Hall Ticket No | | | | | | | | | | | Question Paper Code: AAE007

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER

B.Tech V Semester End Examinations, November- 2019

Regulations: R16

AIRCRAFT PROPULSION

(AERONAUTICAL ENGINEERING)

Time: 3 hours **Max. Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

MODULE– I

1. a) Draw with neat diagram and explain the functions of all the major components in turbojet engine. **[7M]**
   b) Derive with proper steps, and formulate the thrust equation for an ideal turbojet engine in aircraft propulsion. **[7M]**

2. a) Illustrate with proper labelling the parts of a SCRAMJET engine and explain the functions of all the components. **[7M]**
   b) An aircraft having ideal turbojet engine flying at an altitude where the ambient Conditions are 0.458 bar and 248 K. **[7M]**
   Speed of the aircraft: 805 km/h
   Compressor pressure ratio: 4:1
   Turbine inlet temperature: 1100 K
   Nozzle outlet area 0.0935 m^2
   Heat of reaction of the fuel: 43 MJ/kg
   Find the thrust and TSFC assuming c_p as 1.005 kJ/kgK and γ as 1.4

MODULE – II

3. a) Explain stall and reasons on for it in subsonic inlets and operational modes of subsonic inlets **[7M]**
   b) Explain the effect of operating variables on gas turbine engine combustion chamber performance. **[7M]**

4. a) Explain in detail about different operational modes of supersonic inlet with neat and labelled sketch. **[7M]**
   b) Explain different types of combustion chamber with neat sketch and their advantage and disadvantages. **[7M]**

MODULE – III

5. a) Write brief note on nozzle choaking and minimum condition to be satisfied for it with appropriate plots. **[7M]**

   b) Draw with a neat diagram and explain the operating conditions of the convergent-divergent nozzle. **[7M]**

6. a) Derive the equation for the nozzle efficiency and explain the losses in nozzle with complete notations. **[7M]**

   b) Write short notes on:- **[7M]**
   1.Thrust reversal
   2.The need for thrust reversal

MODULE – IV

7. a) Write short notes on principle of operation of centrifugal compressor with neat sketch and valid equations. **[7M]**

   b) The following data are suggested as a basis for the design of a single-sided centrifugal compressor: **[7M]**
   Power input factor c 1.04
   Slip factor s 0.9
   Rotational speed N 290 rev/s
   Overall diameter of impeller 0.5 m
   Eye tip diameter 0.3 m
   Eye root diameter 0.15 m
   Air mass flow m 9 kg/s
   Inlet stagnation temperature T01 295 K
   Inlet stagnation pressure p01 1.1 bar
   Isentropic efficiency hc 0.78.(a) determine the pressure ratio of the compressor and thepower required to drive it assuming that the velocity of the air at the inlet is axial;
   (b) to calculate the inlet angle of the impeller vanes at the root and tip radii of theeye, assuming that the axial inlet velocity is constant across the eye annulus.

8. a) Write short notes on principle of operation of axial flow compressorwith neat sketch and valid equations. **[7M]**

   b) Write a brief note on performance characteristics of axial and centrifugal compressor with appropriate plots. **[7M]**

MODULE – V

9. a) Write a short note on the principle of operation of the axial flow turbine explaining the function of every component. **[7M]**

   b) A single stage axial flow turbine operates with an inlet temperature of 1100 Kand total pressure of 3.4 bar. The total temperature drop across the stage is **[7M]**
   144 K and the isentropic efficiency of the turbine is 0.9. The mean blade speed is 298 m/s and the mass flow rate is 18.75 kg/s. The turbine operates with a rotational speed of 12000 rpm. If the convergent nozzle is operating under choked condition determine (a) blade-loading coefficient (b) pressure ratio of the stage and (c) flow angles.

10. a) A single stage gas turbine operates at its design condition with an axial absolute flow at entry and exit from the stage. The absolute flow angle at the nozzle exit is 70 deg. At stage entry, the total pressure and temperature are 311 kPa and 850oC respectively. The exhaust static pressure is100 kPa, the total to static efficiency is 0.87 and mean blade speed is 500 m/s. Assuming constant axial velocity through the stage, determine (a) the **[7M]**

specific work done (b) the Mach number leaving the nozzle (c) the axial velocity (d) total to total efficiency (e) stage reaction.

b) Write short notes on flame stability problems in ramjet combustors and explain methods used to overcome it. **[7M]**

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COURSE OBJECTIVES:

The course should enable the students to:

I	Analyze parametric cyclic analysis, performance parameters, efficiency, and specific impulse of all air breathing engines.
II	Know the design and performance of subsonic and supersonic inlets, types of combustion chambers and factors affecting the combustors.
III	Discuss the types of nozzles, flow conditions in nozzles, interaction of nozzle flow with adjacent surfaces and thrust reversal.
IV	Explain different types of compressors and turbines, work done, velocity diagrams and stage efficiency calculations.

