BT–MRE –IV– 05.17–0712 Reg. No.

B

B.Tech. Degree IV Semester Examination in Marine Engineering May 2017

MRE 1402 THERMODYNAMICS AND HEAT TRANSFER

(2013 Scheme)

Time : 3 Hours Maximum Marks : 100

(5 × 20 = 100)

I. (a) State Clausius and Kelvin Planck statement. Establish their equivalence. (10)

(b) 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 of heat removed from the cold body by the refrigerator? If the system is used as a heat pump, how many MJ of heat would be available for heating, for each MJ of heat input to the engine? (10)

OR

II. (a) Write short notes on: (10)

(i) Excess air

(ii) Dissociation.

(iii) Vapour pressure.

(iv) Fuel volatility.

(v) Octane rating.

(b) A fuel contains by mass 88% C, 8% H_z 1% S and 3% ash (silica). Calculate the stoichiometric air. (10)

III. (a) Describe the Rankine Cycle with a P-V diagram and derive an expression for thermal efficiency. (10)

(b) Steam at 50 bar, 400°C expands in a Rankine engine to 0.34 bar. For 150 kg/s of steam flow, determine (i) Power developed (ii) Thermal efficiency (iii) Specific steam consumption for the Rankine Cycle. (10)

OR

IV. (a) Explain the difference between impulse and reaction turbine. Show the variation of pressure and velocity in nozzle and blades of a velocity compounded impulse turbine. (10)

(b) Steam issues from the nozzle of a De-Laval turbine with a velocity of 800 m/s. Nozzle angle is 20°. Mean blade velocity is 300 m/s and the friction factor is 0.8. Assuming symmetrical blades, and steam flow of 1 kg/s, find (i) blade angles (ii) axial thrust in the rotor (iii) work done and power developed. (10)

V. (a) Derive an expression for the work done in a reciprocating compressor with clearance, if the compression is polytropic. (10)

(b) A single cylinder reciprocating compressor has a bore of 120 mm and a stroke of 150 mm and is driven at a speed of 1200 rpm. It is compressing CO_2 gas from a pressure of 120 kPa and a temperature of 20° C to a temperature of 215°C. Assuming polytropic compression with n = 1.3 and neglecting clearance, calculate (10)

(i) Pressure at the end of compression.

(ii) Indicated power.

(iii) Shaft power with a mechanical efficiency of 80%

OR

(P.T.O.)

VI. (a) Draw the pv diagram for a 2 stage compressor with perfect inter cooling and explain the work saved. (10)

(b) A single acting 2 stage air compressor deals with 4 m^3/min of air at 1.013 bar and 15°C with a speed of 250 rpm. The delivery pressure is 80 bar and assuming complete intercooling, find the minimum power required by the compressor, bore and stroke of the compressor. Assume an average piston speed of 3 m/s and mechanical efficiency of 75%. Also assume the polytropic index in both the stages to be n = 1.25 and neglect clearance. (10)

VII. (a) State Fourier's law of heat conduction? Derive an expression for heat flow through a cylindrical wall. (10)

(b) A steam pipe of 20 cm outer diameter is covered with 2 layers of insulating materials of 5 cm thick one having thermal conductivity twice the other. Show that the effective conductivity of two layers is less when better insulating material is inside than when it is outside. Determine the percentage reduction. (10)

OR

VIII. (a) Explain the concept of black body and gray body. (10)

(b) Two perfectly black parallel planes 1.2 x 1.2 m are separated by a distance of 1.2 m. One plane is maintained at 550°C and the other at 250°C. The planes are located in a large room whose walls are at 20°C. What is the net heat transfer between the planes? (10)

IX. (a) What is meant by the overall heat transfer coefficient? Obtain an expression for the LMTD of a double pipe heat exchanger. (10)

(b) A heat exchanger is required to cool 1 kg/s of compressed air from 250°C to 40°C using 5 kg/s of water at 20°C. Assuming a value for the overall heat transfer coefficient of 100 W/m^2 K and taking C_p of air and water as 1 kJ/kgK and 4 kJ/kgK respectively, calculate the area required for (i) parallel flow (ii) counter flow. (10)

OR

X. (a) Distinguish between natural convection and forced convection. (10)

(b) Explain: (10)

(i) Prandtl number.
(ii) Nusselt number.
(iii) Reynold's number
(iv) Grashof number.

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