady state and accelerated performance): Based on preliminary design are computed and results used to identify shortfalls. Required changes to various design parameters (W, W/S, T/W etc.) are discussed in order to design requirements.

Unit 5 (Layout and Configuration): Preliminary layout and lofting of the configuration, Wing/tail layout and location of passengers, payload, and crew are discussed.

Unit 6 (Analysis and Estimation): Aerodynamic analysis, performance stability, control, and handling qualities. Estimation of Loads, preliminary design of wing and fuselage structural components (spars, stringers, bulkhead). Re-estimation of weights and iteration of process till satisfactory results are seen.

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		2	2		2		1	1			3		1
CO-5	3	3	3		2					2			3	2	
CO-6	3	3	2		2		2						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		0
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
umerac		10
1. Solving Numerical Problems	10	
ractical or		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	00
5. Hospital	00	
6. Model Studio	00	
thers		10
1. Case Study Presentation	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		

. Course ssessment and eassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.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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Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ▶	SC1	SC2	SC3	SC4	
Subcomponent Type ▶	Term Test 1	Term Test 2	Assignment	Term Project	100 Marks
Maximum Marks ▶	25	25	25	25	
CO-1	×				×
CO-2	×		x		×
CO-3	x		x	×	×
CO-4		x	×	x	×
CO-5		x	x	×	×
CO-6			×	x	×
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	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. Ajoy Kumar Kundu. Aircraft Design, 2010, Cambridge University Press.
2. Daniel P Raymer. (1992) Aircraft Design – A conceptual Approach, 2nd Edition, AIAA Education Series
3. Class Notes

b. Recommended Reading

1. Michael D. Griffin , James R. French, (2004) Space Vehicle Design, 2nd Edition, AIAA Education Series
2. Jon Roskam. (1995) Airplane Design, Vol 8, , 1995, Roskam Aviation and Engineering Corporation
3. Ilan Kroo Aircraft Design: Synthesis and Analysis, 2011
4. Martin J.L. Turner (2009) Rocket and Spacecraft Propulsion: Principles, Practice and New Developments, 3rd Edition, Springer

c. Magazines and Journals

1. AIAA
2. Journal of Aircraft

d. Websites

1. MIT OCW lectures and video

e. Other Electronic Resources

1. NPTEL Videos and Digital Library

10. Course Organization

Course Code	20ASE543A	
Course Title	Conceptual Design of Aerospace Vehicles	
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	23-Oct-2020	
Next Course Specifications Review Date	May-2022	

Course Specifications: Unmanned Air Vehicles

Course Title	Unmanned Air Vehicles
Course Code	20ASE544A
Course Type	Elective Course
Department	Aerospace Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to teach the fundamental knowledge of unmanned air vehicle with emphasize on the dynamics, control systems, conceptual design and modeling of an UAV as well as providing hands on experience building a UAV model

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	Aerospace 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.** Analyse and study the system components, technology trends, configurations, and capabilities of UAVs
- **CO-2.** Describe UAV geometric relationships, graphically depict UAV geometry from parametric definition
- **CO-3.** Estimate aerodynamic performance of UAVs for different propulsion systems and define flight regimes for various UAS classes
- **CO-4.** Select wing and fuselage configurations and arrive at a structural layout using fast and in-expensive methods
- **CO-5.** Select appropriate avionics, launch and recovery techniques for the UAV

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4. Course Contents

Unit 1 (Introduction to Unmanned Air Vehicles): Introduction to various types of UAVs: Small Unmanned Aircraft, Small Tactical Unmanned Aircraft Systems, Tactical Unmanned Aircraft Systems, Medium-Altitude Long Endurance, High-Altitude Long Endurance, Ultra Long Endurance, Uninhabited Combat Aerial Vehicles, Manned Aircraft Conversions, Air-Launched Unmanned Aircraft

Unit 2 (UAV Geometry and Configurations): UAV sizing: Methods for assessment of aerodynamic parameters, use of performance equations for various propulsion classes, deriving constraint diagram. Choosing thrust and wing loading for different classes of UAVs. Aircraft Geometry Relationships, Configuration Drivers, Wing System Configurations, Tail Configurations, Fuselage System Configurations, Propulsion Integration, Launch and Recovery System Integration, Manufacturing Configuration Drivers, Rotorcraft Configurations

