



TULSIRAMJI GAIKWAD-PATIL COLLEGE OF ENGINEERING & TECHNOLOGY

Wardha Road, Nagpur - 441108

Accredited with NAAC A+ Grade

Approved by AICTE, New Delhi, Govt. of Maharashtra

(An Autonomous Institution Affiliated to Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur)



DEPARTMENT OF AERONAUTICAL ENGINEERING

**Structure & Curriculum
M. Tech. 2nd Semester**

As per NEP-2020

From

Academic Year 2024-25



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Institute Vision & Mission

Vision:

- To emerge as a learning Center of Excellence in the National Ethos in domains of Science, Technology and Management.

Mission:

1. To strive for rearing standard and stature of the students by practicing high standards of professional ethics, transparency and accountability.
2. To provide facilities and services to meet the challenges of Industry and Society.
3. To facilitate socially responsive research, innovation and entrepreneurship.
4. To ascertain holistic development of the students and staff members by inculcating knowledge and profession as work practices.

Program Outcomes (POs)

1. Engineering Knowledge
2. Problem Analysis
3. Design/development of solutions
4. Conduct investigations of complex problems
5. Modern tool usage
6. The engineer and society
7. Environment and sustainability
8. Ethics
9. Individual and team work
10. Communication
11. Project management and finance
12. Lifelong learning



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Department Vision & Mission

Vision:

- To foster technically skilled Aeronautical Engineers of the utmost academic principles, to convene the needs of academia, industry and society.

Mission:

1. Impart quality technical education and unique interdisciplinary experiences.
2. Develop the analytical, computational and design capabilities to provide sustainable solutions.
3. Expose the students to the current trends and opportunities in the Aerospace industry.
4. Inculcate professional responsibility based on an innate ethical value system.

Program Educational Objectives (PEOs)

1. Under graduate students will acquire knowledge to investigate and solve Aeronautical Engineering problems using basics of applied science and engineering.
2. Under graduate students will utilize the modern technology and techniques to explore new skills and ideas to satisfy the need of society as well as industry.
3. Under graduate students will get finest employment opportunities in the field of Aeronautical Engineering.
4. To develop the environment of societal and ethical values to concern with engineering issues.
5. Under graduate students will contribute in the domain specific and inter disciplinary research through the project based learning.

Program Specific Outcomes (PSO)

1. Develop profound working knowledge to solve combination of complex problems in aerodynamics, propulsion, structures, flight mechanics and allied courses.
2. Be equipped to use CAE packages, simulation languages and advanced tools to solve practical design and analysis problems.
3. Under graduates will be able to utilize the extensive knowledge of design, manufacturing, testing or maintenance of systems and subsystems to pursue career in aeronautical engineering.

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Scheme of Instructions: First Year M. Tech. in Aeronautical Engineering Semester-II (1st Year -2024-25)

Sr. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs/Wk	Credits	EXAM SCHEME				
									CT1	CT2	TA/CA	ESE	TOTAL
1	PCC	MAE21201	Flight Dynamics & Control	4	-	-	4	4	20	20	-	60	100
2	PCC	MAE21202	Rocket Propulsion	4	-	-	4	4	20	20	-	60	100
3	PCC	MAE21203	Aircraft Design	4	-	-	4	4	20	20	-	60	100
4	PCC	MAE21204	Aeronautical Engineering-2 Lab	-	-	4	4	2	-	-	50	50	100
5	FC	MAE21205	Research Methodology	3	-	-	3	3	20	20	-	60	100
6	PEC	MAE21206-09	Program Elective-III	3	-	-	3	3	20	20	-	60	100
Total				18	-	4	22	20	100	100	50	350	600

L- Lecture

T- Tutorial

P- Practical

CT-1- Class Test-I

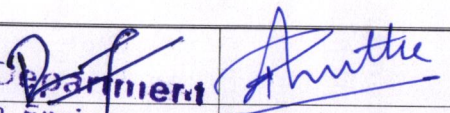
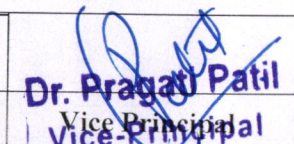
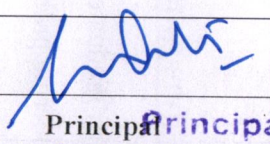
CT-2 - Class Test-2

TA/CA - Teacher Assessment/ Continuous Assessment

ESE- End Semester Examination (For Lab & Theory End Semester Exam

Professional Elective/Audit Course/ Open Elective (List is provided at the end of structure).

