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Question Paper Code : 71326

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2017.

Fourth Semester

Aeronautical Engineering

AE 6404 – PROPULSION – I

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define thermal efficiency for a piston engines.
2. Draw the T-S diagram of a turbojet engine with afterburner.
3. Name the major components of a typical gas turbine combustor.
4. Why over - expansion is possible in supersonic flows only?
5. What is meant by stagger angle in an axial flow machine?
6. What parameters decide the mass flow and pressure rise through a centrifugal compressor?
7. What is the physical meaning of degree of reaction of an axial flow turbine?
8. State the function of nozzle guide vanes.
9. Draw the variation of static pressure along the axis of an ideal ramjet engine.
10. List down the potential applications of ramjet engines.

PART B — (5 × 13 = 65 marks)

11. (a) Explain with necessary graphs the effect of compressor pressure ratio and turbine inlet temperature on performance of turboject engine.

Or

(b) Explain the working of a typical twin spool turbofan engine with neat sketch. Also derive the thrust equation for the same.

12. (a) With the help of neat sketches explain the step by step procedure to start a fixed geometry supersonic intake.

Or

(b) Explain with suitable sketches any two methods of flame stabilization used in gas turbine engines.

13. (a) The first stage of an axial flow compressor is designed with no IGVs.

N=6000 rpm, Stagnation temperature rise of the stage is 20°C. Hub to tip ratio is 0.6. Work done factor =0.93.

Isentropic efficiency of stage =0.89. Inlet velocity is 140m/s. P_{01}=1.01 bar,

T_{01}=288K. Compute the following:

(i) The tip radius and corresponding rotor air angles, if the Mach number relative to tip is limited to 0.95. (7)

(ii) The mass flow entering the stage. stagnation pressure ratio and power required. (6)

Or

(b) A single sided centrifugal compressor has the following data:

Power input factor = 1.04, No of vanes= 20, RPM = 15,000, Overall diameter of impeller = 0.5 m, Eye tip diameter= 0.3 m, Eye root diameter =0.15 m, Mass flow rate= 9 kg/s. Stagnation temperature at inlet= 295 K, Stagnation pressure at inlet = 1 bar, Isentropic efficiency of compressor = 0.75.

Assume the velocity of air at inlet is axial and the axial inlet velocity is constant across the Eye annulus. Determine,

(i) The pressure ratio and power required to drive the compressor (7)

(ii) Inlet angles of impeller vanes at root and tip. (6)

14. (a) A single stage axial flow turbine has a mean radius of 30 cm and a blade height of 6 cm at the stator inlet. The gases enter the turbine stage at 1900kPa and 1200K. The absolute velocity leaving the stator is 600m/s and inclined at an angle 65° to the axial direction. The relative angles at the inlet and outlet of the rotor are 25° and 60° respectively. The stage efficiency is 0.88. Assume stage inlet and exit velocities are same and take γ = 1.33 and R= 290 J/gK. Determine the following:

(i) The absolute angle at rotor exit. (3)

(ii) Rotor rotational speed in rpm. (3)

(iii) The stage pressure ratio. (3)

(iv) Degree of reaction. (4)

Or

(b) Explain in detail how the compressor and turbine of a gas turbine engine is matched with the help of performance maps.

15. (a) Explain in detail the different modes of operation of supersonic inlets.

Or

(b) Explain in detail the effect of Mach number on TSFC and Specific thrust of an ideal ramjet.

PART C — (1 × 15 = 15 marks)

16. Write a case study on the recent developments in gas turbine engines used for commercial transport airplanes.
