00328

# The Open University of Sri Lanka
# Faculty of Engineering Technology

| | |
|---|---|
| Study Programme | : Bachelor of Technology Honours in Engineering |
| Name of the Examination | : Final Examination |
| Course Code and Title | : **MEX 3212 – BASIC THERMO FLUID** |
| Academic Year | : 2016/17 |
| Date | : 23rd, November 2017 |
| 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 **9.81 N/kg** and **1000 kg/m3** respectively where necessary.

---

**Q1.**

**(a).** Explain what is meant by renewable energy sources. **5-marks**

**(b).** State 3 alternative energy sources in Sri Lanka with their applications. **5-marks**

**(c).** Write down 3 advantages and 3 disadvantages of using renewable energy. **5-marks**

**(d).** What is "gasification"? State the series of process of gasification. **5-marks**

**Q2.**

**(a).** Explain the followings related to combustion. ***8-marks***

I. Ultimate analysis

II. Proximate analysis

III. Stoichiometric air-fuel ratio

IV. Flash point and fire point

**(b).** Write down the balance chemical equation for the combustion of candle paraffin wax, having the chemical formula $C_{25}H_{52}$. ***4-marks***

**(c).** If 100g of candle paraffin wax is completely burned, how many grams of $CO_2$ would be produced? ***8-marks***

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

**Q3.**

**(a).** On what factors does heat flow by thermal conduction depend on? 3-marks

**(b).** Write down the fourier's equation for thermal conduction and name its different terms with their SI Units of measurments. 5-marks

**(c).** Find the heat transfer per unit area through the composite wall shown in Figure Q3. The heat transfer coefficients of the components A, B, C and D are $k_A$=150 $Wm^{-1}{}^oC^{-1}$ , $k_B$=30 $Wm^{-1}{}^oC^{-1}$, $k_C$=50 $Wm^{-1}{}^oC^{-1}$ and $k_D$=70 $Wm^{-1}{}^oC^{-1}$ respectively. Inside temperature($T_1$) is 375°C and outside temperature($T_2$) is 60°C. 12-marks

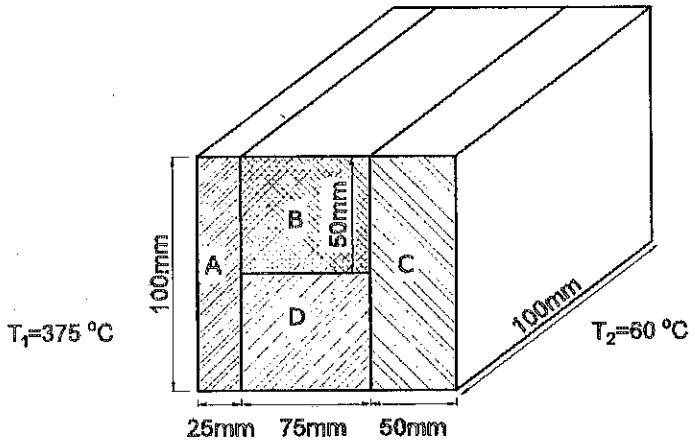



Figure Q3

**Q4.**

**(a).** Write down the Bernoulli's equation and the assumptions made to apply it to a fluid flow. 3-marks

**(b).** Show that the flow rate Q of the venturi meter (shown in Figure Q4) is given by, 12-marks

$$Q = \frac{A_2}{\sqrt{1-(D_2/D_1)^4}}\sqrt{\frac{2gh(\rho_m-\rho)}{\rho}}$$

Where $\rho_m$ is the density of manometer fluid.

**(c).** Elaborate the above relationship of **Q** and **h** by considering the applications of venturi meter. 5-marks

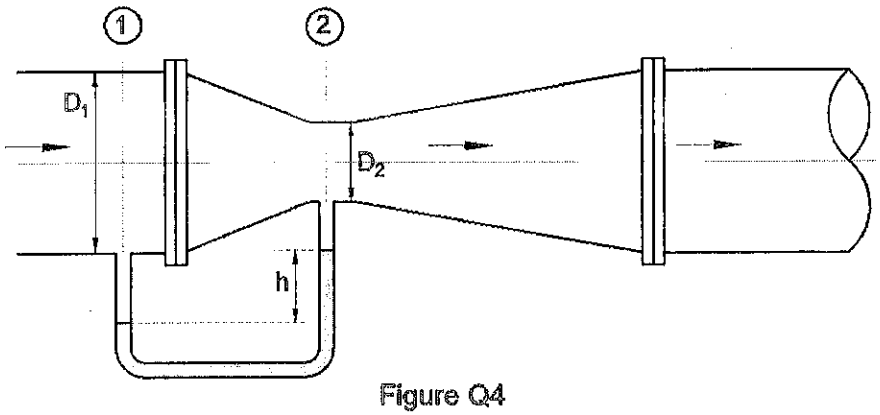



Figure Q4

**Q5.**

**(a).** What is meant by terminal velocity?

**(b).** Write down the Stokes equation that gives the resistive force when a spherical object is falling through a viscous fluid and show that the terminal velocity ($v_t$) of the object is given by, **3-marks**

$$v_t = \frac{2r^2 g(\rho_{ob} - \rho_f)}{9\eta}$$ **7-marks**

Where, $r$: radius of the sphere, $\rho_{ob}$: density of the object , $\rho_f$: density of the fluid , $\eta$: viscosity of fluid and $g$: acceleration due to gravity.

