THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

Faculty of Engineering & Technology

DEPARTMENT OF MECHANICAL AND AUTOMOTIVE ENGINEERING

DIPLOMA IN CHEMICAL ENGINEERING

STAGE III SEMESTER II EXAMINATIONS

APRIL/MAY 2010 SERIES

THERMO-FLUIDS

TIME: 2 HOURS

Instructions to Candidates

You should have the following for this examination:

- Drawing Instruments
- Scientific Calculator
- Transport and thermodynamic properties of fluids tables by Rogers and Mayhew.

This paper consists of **FIVE** Questions in **THREE** Sections, Question **ONE** is compulsory, Answer Question **ONE** and any **ONE** Question from each of the **TWO** Section **B** and **C,** Maximum marks for each part of a question are as shown.

SECTION A

Question ONE

(a). (i). State **FOUR** thermodynamic properties of an ideal refrigeration.

(4 Marks)

(ii). A Freon 12 refrigerator producing a cooling effect of $20kJ/s$ operates on a simple cycle with the limits of 1.509 bar and 9.607 bar. The vapour leaves the evaporator dry saturated and there is no under cooling. Determine the power required by the machine.

Exact of Properties of Freon 12

Temp. (ºC)	**P_s (bar)**	**Vg (m^3/kg)**	**Enthalpy**		**Entropy**		**Specific Heat kJ/kg K**
			h_f kJ/kg	**h_g kJ/kg**	**S_f**	**S_g**	
-20	1.509	0.1088	17.8	178.61	0.073	0.7082	-
40	9.607	-	74.53	203.05	0.2716	0.682	0.747

(6 Marks)

(b). Sketch indicator diagrams for a reciprocating pump;

(i). Ignoring acceleration and friction effects.
(ii). Taking into account friction effect.

(4 Marks)

(c). The following particulars relate to a reciprocating pump.

Plunger diameter 250mm; stroke 450mm; diameter of delivery pipe 110mm; length of delivery pipe 48m; friction factor f=0.01 and pump speed 20RPM. Determine the maximum loss of head in the delivery pipe. **(6 Marks)**

Question TWO

(a). Distinguish between the following calorific values:

(i). Higher calorific value.
(ii). Net calorific value.

(4 Marks)

(b). A gaseous fuel has the following percentage analysis by volume:

$CO = 13\%$ $H_2 = 40\%,$ $CH_4 = 25\%,$ $O_2 = 3\%,$ $CO_2 = 4\%,$ $N_2 = 15\%$

Determine the gravimetric analysis of the total products of combustion when the actual air /fuel ratio is 15% weak. (Air contains 21%O_2,79% N_2 by volume)

(16 Marks)

SECTION B

Question THREE

(a). A boiler generates 4500kg of steam/h at 15 bar. The steam temperature is 325ºC and the feed water temperature is 48ºC. The efficiency of the boiler plant is 80% when using oil calorific value of 45,000 kJ/kg. The steam generated is supplied to a turbine which develops 0.5MW and exhausts at 7.8 bar the dryness fraction of the steam being 0.98. Determine:

(i). mass of oil used per hour.
(ii). fraction of the enthalpy drop through the turbine which is converted to useful work.

(10 Marks)

(b). In a steam turbine steam at 20 bars, 350ºC is expanded to 0.08 bar. It then enters a condenser where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. Assuming ideal cycles, determine:

(i). net work per kg of steam flow.
(ii). cycle efficiency.

(10 Marks)

SECTION C: FLUID MECHANICS (Attempt ONE Question from this Section)

Question FOUR

(a). State **THREE** main types of energy losses in Turbulent flow through pipelines. **(3 Marks)**

(b). A pipe of 50mm diameter and 45m long is connected to a large tank, the entrance to the pipe being 3m below the surface.

The lower end of the pipe which is 6m below the upper end is joined by a horizontal pipe of 100mm diameter and 75m long, which discharges to the

atmosphere. Calculate the discharge rate taking into account the sudden enlargement and entry loses. Friction factor for both pipes f = 0.008.

(17 Marks)

Question FIVE

(a). Distinguish the following

(i). Fundamental dimensions and derived dimensions.

(ii). Geometrical similarity and dynamic similarity.

(b). (i). Show by dimensional analysis that the drag force f, on a sphere placed in moving water is given by:

$$F = \rho u^2 d^2 \phi\left(\frac{\rho u d}{\mu}\right)$$

where:

ρ = Density
μ = Fluid velocity
d = Diameter
μ = Dynamic viscosity

(ii). A sphere of certain dimensions is placed in water moving with velocity 2m per second. Another sphere of twice diameter is placed in a wind tunnel. Find the velocity of air for dynamic similarity.

For air; $\mu = 17.7 \times 10^{=6} kgm^{-1}s^{-1}$
$\rho = 1.23 kgm^{-3}$

For water: $\mu = 1.12 \times 10^{=3} kgm^{-1}s^{-1}$
$\rho = 100 kgm^{-3}$

(20 Marks)