B.E. DEGREE EXAMINATIONS: NOV/DEC 2010

Fourth Semester

AERONAUTICAL ENGINEERING

U07AR404: Propulsion-I

(Use of Gas Table is permitted)

Time: Three Hours   **Maximum Marks: 100**

Answer ALL Questions:-

PART A (10 x 1 = 10 Marks)

1. By pass ratio is the ratio of

   A) Mass of cold air to hot air   B) Mass of hot air to cold air

   C) Mass of cold air to total mass   D) Mass of hot air to total mass

2. Rocket engine operation depends on

   A) Atmospheric air   B) Propellant stored inside the engine

   C) Propellant stored outside   D) Sea level atmospheric air.

3. Supersonic intake is where

   A) Flow is supersonic throughout   B) Flow is subsonic throughout

   C) Flow is supersonic then subsonic   D) Both A & C

4. Subsonic inlet has Mach number

   A) Less than one   B) More than one

   C) First less than one then more than one   D) Both A & B.

5. Pressure loss factor is given by

   A) $\Delta p0/ (m^{.2}/2\rho_1 A_m)$ B) $\Delta p0/ (m /\rho_1 A_m^2)$ C) $\Delta p0/ (m^{.2}/2\rho_1 A_m^2)$ D) $\Delta p0/ (m^{.2}/2\rho_1)$

6. In dilution zone the product of combustion is mixed with remaining air to

   A) cool the temperature acceptable to turbine   B) give more hot combustion products

   C) provide proper SFC for the engine   D) Both A & B.

7. For a C-D nozzle the throat has the

   A) Maximum area and Maximum mass flow   B) Minimum area but maximum mass flow

   C) Minimum area and Minimum mass flow   D) Maximum area but Minimum mass flow

8. "Supersonic nozzle can be used as subsonic diffuser and subsonic nozzle can be used as

   supersonic diffuser." – The statement is based on the relation

   A) $dV/V = - (1 - M^2) dA/A$ B) $dV/V = (1- M^{2)} dP/P$

   C) $dV/V = - (M^2 -1) dA/A$ D) $dP/P = - (M^2 -1) dA/A$

9. Flow coefficient for axial flow compressor is given by

   A) C_a/u B) u/C_a C) W/u^2 D) u^2/W

10. power input factor for a centrifugal compressor is given by

   A) $E/ \mu u_2$ B) $E/ \mu u_2^2$ C) $C_p.\Delta T_c/ \mu u_2^2$ D) Both B & C.

PART B (10 x 2 = 20 Marks)

11. Define Froude efficiency, what is its effect on thrust?
12. Define SFC.Write down its significance.
13. What do you understand by pressure recovery factor of the intake?
14. What are the requirements of an aircraft intake?
15. Define combustion intensity?
16. What is the purpose of dilution air in combustion chamber?
17. Give any four functions of an exhaust nozzle.
18. What is choked nozzle?
19. Define degree of reaction for an axial flow compressor.
20. Distinguish between surging and stalling.

PART C (5 x 14 = 70 Marks)

21. (a) An advanced fighter engine operating at Mach 0.8 and 10Km altitude where, Ta=223.297K & Pa=0.2649 bar has the following uninstalled performance data and uses a fuel with C.V= 42,800KJ/Kg:

    Thrust   = 50 KN

    Mass flow of air   = 45Kg/s

    Mass flow of fuel   = 2.65 Kg/s

Determine the specific thrust, thrust specific fuel consumption; exit velocity, thermal efficiency, propulsion efficiency, and overall efficiency (assume exit pressure equal to ambient pressure).

(OR)

  (b) (i) Discuss the different methods of thrust augmentation. Draw T-S diagram for turbojet engine with thrust augmentation. (7)

    (ii) Discuss the typical turbojet cycle performance with suitable sketches. (7)

22. (a) A supersonic inlet is designed with a two-dimensional conical spike (with two half-cone angles 10^0 and 20^0 relative to the axial centerline, respectively). The inlet is to operate at a flight Mach number of 1.9.The two standing oblique shocks are attached to the spike and cowl, and a converging inlet section with a throat of area A* is used to decelerate the flow through internal compression. Assume $\gamma = 1.4$ and internal diffuser pressure recover factor $\Pi_r = 0.97$. Estimate the overall recovery factor Π_d on the assumption that the inlet starts (i.e., the normal shock is swallowed). Also, find the required A*/A$_1$.

(OR)

  (b) What are the different modes of inlet operation? Explain with suitable sketches.

23. (a) (i) What are the important factors affecting combustor design? (7)

    (ii) Write down the methods of flame stabilization and explain with sketch. (7)

(OR)

(b) (i) What are the three types of combustion chamber? Compare its advantages and disadvantages. (7)

(ii) Name the material used for combustion chamber and discuss the special qualities of the material used for combustion chamber? (7)

24. (a) (i) Plot Mach number, static temperature, static pressure and static density variations along the longitudinal axis of a convergent-divergent nozzle, when it flows full. Explain the variations. (7)

(ii) A De Laval nozzle has to be designed for an exit Mach number of 1.5 with exit diameter of 200 mm. Find the ratio of throat area/exit area necessary. The reservoir conditions are given as $P_0 = 106$ Pa, $T_0 = 20^0C$. Find also the maximum mass flow rate through the nozzle. What will be the exit pressure and temperature? (7)

(OR)

(b) A converging-diverging is designed to operate with an exit Mach number of 1.75. The nozzle is supplied from an air reservoir at 68bar (abs.). Assuming 1-d flow, calculate:

(i) Maximum backpressure to choke the nozzle. (4)

(ii) Range of backpressure over which a normal shock will appear in the nozzle. (4)

(iii) Back pressure for the nozzle to be perfectly expanded to design M. (4)

(iv) Range of back pressure for supersonic flow at the nozzle exit plane. (4)

25. (a) Find the polytropic efficiency of an axial flow compressor from the following data :

The total head pressure ratio	: 4.
Overall total head isentropic efficiency	: 85%
Total head inlet temperature	: 290 K

The inlet and outlet air angles from the rotor blades of the above compressor are 45^0 and 10^0 respectively. The rotor and stator blades are symmetrical. The mean blade speed and axial velocity remain constant throughout the compressor. Assuming a value of 220 m/s for blade speed and the work done factor as 0.86, find the number of stages required. Also find the inlet Mach number relative to rotor at the mean blade height of the first stage.
    Assume R = 284.6 kJ/kg K.

(OR)

(b) (i) Explain the working of a centrifugal compressor and draw the velocity triangles.(7)

(ii) A centrifugal compressor has a pressure ratio of 4:1 with an isentropic efficiency of 80% when running at 15000 rpm and inducing air at 293 K. Curved vanes at inlet give the air a prewhirl of 250 to the axial direction at all radii and the mean dia of eye is 250 mm. The absolute air velocity at inlet is 150 m/s. impeller tip dia is 600 mm. Calculate the slip factor. (7)

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