TOTAL CREDITS: 20+20=40

 Dean Academics	 Vice-Principal	 Principal	Dec, 2024	1.00	Applicable
Date of Release			Version	For AY 2024-25 Onwards	

Head of Department
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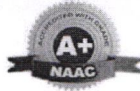


List of Program Elective Courses

Semester II
Program Elective-III
MAE21206: Aircraft Systems
MAE21207: Fundamentals of Combustion
MAE21208: Helicopter Engineering
MAE21209: Aviation Management

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First Year (Semester-II) M. Tech. Aeronautical Engineering

First Year M. Tech. (Semester-II)

MAE21201: Flight Dynamics and Control

Teaching Scheme		Examination Scheme	
Lectures	4 Hr / Week	ESE	60 Marks
Tutorial	-	CIE	40 Marks
Practical	-	Total	100 Marks

Theory Credits : 4

Duration of Exam : 3 Hours

Course Objectives

The Objectives of this course are:

1. Study the Forces and moments acting on a flight vehicle,
2. Characterize the Performance of airplane in level flight.
3. Study the Gliding flight and Turning performance
4. Explain the basic concepts equilibrium equation, Stability criterion.
5. Understand the Dihedral effect, Lateral control, Coupling between rolling and yawing moments

Course Contents

Unit I	Forces and Moment on the Airplane Forces and moments acting on a flight vehicle, Equation of motion of a rigid flight vehicle, Different types of drag, Drag polars of vehicles from low speed to high speeds, Variation of thrust, power and SFC with velocity and altitudes for air breathing engines and rockets, Power available and power required curves.
Unit II	Aircraft Performance Performance of airplane in level flight, Maximum speed in level flight, Conditions for minimum drag and power required Range and endurance, Climbing flight (Maximum rate of climb) and steepest angle of climb, Service and absolute ceiling.
Unit III	Gliding and Turning performance Gliding flight (minimum rate of sink and shallowest angle of glide), Turning performance (Turning rate turn radius). Bank angle and load factor, take-off and landing performance, Limitations of pulls up and pushes over.
Unit IV	Static Longitudinal Stability and Control (Stick Fixed and Stick Free) Degree of freedom of rigid bodies in space, Static and dynamic stability, Purpose of controls in airplanes, inherently stable and marginal stable airplanes, Static, Longitudinal stability, Stick fixed stability, Basic equilibrium equation, Stability criterion, Effects of fuselage and nacelle, Influence of CG location, Power effects, Stick fixed neutral point. Stick free stability, Hinge moment coefficient, Stick free neutral points, Symmetric maneuvers, stick force gradients, Stick force per 'g', Aerodynamic balancing. Determination of neutral points and maneuver points from flight test.
Unit V	Lateral and Directional Stability Dihedral effect, Lateral control, Coupling between rolling and yawing moments, Adverse yaw effects, Aileron reversal, Static directional stability, Weather cocking effect, Rudder requirements, One engine inoperative condition, Rudder lock.



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1	Perkins, C. D. and Hage, R. E., Airplane Performance stability and Control, John Wiley & Son:, Inc, New York, 3rd Edn. 2008.
2	Nelson, R. C., Flight Stability and Automatic Control, McGraw-Hill Book Co., 1st Ed., 1998.
3	Etkin, B., Dynamics of Flight Stability and Control, John Wiley, New York, 2nd Ed., 1982.

Reference Books

1	Babister, A. W., Aircraft Dynamic Stability and Response, Pergamon Press, Oxford, 1st Ed., 1980.
2	Dommasch, D. O., Shelby, S. S., and Connolly, T. F., Aeroplane Aero dynamics, Issac Pitman, London, 3rd Ed., 1981.
3	J. D Anderson, A. W., Aircraft Dynamic Stability and Response, Pergamon Press, Oxford, 1st Ed., 1980.

Useful Links

1	https://nptel.ac.in/courses/101/104/101104061/
2	https://nptel.ac.in/courses/101/106/101106041/
3	https://nptel.ac.in/courses/101/104/101104007/

MAE1201	Course Outcomes
CO1	Describes the fundamentals of aircraft design and aerodynamic characteristics.
CO2	Estimate the drag and thrust of the flight vehicle under given operating condition.
CO3	Enumerate steady level flight performance of an aircraft.
CO4	Examine accelerated flight performance of an aircraft under given loading condition.
CO5	Examine the static and lateral stability of an aircraft.

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First Year (Semester-II) M. Tech. Aeronautical Engineering

First Year M. Tech (Semester-II)

MAE21202: Rocket Propulsion

Teaching Scheme		Examination Scheme	
Lectures	4 Hr / Week	ESE	60 Marks
Tutorial	-	CIE	40 Marks
Practical	-	Total	100 Marks
Theory Credits : 4		Duration of Exam : 3 Hours	

Course Objectives

The Objectives of this course are:

1.	Study the types of rockets and their working principles.
2.	Characterize the advancement, performance and parameters of rocket engines.
3.	Study different type of feed systems used in modern chemical rockets.
4.	Explain the basic concepts and working principle of electric and Ion Propulsion.
5.	Understand the configurations of rocket nozzles, associated problems its application.

