Fifth Semester B.E. Degree Examination, June/July 2015
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 steady flow energy equation for compressible flow Turbo machines. **(08 Marks)**
   b. Briefly explain the principles of aircraft propulsion. Name different types of aircraft power plant. **(06 Marks)**
   c. Air at 20^0C blows over a hot plate of area $50 \times 75cm$ maintained at 250^0C. The convection heat transfer coefficient is $25W/m2^0C$. Calculate the Convection Heat Transfer. **(06 Marks)**

2 a. Explain the following with reference to gas turbine engines :
      i) Thermal efficiency   ii) Propulsive efficiency   iii) Overall efficiency   iv) Thrust augmentation. **(08 Marks)**
   b. Explain the factors affecting thrust of an aircraft gas turbine engine with related plots/sketches. **(06 Marks)**
   c. Calculate thrust at sea level static condition for following propulsion system :
      Exit Area = $0.2150m^2$, Exit pressure = 143.325 KPa , Pressure at Inlet = 101.325 KPa, Mass flow rate = 70 kg/s and Jet velocity = 590 m/s. With reheat (After burns) in the same propulsive system , following changes occur , Exit Area = $0.2900m^2$, Exit pressure = 136.325 KPa and Jet velocity = 740 m/s. Calculate the % increase in thrust (with respect to without reheat). **(06 Marks)**

3 a. What is the purpose of inlets in gas turbine engines? Briefly explain supersonic inlets. **(06 Marks)**
   b. Write short notes on :
      i) Internal flow and stall in subsonic inlets   ii) Diffusers   iii) Boundary layer separation. **(08 Marks)**
   c. Explain with neat sketches, "Shock – Swallowing" in the supersonic inlets. **(06 Marks)**

4 a. Explain different types of combustion chambers used in gas turbine engines. Briefly discuss their advantages and disadvantages. **(06 Marks)**
   b. Write short notes on :
      i) Primary zone   ii) Fuel Injection   iii) Flame Tube cooling   iv) Dependence of Emissions on fuel / air ratio. **(08 Marks)**
   c. Write short notes on :
      i) Thrust Reversal   ii) Gross Thrust coefficient and Flow coefficient   iii) De Laral Nozzle and choking. **(06 Marks)**

PART - B

5 a. Describe the principle of operation of a centrifugal compressor (with neat sketches). Derive expressions for work done and pressure rise with the help of velocity triangles. **(06 Marks)**

b. Write short notes on :
   i) Surging and stalling of Axial flow compressors   ii)   Degree of Reaction for compressor   iii)   Air angles distribution for free vertex design   iv)   High fluid deflection in the rotor blades. **(08 Marks)**

c. Given :
   i) Power input factor $\Psi = 1.04$ ii)   Slip factor $\sigma = 0.9$ iii)   Rotational speed $N = 290$ rev/S   iv)   Overall diameter of Impeller $= 0.5$m   v)   Eye tip diameter $= 0.3$m   vi)   Eye root diameter $= 0.15$m   vii)   Air mass flow is $= 9$kg/s   viii)   Inlet stagnation temperature $T_{01} = 295$ K   ix)   Inlet stagnation pressure $P_{01} = 1.1$ bar   x)   Isentropic efficiency $\eta_c = 0.78$ xi)   Axial velocity, $C_a = 143$ m/s.
   Calculate following :
   i) Pressure ratio of the compressor.
   ii) Power required to drive if assuming that velocity of the air at inlet is axial.
   iii) Inlet angle of the impeller vanes at the root and tip radii of the eye, assuming that the axial inlet velocity is constant across the eye annuls. **(06 Marks)**

6 a. With reference to Turbines define i) Blade loading coefficient   ii)   Degree of reaction   iii)   Flow coefficient. Write the expression for each one of them in terms of blade angles, considering all in Axial Flow turbine. **(06 Marks)**
   b. With reference to Turbine stage performance, discuss the limiting factors in turbine design. **(08 Marks)**
   c. With neat sketches, and velocity triangles, explain the working principle of radial flow turbine and derive expression for Nozzle loss coefficient and rotor loss coefficient. **(06 Marks)**

7 a. Explain the principles of Scramjet engine. What are the advantages and disadvantages? **(06 Marks)**
   b. With neat diagram, explain the working principle of a Ramjet Engine. With the help of thermodynamic cycle (T – S diagram), derive an expression for jet velocity for a Ramjet engine. **(08 Marks)**
   c. Discuss the advantages, disadvantages and characteristics of a Ramjet engine. **(06 Marks)**

8 a. Discuss the performance differences of the Air breathing Engine and the rocket engine. Using basic principle of Rocket Propulsion, derive an expression for power required to give an exhaust velocity (Cj). **(08 Marks)**
   b. Discuss in detail the classification of chemical rockets based on the type of propellant used. Use necessary sketches. **(06 Marks)**
   c. A Rocket has the following data :
      Propellant flow rate = 5 kg/s   ;   Nozzle exit diameter = 10cm
      Nozzle exit pressure = 1.02 bar   ;   Ambient pressure = 1.013 bar
      Thrust chamber pressure = 20 bar   ;   Thrust = 7 kN.
      Determine the effective Jet velocity, actual Jet velocity and Specific impulse. **(06 Marks)**

*****