The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	Diploma in Technology/Bachelor of Technology (Engineering)
Name of the Examination	:	Final Examination
Course Code and Title	:	**MEX3212 Basic thermo-fluids**
Academic Year	:	2012/13
Date	:	05 – 08 - 2013
Time	:	9.30am – 12.30pm
Duration	:	3 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of 8 questions. All questions carry equal marks.
3. Answer **any 5** questions only.

Q1 (a) Write down the equations for following heat transfer modes. ***6 marks***

(i) Conduction and (ii) Convection of heat from a surface

(b) A multi-layered wall consisting of 3 different materials 1, 2 and 3 is shown in Figure Q1. ***8 marks***

L_1, L_2, L_3 are the thicknesses of layers
k_1, k_2, k_3 are the thermal conductivities
h_{s1}, h_{s2} are the surface heat transfer coefficients
T_{f1} and T_{f2} are the space temperature away from each surface
T_{s1} and T_{s2} are the surface temperatures
Derive an expression for the overall heat transfer coefficient.

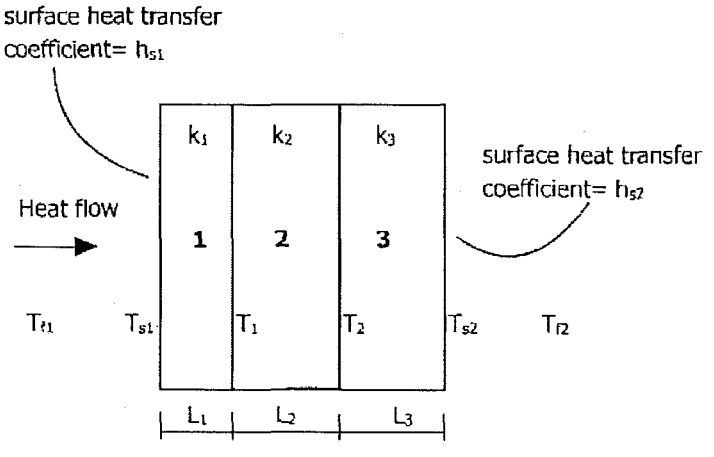


Figure Q1

(b) Calculate the interface temperatures T_1 and T_2 with the following data. ***6 marks***

$L_1 = L_2 = L_3 = 10mm$

$k_1 = 0.6W/mK$ $k_2 = 0.06W/mK$ $k_3 = 0.04W/mK$

$h_{s1} = 2W/m^2K$ $h_{s2} = 3W/m^2K$

$T_{f1} = 60^oC$ $T_{f2} = 20^oC$

Q2 (a) Heat transfer in a parallel flow heat exchanger is given by the following equation.

$$Q = UA\left[\frac{\Delta t_1 - \Delta t_2}{ln\left(\frac{\Delta t_1}{\Delta t_2}\right)}\right]$$

(i) Sketch the temperature variation of the cold and hot fluid streams along the length of the heat exchanger. ***6 marks***

(ii) Name all the terms of the above equation, indicating their SI units of measurement. ***6 marks***

(b) Determine the overall heat transfer coefficient, if the heat transfer rate from the hot fluid to cold fluid is 100W, taking effective area of conduction heat transfer as $0.01m^2$ with the following inlet and exit temperatures. ***8 marks***

Hot fluid:
Inlet : 100^oC, Exit: 70^oC
Cold fluid:
Inlet: 30^oC, Exit: 50^oC

Q3 (a) Write down the Bernoulli equation and briefly explain its different terms. ***6 marks***

(b) A pump with a head of 15m is used to pump water from a reservoir. The pipe diameter is 25mm and the total length of the pipe is 20m. A head loss per meter length of the pipe is 0.1m.

Determine

(i) Vertical height, the water is lifted if the exit velocity is 4m/s ***6 marks***

(ii) Maximum height, the water can be lifted by the pump ***4 marks***

(iii) Power of the pump ***4 marks***

Q4 (a) Explain, what is meant by Center of Pressure when a flat plate is immersed in a fluid. ***4 marks***

(b) When a flat plate is immersed in water such that its top edge is on the water surface, show that the distance to the Center of pressure from the free surface is equal to 2/3 of the immersed height of the plate. ***8 marks***

(c) Figure Q4 shows a flat gate of width 0.6m and height 3m is held against water by a spring. When the water level rises to 2m, the gate should open. Determine the value of the spring force. ***8 marks***

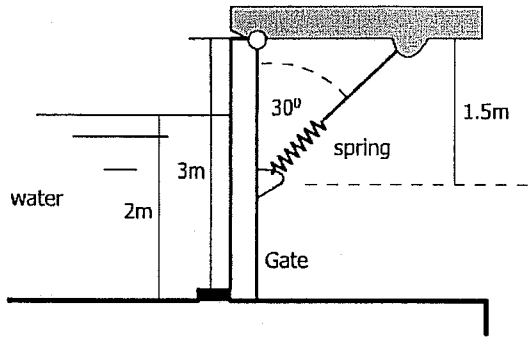


Figure Q4

Q5 (a) Write down the relationship for the dynamic viscosity (η) of a fluid in terms of velocity gradient and the shear stress, naming the terms with SI units of measurements. ***4 marks***

(b) Figure Q5 shows a rotating disc viscometer, in which a disc of radius R rotates at an angular speed of ω. The distance from the disc surface to the stationary housing is 'h' in each side. ***10 marks***

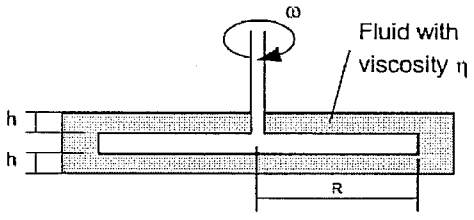


Figure Q5

Show that the torque T is given by the formula:

$$T = \frac{\pi\omega R^4}{h}\eta$$

(c) Find the viscosity of the fluid if the following observations are made for the rotating disc viscometer, mentioned in part (b) above. ***6 marks***

$$R = 25mm,\ h = 3mm,$$
$$Speed\ of\ rotation = 2000rpm, T = 6\,x10^{-3}Nm$$

Q6 (a) Explain briefly the terms "Ultimate Analysis" and Proximate Analysis" for a fuel. ***6 marks***

(b) Explain what is meant by "incomplete combustion" of a fuel. ***4 marks***

(c) Methane (CH_4) is burned with 20% excess air. Write down the balanced chemical equation assuming that air consists of 20% oxygen and 80% nitrogen by volume. ***4 marks***

(d) Calculate the percentage mass of each compound in the combustion products. ***6 marks***

Atomic weights: C- 12, H – 1, O – 16, N - 14

Q7 (a) Explain briefly processes taking place in the Petrol Engine Cycle in sequence. ***5 marks***

(b) Describe the Otto Cycle used to describe Petrol Engine Cycle with the aid of P-V diagram. ***5 marks***

(c) Derive an expression for the thermal efficiency of Otto Cycle in terms of temperatures. ***5 marks***

(d) Sketch the Diesel Cycle on P – V axes and describe briefly each process. ***5 marks***

Q8 (a) With a layout diagram, describe vapor compression refrigeration cycle, indicating what happens when the refrigerant goes through each component of the cycle. ***5 marks***

(b) How is the Coefficient of Preference (COP) defined for a refrigerator and for a heat pump? ***5 marks***

(c) Explain briefly "Evaporative Cooling". ***5 marks***

(d) Explain briefly the processes undergone by air in an Air Conditioning Unit. ***5 marks***

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