00549

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	:	2013/14
Date	:	18 – 08 - 2014
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.
4. Take acceleration due to gravity and the density of water as 9.81N/kg and 1000kg/m^3 respectively where necessary

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Q1 (a) Show that radial conduction heat transfer rate, Q through a cylinder is give by the following equation. ***6 marks***

$$Q = \frac{2\pi kL}{ln\left(\frac{R_o}{R_i}\right)}(T_i - T_o)$$

Where
T_i *and* T_o - temperatures of internal and external surfaces respectively
R_i *and* R_o - internal and external radii of the cylinder respectively
k – thermal conductivity
L – length of the cylinder

(b) A fluid flows through a cylindrical pipe of length 3m as shown in Figure Q1. Inner and outer radii are 30mm and 40mm respectively. Inlet and outlet fluid temperatures are 100°C and 80°C respectively. Thermal conductivity of the cylinder material is 0.01W/mK

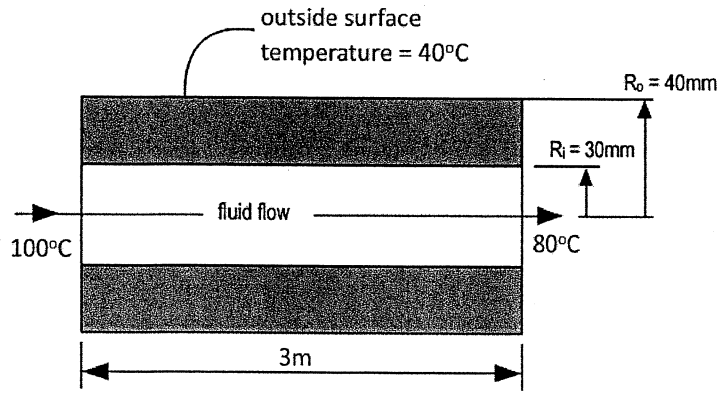


Figure Q1

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(i) Find out the rate of heat loss through the cylinder wall, taking cylinder inner surface temperature as the average of inlet and outlet fluid temperature. ***7 marks***

(ii) Find the mass flow rate of the fluid, if the specific heat capacity of the fluid is 2.5kJ/kgK. ***7 marks***

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

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

With the aid of a diagram showing the temperature variations, define the different terms of the above equation, with the SI units of measurement. ***5 marks***

(b) In a parallel counter flow heat exchanger the hot fluid enters at a temperature of 100°C and exits at 70°C as shown in Figure Q 2.The cold fluid enters at 30°C.

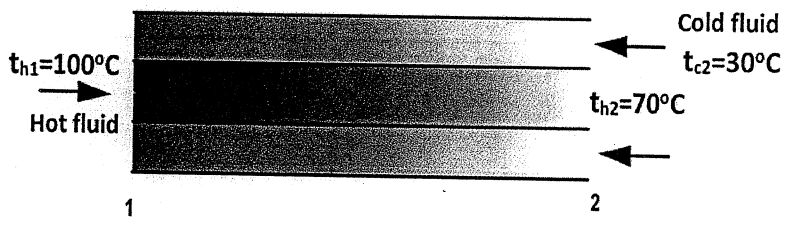


Figure Q2

(i) Find the exit temperature of the cold fluid, if the heat transfer rate between the fluids and the mass flow rate of the cold fluid are 300W and 0.005 kg/s respectively. ***8 marks***

Take specific heat capacity of the cold fluid as 3kJ/kgK.

(ii) Find the overall heat transfer coefficient, if the effective area of conduction heat transfer of the heat exchanger is 0.01m^2. ***7 marks***

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

(b) Figure Q3 shows a pipe that takes water from a well to a higher elevation situated 12m above the water level. Diameter of the pipe is 25mm. A head loss per meter length of the pipe is 0.1m.

