BT MRE–IV(S)–04.21–0292 Reg. No. | | | | | | | | |

B

B.Tech. Degree IV Semester Supplementary Examination in Marine Engineering April 2021

MRE 1402 THERMODYNAMICS AND HEAT TRANSFER

(2013 Scheme)

Time: 3 Hours Maximum Marks: 100

I. (a) State the two different statements of the second law of thermodynamics and prove their equivalence. (10)

(b) A domestic food freezer maintain a temperature of d –20°C. The ambient air temperature is 30°C. If heat leaks into the freezer at a continuous rate of 2 KJ/s, what is the least power necessary to pump this heat out continuously? (10)

OR

II. (a) Write short notes on: (10)
- (i) Stoichiometric combustion
- (ii) Excess air
- (iii) Equivalence ratio
- (iv) Dissociation
- (v) Vapour pressure

(b) A fuel contains by mass 88%C, 8%H_2,1%S and 3% Ash (Silica).Calculate the stoichiometric air (10)

III. (a) Explain a binary vapor cycle and its effect on thermal efficiency. (10)

(b) In a Rankine cycle steam at 20 bar, 300°C is expanded in a steam turbine to 0.08 bar. It then enters a condenser where it is condensed to saturated liquid water. The pump feeds back the water into boiler. Assuming ideal processes, find per kg of steam, the net work, cycle efficiency and SSC. (10)

OR

IV. (a) Describe velocity compounding and pressure compounding in turbines showing variation of pressure and velocity during steam expansion. (10)

(b) Steam issues from the nozzle of a De-Lavel turbine with a velocity of 1000 m/s. The nozzle angle is 20°, mean blade velocity is 300 m/s, the blades are symmetrical, the mass flow rate is 1200 kg/hr, friction factor is 0.8. Determine (10)
- (i) Blade angles
- (ii) Axial thrust on the rotor turbine
- (iii) Work done per kg of steam
- (iv) Power developed
- (v) Blade effieciency

V. (a) Derive an expression for the work done in a single stage air compressor with clearance. (10)

(b) A single stage reciprocating air compressor has a swept volume of 2500 cm^3 and run at 1000 rmp. It operate on a pressure ratio of 8, with a clearance of 5% of the swept volume. Assume NTP room conditions and at inlet (p = 101.3 KPa, t = 15°C) and poly tropic compression and expansion with n = 1.25. Calculate (10)
- (i) Indicated power
- (ii) Volumetric efficiency
- (iii) Mass flow rate
- (iv) FAD
- (v) Isothermal efficency

OR

(P.T.O.)

VI. (a) What is perfect inter cooling in a compressor. Show with a diagram work saved due to perfect inter cooling. (10)

(b) A gas is compressed in a two stage reciprocating compressor from 1 bar, 300 K to 12 bar. Assuming perfect inter cooling, estimate the compressor work and the total heat transfer. (10)

(Take R = 0.287 KJ/kg.K, C_p= 1.042 KJ/kg K, and n = 1.3)

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

(b) A cold storage room has walls made of 0.3 m of brick on the outside, 0.01 m of plastic foam and finally 2 m of wood on the inside. The outside and inside temperatures are 22°C and -2°C respectively, if the inside and outside heat transfer coefficients are respectively 29 and 12 $W/m^2\ ^oK$ and the thermal conductivities of brick, foam, wood are 0.98, 0.02 and 0.17 W/mK respectively, determine (i) the rate of heat removed by refrigeration if the total wall area is 90 m^2 (ii) temperature of the inside surface of the brick. (10)

OR

VIII. (a) Write notes on radiation heat transfer. (10)

(b) Two black parallel planes 1×1 m are separated by a distance of 1 m. One plane is maintained at 800°C and the other at 200°C. The planes are located in a large room where walls are at 25°C. What is the net heat transfer between the planes. (10)

IX. (a) Derive an expression for LMTD for a parallel flow heat exchanger. (10)

(b) An oil cooler for a lubrication system has to cool 1000kg/hr of oil (C_p = 2.09 KJ/kg k) from 100°C to 40°C by using a cooling water flow of 1200 kg/hr available at 30°C. Give your choice for parallel flow or counter flow heat exchange with reasons. Estimate the surface area of the heat exchanger, if overall heat transfer coefficient is $24 W/m^2K$ (C_p of water = 4.18 KJ/Kg.K) (10)

OR

X. (a) Explain natural convection and forced convection (10)

(b) Explain the following dimensionless number and its physical importance. (10)

(i) Prandtl No.
(ii) Nusselt No.
(iii) Reynold's No.
(iv) Stanton No.
(v) Grashoff No.

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