

***B.Tech. Degree III Semester Examination in Marine Engineering
December 2013***

MRE 303 THERMODYNAMICS AND HEAT TRANSFER

Time : 3 Hours

Maximum Marks : 100

- I. (a) What is meant by Entropy? The Entropy of a hot baked potato decreases as it cools. Is this a violation of the increase of Entropy principle? Explain. (4)
- (b) Is the value of $\int_1^2 \frac{\delta Q}{T}$ same for all processes between states 1 and 2? Explain. (3)
- (c) The interior lighting of refrigerators is provided by incandescent lamps whose switches are actuated by the opening of the refrigerator door. Consider a refrigerator whose 40W light bulb remains on continuously as a result of a malfunction of the switch. If the refrigerator has a coefficient of performance of 1.3 and the cost of electricity is 8 paise per kwh. Determine the increase in the energy consumption of the refrigerator and its cost per year of the switch is not properly fixed. (13)
- OR**
- II. (a) What are the approximate chemical compositions of gasoline, diesel fuel and natural gas? (3)
- (b) Define equivalence ratio. Explain the effect of equivalence ratio variation on combustion process. (5)
- (c) Methyl alcohol (CH_3OH) is burned with stoichiometric amount of air. Calculate the mole fraction of each of the products, and the apparent molar mass of the product gas. Also calculate the mass of water in the products per unit mass of fuel burned. (12)
- III. (a) Why is the carnot cycle not a realistic model for steam power plants? (3)
- (b) Sketch ideal reheat Rankine cycle on T-S diagram. (3)
- (c) A steam power plant operates on an ideal reheat Rankine Cycle between the pressure limits of 15 Mpa and 10Kpa. The mass flow rate of steam through the cycle is 12kg/sec. Steam enters both stages of the turbine at 500°C. If the moisture content of the steam at the exit of the low-pressure turbine is not to exceed 10 percent, determine (14)
- (i) the pressure at which reheating takeplace
- (ii) the total rate of heat input in the boiler
- (iii) the thermal efficiency of the cycle.
- OR**
- IV. (a) Explain theoretical and actual indicator diagram of a steam engine. (5)
- (b) Explain the following: (5)
- (i) Mean effective pressure (ii) Diagram factor (iii) Missing quantity
- (c) Estimate the brake horse power of simple steam engine having 250mm piston diameter, and 40mm piston rod diameter with 250mm stroke length operating at 300rpm. The initial and back pressure of steam is 8.5 bar and 1.2 bar respectively. Assume 90% mechanical efficiency, cut-off at 25% of the forward stroke and 73% diagram factor. Neglect clearance and compression. (10)

(P.T.O.)

- V. (a) Explain Wilson line. What is its importance? (5)
 (b) Super saturated expansion occurs in a nozzle supplied with steam at 2MN/m^2 and 325°C . The law for expansion may be taken as $pv^{1.3} = c$ up to the exit pressure of 0.36MN/m^2 . For a flow rate of 450 kg/min , determine (i) the throat and the exit areas (ii) the degree of under cooling. (15)

OR

- VI. (a) Show that the maximum blade efficiency for a reaction turbine is $\eta_{blade} = \frac{2\cos^2\alpha}{1+\cos^2\alpha}$ (7)
 where α is the nozzle angle with the horizontal.
 (b) A steam at 6 bar absolute and 180°C is supplied to a single stage impulse turbine where it is exhausted in to a condenser at a pressure of 0.2 bar absolute . The blade speed is 300 m/s and nozzle angle is 20° and nozzle efficiency is 0.85 . Blade velocity coefficient is 0.7 and blades are equiangular. Calculate the following for a steam flow rate of 1kg/sec . (13)
 (i) Axial thrust on the blade
 (ii) Steam consumption per brake power if the mechanical efficiency is 90%
 (iii) Blade efficiency
 (iv) Stage efficiency
 (v) Maximum blade efficiency
 (vi) Heat equivalent of the friction of blading

- VII. (a) Explain the effect of insulation thickness on heat transfer rate. (2)
 (b) Derive an expression for critical radius of insulation on a sphere. (4)
 (c) The two insulation material are purchased in powder form as A and B with thermal conductivities 0.005 and 0.035 W/mk respectively. These materials was to apply over a 40cm diameter sphere as inner layer 4cm thick and outer layer 5cm thick respectively. But due to lapse of attention, the material B was applied as first layer and subsequently material A as outer layer. Estimate its effect on conduction heat transfer. (14)

OR

- VIII. (a) Explain the following: (6)
 (i) Radiosity (ii) Kirchhoff's law
 (b) A thermosflask has a double walled bottle and the space between the walls is evacuated so as to reduce the heat flow. The bottle surfaces are silver plated and the emissivity of each surface is 0.025 . If the contents of the bottle are at 375k , find the rate of heat loss from the thermos bottle to the ambient air at 300k . What thickness of cork ($K = 0.03\text{ W/mk}$) would be required if the same insulating effect is to be achieved by the use of cork? (14)

- IX. (a) What is meant by fouling factor? How does it affect the performance of a heat exchanger? (5)
 (b) A counter flow heat exchanger operates under the following conditions: (15)
 Fluid A: Inlet and outlet temperatures 80°C and 40°C
 Fluid B : Inlet and outlet temperatures 20°C and 40°C
 The exchanger is cleaned, causing an increase in overall heat transfer coefficients by 10% and the inlet temperature of fluid B is changed to 30°C , what would be the new outlet temperature of fluid A and B? Assume heat transfer coefficient and capacity rates are unchanged by temperature changes.

OR

- X. (a) Explain the following non-dimensional numbers and its physical importance: (6)
 (i) Prandtl number (ii) Stanton number
 (b) A horizontal 40W fluorescent tube which is 3.8cm in diameter and 120cm long stands in still air at 1 atm and 20°C . If the surface temperature is 40°C and radiation is neglected. What percentage of power is being dissipated by convection? (14)