Unit 3 (UAV Structural Design and Propulsion Systems): Structural design: Aircraft Loads; Shell Structure Analysis; Wing Sizing; Fuselage Analysis and Sizing. Propulsion Systems: Propellers; Reciprocating Engines; Turbofans and Turbojets; Turboshafts and Turboprops; Electric Motors; Batteries; Fuel Cells; Solar Power; Hybrid Electric

Unit 4 (Flight Performance, Launch and Recovery): Flight Performance: Operating Environment; Mission Profiles; Constraint Analysis; Flight Performance Analysis. Launch and Recovery: Introduction; Physics of UAV Launch and Recovery; Conventional Launch and Recovery; Vertical Takeoff and Landing; Rail Launchers; Rocket Launch; Air Launch; Hand Launch; Tensioned Line Launch; Gun Launch; Ground-Vehicle Launch; Skid and Belly Recovery; Net Recovery; Cable-Assisted Recovery; Parachutes

Unit 5 (Avionics): Avionics; Flight Software Elements of Communication Systems; RF Performance Simulation; Line-of-Sight Communications; Beyond Line-of-Sight Communications

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			1	1	1	3	2	1	1	3	1	3
CO-2	3	2	1						3	2		1	3		3
CO-3	3	2	1			1		1	2	2	1	1	3	1	2
CO-4	2	2	1			1			2			1	2	1	2
CO-5	2	2	1			1			2		1	1	2	1	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		10
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	02	
3. Demonstration on a Computer	06	
Numeracy		05
1. Solving Numerical Problems	05	
Practical Work		03
1. Course Laboratory	00	
2. Computer Laboratory	03	
3. Engineering Workshop / Course/Workshop	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		02
1. Assignment Discussion	02	
2. Case Study Presentation	00	
3. Guest Lecture	00	
4. Industry / Field Visit	00	
5. Brain Storming Sessions	00	
6. Group Discussions	00	
7. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Tech. (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.

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

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

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, 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, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignments, Examination
14.	Personal Management	Assignments
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. Ajoy Kumar Kundu, 2010, Aircraft Design, Cambridge University Press.
3. Daniel P Raymer, 2018, Aircraft Design – A conceptual Approach, 6th Edition, AIAA Education Series
4. Paul Fahlstrom and Thomas Gleason, 2012, Introduction to UAV Systems, 4th Edition, Wiley

b. Recommended Reading

1. Jan Roskam, 1995, Airplane Design, Vol 8, Roskam Aviation and Engineering Corporation
2. John D. Anderson, 1999, Aircraft Performance and Design, McGraw-Hill
3. Nelson, R.C., 1998, Flight Stability and Automatic Control, 2nd Edition, McGraw Hill.
4. AIAA Aerospace Design Engineers Guide, 2003, 5th Edition
5. Ilan Kroo, 2011, Aircraft Design: Synthesis and Analysis

c. Magazines and Journals

1. AIAA Journal
2. Journal of Aerospace Sciences and Technology
3. Flight

d. Websites

1. http://uasjournal.org/
2. http://www.nrcresearchpress.com/journal/juvs

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e. Other Electronic Resources

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

10. Course Organization

Course Code	20ASE544A	
Course Title	Unmanned Air Vehicles	
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	23-Oct-2020	
Next Course Specifications Review Date	May -2022	

Course Specifications: Internship

Course Title	Internship
Course Code	20ASP521A
Course Type	Internship
Department	Aerospace Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to make a student experience an industrial or business environment. The student will visit various departments of an industry/business and observe the activities in each department for a certain duration of time and try to relate his/her experience with the theory practiced back at the faculty. The student should develop a report and make a presentation on his/her experience at the industry/business.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	0:0:4
Total Hours of Interaction	240
Number of Weeks in a Semester	5
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 organization structure of the industry/business
- **CO-2.** Identify Business objectives of the organization
- **CO-3.** Describe the various departments of the organization and their activities and responsibilities to meet the business objectives
- **CO-4.** Discuss the limitations and new opportunities for growth of the organization
- **CO-5.** Express the education and skill requirement of graduates to pursue their career in industry