Course Contents

Unit I	<p>History and Principles of Rocket Propulsion The development of the rocket, Classification of rocket engines and their operating principle, Multi-stage rockets, Thermal Rocket engine: Basic configuration, the development of thrust and the effect of the atmosphere, The thermodynamics of the rocket engine, The thermodynamic thrust equation, Specific impulse of rocket engine; Numerical problems.</p>
Unit II	<p>Rocket Nozzle Theory Ideal Rocket Nozzle, Assumptions for ideal rocket nozzle, Thermodynamic relations, Isentropic flow through nozzle, under expanded and over expanded nozzles Nozzle configurations: Conical, Bell shaped nozzles, Two stepped nozzles, Nozzles with aerodynamic boundaries Real nozzles: Principal losses, multiphase flow, performance correction factors and performance parameters.</p>
Unit III	<p>Solid Propellant Rocket Engines Basic configuration, the properties and the design of solid motors, Propellant composition: Additives, Toxic exhaust, thrust stability, thrust profile and grain shape; Integrity of the combustion chamber: Thermal protection, Inter-section joints, Nozzle thermal protection; Ignition, Thrust vector control.</p>
Unit IV	<p>Liquid Propellant Rocket Motors The basic configuration of the liquid propellant engine, the combustion chamber and nozzle: Injection, Ignition, Combustion instability, thrust vector control; Liquid propellant distribution systems, Cooling of liquid-fueled rocket engines. Hybrid rocket motors: The basic configuration of a hybrid motor, Propellants and ignition, Combustion, Grain cross-section, Propulsive efficiency.</p>
Unit V	<p>Electric Propulsion: Principles of electric propulsion: Electric vehicle performance, Vehicle velocity as a function of exhaust</p>



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	velocity, Vehicle velocity and structural/propellant mass. Electric thrusters: Electro-thermal thrusters, Arc-jet thrusters, Non-Thermal electric thrusters, Propellant choice, Electrical efficiency; Plasma thrusters, Low-power electric thrusters, Electrical power generation, Applications of electric propulsion. Introduction and fundamentals of Ion propulsion: Performance Analysis, Characteristic Velocity, Payload, Specific Power; Electrical Thrust Devices: Ion and Colloid. Electromagnetic thrusters: Ion propulsion, Electric field and potential, Ion thrust.
Text Books	
1	George P. Sutton, Elements of rocket propulsion, Wiley and Sons, Inc, 7th Edition, 2001.
2	Martin J.L Turner, Rocket and Spacecraft Propulsion: Principles, Practice and New Developments, Springer: Praxis Publishing, 3rd Edition, 2009.
3	K. Ramamurthi, Rocket Propulsion, Trinity Press, 3rd Edition, Reprint, 2016.
Reference Books	
1	Mukunda H. S., Understanding Aerospace chemical propulsion, Interline publications, 2nd Ed. 2004.
2	Philip G. Hill, Carl R. Peterson, Mechanics and Thermodynamics of Propulsion, Pearson, 12th Edition, 2014.
3	Gorden, C.V., Aerothermodynamics of Gas Turbine and Rocket Propulsion, AIAA Education Series, New York, 3rd Edition, 1986.
Useful Links	
1	https://nptel.ac.in/courses/101/106/101106033/
2	https://nptel.ac.in/courses/101/101/101101002/
3	https://nptel.ac.in/courses/101/106/101106082/

MAE1202	Course Outcomes
CO1	Understand various concepts of advanced propulsion techniques.
CO2	Identify and describe various configurations of nozzles, problems associated with real nozzle and need of idealization.
CO3	Comprehend the problems on solid, liquid and hybrid rocket motors and their composition.
CO4	Solve the problems on thermodynamic thrust equation and specific impulse.
CO5	Explicate the fundamentals of rocket propulsion and working of individual rocket propulsion components.

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First Year (Semester-II) M. Tech. Aeronautical Engineering

First Year M. Tech (Semester-II)