COURSE OUTCOMES (COs):

CO 1	Describe the various types, basic function, and performance analysis of air-breathing engine.
CO 2	Understand the various inlets and combustion chamber performance parameters affecting it.
CO 3	Explain theory of flow in isentropic nozzles and variable area nozzle
CO 4	Describe principle operations of compressors, with work done and pressure rise explaining the design and performance parameters
CO 5	Determine the various types of turbine, understand configuration associated with it

COURSE LEARNING OUTCOMES (CLOs):

AAE007.01	Apply knowledge and understand the essential facts, concepts and principles of thermodynamics.
AAE007.02	Understand the basic function of all aircraft engine components and how they work.
AAE007.03	Analyze the engine performance parameters and parameters influencing them.
AAE007.04	Understand the impact of performance parameters on endurance and range how they affect the aircraft performance.
AAE007.05	Demonstrate different type's aircraft engine operating principle.
AAE007.06	Understand step by step procedure of engine parametric cycle analysis.
AAE007.07	Understand steps involved in performance analysis of all aircraft engine.
AAE007.08	Describe operational modes of subsonic inlets and parameters influencing it.
AAE007.09	Analyze diffuser performance, losses in it and their impact on engine performance.
AAE007.10	Describe supersonic inlets, starting problem in it and their operating modes.
AAE007.11	Understand different types of combustion chamber and functions of all the components.
AAE007.12	Analyze combustion chamber performance and parameters influencing them.
AAE007.13	Describe theory of flow in isentropic nozzle and physics behind nozzle operation.
AAE007.14	Understand different nozzle operating conditions for convergent and divergent nozzle.

AAE007.15	Describe principle of operation of axial and centrifugal compressor.
AAE007.16	Understand different design of compressor and limitations of each method.
AAE007.17	Analyze performance characteristics of axial and centrifugal compressor.
AAE007.18	Describe principle of operation of centrifugal and axial flow turbine.
AAE007.19	Understand different design of axial and centrifugal turbine.
AAE007.20	Design of ramjet engine and steps involved in it.

MAPPING OF SEMESTER END EXAMINATION - COURSE OUTCOMES

SEE Question No		Course Learning Outcomes		Course Outcomes	Blooms Taxonomy Level
1	a	AAE007.02	Understand the basic function of all aircraft engine components and how they work.	CO 1	Understand
	b	AAE007.03	Analyze the engine performance parameters and parameters influencing them.	CO 1	Understand
2	a	AAE007.01	Apply knowledge and understand the essential facts, concepts and principles of thermodynamics.	CO 1	Understand
	b	AAE007.06	Understand step by step procedure of engine parametric cycle analysis.	CO 1	Understand
3	a	AAE007.08	Describe operational modes of subsonic inlets and parameters influencing it.	CO 2	Understand
	b	AAE007.12	Analyze combustion chamber performance and parameters influencing them.	CO 2	Remember
4	a	AAE007.10	Describe supersonic inlets, starting problem in it and their operating modes.	CO 2	Remember
	b	AAE007.11	Understand different types of combustion chamber and functions of all the components.	CO 2	Remember
5	a	AAE007.13	Describe theory of flow in isentropic nozzle and physics behind nozzle operation.	CO 3	Understand
	b	AAE007.14	Understand different nozzle operating conditions for convergent and divergent nozzle.	CO 3	Understand
6	a	AAE007.13	Describe theory of flow in isentropic nozzle and physics behind nozzle operation.	CO 3	Understand
	b	AAE007.13	Describe theory of flow in isentropic nozzle and physics behind nozzle operation.	CO 3	Understand
7	a	AAE007.15	Describe principle of operation of axial and centrifugal compressor.	CO 4	Understand
	b	AAE007.16	Understand different design of compressor and limitations of each method.	CO 4	Remember
8	a	AAE007.15	Describe principle of operation of axial and centrifugal compressor.	CO 4	Understand
	b	AAE007.17	Analyze performance characteristics of axial and centrifugal compressor.	CO 4	Remember
9	a	AAE007.18	Describe principle of operation of centrifugal and axial flow turbine.	CO 5	Understand
	b	AAE007.20	Design of ramjet engine and steps involved in it.	CO 5	Understand
10	a	AAE007.18	Describe principle of operation of centrifugal and axial flow turbine.	CO 5	Understand
	b	AAE007.20	Design of ramjet engine and steps involved in it.	CO 5	Understand

Signature of Course Coordinator **HOD, AE**