**(c).** Two water drops of equal size are falling through air with a constant speed of 0.1 $ms^{-1}$. If the drops coalesce (joined together), what would be the new constant speed? **10-marks**

**Q6.**

**(a).** Briefly explain the application of the impact of water jets in engineering. **3-marks**

**(b).** Develop an expression for the force exerted by a jet of liquid which strikes a stationary flat plate normally. **5-marks**

**(c).** A square plate of uniform thickness and length of side **50cm** hangs vertically from hinges at its top edge as shown in **Figure Q6**. When a horizontal jet strikes the plate at its center, the plate is deflected and comes to rest at an angle of $30^0$ to the vertical. The jet of water is **15mm** in diameter and has velocity of 20$ms^{-1}$ . Calculate the mass of the plate and the distance along the plate, from the hinge, to the point at which the jet strikes the plate in its deflected position. **12-marks**

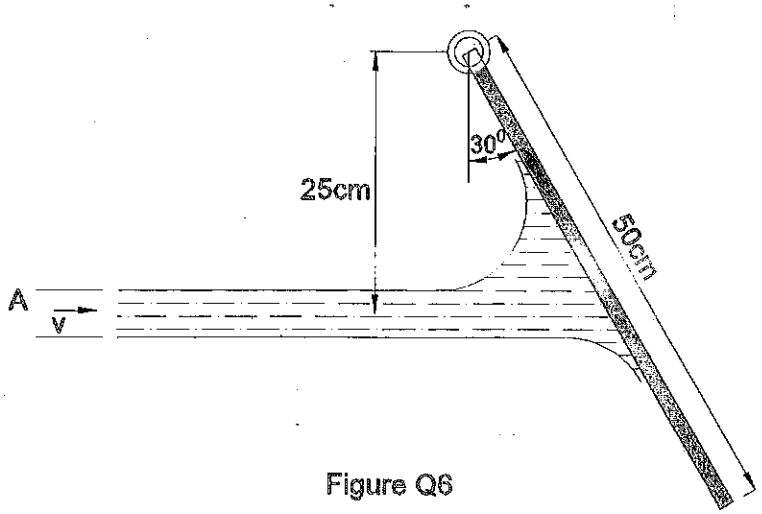



Figure Q6

Q7.

(a). Sketch the air standard cycle used to analyse the four stroke petrol engines (Otto cycle) on P-V axes and explain all process. **6-marks**

(b). Define thermal efficiency for Otto cycle and derive an expression in terms of temperatures. **7-marks**

(c). Illustrate a closed loop gas turbine power plant layout using a schematic diagram showing the main components. Also show the process on a PV diagram. **7-marks**

**Q8.**

As shown in **Figure Q8**, a plane of surface area **A** is totally immersed in a liquid of density **ρ**. This surface is inclined at an angle **θ** to the horizontal and its centroid is at a vertical depth $\mathbf{h_c}$ below the free surface.

(a). Derive an expression for the resultant force $\mathbf{F_R}$ on one side of the surface and show that distance to the centre of pressure from the free surface is given by the expression, **10-marks**

$$y_{cp} = \frac{\int y^2 dA}{\int y dA}$$

(b). A rectangular plate of 2m x 0.5m is immersed in water with an angle of $30^0$ to the horizontal. Calculate the depth to the center of pressure and the total thrust on the plate. **10-marks**

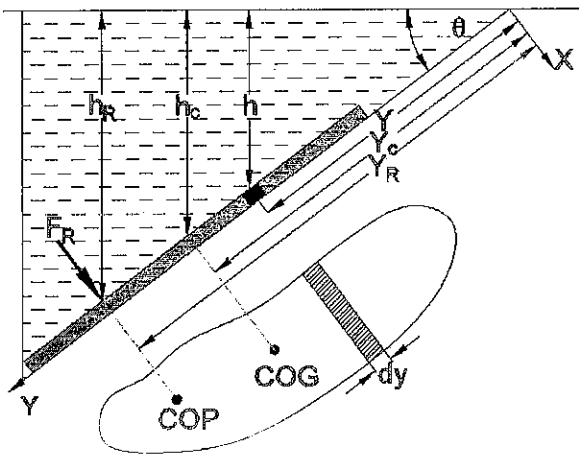



Figure Q8

*End of Paper*