AQ – 2845

Second Semester M. E. (Mechanical Engg.) (Thermal Engg.) Examination

GAS TURBINE AND JET PROPULSION

2 MTE 4

P. Pages : 3

Time : Three Hours] [Max. Marks : 80

Note : (1) Separate answer book must be used for each section in the subject Geology, Engineering material of civil branch and Separate answer book must be used for Section A and B in Pharmacy and Cosmetic Tech.
(2) Answer **Three** questions from Section **A** and **Three** questions from Section B.
(3) Assume suitable data wherever necessary.
(4) Illustrate your answer wherever necessary with the help of neat sketches.
(5) Use of slide rule, logarithmic tables, Steam tables, Mollier's Chart, Drawing instrument, Thermodynamic table for moist air, Psychrometric Charts and Refrigeration charts is permitted.
(6) Use pen of Blue ink/refill only for writing the answer book.

SECTION A

1. (a) With neat sketch explain the principle of working of a centrifugal compressor with its applications. 7

   (b) What are the different types of blade shapes possible for centrifugal compressor ? Explain with sketch. 7

2. (a) Explain how different losses affects the performance of Axial flow compressors. 6

   (b) What do you mean by a velocity compounding with figure ? Explain its limitations and advantages. 7

3. (a) Why cooling of Gas turbine blades is necessary ? Explain its different methods with sketch. 6

(b) Define degree of Reaction (Rd) and prove that

$$Rd = \frac{Va_1}{2U} [\tan \beta_2 - \tan \beta_1]$$ 7

4. (a) Explain pressure compounding with the help of neat sketch for a multistage impulse turbine. 6

(b) A 50% reaction turbine has mean blade speed of 350 m/s. The nozzle exit angle is 15^0 and the exit velo. from moving blade is axial and 100 m/s. Find out the enthalpy drop per row of blade if the turbine inlet temperature is 850^0C and exit temp. is 620^0C. Also determine the number of stages required. 7

5. (a) What are the different materials and its properties required for Gas turbines ? 6

(b) A multistage gas turbine is to be designed with impulse stages. The pressure and temperature are 6 bar and 900 K, and exit pressure is 1 bar. The isentropic efficiency is 85%. All the stages have a nozzle outlet angle of 15^0. The inlet and outlet blade angles are equal. The mean baled speed is 250 m/sec. The inlet and outlet gas velocities are equal. Find out the number of stages required. Take C_p = 1.1 kJ/kg–K, γ = 1.33 for gas. 7

SECTION B

6. (a) Explain the principle of Jet propulsion and mention how jet propulsion engines are classified. 7

(b) Explain the term air breathing engines with neat sketch, explain how ramjet engine works. 7

7. (a) With the help of a diagram explain working principle of pulse jet engine and also draw idal and actual P-V diagram. 6

(b) What do you mean by thrust ? Derive thrust equation for general propulsion system. 7

8. (a) With neat sketch explain turbo-prop engine w.r.t. Following points :—

(1) Construction.

(2) Working

(3) Applications

(4) Advantages

(5) Disadvantages. 6

(b) A turbo jet engine flying at a speed of 990 km/hr consumes air at a rate of 54.5 kg/s.

Calculate :—

(a) Exit velo. of Jet when enthalpy changes for the nozzle is 200 kJ/kg and velo. coe. is 0.97.

(b) Fuel flow rate in kg/s when air fuel ratio is 75:1

(c) When thermal efficiency of the plant when combustion efficiency is 93% and calorific value of fuel is 45,000 kJ/kg. Calculate propulsive power. 7

9. (a) Explain the principle of After burner in thrust Augmentation. 6

(b) Draw a schematic diagram of a liquid propellant rocket. What are the different systems of injecting liquid propellants into the combustion chamber ? 7

10. (a) What is a basic difference between Jet and rockt propulsion ? How Rockets are classified ? 6

(b) A simple turbo jet unit operates with a turbine inlet termperature of 1040^0C. The foll. data refers to the design conditions :— cormpressor pressure ratio = 7.5, compressor efficiency = 84%, turbine efficiency 84%, nozzle efficiency = 98%; pressure drop in combustion chamber = 0.2 bar, mass flow rate = 25 kg/s. Atmospheric pressure and temp = 1 bar and 27^0C, neglecting the mass of fuel and mech. losses, calculate the design thrust and pressure and temperature at the inlet of jet nozzle. 7