

INDIAN MARITIME UNIVERSITY
 (A Central University, Government of India)
End Semester Examination Dec 2019/Jan 2020
B.Tech (Marine Engineering)
Semester- III
Applied Thermodynamics-II
(UG11T1303/2303)

Date: 14.12.2020
 Time: 3 Hours

Max Marks: 70
 Pass Marks: 35

Part – A (compulsory)

Answer the following (10x2=20 Marks)

- 1] How variation of heat capacity affects heat transfer ?
- 2] Define adiabatic flame temperature.
- 3] What is physical significance of Prandtl number ?
- 4] Draw thermal boundary formed during flow of cool fluid over a warm Plate.
- 5] What is fouling in heat exchanger ?
- 6] What are the important parameters for speed of sound ?
- 7] What is stagnation point ?
- 8] Why counter flow heat exchangers are mostly preferred ?
- 9] Define Opaque body
- 10] What is critical thickness of insulation ?

Part – B

Answer any 5 out of 7 questions (5 x 10= 50 marks)

11] A square plate heater 15 cm X 15 cm is inserted between two slabs. Slab A is 2 cm thick (K= 50 W/m °C) and slab B is 1 cm thick (K=0.2 W/m °C). The outside heat transfer coefficients on side A and side B are 200 W/m² °C and 50 W/m² °C respectively. The temperature of surrounding air is 25 °C. If rating of heater is 1 KW Find a] Maximum temp. in the system, b] Outer surface temperature of two slabs.

[10 Marks]

12] a) Define what is a Thermal Boundary Layer

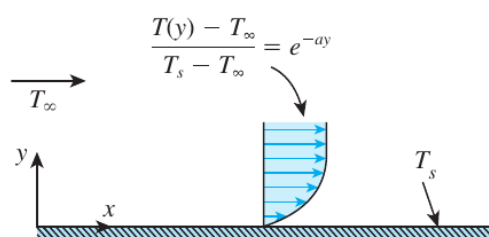
[3 Marks]

b) During the flow of air at $T_{\infty} = 20^{\circ} \text{C}$ over a plate surface maintained at a constant temperature of $T_s = 160^{\circ} \text{C}$, the dimensionless temperature profile within the air layer over the plate is determined to be

$$\frac{T(y) - T_{\infty}}{T_s - T_{\infty}} = e^{-ay}$$

where $a = 3200 \text{ m}^{-1}$ and y is the vertical distance measured from the plate surface in m (see Fig.). Determine the heat flux on the plate surface and the convection heat transfer coefficient.

[7 Marks]



Assume $k = 0.03024 \text{ W/m}\cdot\text{K}$ at a temperature of 90°C .

13] A heat exchanger is to be design to condense an organic vapour at a rate of 500 Kg/min which is available at its saturation temp. 355 K. Cooling water at 286 K is available at a flow rate of 60 Kg/s. The overall heat transfer coefficient is 475 W/m² °C, Latent heat of condensation of the organic vapour is 600 KJ/Kg, Calculate a] The number of tubes required if 25 mm outer diameter 2 mm thick and 4.87 m long tubes are available and b] The number of tube passes, if the cooling water velocity should not exceed 2 m/s . [10 Marks]

14] A steam pipe of outer diameter 120 mm is covered with two layers of lagging inside layer 45 mm thick (K=0.08 W/m °C) and outside layer 30 mm thick (K=0.12 W/m °C).The pipe conveys steam at a pressure of 20 bar with 50 °C super-heat. The outside temperature of lagging is 25 °C, If the steam pipe is 30 m long determine a] Heat lost per hour, b] Interface temp. of lagging, (Assume at **20 bar t_{sat}=212.4 °C** Saturation temp.) [10 Marks]

15] Coal from Singapore which has an ultimate analysis by mass as 84.36 % C, 1.89 % H₂, 4.40 % O₂, 0.63 % N₂, 0.89 % S and 7.83 % ash non combustible is burned with theoretical air, Disregarding ash content Determine mole fraction of the products and the apparent molar mass of the product gases. Find also air fuel ratio. [10 Marks]

16] a] Explain effect of dissociation on IC engine [5 Marks]

b] Air enters the diffuser with velocity of 200 m/s, Determine the speed of sound and Mach number at the diffuser inlet when the air temperature is 30 °C. [5 Marks]

17] Carbon dioxide flows steadily through a varying cross sectional area duct at a mass flowrate of 3 Kg/s. The carbon dioxide enters the duct at a pressure of 1400 KPa and 200 °C with a low velocity and it expands in the nozzle to a pressure of 200 KPa. The duct is designed so that the flow can be approximated is isentropic. Determine the density, velocity, flow area and Mach number at a location where a pressure drop 200 KPa along the duct from inlet Assume following data **C_p=0.846 KJ/Kg, K=1.289, R=0.1889 KJ/Kg** [10 Marks]
