BT-MRE-IV(S)-06.24-3247 Reg. No. | | | | | | | | |

C

B.Tech. Degree IV Semester Supplementary Examination in Marine Engineering June 2024

MRE 1402 THERMODYNAMICS AND HEAT TRANSFER

(2013 Scheme)

Time: 3 Hours Maximum Marks: 100

Answer *ALL* questions (5 × 20 = 100)

I. (a) A refrigerator operating on a reversed Carnot cycle consumes 150 W power in summer when the ambient atmosphere is at 310 K. The heat leakage into the refrigerator through the doors is estimated to be at the continuous rate of 15 W per degree temperature difference between the ambient air and the cold space of the refrigerator. For continuous operation of the refrigerator, determine the temperature at which the cold space is maintained. (10)

(b) Explain availability, irreversibility and reversibility. (10)

OR

II. (a) Explain the properties of an ideal fluid. (10)

(b) A sample of coal supplied to a boiler has the following composition by mass: (10)

Nitrogen = 1 percent, Oxygen = 3 percent , Sulphur = 0.5 percent, Incombustible matter = 2.5 percent, Carbon= 88 percent and hydrogen = 5 percent. Calculate:

(i) Mass of air required for complete combustion of 1 kg of coal.

(ii) Dry analysis both by mass and volume of the products of combustion when 15 percent excess air is supplied.

III. (a) Draw and explain the velocity triangles of impulse and reaction turbine. (10)

(b) Define degree of reaction and derive degree of reaction for turbine. (10)

OR

IV. (a) Explain the effect of friction on flow through nozzle. (10)

(b) Explain mean effective pressure and work transfer in Rankine cycle. (10)

V. (a) Explain the working of any two rotary positive displacement compressors. (10)

(b) Derive the condition for minimum work input for a two stage compressor. (10)

OR

VI. (a) Explain the effect on clearance volume in the working of compressor. (10)

(b) Explain tandem and inline arrangement of compressors. (10)

(P.T.O.)

VII. (a) Derive the temperature profile equation for a flat slab. (10)

(b) Derive the critical thickness equation for hollow cylinder. (10)

OR

VIII. (a) State Maxwell's theory, Max Planck's theory and Wein's displacement law. (10)

(b) A hot water radiator of overall dimensions 2 × 1 × 0.2 m is used to heat the room at 18°C. The surface temperature of radiator is 60°C and its surface is black. The actual surface of the radiator is 2.5 times the envelope for convection for which the convection coefficient is given by $h_c = 1.3*(\Delta T)^{(1/3)} W/m^2K$. Calculate the rate of heat loss from the radiator by convection and radiation. (10)

IX. (a) Explain the difference between natural and forced convection. Also comment on the dimensionless number used in convection. (10)

(b) A large window glass 0.5 cm thick (k = 0.78 W/m.K) is exposed to warm air at 25°C, over its inner surface, with convection coefficient of 15 W/m²K. The outside air is at -15°C with convection coefficient of 50 W/m².K. Determine the heat transfer rate and temperature at the inner and outer surface of the glass. (10)

OR

X. (a) Draw the temperature profile of condenser and evaporator. Also explain their working. (10)

(b) Calculate the Nusselt number for the following cases: (10)

(i) A 1 kW central heating radiator 1.5 m long and 0.6 m high with a surface temperature of 80°C, dissipating heat by radiation and convection into room at 20°C (k = 0.026 W/m.K, assume black body radiation and sigma = 5.67×10^{-8} W / $m^2.K^4$).

(ii) Air at 6°C (k = 0.024 W/m.K) adjacent to a wall 3 m high and 0.15 m thick made of brick with k = 0.3 W/m.K, the inside temperature of the wall is 18°C, the outside wall temperature is 12°C.

***