4. Course Contents:

Internship in relevant industry / R&D Laboratory / or in any reputed academic institution consists of the following:

1	Collection of relevant literature and review of literature
2	Interaction with the users and collection of data
3	Data Analysis, Formulation of a problem of suitable size
4	Writing down the design specifications
5	Detail design calculations
6	Choosing a modeling environment, learning the appropriate tools and techniques
7	Modelling, simulation and analysis of design
8	Defining performance parameters, Evaluation of performance, presentation performance characteristics, Verification of results
9	Demonstration to the defined audience and making a presentation to the assessing team

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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															
CO-2															
CO-3															
CO-4															
CO-5															
ery trong ontri ution trong ontri ution Moderate ontri ution															

6. Course eac i g a ear i g Met o s

Topics	Teaching methods	Hours
ndustry nternship	Field or	
	eport riting	
	resentation preparations	
	resentations to e a iners	
	Total	
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7. Course ssessme t a eassessme t

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.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 (optional), COs are assessed as illustrated in the following Table.

ocus of COs o eac Compo e t or Su compo e t of a uatio		
	Compo e t 1 C (50 eig tage)	Compo e t 2 ter s ip eport (S) (50 eig tage)
Su compo e t ▶	SC1	
Su compo e t pe ▶	Prese tatio	100 Mar s
Ma imum Mar s ▶	100	
CO-1	×	×
CO-2	×	×
CO-3	×	×
CO-4	×	×
CO-5	×	×
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.		

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

Course reassessment policies are presented in the Academic Regulations document.

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8. Achieving COs

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

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

9. Course Resources

a. Essential Reading

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

b. Recommended Reading

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

c. Magazines and Journals

1. Based on the company and area chosen

d. Websites

1. Respective companies website for more details

e. Other Electronic Resources

1. Electronic resources available in the RUAS Library

10. Course Organization

Course Code	20ASP521A	
Course Title	Internship	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-80-4906-5555
	E-mail:	hod.me.et@msruas.ac.in
Course Specifications Approval Date	23-Oct-2020	
Next Course Specifications Review Date	May -2022	

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Course Specifications: Group Project Work

Course Title	Group Project
Course Code	19ASP522A
Course Type	Project
Department	Aerospace Engineering
Faculty	Engineering and Technology

1. Course Summary

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

2. Course Size and Credits:

Number of Credits	8
Credit Structure (L:T:P)	0:0:8
Total number of hours available per student	240
Total number of hours for the team of 4 members	960
Number of Weeks in a Semester	15
Department Responsible	Aerospace Engineering
Total Course Marks	200
Pass Criterion	As per Academic Regulations
Attendance Requirement	As per Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Work in a team and undertake a project in their area of specialization

CO-2. Apply their knowledge of general and automotive engineering and application, develop a system for automotive application

CO-3. Apply appropriate research methodology while formulating a project.

CO-4. Prepare specifications, design, analyse, synthesize, prototype and assess the system

CO-5. Prepare and present appropriate forms of audio-visual and verbal presentations, and written document, to describe the project, its execution and outcome

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4. Course Contents

Sl. No.	Activities
1	Team building, Team work and Leadership skills
2	Preparing design specifications, design, analysis and synthesis, design evaluation
3	Costing, Finance Management, Project management
4	Procurement, prototype building and related manufacturing methods
5	Preparing and presenting audio-visual and verbal presentations and preparing written documents

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

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

6. Course Teaching and Learning Methods

Topics	Teaching methods	Hours
Critical Review, Problem Formulation and stating Objectives	Reading Journal papers , books and other relevant materials and problem formulation	20.00
	Presentation to Reviewers	5.00
System Design	Group work with supervisors	15.00
System Modelling, Simulation and Analysis	Group work with supervisors guidance	40.00
Model Building, Instrumentation, Testing	Group work with supervisors guidance	80.00
Verification/Validation	Group work with supervisors	15.00
Drawing Conclusions	Group work with supervisors	10.00
Video creation, Presentation ,Thesis/Report Writing and Viva Voce	Presentation and Viva voce - Group	5.00
	Thesis/Report writing - Group	30.00
	Project Exhibition and Video creation -	10.00
Tests/Examinations/ Presentations		10.00
Total		240.00
Note: The above time calculation is for each student and a group can consists of 4 students and total hours can be computed accordingly. The project chosen should justify the time allotted.		

