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Question Paper Code : P 1017

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2009.

Fifth Semester

Aeronautical Engineering

AE 1304 — PROPULSION — I

(Regulation 2004)

Time : Three hours | Maximum : 100 marks

Use of gas tables permitted.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define propulsive efficiency (Froude efficiency), what's its effect on thrust?

2. What is choked nozzle? Define by pass ratio?

3. What are the requirements of an aircraft intake?

4. What do you mean by external and internal compression inlets?

5. Distinguish between surging and stalling.

6. Write down differences between centrifugal and axial flow compressors.

7. What are basic requirements of a combustion chamber?

8. What do you mean by combustion intensity?

9. Write performance parameters of nozzle.

10. What is variable area nozzle and what is its use?

PART B — (5 × 16 = 80 marks)

11. (a) A turbojet engine with forward facing ram intake, the jet velocity relative to the propelling nozzle at exit is twice the flight velocity. Determine the rate of fuel consumption in kg/s. when developing a thrust of 25000N under the following conditions

Ambient pressure and temperature: 0.7 bar and 1°C

Compression total head pressure ratio: 5:1

Flight speed: 800 km/h

CV of fuel: 42000 kJ/kg

Ram efficiency: 100%

η_c : 85%

η_t : 90%

η_{comb} : 98 %, Turbine pressure ratio: 2.23

Assume the mass flow of fuel is small compared with the mass flow of air and the working fluid throughout has the properties of air at low temperature. Neglect the extraneous pressure drop.

Or

(b) Define thrust of an engine and derive the thrust equation for a general propulsion system. Also, explain the propulsive efficiency, thermal efficiency and overall efficiency.

12. (a) Explain with neat sketches the modes of operation of a supersonic inlets.

Or

(b) Explain the starting problem and boundary layer separation in supersonic inlets.

13. (a) Explain with sketches the different types of combustion chambers, give their corresponding merits and demerits.

Or

(b) What is flame tube cooling? Write down the different methods used for this purpose and also explain the methods of flame stabilization.

14. (a) (i) Sketch centrifugal compressor and indicate its main parts, also write advantages of centrifugal compressor. (6)

(ii) A centrifugal compressor has a pressure ratio of 4:1, $\eta_c = 80\%$, when 15000 rpm inducing air at 293 K, curved vanes give a pre whirl of 25° to the axial direction at all radii and mean diameter of eye is 250 mm and absolute air velocity at the inlet is 150 m/s, impeller tip diameter is 600 mm. Calculate the slip factor. (10)

Or

(b) What are the losses in axial flow compressor? Explain them briefly.

15. (a) (i) Plot Mach number, static pressure, static temperature, static density along the longitudinal axis of nozzle. (8)

(ii) A C-D diffuser is to be used at Mach number 3.0. The diffuser has to use a variable throat area so as to swallow the staring shock. What percentage increase in throat area will be necessary? (8)

Or

(b) Prove that

$$\dot{m}_{max} = A^* \, p_0 \, (\gamma / \mathbf{R}\mathbf{T}_0)^{1/2} \left\{ (2/(\gamma + D))^{(\gamma+1)/(\gamma-1)} \right\}^{1/2}.$$