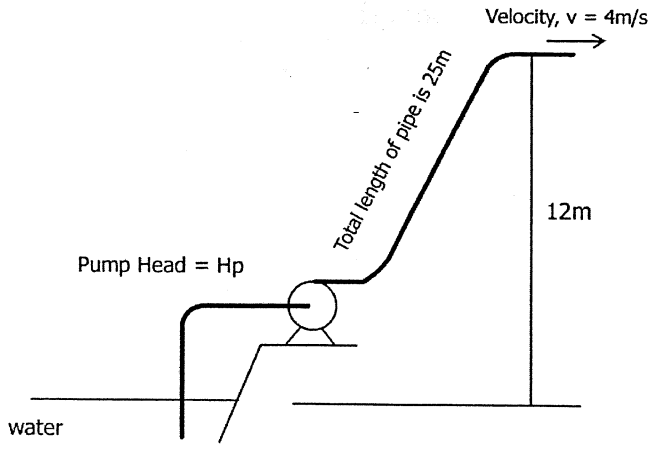


Figure Q3

Find,

(i) Water flow rate if the exit velocity is 4m/s. ***4 marks***

(ii) Head and power of the pump. ***6 marks***

(iii) Maximum height, water can be lifted from the pump. ***4 marks***

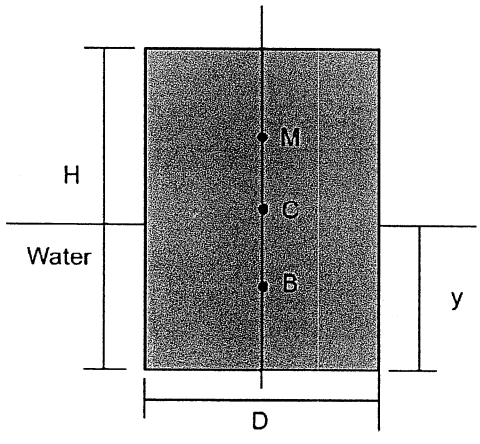
Q4 (a) Explain the following. ***6 marks***

(i) Center of pressure on a flat plate immersed in a fluid

(ii) Center of Buoyancy

(iii) Meta Center

(b) A body with a square cross section floats in water as shown in Figure Q4 below.



C – Center of gravity

B – Center of Buoyancy

M – Meta Center

H – Height of the body

D – One side of the cross section of the body

y – Submerged height

Figure Q4

(i) Find the submerged height of the body in term of H, if the densities of water and the body material are 1000kg/m^3 and 800kg/m^3 respectively. ***2 marks***

. (ii) Find the dimension D in term of H, if the body is in neutral equlibrium state. ***6 marks***

(iii) Explain how the positions of B, C, and M would change, if a heavy weight is placed on the top surface of the body and it is still floating ***6 marks***

You may use the following formulae with usual meanings for the abbreviations, if not mentioned.

Second moment of area of the square section (I)

$$I = \frac{D^4}{12}$$

Distnace between the Center of Bouyancy and the Meta Center

$$BM = \frac{I}{V}$$

Q5 (a) Define dynamic viscosity and kinematic viscosity with SI units of measurement. ***4 marks***

(b) A fluid flows through two horizontal pipes which are connected together to form a pipe of length 3L as shown in Figure Q5. The flow is laminar and fully developed. The pressure drop for the **pipe 1** is 8 times greater than it is for the **pipe 2**. ***10 marks***

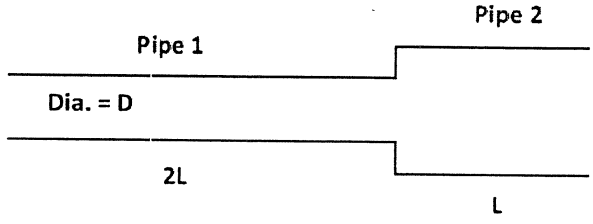


Figure Q5

(i) Determine the diameter of the second pipe in terms of D.

(ii) Calculate the volume flow rate of the fluid with the following data.

Length of pipe 1 (2L) = 2m, Diameter of pipe 1(D) = 30mm, Pressure drop in pipe 1 = 20kPa, Viscosity of the fluid = 0.03Pas

(iii) Calculate the pressure drop in pipe 2.

You may use the following formula with usual meanings for the abbreviations.

$$Q = \frac{\pi}{8}\frac{\Delta P R^4}{\eta L}$$

Q6 (a) Explain the terns Ultimate Analysis and Proximate Analysis for a fuel. ***4 marks***

(b) What are the causes and the results of incomplete combustion of a fuel? ***4 marks***

(c) The chemical formula of Octane is C_8H_{18}. Write the balanced chemical equation for the combustion of Octane and Calculate how many grams of CO_2 would be produced from one mole of Octane? ***6 marks***

(d) If Octane is combusted with 20% excess atmospheric air having 20% Oxygen and 80% Nitrogen, determine the mass of combustion products per 1kg of Octane. ***6 marks***

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

Q7 A certain mass of air contained in a cylinder is compressed isothermally. Initial and final pressures are 100kPa and 200kPa respectively. The initial volume is $0.002m^3$

(a) Sketch the process on P-V axes. ***3marks***

(b) Find, ***12 marks***

(i) Final volume.

(ii) Work done during the compression process.

(iii) Mass of air, if the temperature and the specific gas constant. respectively are 40^oC and 0.287KJ/kgK.

(c) If 200J of heat is added to air mass under constant volume, find out the final temperature reached. The specific heat capacity of air under constant volume is 0.718kJ/kgK. ***5 marks***

Q8 (a) With a layout diagram, describe the operation of a steam power plant, indicating different components and their functions. ***8 marks***

(b) Define the efficiency, in terms of enthalpy changes, for a steam power plant. ***6 marks***

(c) Explain briefly how the efficiency of a steam power plant could be improved. ***6 marks***

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