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10AE55

Fifth Semester B.E. Degree Examination, Dec.2017/Jan.2018

Aircraft Propulsion

Time: 3 hrs.

Max. Marks:100

Note: Answer any FIVE full questions, selecting atleast TWO questions from each part.

PART – A

- 1
 - a. Derive an expression for specific work output and thermal efficiency in terms of pressure ratio and temperature ratio for a simple gas turbine cycle with the help of a schematic diagram, P-V and T-S diagram. (08 Marks)
 - b. Explain principles of aircraft propulsion and the two types of fluid suitable for aircraft propulsion. (08 Marks)
 - c. The following data relate to an oven : Thickness of side wall of the oven – 82.5mm. Thermal conductivity of wall/insulation – 0.044 W/m⁰ C. Temperature on inside of the wall – 175⁰ C. Energy dissipated by the electrical coil within the oven – 40.5 KW. Determine the area of wall surface, Perpendicular to heat flow, so that temperature on the other side of the wall does not exceed 75⁰ C. (04 Marks)
- 2
 - a. Explain the working of a Turbojet engine with the help of a neat schematic diagram. What are its advantages and disadvantages? (08 Marks)
 - b. List and explain the factors affecting flight performance. (06 Marks)
 - c. An aircraft flies at 960 Kmph. One of the turbojet engines takes in 40 kg/s of air and expand the gases to the ambient pressure. The air – fuel ratio is 50 and the lower calorific value of the fuel is 43 MJ/kg. For maximum thrust power, determine i) Jet velocity ii) Thrust iii) Thrust power iv) TSFC. (06 Marks)
- 3
 - a. With the help of neat sketch, explain subsonic inlet with typical streamline patterns. (06 Marks)
 - b. Explain Shock Swallowing by area variation, with neat sketch. (08 Marks)
 - c. Air ($\gamma = 1.4$, $R = 287.43 \text{ J/kg } ^\circ\text{K}$) enters a straight axisymmetric duct at 300K, 3.45 bar and 150 m/s and leaves it at 277K , 2.058 bar and 260 m/s. The area of cross section at entry is 500cm². Assuming adiabatic flow, determine i) stagnation temperature ii) mass flow rate iii) area of cross section at exit. (06 Marks)
- 4
 - a. With the help of a neat sketch, explain the combustion chamber geometry and the different 20nos of combustion. (10 Marks)
 - b. Write short notes on :
 - i) Thrust Reversing and Thrust Vectoring.
 - ii) Over – expanded and Under – expanded nozzles. (10 Marks)

PART – B

- 5
 - a. A centrifugal compressor under test gear the following data : Speed – 11,500 rev/min, Inlet total head temperature – 20⁰C , Outlet and Inlet total head pressure – 4 bar , 1 bar , Impeller dia – 75cm. If the slip factor is 0.92, what is the compressor efficiency? (06 Marks)
 - b. Explain the phenomenon of surging and stalling in a centrifugal flow compressor. (08 Marks)
 - c. Define Degree of reaction for an axial flow compressor and derive an expression for the same. (06 Marks)

- 6 a. Explain with neat sketches, Single stage, Reaction and Impulse turbines. (06 Marks)
- b. With the help of neat sketches, describe the different methods of fixing turbine blades. (06 Marks)
- c. A multistage gas turbine is to be designed with Impulse stages and is to operate with an inlet pressure and temperature of 6 bar and 900K and an outlet pressure of 1 bar. The isentropic efficiency of the turbine is 85%. All the stages are to have a nozzle outlet angle of 75° and equal outlet and inlet blade angles, mean blade speed of 250 m/s and equal inlet and outlet gas velocities. Estimate the maximum number of stages required. Assume $C_p = 1.15 \text{ kJ/kg}^\circ\text{K}$, $\gamma = 1.33$ and Optimum blade speed ratio. (08 Marks)
- 7 a. With the help of a neat sketch, explain the working principle of Scramjet engine. List the advantages and disadvantages. (10 Marks)
- b. Write short notes on :
- Combustion in Ramjet engine. (10 Marks)
 - Preliminary concepts in supersonic combustion. (10 Marks)
- 8 a. Draw a schematic diagram of a liquid propellant rocket. Explain its principle of operation and discuss its advantages and disadvantages. (10 Marks)
- b. Calculate the orbital and escape velocities of a rocket at mean sea level and an attitude of 300 km from the following data :
- Radius of earth at mean sea level – 6341.6km
Acceleration due to gravity at mean sea level – 9.809 m/s^2 . (06 Marks)
- c. List the classification of Rocket Engines. (04 Marks)
