INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

AEROSPACE ENGINEERING

COURSE DESCRIPTOR

Course Title	**AEROSPACE PROPULSION LABORATORY**				
Course Code	AAE108				
Programme	B.Tech				
Semester	VI	AE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	-	-	-	3	2
Chief Coordinator	Dr. Praveen Kumar Balguri, Associate Professor				
Course Faculty	Dr. Praveen Kumar Balguri, Associate Professor Dr. V. Varun, Associate Professor				

I. COURSE OVERVIEW:

The aim of this lab complements the basics of propulsion, working principles of reciprocating engines, flash and fire point, and kinematic and dynamic viscosity of fuels. Students will gain knowledge about the mechanical efficiency of the axial compressor, work, power, thrust requirements, performance diagrams of a gas turbine. They can gain knowledge in the calculation of thermal, propulsive efficiency of a gas turbine, the work output of axial turbine and nozzle performance, understand the calorific values of different fuels, coefficient of convection heat transfer, and calculation of propeller efficiency.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AAE007	V	Aircraft Propulsion	3

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Aerospace Propulsion Laboratory	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✘	Chalk & Talk	✘	Quiz	✘	Assignments	✘	MOOCs
✔	LCD / PPT	✘	Seminars	✘	Mini Project	✔	Videos
✔	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks for internal assessment and 70 marks for semester end lab examination. Out of 30 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end lab examination for 70 marks shall be conducted by two examiners, one of them being Internal Examiner and the other being External Examiner, both nominated by the Principal from the panel of experts recommended by Chairman, BOS.

The emphasis on the experiments is broadly based on the following criteria:

20 %	To test the preparedness for the experiment.
20 %	To test the performance in the laboratory.
20 %	To test the calculations and graphs related to the concern experiment.
20 %	To test the results and the error analysis of the experiment.
20 %	To test the subject knowledge through viva – voce.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during the day to day performance, 10 marks for final internal lab assessment.

Table 1: Assessment pattern for CIA

Component	**Laboratory**		**Total Marks**
Type of Assessment	Day to day performance	Final internal lab assessment	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):
One CIE exam shall be conducted at the end of the 12th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

Preparation	**Performance**	**Calculations and Graph**	**Results and Error Analysis**	**Viva**	**Total**
2	2	2	2	2	10

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Calculations of the observations
PO 2	**Problem analysis:** Identity, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	Calculations of the observations
PO 3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Lab Practices
PO 4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis, and interpretation of data, and synthesis of the information to provide validly conclusions	2	Term observations
PO 5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	2	Presentation on real-world problems

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional skills:** Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, a dynamic and challenging environment for design and development of new products	2	Lab Practices
PSO 2	**Problem-solving Skills:** Imparted through simulation language skills and general-purpose CAE packages to solve practical, design and analysis problems of components to complete the challenge of airworthiness for flight vehicles.	2	Guest Lectures
PSO 3	**Practical implementation and testing skills:** Providing different types of in house and training and industry practice to fabricate and test and develop the products with more innovative technologies	1	Presentation on real-world problems
PSO 4	**Successful career and entrepreneurship:** To prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aeronautical/aerospace allied systems to become technocrats	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the basics of propulsion, working principles of reciprocating engines, flash and fire point, and kinematic and dynamic viscosity of fuels.
II	Knowledge about the mechanical efficiency of the axial compressor, work, power, thrust requirements of a gas turbine and efficiency and performance diagrams.
III	Calculation of thermal, propulsive efficiency of a gas turbine, work output of axial turbine and nozzle performance.
IV	Understand the calorific values of different fuels, coefficient of convection heat transfer, and calculation of propeller efficiency.

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Understand the working mechanism and identifying various components to build an IC engine, flash point, fire point, and kinematic viscosity and dynamic viscosity of given oils.	CLO 1	Understand the working mechanism and identifying various components to build an IC engine
		CLO 2	Understand the importance of flash point and fire point for a given oil.
		CLO 3	Explain the estimation of kinematic viscosity and dynamic viscosity of the given sample
CO 2	Able to calculate the mechanical efficiency of the axial compressor, efficiency and performance parameters of a gas turbine.	CLO 4	Understand the calculation of mechanical efficiency of axial compressor
		CLO 5	Understand the work, power and thrust requirement in gas turbine
		CLO 6	Observe the gas turbine efficiency and performance diagrams
CO 3	Understand the concepts in estimating the gas turbine efficiency, the work output of the axial turbine and nozzle performance	CLO 7	Determine the thermal, propulsive and overall efficiency of turbojet cycle
		CLO 8	Understand the calculation of total work output of axial turbine- output work necessary, available output.
		CLO 9	Analyze various nozzle performance with airflow
CO 4	Analyze the calorific value of different fuels, estimation of convection heat coefficient of a plate and propeller efficiency using a propeller test rig	CLO 10	Observe the calculation of the calorific value of different fuels and materials
		CLO 11	Analyze the convection heat coefficient of a plate using forced jet
		CLO 12	Analyze the propeller efficiency and thrust availability using the propeller test rig at various blade pitch angles.

x. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AAE108.01	CLO 1	Understand the working mechanism and identifying various components to build an IC engine	PO1	2
AAE108.02	CLO 2	Understand the importance of flash point and fire point for a given oil.	PO1, PO3, PO4	2
AAE108.03	CLO 3	Explain the estimation of kinematic viscosity and dynamic viscosity of a given sample	PO3, PO4, PO5	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AAE108.04	CLO 4	Understand the calculation of mechanical efficiency of axial compressor	PO1, PO2	2
AAE108.05	CLO 5	Understand the work, power and thrust requirement in gas turbine	PO1, PO2	2
AAE108.06	CLO 6	Observe the gas turbine efficiency and performance diagrams	PO1, PO2	2
AAE108.07	CLO 7	Determine the thermal, propulsive and overall efficiency of turbojet cycle	PO2, PO3	3
AAE108.08	CLO 8	Understand the calculation of total work output of axial turbine- output work necessary, available output.	PO2, PO3	2
AAE108.09	CLO 9	Analyze various nozzle performance with airflow	PO1, PO2, PO3	2
AAE108.10	CLO 10	Observe the calculation of the calorific value of different fuels and materials	PO2, PO5	2
AAE10811	CLO 11	Analyze the convection heat coefficient of a plate using forced jet	PO2, PO3	3
AAE108.12	CLO 12	Analyze the propeller efficiency and thrust availability using the propeller test rig at various blade pitch angles.	PO1, PO2, PO5	2

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XI. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcome (POs)												Program Specific Outcome (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO 1	2															
CLO 2	2		2	2									1	2		
CLO 3			2	2	2								1	2		
CLO 4	2	2														
CLO 5	2	2														
CLO 6	2	2											2	2		
CLO 7		3	3										2	2	1	
CLO 8		2	2												1	
CLO 9	2	2	2												1	
CLO 10		2			2								2	2		
CLO 11		3	3													
CLO 12	2	2			2											

3 = High; 2 = Medium; 1 = Low

XII. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1, PO2, PO5	SEE Exams	PO1, PO2, PO5	Assignments	-	Seminars	-
Laboratory Practices	PO1, PO2, PO5	Student Viva	PO1, PO2, PO5	Mini Project	-	Certification	-

XIII. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIV. SYLLABUS

LIST OF EXPERIMENTS	
Week-1	**ENGINE DISASSEMBLY AND ASSEMBLY**
a) To understand the working mechanism and identifying various components to build an IC engine. b) Brief description of Components of the engine and its functions.	
Week-2	**FLASHPOINT AND FIRE POINT TEST**
Determination of flash point and fire point for a sample using pen sky martin‘s test.	
Week-3	**DETERMINATION OF DYNAMIC VISCOSITY OF A GIVEN SAMPLE USING REDWOOD VISCOMETER**
a) Determine kinematic viscosity and dynamic viscosity of a given sample using a viscometer. b) Order fluctuating temperature is measured in terms of viscosity	
Week-4	**MECHANICAL EFFICIENCY OF AXIAL COMPRESSOR**
Calculation of the Mechanical efficiency of an axial compressor- power required, power Available, Compression Ratio.	
Week-5	**GAS TURBINE PARAMETERS CALCULATION**
Calculation of work, power and Thrust requirement in a gas turbine- combustion power input, work heat relationship.	
Week-6	**GAS TURBINE EFFICIENCY AND PERFORMANCE DIAGRAMS**
Elucidate T-S, H-S diagrams for the gas turbine and compare efficiencies of non-ideal engine components.	
Week-7	**GAS TURBINE EFFICIENCY CALCULATIONS**
Calculation of thermal, propulsive and overall efficiency of turbojet cycle.	
Week-8	**WORK OUTPUT OF AXIAL TURBINE**
Calculation of total work output of axial turbine- output work necessary, Available output.	
Week-9	**NOZZLE PERFORMANCE**
Calculation of various nozzle performance with airflow.	
Week-10	**CALORIFIC VALUE OF DIFFERENT FUELS**
Calculation of calorific value of different fuels and materials using digital bomb calorimeter and optimizing astute fuels	

WeeK-11	**FREE AND FORCED CONVECTION**
Estimation of the convection heat coefficient of air using a forced jet or free convection apparatus.	
Week-12	**PROPELLER TEST RIG**
Calculation of propeller efficiency and thrust availability using propeller test rig at various blade pitch angles.	

Reference Books:

1. Anderson, J.D., Jr., Computational Fluid Dynamics the Basics with Applications, McGraw-Hill Inc, 1st Edition 1998.
2. Hoffmann, K. A. and Chiang, S. T., "Computational Fluid Dynamics for Engineers", Engineering Education Systems, 4th Edition, 2000.
3. Hirsch, C., "Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics", Butterworth-Heinemann, Vol. I, 2nd Edition, 2007.

XV. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Week No.	Topics to be covered	Course Learning Outcomes	Reference
1-3	Engine disassembly and assembly	CLO 1	T1
4-5	Flashpoint and fire point test	CLO 3	T1
7-8	Determination of dynamic viscosity of a given sample using a redwood viscometer	CLO 3	T1
9-12	Mechanical efficiency of axial compressor	CLO 4	T1
13-16	Gas turbine parameters calculation	CLO 5	T2
17-19	Gas turbine efficiency and performance diagrams	CLO 6	T1
20-22	Gas turbine efficiency calculations	CLO 8	T1
23-24	The work output of an axial turbine	CLO 8	T2
25-27	Nozzle performance	CLO 7	T2
28-30	The calorific value of different fuels	CLO 10	T2
31-33	Free and forced convection	CLO 13	T2
33-36	Propeller test rig	CLO 14	T2

XVI. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S.NO	DESCRIPTION	PROPOSED ACTIONS	RELEVANCE WITH POs
1	To improve standards and analyze the concepts.	Guest Lectures	PO1,PO5
2	Encourage students to solve real-time applications and prepare for competitive examinations.	NPTEL	PO1, PO3

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