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Question Paper Code : 80003

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

Third Semester

Aeronautical Engineering

AE 8301 – AERO ENGINEERING THERMODYNAMICS

(Regulation 2017)

Time : Three hours Maximum : 100 marks

Use of standard thermodynamic tables, Mollier diagram and tables are permitted.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State the conditions for thermodynamic equilibrium of a system.
2. What is meant by the Quasi—Static process?
3. Give some examples of ideal reversible processes.
4. Summarize the characteristics of entropy.
5. Identify the processes in the Stirling cycle.
6. Distinguish between Otto and Diesel cycle.
7. How to improve the thermal efficiency of the Rankine cycle?
8. State the ways to measure the dryness fraction of steam.
9. List the benefit of thrust augmentation in a jet engine.
10. List the characteristics of a black body.

PART B — (5 × 13 = 65 marks)

11. (a) In an air compressor air flows steadily at the rate of 0.5 kg/s through an air compressor. It enters the compressor at 6 m/s with a pressure of 1 bar and a specific volume of 0.85 m^3/kg and leaves at 5 m/s with a pressure of 7 bar and a specific volume of 0.16 m^3/kg. The internal energy of the air leaving is 90 kJ/kg greater than that of the air entering. Cooling water in a jacket surrounding the cylinder absorbs heat from the air at the rate of 60 kJ/s. Calculate

(i) The power required to drive the compressor (8)

(ii) The inlet and output pipe cross-sectional areas. (5)

Or

(b) (i) The following data refer to a 12-cylinder single acting and two-stroke marine diesel engine: Speed = 150 rpm, cylinder diameter = 0.8 m, stroke of the piston = 1.2 m. area of the indicator diagram 5.5×10^{-4} m^2, length of the diagram = 0.06 m. Spring value = 147 MPa per m. Find the net rate of work transfer from the gas to the piston in kW. (8)

(ii) Make a comparison between heat and work. (5)

12. (a) A heat pump working on a reversed Carrot cycle takes in energy from a reservoir maintained at 5°C and delivers it to another reservoir where the temperature is 77°C. The heat pump derives power for its operation from a reversible engine operating within the higher and lower temperatures of 1077°C and 77°C. For 100 kJ/kg of energy supplied to the reservoir at 77°C. estimate the energy taken from the reservoir at 1077°C. (13)

Or

(b) Air is flowing steadily in an insulated duct. The pressure and temperature measurements of the air at two stations A and B are given below.

Property	Station A	Station B
Pressure	130 kPa	100 kPa
Temperature	50°C	13°C

Establish the direction of flow air in the duct. Assume for air C_p = 1.005 kJ/kg K, h = CpT and v/T= 0.287/p, where p, v and T are pressure (in kPa), volume (in m^3/kg) and temperature (in K) respectively.(13)

13. (a) An I.C. engine operating on the dual cycle (limited pressure cycle) the temperature of the working fluid (air) at the beginning of compression is 27°C. The ratio of the maximum and minimum pressures of the cycle is 70 and the compression ratio is 15. The amounts of heat added at constant volume and at constant pressure are equal. Compute the air standard thermal efficiency of the cycle. Take γ = 1.4 for air. (13)

Or

(b) Air enters the compressor of a gas turbine plant operating on Brayton cycle at 101.325 kPa, 27°C. The pressure ratio in the cycle is 6. Calculate the maximum temperature in the cycle and the cycle efficiency. Assume W_T = 2.5 W_C where W_T and W_C are the turbine and the compressor work respectively. Take γ = 1.4. (13)

14. (a) A simple Rankine cycle works between pressures 28 bar and 0.06 bar, the initial condition of steam being dry saturated. Calculate the cycle efficiency, work ratio and specific steam consumption. (13)

Or

(b) Steam is initially at 1.5 MPa, 300°C expands reversibly and adiabatically in a steam turbine to 40°C. Determine the ideal work output of the turbine per kg of steam. Sketch the process in T-s and h-s diagrams. (13)

15. (a) A reactor's wall 320 mm thick is made tip of an inner layer of firebrick (k = 0.84 W/m°C) covered with a layer of insulation (k = 0.16 W/m°C). The reactor operates at a temperature of 1325°C and the ambient temperature is 25°C. (i) Determine the thickness of firebrick and insulation which gives minimum heat loss, and (ii) Calculate the heat loss presuming that the insulating material has a maximum temperature of 1200°C. (13)

Or

(b) An aircraft flies at a speed of 520 kmph at an altitude of 8000 m. The diameter of the propeller of an aircraft is 2.4 m and flight to jet speed ratio is 0.74. Find the following:

(i) The rate of air flow through the propeller

(ii) Thrust produced

(iii) Specific thrust

(iv) Specific impulse

(v) Thrust power. (13)

PART C — (1 × 15 = 15 marks)

16. (a) Air at a temperature of 20°C passes through a heat exchanger at a velocity of 40 m/s where its temperature is raised to 820°C. It then enters a turbine with the same velocity of 40 m/s and expands until the temperature falls to 620°C. On leaving the turbine, the air is taken at a velocity of 55 m/s to a nozzle where it expands until the temperature has fallen to 10°C. If the air flow rate is 2.5 kg/s. calculate

(i) The rate of heat transfer to the air in the heat exchanger,

(ii) The power output from the turbine assuming no heat loss.

(iii) The velocity at the exit from the nozzle, assuming no heat loss.

Take the enthalpy of air as h = CpT, where Cp is the specific heat equal to 1.005 kJ/kg°C and T the temperature. (15)

Or

(b) A room is maintained at 27°C while the surroundings are at 2°C. the temperature of the inner and outer surfaces of the wall (k = 0.71 W/mK) are measured to be 21°C and 6°C respectively. Heat flows steadily through the wall 5 m × 7 m in cross-section and 0.32 m in thickness. Determine (i) the rate of heat transfer through the wall, (ii) the rate of entropy generation in the wall, and (iii) the rate of total entropy generation with this heat transfer process. (15)

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