MAE21203: Aircraft Design

Teaching Scheme		Examination Scheme	
Lectures	4 Hr / Week	ESE	60 Marks
Tutorial	-	CIE	40 Marks
Practical	-	Total	100 Marks
Theory Credits : 4		Duration of Exam : 3 Hours	
Course Objectives			
The Objectives of this course is:			
1.	To make students aware about the aircraft design process and its purpose.		
2.	To make the student understand the choice of the selection of design parameters, fixing the geometry.		
3.	To investigate the performance and stability characteristics of airplanes.		
4.	Explain the basic concepts and working principle of electric and Ion Propulsion.		
Course Contents			
Unit I	Introduction: State of art in airplane design, Purpose and scope of airplane design, Classification of airplanes based on purpose and configuration. Factors affecting configuration, Merits of different plane layouts. Stages in Airplane design. Designing for manufacturability, Maintenance, Operational costs, Interactive designs.		
Unit II	Preliminary Design Procedure Data collection and 3-view drawings, their purpose, weight estimation, Weight equation method, Development and procedures for evaluation of component weights. Weight fractions for various segments of mission. Choice of wind loading and thrust. Loading .		
Unit III	Power Plant Selection Choices available, comparative merits, Location of power plants, Functions dictating the locations.		
Unit IV	Design of Wing, Fuselage and Empennage Selection of aerofoil. Selection of Wing parameters, selection of sweep, Effect of Aspect ratio, Wing Design and Airworthiness requirements, V-n diagram, loads, Structural features. Elements of fuselage design, Loads on fuselage, Fuselage Design. Fuselage and tail sizing. Determination of tail surface areas, Tail design, Structural features, Check for nose wheel lift off.		
Unit V	Design of Landing Gear and Control Surface: Landing Gear Design, Loads on landing gear, Preliminary landing gear design. Elements of Computer Aided and Design, Special consideration in configuration lay-out, Performance estimation. Stability aspects on the design of control surface.		
Text Books			
1	Raymer, D.P. Aircraft conceptual Design, AIAA series, 5th edition, 2012.		
2	Torenbeck, E. Synthesis of Subsonic Airplane Design, Delft University Press, U.K. 1986.		
3	Kuechemann, D, The Aerodynamic Design of Aircraft, American Institute of Aeronautics publishers, 2012		

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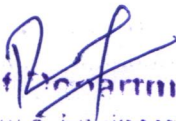
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Reference Books	
1	Jan Roskam, Airplane Design, Vol-I to VII, Dar Corporation, 1997.
2	John P. Fielding, Introduction to Aircraft Design, AIAA, 2nd Edition, 2012.
3	Thomas C. Corke, Design of Aircraft, Prentice Hall, 2003.
Useful Links	
1	https://onlinecourses.nptel.ac.in/noc21_ae04/preview
2	https://archive.nptel.ac.in/courses/101/101/101101083/
3	https://onlinecourses.nptel.ac.in/noc21_ae04/preview

MAE1202	Course Outcomes
CO1	Investigate the preliminary design of an aircraft starting from data collection to satisfy mission specifications
CO2	Perform the weight estimation and power plant selection for a specific aircraft
CO3	Estimate the geometric and design parameters of an airplane
CO4	Design a system, component or process to meet requirements for aircraft systems
CO5	Demonstrate complete design of an aircraft to a level of sufficient detail to satisfy given mission specifications


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First Year M. Tech (Semester-II)

MAE21204: Aeronautical Engineering-2 Lab

Teaching Scheme		Examination Scheme	
Practical	2 Hrs/week	CA	25 Marks
Total Credit	1	ESE	25 Marks
Duration of ESE: 02 Hrs 00 Min.		Total	50 Marks

The Objectives of this course is:

1	To study the types of rockets and their working principles.
2	To characterize the advancement, performance and parameters of rocket engines.
3	To Study different type of feed systems used in modern chemical rockets.
4	To get students know the need of data collection on different aircrafts for design.
5	To get students know about Airfoil selection, Wing tail and control surfaces selection
6	To get students the need of layouts of balance diagram and three view drawings.

Sr. No.	List of Experiment	CO
1	Estimate the calorific value of solid rocket propellant	1
2	Determination of heat of combustion of aviation fuel	1
3	Performance study of hybrid motor using a thrust stand	2
4	Analysis of grain stress and strain of a solid propellant	2
5	Estimate the performance of a propeller at different speeds	3
6	Comparative configuration study of different types of airplanes	3
7	Comparative graphs preparation and selection of main parameters for the aircraft design	3
8	Preliminary weight estimations and selection of main parameters	4
9	Power plant selection, Airfoil selection, Wing tail and control surfaces selection	4
10	Preparation of layouts of balance diagram and three view drawings	5
11	Estimation of various drags on aircraft and shown the plots with mach no.	5
12	Detailed performance calculations and stability estimates	5

Text Books

1	Raymer, D.P. Aircraft conceptual Design, AIAA series, 5th edition, 2012.
2	Torenbeck, E. Synthesis of Subsonic Airplane Design, Delft University Press, U.K. 1986.
3.	Kuechemann, D, The Aerodynamic Design of Aircraft, American Institute of Aeronautics publishers, 2012

