D 056

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2003.

Third Semester

Electrical and Electronics Engineering

ME 251 — THERMODYNAMICS

Time : Three hours Maximum : 100 marks

Answer ALL questions.

Use of Steam tables, Mollier chart and HMT databook permitted.

PART A — (10 × 2 = 20 marks)

1. What is meant by 'Perpetual Motion Machine of First kind'?

2. Write the two statements of the Second law of thermodynamics.

3. What is the effect of cut-off ratio on the efficiency of diesel cycle when the compression ratio is kept constant?

4. Sketch Otto and Diesel cycle for the same compression ratio and heat input and compare the efficiency.

5. One kg of steam at 10 bar has an enthalpy of 2500 kJ/kg. Find its quality.

6. What is the necessity of compounding of steam turbine? Name two types.

7. What is sub cooling? What is its effect on COP of vapour compression system?

8. Name any two rotary type of air compressors.

9. State Fourier's law of heat conduction.

10. Define emissivity.

PART B — (5 × 16 = 80 marks)

11. (i) Sketch the dual cycle on P-V and T-S co-ordinates and name the various processes. (4)

(ii) Sketch the Brayton cycle. Air enters the compressor of the cycle at 1 bar and 25°C : Pressure after compression is 3 bar. Temperature at turbine inlet is 650°C. Determine per kg of air the cycle efficiency, heat supplied to air, work available, heat rejected in the cooler and temperature of air leaving the turbine. (12)

12. (a) Air undergoes a cyclic process in a cylinder and piston arrangement. Atmospheric air at 1 bar and 27°C is compressed adiabatically to 10 bar, expanded isothermally to initial pressure and brought to initial condition at constant pressure. Find the change in internal energy, enthalpy change, heat transfer and work transfer for each process and for the cycle. (16)

Or

(b) Two reversible heat engines *A* and *B* are arranged in series. A rejects heat directly to *B*. A receives 200 kJ at 421°C from the hot source while *B* rejects heat to cold sink at 5°C. Work output of *A* is twice that of *B*. Find the intermediate temperature between *A* and *B*, efficiency of each engine and heat rejected to the sink. (16)

13. (a) Steam at 10 bar and 0.95 dry is available. Find the final dryness fraction of steam for each of the following operations, using steam tables :

(i) 160 kJ of heat is removed per kg of steam at constant pressure.

(ii) It is cooled at constant volume till its temperature falls to 140°C.

(iii) Steam expands isentropically in the steam turbine developing 200 kJ of work per kg of steam flow and pressure becomes 0.5 bar. (7 + 5 + 4)

Or

(b) A coal fired boiler plant consumes 400 kg of coal per hour. The boiler evaporates 3200 kg of water at 45°C into superheated steam at a pressure of 12 bar and 275°C. If the calorific value of fuel is 32760 kJ/kg of coal, determine ; (i) Equivalent evaporation "from and 100°C," and

(ii) Thermal efficiency of the boiler. Specific heat of super heated steam = 2.1 kJ/kgK. (12 + 4)

14. (a) (i) State four advantages of multistage compression. (4)

(ii) A two stage air compressor compresses air from 1 bar and 20°C to 42 bar. If the law of compression is $PV^{1.35}$ = constant and the intercooling is complete to 20°C find per kg of air the compressor work. Find also mass of water circulated in the intercooler if its temperature raise is 25°C. (12)

Or

(b) (i) List atleast four desirable properties of a good refrigerant. (4)

(ii) A refrigeration system operates with condensing and evaporating temperatures of 30°C and –5°C. There is no sub cooling and refrigerant is dry saturated at the end of compression. Sketch the cycle on T-s and P-h diagrams and find the theoretical COP. (12)

The properties of refrigerant :

Temperature	Enthalpy (kJ/kg)		Entropy (kJ/kg-K)	
	Liquid	Vapour	Liquid	Vapour
–5°C	158.3	1431.9	0.63	5.41
30°C	323.	1465.4	1.202	4.984

15. (a) A furnace wall is made up of three layers of thickness 250, 100 and 150 mm with thermal conductivities of 1.65 K and 9.2 W/m°C respectively. The inside is exposed to hot gases at 1250°C with convection coefficient of 25 W/m^2 °C. Inside surface temperature is 1100°C and outside surface is exposed to air at 25°C with a convection co-efficient of 12 W/m^2 °C. Determine the thermal conductivity, overall heat transfer co-efficient and all the surface temperatures. (16)

Or

(b) A steel rod 22 mm in diameter is to be heated from 420°C to 540°C. It is placed concentrically in a long cylindrical furnace which has an inside diameter 180 mm. The inner surface of the furnace is at 1100°C and its emissivity is 0.82. The rod surface has an emissivity of 0.62. Find the time required for heating operation. Specific heat of steel is 0.67 kJ/kg-K and density is 7845 kg/m^3. (16)

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