B 2048

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2007.

Third Semester

Aeronautical Engineering

AT 231 — ENGINEERING THERMODYNAMICS

(Common to Automobile Engineering and Production Engineering)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. A gas in a piston-cylinder device is compressed and as a result its temperature rises. Is this a heat or work interaction?

2. What is the Kelvin-Planck expression of the second law of thermodynamics?

3. What are the air-standard assumptions?

4. What are the effects of clearance upon the performance of an air-compressor?

5. What is meant by dryness fraction?

6. Define the terms; stagnation pressure and stagnation temperature.

7. What are the advantages of absorption refrigeration?

8. What qualities are to be considered for selecting a refrigerant for a certain application?

9. What is thermal boundary layer?

10. What is blackbody radiation?

PART B — (5 × 16 = 80 marks)

11. (a) In the turbine of a gas turbine unit the gases flow through the turbine at 17 kg/s and the power developed by the turbine is 14000 kW. The specific enthalpies of the gases at inlet and outlet are 1200 kJ/kg and 360 kJ/kg respectively, and the velocities of the gases at Inlet and outlet are 60 m/s and 150 m/s respectively. Calculate the rate at which heat is rejected from the turbine. Find also the area of the inlet pipe given that the specific volume of the gases at inlet is 0. 5 m^3/kg.

Or

(b) Air at 1.02 bar, 22°C, initially occupying a cylinder volume of 0.015 m^3, is compressed isentropically by a piston to a pressure of 6.8 bar. Calculate the final temperature, the final volume, and the work done on the mass of air in the cylinder.

12. (a) A diesel engine has an inlet temperature and pressure of 15°C and 1 bar respectively. The compression ratio is 12/1 and the maximum cycle temperature is 1100°C. Calculate the air standard thermal efficiency based on the diesel cycle.

Or

(b) In a single-acting, two-stage reciprocating air compressor 4.5 kg of air per minute are compressed from 1.013 bar and 15°C through a pressure ratio of 9 to 1. Both stages have the same pressure ratio, and the law of compression and expansion in both stages is $pV^{1.3}$ = constant. It intercooling is complete, calculate the indicated power and the LP stage cylinder swept volume. Assume that the clearance volumes of both stages an 5% of their respective swept volumes and that the compressor runs at 300 rev/min.

13. (a) Calculate the specific volume, specific enthalpy, and specific internal energy of wet steam at 18 bar and dryness fraction 0.9.

Or

(b) A steam power plant operates between a boiler pressure of 42 bar and a condenser pressure of 0.035 bar. Calculate for these limits the cycle efficiency, the work ratio, and the specific steam consumption for a Rankine cycle with dry saturated steam at entry to the turbine

14. (a) An ammonia refrigerator produces 15 tons of ice from and at 0°C in a day. The temperature range of the working cycle is 25°C and - 15°C. The ammonia vapour is dry and saturated at the end of compression. Assume actual COP is 55% of the theoretical value. Calculate the power required to drive the compressor and mass flow rate in kg/min.

Take latent heat of ice = 335 kJ/kg and C_p(water) = 4.2 kJ/kg°C

Temperature °C	Specific enthalpy kJ/kg		Specific entropy kJ/kgK	
25	380.74	1319.21	0.3473	4.4894
-15	-54.56	1304.99	-0.2134	5.0585

Or

(b) With neat sketches, explain the working of summer air-conditioning system.

15. (a) The door of a cold storage plant is made from two 6 mm thick glass sheets separated by a uniform air gap of 2 mm. The temperature of the air inside the room is – 20°C and the ambient air temperature is 30°C. Assuming the heat transfer coefficient between glass and air to be 23.26 W/m²K, determine the rate of heat leaking into the room per unit area of the door. Neglect convection effects in the air gap. Take k_{glass} = 0.75 W/mK and k_{air} = 0.02 W/mk.

Or

(b) In a double pipe counter flow heat exchanger, 10,000 kg/h of an oil having a specific heat of 2095 J/kg.K is cooled from 80°C to 50°C by 8000 kg/h of water entering at 25°C. Determine the heat exchanger area for an overall heat transfer coefficient of 300 W/m³K. Take C_p for water as 4180 J/kg.K.

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