Reference Books

1	Jan Roskam, Airplane Design, Vol-I to VII, Dar Corporation, 1997.
2	John P. Fielding, Introduction to Aircraft Design, AIAA, 2nd Edition, 2012.
3	Thomas C. Corke, Design of Aircraft, Prentice Hall, 2003



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Useful Links

1	https://onlinecourses.nptel.ac.in/noc21_ae04/preview
2	https://archive.nptel.ac.in/courses/101/101/101101083/

MAE1204	Course Outcomes
CO1	Estimate the performance of premixed flames and jet engine combustion chamber and ignition delay of solid rocket propellant.
CO2	Evaluate the performance of a aviation fuel/ propellant and hybrid rocket propellant.
CO3	Evaluate the performance of propeller at different speeds
CO4	Analysis the different Structural configurations of fuselage and wings on 3-D Design Software.
CO5	Understand the simulation 3-D Components subjected to various structural loadings.
CO6	Estimate weight and load of aircraft components such as wings and fuselage.


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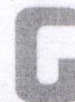
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MAE21205- Research Methodology

Teaching Scheme		Examination Scheme	
Lectures	3 Hr / Week	ESE	60 Marks
Tutorial		CIE	40 Marks
Practical	-	Total	100 Marks
Theory Credits : 3		Duration of Exam : 3 Hours	

Course Objectives

The Objectives of this course is:

1. To make students aware of research philosophy
2. To make the student understand the purpose of literature review
3. To get the knowledge of research planning
4. To make students aware of data handling and statistics analysis
5. To make the student develop the research and article writing skills.

Course Contents

Unit I	Research Foundation What is Research, Objectives of Research, Types of Research, Scientific Research, Research and Theory, Conceptual and theoretical Models, Philosophy of research, Physical, psychological health and research.
Unit II	Review of Literature Need for Reviewing Literature, What to Review and for what purpose, Literature Search Procedure, Sources of Literature, Planning of Review work, Note Taking, Library and documentation.
Unit III	Planning of Research The planning process, Selection of a Problem for Research, Formulation of the Selected Problems, Hypothesis, Research Design and Sampling, Measurement, Research Design/Plan.
Unit IV	Processing of Data and Statistical Analysis of Data Introduction to Statistical Software, Statistical analysis of data MINITAB, SPSS, Measures of Relationship, Simple Regression Analysis, Multiple Correlation and Regression, Partial Correlation, Questioners Preparation and Presentation Skills, Application Orientation in Research.
Unit V	Report and Thesis writing Types of Reports, Planning of Report Writing, Research Report Format, Principles of Writing, Data and Data Analysis Reporting in a Thesis, Use of Endnote, Language Proficiency, Citations and Plagiarism, Bibliography, API, appendix, table, Observations arrangement, Preparation of type script and lay-out of thesis, Use of LATEX Indexing of Journals, Impact factor and social Media for Researchers.

Text Books

1	Research Methodology: Methods and Techniques by C. R. Kothari, New Age International Publishers, ISBN:81-224-1522-9 2
2	Statistical Methods for Research Workers by Fisher R. A., Cosmo Publications, New Delhi ISBN:81-307-0128-6

Reference Books

1	Design and Analysis of Experiments by Montgomery D.C. (2001), John Wiley, ISBN: 0471260088
2	Methodology of Research in Social Sciences by O. R. Krishnaswamy and M. Rangnatham Himalaya



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	publication House, 2005, ISBN: 8184880936
3	SPSS online manual
Useful Links	
1	https://nptel.ac.in/courses/127/106/127106227

MAE1205	Course Outcomes
CO1	Learn philosophy of research.
CO2	Describe conceptual and methodological issues that will conduct successful research
CO3	Describe process of planning and proposing, testing of hypothesis.
CO4	Describe different statistical analysis methods.
CO5	Develop research and article writing skills.

