No. of Printed Pages : 5

ET-201(B)

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B.Tech. Civil (Construction Management) / B.Tech. Civil (Water Resources Engineering) B.Tech. (Aerospace Engineering)

Term-End Examination

December, 2010

ET-201(B) : ENGINEERING THERMODYNAMICS

Time : 3 hours *Maximum Marks : 70*

Note : *Answer **any seven** questions. All questions carry **equal** marks. Use of calculator is permitted.*

1. (a) A vacuum gauge mounted on a condenser reads 0.66m Hg. What is the absolute pressure in the condenser in k Pa when the atmospheric pressure is 101.3 kPa ? **5+5**

   (b) What are intensive and extensive properties? Explain what is meant by thermodynamic equilibrium.

2. (a) Define an isolated system. Distinguish between the terms 'change of state', 'path' and 'process'. **5+5**

   (b) A mass of gas is compressed in a quassi-static process from 80 kPa, 0.1 m^3 to 0.4 M Pa, 0.03 m^3. Assuming that the pressure and volume are related by PV^n = constant, find the work done by the gas system.

3. (a) A single - cylinder, single - acting, 4 stroke engine of 0.15m bore develops an indicated power of 4 kW when running at 216 rpm. Calculate the area of the indicator diagram that would be obtained with an indicator having a spring constant of 25×10^6 N/m^3. The length of the indicator diagram is 0.1 times the length of the stroke of the engine. **5+5**

(b) A stationary mass of gas is compressed without friction from an initial state of 0.3 m^3 and 0.105 M Pa to a final state of 0.15 m^3 and 0.105 M Pa, the pressure remaining constant during the process. There is a transfer of 37.6 kJ of heat from the gas during the process. How much does the internal energy of the gas change?

4. (a) State the first law of thermodynamics for a closed system undergoing a cycle. **5+5**

(b) During one cycle the working fluid in an engine engages in two work interactions: 15 kJ to the fluid and 44 kJ from the fluid, and three heat interactions, two of which are known: 75 kJ to the fluid and 40 kJ from the fluid. Evaluate the magnitude and direction of the third heat transfer.

5. (a) In a cyclic process, heat transfers are +14.7 kJ, −25.2 kJ, −3.56 kJ, and +31.5 kJ. What is the net work for this cyclic process. 4+6

(b) When a system is taken from a state a to state b, as shown in Figure 1, along path acb, 84 kJ of heat flow into the system, and the system does 32 kJ of work.

(i) How much will the heat that flows into the system along path adb be, if the work done is 10.5 kJ?

(ii) When the system is returned from b to a along the curved path, the work done on the system is 21 kJ. Does the system absorb or liberate heat, and how much of the heat is absorbed or liberated?

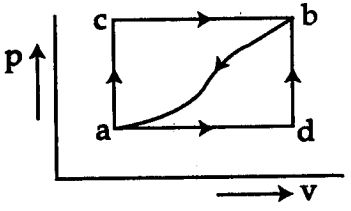

Figure - 1

6. (a) A domestic refrigerator is loaded with food and the door closed. During a certain period the machine consumes 1 kWh of energy and the internal energy of the system drops by 5000 kJ. Find the net heat transfer for the system. 5+5

(b) A system composed of 2 kg of fluid expands in a frictionless piston and cylinder machine from an initial state of 1 MPa, 100°C to a final temperature of 30°C. If there is no heat transfer, find the net work for the process.

7. (a) A domestic food freezer maintains a temperature of −15°C. The ambient air temperature is 30°C. If heat leaks into the freezer at the continuous rate of 1.75 kJ/s, what is the least power necessary to pump this heat out continuously? 5+5

(b) State and explain the Clausious statement of the second law of thermodynamics.

8. (a) What are the causes of irreversibility of a process? Show that heat transfer through a finite temperature difference is irreversible. 5+5

(b) What is a heat pump? How does it differ from a refrigerator?

9. (a) Using an engine of 30% thermal efficiency to drive a refrigerator having a COP of 5, what is the heat input into the engine for each MJ removed from the cold body by the refrigerator? 5+5

(b) A heat engine is used to drive a heat pump. The heat transfers from the heat engine and from the heat pump are used to heat the water circulating throught the radiators of a building. The efficiency of the heat engine is 27% and the COP of the heat pump is 4. Evaluate the ratio of the heat transfer to the circulating water to the heat transfer to the heat engine.

10. (a) Show that entropy is a property of a system. Establish the inequality of Clausius. 5+5

(b) Water is heated at a constant pressure of 0.7 MPa. The boiling point is 164.97°C. The initial temperature of water is 0°C. The latent heat of evaporation is 2066.3 kJ/kg. Find the increase of entropy of water, if the final state is steam.
