Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 50080

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

Fourth Semester

Aeronautical Engineering

AE 8404 — PROPULSION – I

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define thermal efficiency for a piston engine.
2. Define thrust.
3. Why over expansion is possible in supersonic flows only?
4. Explain the process of choking in isentropic nozzles.
5. Differentiate between HHV and LHV.
6. What are the classification of combustion chambers?
7. What parameters decide the mass flow and pressure rise through a centrifugal compressor?
8. Define flow coefficient.
9. Differentiate between radial and axial flow turbine.
10. List the factors affecting in design of turbine blade profile.

PART B — (5 × 13 = 65 marks)

11. (a) What is thrust augmentation and factors affecting thrust? Explain different methods of thrust augmentation employed.

Or

(b) Explain working principles and various classification of piston engines in detail.

12. (a) Explain different modes of inlet operation in a supersonic inlet and starting problem in supersonic inlets.

Or

(b) Explain the boundary layer development and effect of pressure gradient in subsonic diffusers and different factors to be considered while designing a subsonic inlet.

13. (a) Explain different types of combustion chambers used in gas turbine engines and important factors affecting combustion chamber design.

Or

(b) Sketch the typical flow pattern in the flame tube of a typical gas turbine combustion chamber and mark all the regions in the flow pattern. Explain the salient features of these regions.

14. (a) Explain the working principle of centrifugal compressor and derive work done equation through velocity triangle diagrams.

Or

(b) The condition of air at the inlet of an axial flow compressor is that the pressure is 765 mm of Hg, temperature 40°C. At the mean blade section the diameter, and peripheral velocity are 500 mm and 100 m/s respectively. The inlet blade angle is 50° and inlet and exist flow angles are 10° and 80° respectively with the axial direction. The mass flow rate is 25 kg/s. Work done factor may be assumed as 0.9 and mechanical efficiency and stage efficiencies as 92% and 88% respectively. Compute:

(i) Air angle at the stator entry

(ii) Blade height

(iii) Stage loading coefficient

(iv) Stage pressure rise

(v) Power input of the motor to drive the compressor.

15. (a) Explain working of an axial flow turbine and with help of velocity diagram derive expression for degree of reaction, work done.

Or

(b) Explain various methods of turbine blade cooling.

PART C — (1 × 15 = 15 marks)

16. (a) A centrifugal compressor runs at 15,000 rpm and has 20 radially tipped blades with an outer tip diameter of 600 mm. The absolute velocity at compressor inlet is radial to ensure shockless entry. The compressor has radial blades at such that exit meridional component is 135 m/s and $\eta_{t-t} = 70\%$. The stagnation conditions at inlet are 1 bar and 25°C. Find the Slip and Slip factor, the actual exit blade angle. What is the actual and isentropic temperature rise through the compressor?

Or

(b) A sixteen-stage axial flow compressor is to have a pressure ratio of 6:3. Tests have shown that a stage total-to-total efficiency of 0.9 can be obtained for each of the first six stage and 0.89 for each of the remaining ten stages. Assuming constant work done in each stage and similar stages, find the compressor overall total-to-total efficiency. For a mass flow rate of 40kg/s determine the power required by the compressor. Assume an inlet temperature of 288 K. Also discuss the factors affecting stage pressure rise of an axial flow compressor with suitable sketches.