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Program Elective-III			
First Year (Semester-II) M. Tech. Aeronautical Engineering			
First Year M. Tech. (Semester-II)			
MAE21206- Aircraft System			
Teaching Scheme		Examination Scheme	
Lectures	3 Hr / Week	ESE	60 Marks
Tutorial		CIE	40 Marks
Practical	-	Total	100 Marks
Theory Credits : 4		Duration of Exam : 3 Hours	
Course Objectives			
The Objectives of this course is:			
1.	To make students aware about flight control systems and operation of flight control system.		
2.	To make the student understand the concept of hydraulic and pneumatic systems.		
3.	To get the knowledge of electrical system to operate electronic and other Mechanical parts.		
4.	To make students aware about flight control systems and operation of flight control system.		
5.	To make the student understand the concept of hydraulic and pneumatic systems.		
Course Contents			
Unit I	Flight Control Systems Principles of flight control, flight control surfaces, control surface actuation, flight control linkage systems, trim and feel. Power control, mechanical, direct drive, electromechanical, electro- hydrostatic actuation, and multiple redundancies, fly by wire system, Inter-relationship of flight control, guidance and vehicle management systems. Air conditioning and Cabin pressurization Air Supply – Sources including engine bleed, APU and ground Cart - Air-conditioning System component layout, functioning of individual components & routine checks on the system Distribution System Flow temperature and humidity control.		
Unit II	Fire protection system Fire and smoke detection and warning system, Fire Extinguishers system, Portable fire extinguisher type of Fire detectors, standard operating procedures for fire on ground. Fuel System: Characteristics of aircraft fuel systems, System layout, checks during routine servicing, and common problems in the system components, Fuel system components, fuel transfer pumps, fuel booster pumps, fuel transfer valves, non-return valves, Fuel quantity measurement systems, level sensors, fuel gauging probes, Fuel pressurization, engine feed use of fuel as heat sink, external fuel tanks, fuel jettison, in-flight refueling.		
Unit III	Hydraulic and Pneumatic System System layout, hydraulic reservoirs and accumulators, pressure Generation, pressure control, indication and warning system functioning of hydraulic pump, Checks on hydraulic oil, Pneumatic layout System. Pneumatic reservoirs and accumulators, pressure Generation, pressure control, indication and warning system functioning of Air Pump of Pneumatic Systems. Sources pneumatic power, the engine bleed air, engine bleed air control, Uses of pneumatic power.		

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Unit IV	<p>Ice Protection Systems: Ice formation classification and detection anti-icing system, de-icing system and working of system in general, Effect of ice formation on functioning on various systems.</p> <p>Oxygen system System layout, supply regulation, sources, storage charging and distribution. Indications and warning Engine oxygen system, procedures for carrying out oxygen leak check, precaution while working on oxygen system.</p>
Unit V	<p>Electrical Systems: Aircraft electrical system characteristics, power (AC and DC) generation, Power generation control, voltage regulation, parallel operation, supervisory and protection functions. Modern electrical power generation types, constant frequency, variable frequency, variable speed constant frequency types, Primary power distribution, power conversion and energy storage. Secondary power distribution, power switching, load protection. Electrical loads, motors and actuators, lighting, heating, subsystem controllers, ground power, Emergency power generation, and Electrical load management system.</p>
Text Books	
1	Fluid mechanics by R. K. Bansal, Laxmi Publications, 9th Ed., 2007.
2	Heat transfer by R. K. Rajput, S Chand & Co Ltd, 5th Ed., 2004.
3	Introduction to Fluid Mechanics by E. J. Shaughnessy, Oxford University Press, 2nd Ed., 2005
Reference Books	
1	Boundary layer theory by H. Schlichting, Springer, India, Revised, Enlarged Ed., 2003.
2	Further aerodynamics for Engg. Students by Houghton and Boswell, Edward Arnold, 1st Ed., 1969.
3	Aerodynamics for Engineering Students by E. L. Houghton, Steven H. Collicott, P. W. Carpenter, Daniel T., 7th Edition, 2016.
Useful Links	
1	https://archive.nptel.ac.in/courses/101/105/101105088/
2	https://nptel.ac.in/content/storage2/courses/112104118/ui/Course_home-9.htm
3	https://nptel.ac.in/courses/112/106/112106190/

MAE1205	Course Outcomes
CO1	Understand the need of flight control systems and its various parts Operation of flight control system.
CO2	Apply the concept the operation of fire protection system, operation of air conditioning and cabin pressurization system.
CO3	Describe the concept of hydraulic and pneumatic systems and eliminate the Problems of these systems
CO4	Understand deicing system, its effects in flying and oxygen system layout and utility.
CO5	Apply knowledge of electrical system to operate electronic and other Mechanical parts in the aircraft.



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Department Elective-III

First Year (Semester-II) M. Tech. Aeronautical Engineering

First Year M. Tech (Semester-II)

MAE21207: Fundamentals of Combustion

Teaching Scheme		Examination Scheme	
Lectures	3 Hr / Week	ESE	60 Marks
Tutorial	-	CIE	40 Marks
Practical	-	Total	100 Marks
Theory Credits : 4		Duration of Exam : 3 Hours	

Course Objectives

1. Study the different types of rockets engine
2. Characterize the advancement, performance of fuels and refining process of fuel
3. Study different type of combustions in rockets motor in modern.
4. Explain the basic concepts and working combustion technology.