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Tech. (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 and SC2), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50 %)		Component 2: Project Report (SEE) (50% Weightage)
Subcomponent ▶	SC1	SC2	
Subcomponent Type ▶	Mid Term Presentation	Final Presentation	200 Marks
Maximum Marks ▶	50	150	
CO-1	×	×	×
CO-2	×	×	×
CO-3	×	×	×
CO-4		×	×
CO-5		×	×
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.			

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

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

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9. Course Resources

a. Essential Reading

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

b. Recommended Reading

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

c. Magazines and Journals

1. Flight
2. Space

d. Websites

1. www.Flight.org
2. Will be advised based on the domain chosen.

e. Other Electronic Resources

1. Digital electronic resources available in RUAS Library

10. Course Organization

Course Code	19ASP522A	
Course Title	Group Project	
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	23-Oct-2020	
Next Course Specifications Review Date	May-2022	

Course Specifications: Dissertation and Publication

Course Title	Dissertation and Publication
Course Code	19ASP524A
Course Type	Project
Department	Aerospace Engineering
Faculty	Engineering and Technology

1. Course Summary

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

2. Course Size and Credits:

Number of Credits	24
Credit Structure (Lecture: Tutorial: Practical)	0:0:24
Total number of hours available for student	720
Number of Weeks in a Semester	15
Department Responsible	Aerospace Engineering
Total Course Marks	400
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO 1 Critically review scholarly literature collected from various sources for the project purpose and formulate a research problem

CO 2 Prepare and present a research proposal

CO 3 Conduct research to achieve research objectives

CO 4 Propose new ideas/methodologies or procedures for further improvement of the research undertaken

CO 5 Create research document and write research papers for publications

CO 6 Defend the research findings in front of scholarly audience

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4. Course Contents

The course will cover the following activities:

Sl. No	Activities
1	Research Methodology
2	Information search, retrieval and review
3	Project definition and project planning
4	Use of conceptual models and frameworks Problem solving and Evaluation Interpretations and drawing conclusions Proposing ideas or methods for further work Thesis writing
5	Oral presentation
6	Authoring Research paper

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

6. Course Teaching and Learning Methods

Topics	Teaching methods	Hours
Information search, retrieval and review, Project definition and project planning	Reading Journal papers , books and other relevant materials and problem formulation	60.00
	Presentation to Reviewers	20.00
Use of conceptual models and frameworks	Individual work with supervisors guidance	80.00
Problem solving and Evaluation	Individual work with supervisors guidance	200.00
Interpretations and drawing conclusions	Individual work with supervisors guidance	100.00
Proposing ideas or methods for further work	Individual work with supervisors guidance	40.00
Presentation ,Thesis/Report Writing and Viva Voce, Authoring Research paper	Presentation and Viva voce	30.00
	Thesis/Report writing, Authoring research paper	160.00
	Video creation	15.00
	Tests/Examinations/presentations	15.00
	Total	720.00

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7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Tech. (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 and SC2), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)		Component 2: (SEE) (50% Weightage)	
Subcomponent ▶	SC1	SC2	SC 1	SC2
Subcomponent Type ▶	Mid Term Presentation	Final Presentation	Journal Paper	Thesis Report
Maximum Marks ▶	100	300	100	300
CO-1	×			×
CO-2	×			×
CO-3	×	×		×
CO-4		×		×
CO-5			×	×
CO-6		×	×	×
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.				

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

8. Achieving COs

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

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

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9. Course Resources

a. Essential Reading

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

b. Recommended Reading

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

c. Magazines and Journals

1. SAE Journals - Aerospace Editions
2. Space related Journal
3. Materials for Today
4. Sadhana

d. Websites

1. www.flight.org

e. Other Electronic Resources

1. Digital electronic resources available in the RAUS Library.

10. Course Organization

Course Code	19ASP524A	
Course Title	Dissertation and Publication	
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	23-Oct-2020	
Next Course Specifications Review Date	May - 2022	

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