Register Number……

B.E. DEGREE EXAMINATIONS: NOVEMBER 2009

Fourth Semester

AERONAUTICAL ENGINEERING

U07AR404: Propulsion - I

(Use of gas tables permitted)

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

Answer ALL the Questions:-

PART A (10 x 1 = 10 Marks)

1. Air expands in an ideal turbine as per following law.
   A) Perfect gas equation PV = RT B) Boyle's law C) Charle's law D) None of these
2. Simple gas turbine design mechanical efficiency varies
   A) 70%–80% B) 80%–90% C) 90%–95% D) 98%-100%
3. Diffuser is used in gas turbine when Mach Number is more than
   A) 3 B) 0.3 C) 0.03 D) 6
4. Prime operation of intake is
   A) Decrease the pressure B) Minimize the pressure loss up to the compressor
   C) Increase the energy D) Work as a turbine
5. Primary zone of combustion chamber uses------- percentage of compressed air.
   A) 10 B) 20 C) 25 D) 50
6. At the exit of gas turbine combustion chamber the temperature usually is.
   A) 900^{o}C B) 1000^{o}C C) 2000^{o}C D) 2222^{o}C
7. C-D nozzle sometimes is called
   A) Convergent nozzle B) Bell shape nozzle C) Plug nozzle D) De Laval nozzle
8. Optimum expansion of nozzle is when
   A) Back pressure (p_b) is more than exit pressure (p_e) B) p_b less than p_e
   C) p_b is just equal to p_e D) p_b does not exist.
9. In centrifugal compressor the function of volute is
   A) Increases the pressure B) Decreases the pressure
   C) Collects the fluid D) Changes the direction of flow.
10. In an axial flow compressor one set of stator blades and one set of rotor blades constitute a
    A) Set B) Sub set C) Stage D) Rack

PART B (10 x 2 = 20 Marks)

11. What do you mean by polytrophic efficiency?
12. Define Bye pass ratio.
13. Write down any two requirements of an aircraft intake.
14. What is "buzz" in supersonic inlets?
15. Define Combustion intensity.
16. What is the need for the use of flame holder?
17. What is variable area nozzle?
18. Define nozzle efficiency.
19. Define degree of reaction of axial flow compressor.
20. What do you meant by "Surging" in centrifugal compressor?

PART C (5 x 14 = 70 Marks)

21. (a) What is meant by thrust? Derive the thrust equation for general propulsion system.

(OR)

(b) Air enters a turbojet engine at a rate of $12x10^4$ kg/h at 15°C and 1.03 bar and is compressed adiabatically to 182°C and four times the pressure. Products of combustion enter the turbine at 815°C and leaves it at 650°C to enter the nozzle. Calculate the isentropic efficiency of the compressor, the power required to derive the compressor, the exit speed of gases and thrust developed when flying at 800 km/h. Assume the isentropic efficiency of the turbine is same as that of the compressor and the nozzle efficiency is 90%.

22. (a) Derive a relation between area ratio A_{max}/A_i and external deceleration ratio u_i/u_a. The subscript 'i' indicates inlet and 'a' indicates free stream.

(OR)

(b) With appropriate figures, define four modes of operation of supersonic inlets.

23. (a) Describe briefly the factors affecting the combustion chamber design.

(OR)

(b) Mention any three different combustion chamber geometries with sketches and write down their relative merits and demerits.

24. (a) Air flows a frictionless adiabatic C-D nozzle. The air stagnation pressure and temperature are 7 bar and 500 K, respectively. The diverging portion of nozzle has an area ratio A_{exit}/A_{throat} = 11.91. A normal shock wave stands in the divergent portion of nozzle where Mach number is 3.0. Determine the Mach number and static pressure and temperature at the nozzle exit plane.

(OR)

(b) Show that $(A/A^*)^2 = 1/M^2\{(2/\gamma+1)[1+(\gamma-1/2)M^2]\}^{(\gamma+1)/(\gamma-1)}$

25. (a) 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 25° to the axial direction at all radii and the mean diameter of eye is 250mm. The absolute air velocity at inlet is 150 m/s. Impeller tip diameter is 600 mm. Calculate slip factor.

(OR)

(b) Explain briefly about surging, stalling and rotating stall in axial flow compressor.

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