Course Contents

Unit I	INTRODUCTION TO COMBUSTION INSTABILITY: Steady and unsteady combustion; origins of combustion instability; types of combustion instability; effects of combustion instability; factors affecting combustion instability.
Unit II	INSTABILITIES IN SOLID ROCKET PROPULSION: Introduction; general features; bulk, transverse, and axial mode instabilities; aerodynamic instabilities; processes contributing to stability; measurement methods for stability testing; particulate damping; effect of propellant characteristics; control of combustion instability.
Unit III	INSTABILITIES IN LIQUID ROCKET PROPULSION: Overview; classification of instabilities; initiation of instabilities; dynamic stability; dynamics of processes in liquid rocket engines; wave propagation; effects of design factors on excitation and damping; effects of atomization and droplet combustion; experimental evaluation of instability; control of combustion instability.
Unit IV	ANALYSIS OF COMBUSTION INSTABILITY: Introduction; thermal lags in solid phase; linear analysis of instability in solid rocket motors; analysis of low, intermediate, and high-frequency instability in liquid rocket engines using time lag models.
Unit V	INSTABILITIES IN HYBRID ROCKET PROPULSION: Introduction; subsystems of hybrid rocket motors; transient events in hybrid rocket propulsion; hybrid rocket instabilities; feed system coupled instabilities; chuffing; low-frequency instabilities; comparison among solid, liquid, and hybrid low-frequency instabilities; experimental evaluation of instability; driving mechanisms for instabilities; control of combustion instability; analysis of instability in hybrid rocket motors.

Text Books

1	M. Barrere, A. Jaumotte, B.F. De Veubeke and J. Vandenkerchove, Rocket Propulsion, Elsevier.
2	M.S. Natanzon and F.E.C. Culick, Combustion Instability, Progress in Astronautics and Aeronautics, 2008.
3	Introduction to Aerospace Materials by Adrian P Mouritz, Elsevier Science, 1st Edition, 2012.



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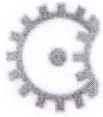


Reference Books	
1	V. Yang and W. Anderson (Eds.). Liquid Rocket Engine Combustion Instability. Progress in Astronautics and Aeronautics Vol. 169, AIAA, Washington DC, 1995.
2	M.J. Chiaverini and K.K. Kuo (Eds.) Fundamentals of Hybrid Rocket Combustion and Propulsion. Progress in Astronautics and Aeronautics Vol. 218, AIAA, Reston, Virginia, 2007.
3	
Useful Links	
1	https://nptel.ac.in/courses/101204089
2	https://archive.nptel.ac.in/courses/112/106/112106073/
3	

MAE1206	Course Outcomes
CO1	Identify the type of combustion instability in different types of rocket motors.
CO2	Analyze experimental data on combustion instability.
CO3	Identify measures to be taken for stabilizing unstable combustion.
CO4	Carry out linear instability analysis.
CO5	Design rocket motors with consideration to the effects of instabilities.

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Department Elective-III			
First Year (Semester-II) M. Tech. Aeronautical Engineering			
First Year M. Tech (Semester-II)			
MAE21208- Helicopter Engineering			
Teaching Scheme		Examination Scheme	
Lectures	3 Hr / Week	ESE	60 Marks
Tutorial		CIE	40 Marks
Practical	-	Total	100 Marks
Theory Credits : 4		Duration of Exam : 3 Hours	
Course Objectives			
The Objectives of this course is:			
1.	To Study the Historical Development of Helicopters.		
2.	To Study students about the Momentum Theory. Blade Element Theory.		
3.	Study different type of helicopter flights.		
4.	Explain the basic concepts Standards, and Specifications:		
Course Contents			
Unit I	History of helicopter flight. Fundamentals of Rotor Aerodynamics; Momentum theory analysis in hovering flight. Disk loading, power loading, thrust and power coefficients. Figure of merit, rotor solidity and blade loading coefficient. Power required in flight. Axial climb, descent, and autorotation.		
Unit II	Blade Element Analysis: Blade element analysis in hovering and forward flight. Rotating blade motion. Types of rotors. Concept of blade flapping, lagging and coning angle. Equilibrium about the flapping hinge, lead/lag hinge, and drag hinge		
Unit III	Basic Helicopter Performance: Forces acting on helicopters in forward flight. Methods of achieving translatory flight. Controlling cyclic pitch: Swash-plate system. Lateral tilt with and without coning. Lateral and longitudinal asymmetry of lift in forward flight. Forward flight performance- total power required, effects of gross weight, effect of density altitude. Speed for minimum power, and speed for maximum range. Factors affecting forward speed, and ground effects.		
Unit IV	Helicopter Stability and Control. Introductory concepts of stability. Forward speed disturbance, vertical speed disturbance, pitching angular velocity disturbance, side-slip disturbance, yawing disturbance. Static stability of helicopters: longitudinal, lateral directional and directional. Dynamic stability aspects. Main rotor and tail rotor control. Flight and Ground Handling Qualities-General requirements and definitions. Control characteristics, Levels of handling qualities.		
Unit V	Standards, and Specifications: Scope of requirements. General and operational requirements. Military derivatives of civil rotorcraft. Structural strength and design for operation on specified surfaces. Rotorcraft vibration classification.		
Text Books			
1	J. Gordon Leishman, Principles of Helicopter Aerodynamics, Cambridge University Press, 2002		
2	George H. Saunders, Dynamics of Helicopter Flight, John Wiley & Sons, Inc, NY, 1975.		



