B.Tech Degree III Semester Examination in Marine Engineering, March 2008

MRE 303 THERMO DYNAMICS AND HEAT TRANSFER

Time : 3 Hours | Maximum Marks : 100

I. (a) State the Kelvin -Planck and Clausius Statements of the second law of thermodynamics. (10)

(b) Prove that no heat engine operating in a cycle between two constant temperature heat reservoirs can be more efficient than a reversible engine operating between the same two reservoirs. (10)

OR

II. (a) Define irreversibility. Show that irreversibility of a process is given by the product of the temperature of surroundings and the net entropy change. (10)

(b) Steam at 10 bars and 200^0C is cooled till it becomes dry saturated and is then throttled to 1 bar pressure. Determine the change in enthalpy and heat transferred during each process. Also find the quality of steam at the end of throttling process. Take the sp. heat of super heated steam = 2.25 KJ/Kg. (10)

III. (a) Describe a Carnot power cycle employing a condensable vapour as a working medium and mention the drawbacks associated with the design of an engine based on Carnot Cycle. (8)

(b) A steam power plant is to operate with a boiler pressure of 50 bar and a condenser pressure of 0.07 bar. The steam leaving the boiler is at a temperature of 350^0C. Compare the efficiency, specific steam consumption and work ratio of the Rankine Cycle with corresponding values for a Carnot Cycle working with saturated steam between the same pressure limits. (12)

OR

IV. (a) Explain the term missing quantity as used for steam engine. How it is caused and how it is reduced? (8)

(b) A double acting single cylinder steam engine with cylinder 15 cm diameter and 20 cm stroke, is to develop 20KW of indicated power at 300 rpm with a cut of at 20% of the stroke. The back pressure is 0.28 bar. Determine the admission pressure if the diagram factor is 0.72. Also calculate the indicated thermal efficiency of the engine if it receives 222 Kg of dry steam per hour. (12)

V. (a) Derive an expression for maximum mass flow per unit area of flow through a convergent divergent nozzle when steam expands isentropically from rest. (8)

(b) Steam at a pressure of 10 bar and dryness fraction of 0.9 is discharged through a convergent divergent nozzle to a back pressure of 0.1 bar. The mass flow rate is 10 Kg/Kw-hr. If the power developed is 200KW determine

(i) pressure at the throat and

(ii) number of nozzle required, if

10% of the overall isentropic enthalpy drop reheats by friction the steam in the divergent portion. (12)

OR

VI. (a) Explain velocity compounded impulse steam turbine showing pressure and velocity variations along the axis. (8)

(b) In a stage of impulse reaction turbine operating with 50% degree of reaction, the blades are identical. The outlet of moving blades is 17^0 and the absolute discharge velocity of the steam is 50 m/s. in the direction at 110^0 to the motion of the blades. Draw the velocity diagram and calculate the work done per Kg mass of flow per second. (12)

(Turn Over)

VII. (a) Discuss the following :

(i) Absorptivity
(ii) Reflectivity
(iii) Transmissivity
(iv) Emissivity (10)

(b) In a pipe carrying steam, the outside surface (15 cm OD) is at 300^0C. The pipe is to be covered with insulation (K = 0.07W/mK). Such that the outside surface temperature does not exceed 60^0C. The atmosphere is at 25^0C and the heat transfer coefficient is 11.6 Wm^2K. Find the thickness of insulation required and the rate of heat loss per m of pipe length. (10)

OR

VIII. (a) Define the following :

(i) Film temperature
(ii) Bulk temperature
(iii) Newton's Law of cooling
(iv) Black body
(v) Gray body (10)

(b) Two perfectly black parallel planes 1.2 by 1.2 m are separated by a distance of 1.2 m. One plane in maintained at 550^0C and the other at 250^0C. The planes are located in a large room whose walls are at 20^0C. What is the net heat transfer between the planes? (10)

IX. (a) What is meant by the over all heat transfer coefficient? Obtain an expression for the LMTD of a double-pipe heat exchangers. (8)

(b) A heat exchanger is required to cool 1 Kg/s of compressed air from 250^0C to 40^0C using 5 Kg/s of water at 20^0C. Assuming a value for the over all heat transfer coefficient of $100W/m^2K$, and taking Cp, air = 1KJ/Kg ^{0}K and cp, water = 4 KJ/Kg K, calculate the area required for (i) Parallel flow (ii) Counter flow (12)

OR

X. (a) (i) Distinguish between Natural Convection and Forced Convection. (4)

(ii) Discuss the significance and use of Reynolds Number, Prandtl Number and Grashof Number in heat transfer problems. (6)

(b) The local Nusselt number for flow over a triangular plate of length L and base width W is given by the expression $Nu_x = C.\, Re_x^n$, where x is the distance from the apex. For a plate with a constant surface temperature and with the apex at the leading edge of the flow, show that the average Nusselt number

Nu_{av} is given by $Nu_{av} = \dfrac{2C}{(n+1)} Re_L^n$. (10)

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