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	: **MEX 3212 – BASIC THERMO FLUID**
Academic Year	: 2015/16
Date	: 01 - 12 - 2016
Time	: 9.30am -12.30pm
Duration	: 3 hours

General Instructions

1. Read all instruction 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). Write down 3 advantages and 3 disadvantages of using renewable energy. **5-marks**

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

(d). Write a short account on importance of sustainable use of energy in a developing country like Sri Lanka. **5-marks**

Q2.

(a). What are the three main methods of heat transfer ? Explain by giving two examples of each. **3-marks**

(b). Show that radial conduction heat transfer rate, Q through a tube is given by the following equation, with usual meaning of notation. **7-marks**

$$Q = \frac{2\pi KL}{\ln\left(\frac{R_{out}}{R_{in}}\right)}\left(T_{in} - T_{out}\right)$$

(c). A stainless steel tube (k_1=**21.63 W/mk**) with dimensions of **30mm** inner diameter and **50mm** outer diameter is covered with a **50mm** layer of asbestos (k_2=**0.2423 W/mk**). The inside wall temperature of the pipe is **400^{0}C** and the outside surface of the insulation is at **37.5^{0}C**. Calculate the heat loss for a **500mm** length of the pipe and the temperature at the interface between the steel and the insulation. **10-marks**

Q3.

(a) Explain ultimate analysis and proximate analysis for a fuel. **5-marks**

(b) What is meant by Stoichiometric air-fuel ratio in combustion? **5-marks**

(c) The chemical formula of Heptane is C_7H_{16}. Write the balance chemical equation for the combustion of Heptane and calculate how many grams of **water** would be produced from **10g** of Heptane? **5-marks**

(d) If Heptane is combusted with **20%** excess atmospheric air having **20%** O_2 and **80%** N_2 by volume, determine the mass of combustion products per **mole** of Heptane. **5-marks**

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

Q4.

(a). Briefly describe the vapour compression refrigeration cycle with suitable diagrams. **5-marks**

(b). Explain the process of a steam power plant with a suitable diagram. **5-marks**

(c). With the aid of a P-V diagram explain the Diesel cycle and derive an expression for the thermal efficiency. **10-marks**

Q5.

(a). What is meant by terminal velocity. **3-marks**

(b). Write down the Stokes equation that gives the resistive force when a spherical object is falling through viscous fluid and show that the terminal velocity (v_t) of the object is given by, **7-marks**

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

where,

r: radius of the sphere, ρ_{ob}: density of the object , ρ_f: density of the fluid , η: viscosity of fluid and ***g:*** acceleration due to gravity.

(c). An oil droplet has a density of **930 kgm^{-3}**. The terminal velocity of a spherical drop of this oil falling in air at **20^{0}C** is **0.18 ms^{-1}**. At **20^{0}C**, density of air is **1.2 kg.m^{-3}** and its viscosity is **18x10^{-6} kgs^{-1}m^{-1}**. Find the radius of the droplet. **10-marks**

Q6.

As shown in **Figure 6a**, a plane surface area of **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 y_c below the free surface.

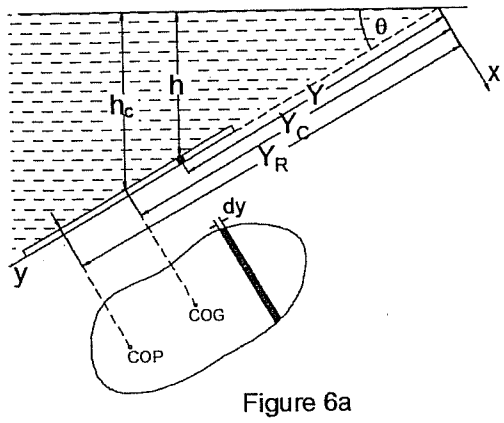

Figure 6a

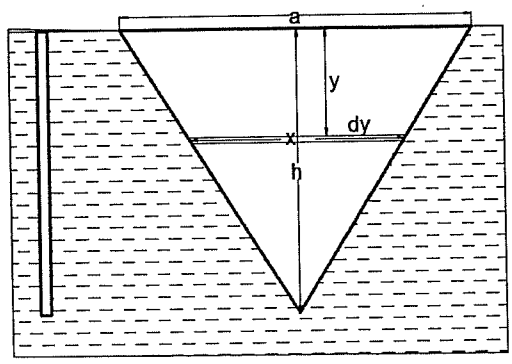

Figure 6b

(a). Derive an expression for the resultant force F_R on one side of the surface. **5-marks**

(b). Show that the distance to the centre of pressure from the free surface is given by the expression, **5-marks**

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

(c). Show that, the distance to the centre of pressure of the triangular surface, shown in **Figure 6b** is given by, **10-marks**

$$y_{cp} = \frac{2h}{3}$$

Q7.

(a). A jet of water issues from a nozzle with a velocity **v** and strikes normally a flat plate which is moving with a velocity **u** in the same direction as the jet. If the cross section area of the jet is **A** and the density of water is **ρ**, show that the force exerted on the plate (***P***) is given by, **5-marks**

$$P = \rho A(v-u)^2$$

(b). A jet of water **22.5 cm** in diameter strikes normally on a flat plate moving at **0.6** $\mathbf{ms^{-1}}$ in the same direction as the jet. If the discharge is **0.14** $\mathbf{m^3\ s^{-1}}$, find the force and the work done per second on the plate. **10-marks**

(c). Briefly explain the application of the impact of water jets in engineering. **5-marks**

Q8.

(a). What are meant by ***inviscid fluid***, ***incompressible fluid***, ***steady flow*** and ***uniform flow*** ? **5-marks**

(b). Write down the ***Bernoulli's equation*** and the assumptions that you make to apply it for a fluid flow. **5-marks**

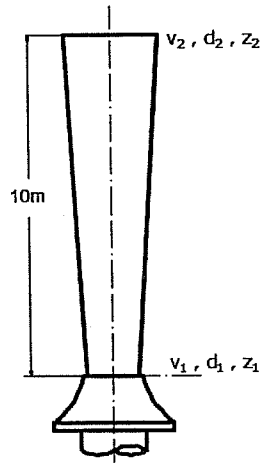

Figure 8c

(c). **Figure 8c** shows a jet of water ejecting from a nozzle of **50mm** in diameter and is directed vertically upwards. Assuming that the jet remains circular and neglecting any loss of energy, what will be the diameter of the jet at a point, **10m** above the nozzle if the velocity with which the water leaves the nozzle is **25ms^{-1}** . **10-marks**