B.TECH. (AEROSPACE ENGINEERING) PROGRAMME (BTAE)

Term-End Examination

June, 2011

BAS-016 : PROPULSION - II

Time : 3 hours *Maximum Marks : 70*

Note : *Answer **any seven** questions. All questions carry **equal** marks. Use of calculator is permitted.*

1. (a) What is the purpose of an aircraft gas turbine inlet and nozzle ?   **4+6=10**

    (b) The turbojet plant uses petrol having a calorific value of 43 MJ/kg. The fuel consumption is 0.18 kg per hour per N of thrust, when the thrust is 9 KN. The aircraft velocity is 500 m/s, the mass of air passing through the compressor is 27 kg/s. Calculate the air-fuel ratio and overall efficiency.

2. (a) What are the two types of nozzles used in an aircraft engine ? Briefly explain them.   **4+6=10**

    (b) The exit velocity from a jet unit is 650 m/s for an air flow of 40 kg/s through the unit. The air craft is flying at 250 km/h. Calculate the thrust developed, the thrust power and the propulsion efficiency. Neglect the effect of fuel.

3. (a) Explain the process of combustion in a gas turbine combustion chamber. **4+6=10**

   (b) A centrifugal compressor has to deliver 35 kg of air per sec. The impeller is 76 cm diameter revolving at 11,500 rpm with an adiabatic efficiency of 80%. If the pressure ratio is 4.2 : 1, estimate the probable axial width of the impeller at the impeller tip if the radial velocity is 120 m/s. The inlet conditions are 1 bar and 47°C.

4. (a) Explain the principle of jet propulsion and mention how the jet propulsion engines are classified. **4+6=10**

   (b) A centrifugal compressor has an inlet eye 15 cm dia. The impeller revolves at 20,000 rpm and the inlet air has an axial velocity of 107m/s, inlet stagnation temperature 294 K and inlet pressure 1.03 kg/cm^2. Determine
      (i) Theoretical angle of the blade at this point, and
      (ii) Mach number of the flow at the tip of the eye.

5. (a) What are the advantages and disadvantages of a ramjet engine and what are its applications ? **4+6=10**

   (b) A 10 stage axial flow compressor provides an overall pressure ratio of 5 : 1 with an overall isentropic efficiency of 87%. When the temperature of air at inlet is 15°C. The work is equally divided between the stages. A 50% reaction is used with a blade speed of 210 m/s and a constant axial velocity of 170 m/s. Estimate the blade angle. Assume a work done factor of 1.

6. (a) Mention the various advantages and disadvantages of a turbo-prop engine and also bring out the applications. **4+6=10**

   (b) Air enters an axial flow compressor at 1 bar and 20°C at low velocity. It is compressed through a pressure ratio of 11. Find the final temperature and pressure at outlet from the compressor. Take the compressor efficiency as 85%.

7. (a) With a suitable diagram explain the working principle of a centrifugal compressor. **4+6=10**

   (b) Dry saturated steam enters a frictionless adiabatic nozzle with negligible velocity at a temperature of 300°C. It is expanded to a pressure of 5000 kPa. The mass flow rate is 1 kg/s. Calculate the exit velocity of stem. Given :

Sat. temp (°C)	Sat. Pressure (Kpa)	Enthalpy (kJ/kg)		Entropy (kJ/kg - °C)		Specific volume (m³/kg)	
		Sat. liquid	Sat. vapour	Sat. liquid	Sat. vapour	Sat. liquid	Sat. vapour
300	8593	1345	2751	3.2552	5.7081	0.0014	0.0216
263.9	5000	1154.5	2794.2	2.9206	5.9735	0.0012	0.0394

8. (a) What are the basic requirements of compressors for aircraft applications ? Do axial flow compressors meet them ? Explain. **4+6=10**

   (b) Air enters a frictionless adiabatic converging nozzle at 10 bar 500 K with negligible velocity. The nozzle discharges to a region at 2 bar. If the exist area of the nozzle is 2.5 cm², find the flow rate of air through the nozzle. Assume for air $C_P = 1005$ J/kg-K and $C_v = 718$ J/kg-k

9. (a) Explain the principle of operation of a turbine and what are the primary parts of a turbine ? **4+6=10**

   (b) Find the required air-fuel ratio in a gas turbine whose turbine and compressor efficiencies are 85% and 80% respectively. Maximum cycle temperature is 875°C. The working fluid can be taken as air ($C_P = 1.0$ kJ/kg-K, $\gamma = 1.4$), which enters the compressors at 1 bar and 27°C. The pressure ratio is 4. The fuel used has calorific value of 42000 kJ/kg. There is a loss of 10% of calorific value in the combustion chamber.

10. (a) Mention the various practical problems in the operation of a combustion chamber. **4+6=10**

    (b) Write short notes on *any three* of the following :
    (i) Blade spacing.
    (ii) the inlet easing of centrifugal compressor.
    (iii) the impeller of centrifugal compressor.
    (iv) Lubrication system.
    (v) flame stability.

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