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3	Stepniewski & Keys: Rotary wing Aerodynamics, Dover Publications, 3 rd Edition, 2004
Reference Books	
1	Wayne Johnson: Helicopter Theory, Dover Publications.
2	Gordon Leishman: Principles of Helicopter Aerodynamics, Cambridge Aerospace Series.
Useful Links	
1	https://nptel.ac.in/courses/101/104/101104017/
2	https://nptel.ac.in/courses/101/104/101104015/

MAE1207	Course Outcomes
CO1	Explain the different configurations of helicopter.
CO2	Solve the problems on the concepts of rotor dynamics and related theories.
CO3	Compute the Performance of Helicopter.
CO4	Examine the stability and control of forward moving helicopter.
CO5	Study the Standards, and Specifications

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Department Elective-III

First Year (Semester-II) M. Tech. Aeronautical Engineering

First Year M. Tech (Semester-II)

MAE21209- Aviation Management

Teaching Scheme		Examination Scheme	
Lectures	3 Hr / Week	ESE	60 Marks
Tutorial		CIE	40 Marks
Practical	-	Total	100 Marks
Theory Credits : 4		Duration of Exam : 3 Hours	

Course Objectives

The Objectives of this course is:

1. Introduce the basic concepts of air traffic management.
2. Make students familiarize themselves with air traffic controllers.
3. Impart knowledge about the flight phases.
4. Infer about the basic concepts air space managements.
5. Introduce the aircraft emergency.

Course Contents

Unit I	Introduction to ATM: Comparison with other modes of transport, Role of IATA, ICAO, The general aviation industry airline, Factors affecting general aviation, use of aircraft, airport: airline management and organization, levels of management, functions of management, Principles of organization planning the organization, chart, staff departments and line departments.
Unit II	Air Traffic Controller (ATC): Vocabulary and units, Missions and actors of the air traffic management system, Visual flight rules and instrumental flight rules, Airspace classes, Airspace organization and management, Flight information regions and functional airspace blocks, Lower and upper airspace, Controlled airspace: en-route, approach or airport control, Air route network and airspace sectoring.
Unit III	The Flight Phases: The Context of Air Traffic Management, Traffic separation, Separation standard, loss of separation Conflict detection and resolution, The distribution of tasks among controllers, The controller tools, Traffic regulation, Capacity and demand, Workload and air traffic control complexity, Airspace management in en-route air traffic control centers, Operating air traffic control sectors in real time, Anticipating sector openings (France and Europe), Air traffic flow management.
Unit IV	Airspace Management: Airspace sector design, Functional airspace block definition, Simulated annealing algorithm, Ant colony algorithm, A fusion-fission method, Comparison of fusion-fission and classical graph partitioning methods, Prediction of air traffic control sector openings, Problem difficulty and possible approaches, Using a genetic algorithm, Tree-search methods, constraint programming, A neural network for workload prediction, Conclusion on the prediction of sector openings.
Unit V	Aircraft Emergency: Introduction, Airports' main challenges, Known difficulties, Optimization problems in airport traffic management, Gate assignment, Problem description, Resolution methods, Runway scheduling, problem description, problem formulation, resolution methods, surface routing, Problem



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	description, Related work, Global airport traffic optimization, Problem description , Coordination scheme between the different predictive systems.
Text Books	
1	Fedric J.H., "Airport Management", English Book House, New Delhi-I
2	Gene Krope, "Airline Procedures", English Book House, New Delhi-I.
3	Wilson & Bryon, "Air Transportation", English Book House, New Delhi-I
Reference Books	
1	Philip Lockin D, "Economics of Transportation", English Book House, New Delhi-I.
2	Indian Aircraft manual", Published by DGGA, English Book House, New Delhi-I.
3	Alexander T Wells, "Air Transportation", Wadsworth Publishing Company, California, 1993.
Useful Links	
1	https://nptel.ac.in/content/syllabus_pdf/101104005.pdf
2	https://nptel.ac.in/courses/101/104/101104071/
3	https://www.nptelvideos.com/lecture.php?id=5030

MAE1208	Course Outcomes
CO1	Understand the history of air traffic managements and its roles in airlines.
CO2	Study about concept of airspace structures and air traffic controller.
CO3	Apply the concept of phases of flight in ATM
CO4	Understand flight scheduling methods and related practices
CO5	Identify the problems solving between ATC and ATM.


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