



THE OPEN UNIVERSITY OF SRI LANKA
 BACHELOR OF INDUSTRIAL STUDIES /
 BACHELOR OF TECHNOLOGY
 FINAL EXAMINATION – 2009/2010
 TTX5234 PLANT UTILITIES
 DURATION - THREE HOURS

DATE: 22nd March 2010

TIME: 1400 - 1700 HOURS

Total Number of Questions = 09 Number of questions to be answered = 06

Answer the question 1, which is compulsory, and five (05) additional questions.
 Question 1 carries twenty five (25) marks and questions 2 to 10 carry fifteen (15) marks each.

01. Compulsory Question

- a) State five (5) primary sources of useful energy. (02 Marks)
- b) What do you understand by “Fractional Distillation” of Crude Oil? (01 Mark)
- c) What are the three (3) forms of energy in a moving fluid? (01 Marks)
- d) State four (4) different types of air compressors. (02 Marks)
- e) Why is it necessary, to de-aerate boiler feed water? (02 Marks)
- f) Name the three (3) main categories of boilers. (03 Marks)
- g) Heat exchangers are used for several functions. State four such functions (04 Marks)
- h) State Lambert’s cosine law of illumination. (02 Marks)
- i) What do you understand by the following abbreviations? :TDS,DO,,COD and SS? (02 Marks)
- j) Differentiate between Moisture Content and Moisture Regain. (02 Marks)
- k) What do you understand by BOD (Biochemical Oxygen Demand)? (02 Marks)
- l) State four (4) physical water treatment processes. (02 Marks)

- 02) a. Explain the Carnot Cycle with the aid of P-V and T-s diagrams. (10 Marks)
- b. Steam engines operate on the Rankine Cycle. What are the differences between Carnot Cycle and Rankine Cycle? (5 Marks)

03) a. Explain the following terms:

- i. Wet Steam ii. Dry Steam iii. Super Heated Steam
iv. Liquid Enthalpy v. Enthalpy of Evaporation vi. Super Heat Enthalpy (6 Marks)

b. Draw an Enthalpy- Temperature curves for formation of superheated steam from water, for three different pressures of p_1, p_2 and p_3 , where $p_1 > p_2 > p_3$. In the graph indicate the Liquid Enthalpy, Enthalpy of Evaporation, Enthalpy of Dry Saturated Vapour and Enthalpy of Super Heated Vapour. (9 Marks)

04) a. Following values are taken from steam tables for a pressure of 15 bar.

p in bars	t_s in $^{\circ}\text{C}$	v_g in m^3/kg	u_f in kJ/kg	u_g in kJ/kg	h_f in kJ/kg	h_{fg} in kJ/kg	h_g in kJ/kg
15	198.3	0.1317	843	2595	845	1947	2792

- i. How much is the specific enthalpy of dry saturated steam at 15 bar?
ii. How much is the specific internal energy of dry saturated steam at 15 bar?
iii. Calculate the specific enthalpy of 90% dry steam at 15 bar.
iv. Calculate the specific internal energy of 90% dry steam at 15 bar. (10 Marks)

b. A lamp has a luminous intensity of 200 candle power in all directions. It is placed 2m above the centre of a working plane of 4m x 3m. Find the illumination;
i. At a point on the ground directly under the lamp and
ii. At a one corner of the working plane. (5 Marks)

05) a. Explain the following terms.

- i. Dry Bulb Temperature ii. Wet bulb temperature iii. Enthalpy
iv. Dew point temperature v. Relative Humidity (5 marks)

b. Calculate the enthalpy of 1 kg of dry air of temperature 30°C having a humidity ratio of 0.02 kg of moisture in kg of dry air.

$$C_{p \text{ air}} = 1.04 \text{ kJ/kg } ^{\circ}\text{C}, C_{p \text{ vapour}} = 2.093 \text{ kJ/kg } ^{\circ}\text{C}, r_0 = 2258 \text{ kJ/kg} \quad (5 \text{ marks})$$

(In order to save time you need not simplify the final answer)

c) Locate the condition of 35°C dry bulb temperature, and 0.010 kg moisture in 1 kg dry air on the psychrometric chart, and determine its;

- i. Enthalpy ii. Dew point (saturation temperature) iii. Wet bulb temperature
iv. Specific volume and relative humidity. (5 marks)

- 06) In air conditioning, there are certain sub processes to increase or decrease the temperature of air, and to increase or decrease the humidity of air.
- a) Explain the following process:
 i) Sensible heating ii. Sensible cooling iii. Adiabatic saturation
 iv) Spraying hot or cold water (10marks)
- b) Graphically show the tendency of this effect of each of these processes, as it would appear in a psychrometric chart.
(Identify the each process separately) (5 marks)
- 07) In most air conditioning plants mixing of two flows of air (partly from outside and partly from the conditioned space) is quite common.
 One air flow (indicated by 'a') has a mass flow rate of G_a kg of dry air per unit time, specific enthalpy of h_a and an absolute humidity (moisture content) of w_a .
 The other flow (indicated by 'b') has a mass flow rate of G_b kg of dry air per unit time, specific enthalpy of h_b and an absolute humidity of w_b .
 After mixing, the mixed flow (indicated by 'm') has a flow rate of G_m , specific enthalpy of h_m and an absolute humidity of w_m . The mixing process is adiabatic (means there is no change in enthalpy or neither heat is added nor removed from the system.)
- a. Write the equation of continuity for dry air. (What comes in goes out) (3 marks)
- b. Write the energy equation (no change in enthalpy). (3 marks)
- c. Write the equation for water vapour equilibrium (What comes in goes out). (3 marks)
- From the above equations;**
- d. Derive an equation for h_m . (3 marks)
- e. Derive an equation for w_m . (3 marks)
- 08) a. If you are to design an effluent treatment plant, what are the parameters that you would try to establish? (5 marks)
- b. Draw a schematic diagram of a waste-water treatment system applicable to chemical industry and name the different units. Explain the process of treatment briefly. (10 marks)
- 09) a. Explain what you understand by safety engineering and safety management. (5 marks)
 b. Identify and briefly explain the different forms of accident causing energies. (10 marks)

PSYCHROMETRIC CHART

NORMAL TEMPERATURES

SI METRIC UNITS

Barometric Pressure 101.325 KPa

SEA LEVEL

