D 23426-A (Pages : 3) Name.....

Reg. No.....

FIFTH SEMESTER B.TECH. (ENGINEERING) DEGREE EXAMINATION DECEMBER 2011

EC 04 502—MECHANICAL ENGINEERING

(2004 Admissions)

Time : Three Hours Maximum : 100 Marks

1. (a) What is the difference between the classical and the statistical approaches to thermodynamics ? Consider the process of heating water on top of an electric range. What are the forms of energy involved during this process ? What are the energy transformation that takes place ?

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

   (c) Is it possible to develop (i) an actual ; (ii) a reversible heat engine cycle that it more efficient than a Carnot cycle operating between the same temperature limits ? Explain.

   (d) Differentiate Carnot vapor cycle with Ideal Rankine cycle. List out the process involved in the cycles.

   (e) What are the mechanisms of heat transfer ? What is the physical mechanism involved in the thermoflask ?

   (f) What is the physical significance of the Prandtl number. Does the value of the Prandtl number depend on the type of flow on the flow geometry ?

   (g) What is mean by capillarity ? Why rise in water on fall in mercury in the tube ?

   (h) List out the various measuring devices for flow measurement. Compare these devices with coefficient of discharge.

   (8 × 5 = 40 marks)

2. (a) (i) A rigid tank contains 10 kg of water at 90°C. If 8 kg of the water is in the liquid form and the rest is in the vapor form determine the pressure in the tank and volume of the tank.

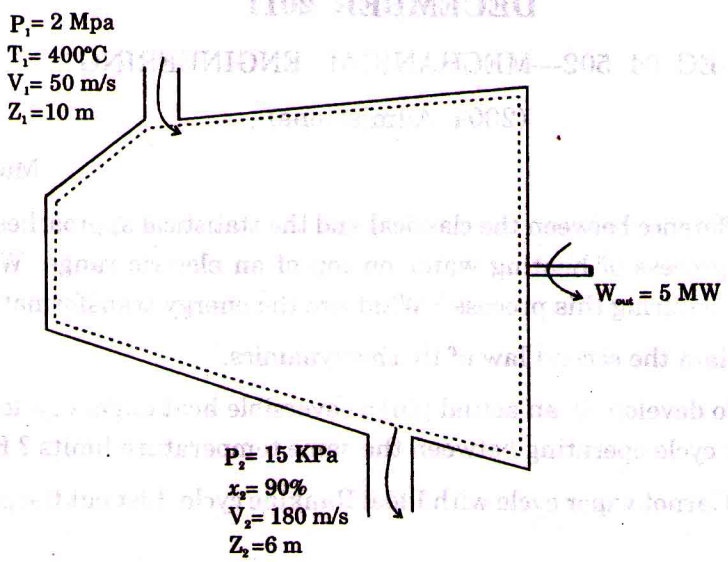
   (7 marks)

   (ii) A piston cylinder device contains 0.05 m^3 of a gas initially of 20 KPa. At this state, a linear spring that has a spring constant of 150 kN/m is touching the piston but exerting no force on it. Now heat is transferred to the gas, causing the piston to rise and to compress the spring until the volume inside the cylinder doubles. If the cross-sectional area of the piston is 0.25 m^2, determine the final pressure inside the cylinder and fraction of this work done against the spring to compress it.

   (8 marks)

Or

(b) The power output of an adiabatic steam turbine is 5 MW, and the inlet and the exit conditions of the steam is indicated in the following figure.



Determine :

(i) Compare the magnitudes of $\Delta h, \Delta ke$ and Δpe.

(ii) Determine the work done/unit mass of the steam flowing through the turbine.

(iii) Calculate the mass flow rate of the steam.

(15 marks)

3. (a) (i) How can we increase the COP of a Carnot refrigerator ? (5 marks)

(ii) A heat engine is operating on a Carnot cycle and has a thermal efficiency of 55%. The waste heat from this engine is rejected to a nearby lake at 16°C at a rate of 844 kJ/min. Determine :

(1) the power output of the engine.

(2) the temperature of the source.

(10 marks)

Or

(b) Consider a steam power plant operating on the Simple Rankine cycle. The steam enters the turbine at 3 MPa and 350°C and is condensed in the condensor at a pressure of 75 KPa. Determine the thermal efficiency of this cycle.

(15 marks)

4. (a) (i) Consider a 0.8 m high and 1.5 m wide double-pore window consisting of two 4 mm thick layers of glass [k = 0.78 W/m.K] separated by a 10 mm wide stagnant air space [k = 0.026 W/mK]. Determine the steady rate of heat transfer through this double pore window which the room is maintained at 20°C and the outdoor is –10°C. [h_i = 10 W/m^2 K and h_o = 40 W/m^2.K].

(7 marks)

(ii) Hot water at (Ti) = 120°C flows in a stainless steel pipe [k = 1.5 W/mK] whose inner diameter is 1.6 cm and thickness is 0.2 m. The pipe is to be covered with adequate insulation so that the temperature of the outer surface of the insulation does not exceed 40°C when the ambient temperature is 250°C. Taking $h_i = 70$ W/m^{2}K and $h_o = 20$ W/m^{2}K respectively. Determine the thickness of the fiber glass insulation [k = 0.038 W/mK] that needs to be installed on the pipe.

(8 marks)

Or

(b) Water is to be heated from 15°C to 65°C as it flows through a 3 cm internal diameter and 5 m long tube. The tube is equipped with an electric resistance heater that provides uniform heating throughout the surface of the tube. The outer surface of the tube is well insulated, so that in steady operation air heat generated is to provide hot water at a rate of 10 L/min. Determine the power rating of the resistance heater. Also, estimate the inner surface temperature of the tube at exit. [k = 0.631 W/m.K, e = 992.1 kg/m^3, $\in_p$ = 4180 J/kgK, Pr = 4.32 and $\nu = 0.658 \times 10^{-6}$ m^2/s].

(15 marks)

5. (a) (i) Derive the expression for Bernoulli by suitable assumption. (7 marks)

(ii) In a vertical pipe converging oil of specific gravity 0.8, two pressure gauges ha s been installed at A and B where the diameters are 16 cm an d 8 cm respectively A is 2 metres above B. The pressure gauge readings have shown that the pressure at B is greater than at A by 0.981 N/cm^2. Neglecting all lanes, calculate the flow rate. If the gauges at A and B are replaced by tubes filled with the same liquid and connected to a U-tube containing mercury, calculate the difference level of mercury in the two limbs of the U-tube.

(8 marks)

Or

(b) Derive the expression to find coefficient of discharge for orifice meter with neat sketch.

(15 marks)

[4 × 15 = 60 marks]