

THE OPEN UNIVERSITY OF SRI LANKA  
BACHELOR OF INDUSTRIAL STUDIES/  
BACHELOR OF TECHNOLOGY

FINAL EXAMINATION – 2006

TTX5234 PLANT UTILITIES

DURATION THREE (3) HOURS

Date: 04<sup>TH</sup> APRIL 2007

Time: 0930 -1230 hours

Answer six questions including Question Number one (1) which is compulsory. Question number 1 carries 25 marks and all the other questions carry 15 marks each. Psychrometric chart is also provided.

1. a) State five primary sources of Energy. (2 marks)
- b) What are the three forms of energy in a moving fluid? (3 marks)
- c) Illustrate in a graph with Temperature as Y-axis and pressure as X-axis, the behaviour of water at different temperatures and pressures. In this graph indicate the following.
  - i. Solid, liquid and superheated vapour phases of water
  - ii. Triple Point
  - iii. Liquid-Vapour Equilibrium line
  - iv. Solid-Liquid equilibrium line (4 marks)
- d) Name the three main categories of boilers. (1 mark)
- e) In selecting an ideal boiler what are the qualities that you would look for? (3 marks)
- f) Heat exchangers are used for several functions. State four such functions. (2 marks)
- g) In the air conditioning process, among the large number of sub-processes of treating air, “sensible heating” and “sensible cooling” are two of such sub-processes. What do you understand by sensible heating and sensible cooling? (3 marks)  
Indicate one difference between the two processes. (1 mark)
- h) State six physical characteristics of water with regard to water or waste water treatment. (3 marks)
- i) What are the aspects covered under;
  - i) Safety Engineering
  - ii) Safety Management (3 marks)

2. Illustrate the four processes of the Carnot Cycle of heat engines with;
- P-V diagram
  - T-S diagram
- Explain the each process of the cycle with regard to the P-V and T-S diagram. **(15 marks)**
3. a) Explain why electricity is transmitted at a higher voltage? **(5 marks)**
- b) With the aid of a schematic diagram, explain how electricity is transmitted from a generator to the final load. **(5 marks)**
- c) The Faraday's law is expressed as;  $V = N d\phi/dt$ . What do these symbols in the equation denote? **(5 marks)**
4. a) The usage of compressed air can be divided into three main categories. Name and explain these uses with at least one example for each category. **(3 marks)**
- b) What are the three classes of compressed air plants based on pressure values? Indicate the range of pressure value of each class. **(3 marks)**
- c) When air is compressed considerable heat is generated. On what factors does the heat contained in the output air in a compressor depend? **(3 marks)**
- d) Why is it important to remove the heat in the compressed air? **(3 marks)**
- e) Briefly explain the three phases of the compression cycle of a reciprocating compressor of positive displacement design. **(3 marks)**
5. a) Explain the following:
- Specific Liquid Enthalpy ( $h_f$ )
  - Specific Enthalpy of Evaporation ( $h_{fg}$ )
  - Specific Enthalpy of Dry Saturated Vapour ( $h_g$ )
  - Enthalpy of Superheated Vapour **(8 marks)**
- b) Draw Enthalpy-Temperature curves for three different pressures  $p_1, p_2, p_3$  where  $p_1 > p_2 > p_3$ . Indicate  $h_f, h_{fg}$ , and  $h_g$  in the graph. **(7 marks)**
6. a) Define the following terms:
- Luminous Flux
  - Luminous Intensity
  - Illumination **(3 marks)**
- b) If E – Illumination, I – Luminous Intensity, d – Distance of the surface from the source  $\theta$  – Angle between the normal to the surface and the direction of incident light, express the first, second and third law of illumination in terms of the symbols given above. **(3 marks)**

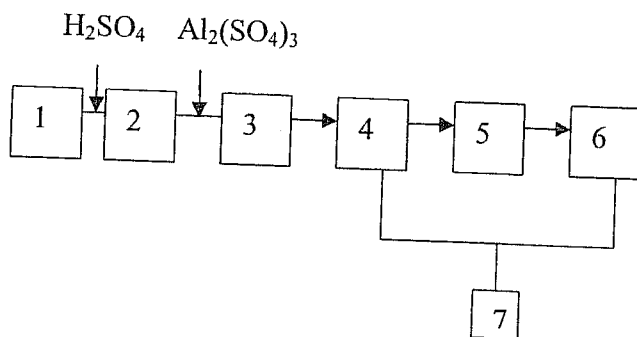
- c) A lamp is having a luminous intensity of 450 candela uniformly distributed in every direction. The lamp is placed 3 m above the ground. Find the illumination;  
 i) at a point on the ground directly under the lamp  
 ii) at a point horizontally 3 m away from the above point (i) (9 marks)  
**(It is not necessary to simplify the answer)**

7. a) Define the following terms  
 i) Dry Bulb Temperature ii) Wet Bulb Temperature iii) Dew Point Temperature  
 iv) Specific Volume v) Relative Humidity vi) Enthalpy (9 marks)  
 b) Calculate the enthalpy of 1 kg of dry air of the temperature  $30^{\circ}\text{C}$  having a humidity ratio of 0.015 kg of moisture in kg of dry air. (6 marks)

$$C_{\text{pair}} = 1.04 \text{ KJ/kg}^{\circ}\text{C} \quad C_{\text{pvapour}} = 2.093 \text{ KJ/kg}^{\circ}\text{C} \quad r_0 = 2258 \text{ KJ/kg}$$

8. The air entering the spray unit of an air conditioning plant has a temperature of  $22^{\circ}\text{C}$  and a relative humidity of 40%. Air leaving the spray unit has a temperature of  $20^{\circ}\text{C}$  and a relative humidity 65%.
- Draw this process on the psychrometric chart. (6 marks)
  - Determine the specific enthalpy difference between outgoing and incoming air. (3 marks)
  - What is the amount of moisture added to one kg of dry air? (3 marks)
  - If airflow rate through the spray unit is 5000 kg dry air per one hour, what is the weight of moisture added during one hour? (3 marks)
9. a) What do you understand by BOD, COD and DO? (3 marks)
- b) The treatment processes can be classified into three broad categories namely, physical, chemical and biological processes. What are the basic processes that fall under each broader category? (3 marks)

c)



Above figure shows a water treatment system that can be used for a plant using waste water from the chemical industry.

Identify the units 1 to 7 and briefly explain the system. **(9 marks)**

10. a) Energy analysis is one of the ways of identification of potential safety hazards. According to this analysis, what are the forms of accident causing energy? Briefly explain them. **(10 marks)**

b) The central purpose of safety engineering is the control of system hazards. Explain three methods by which hazards can be controlled. **(5 marks)**

# PSYCHROMETRIC CHART

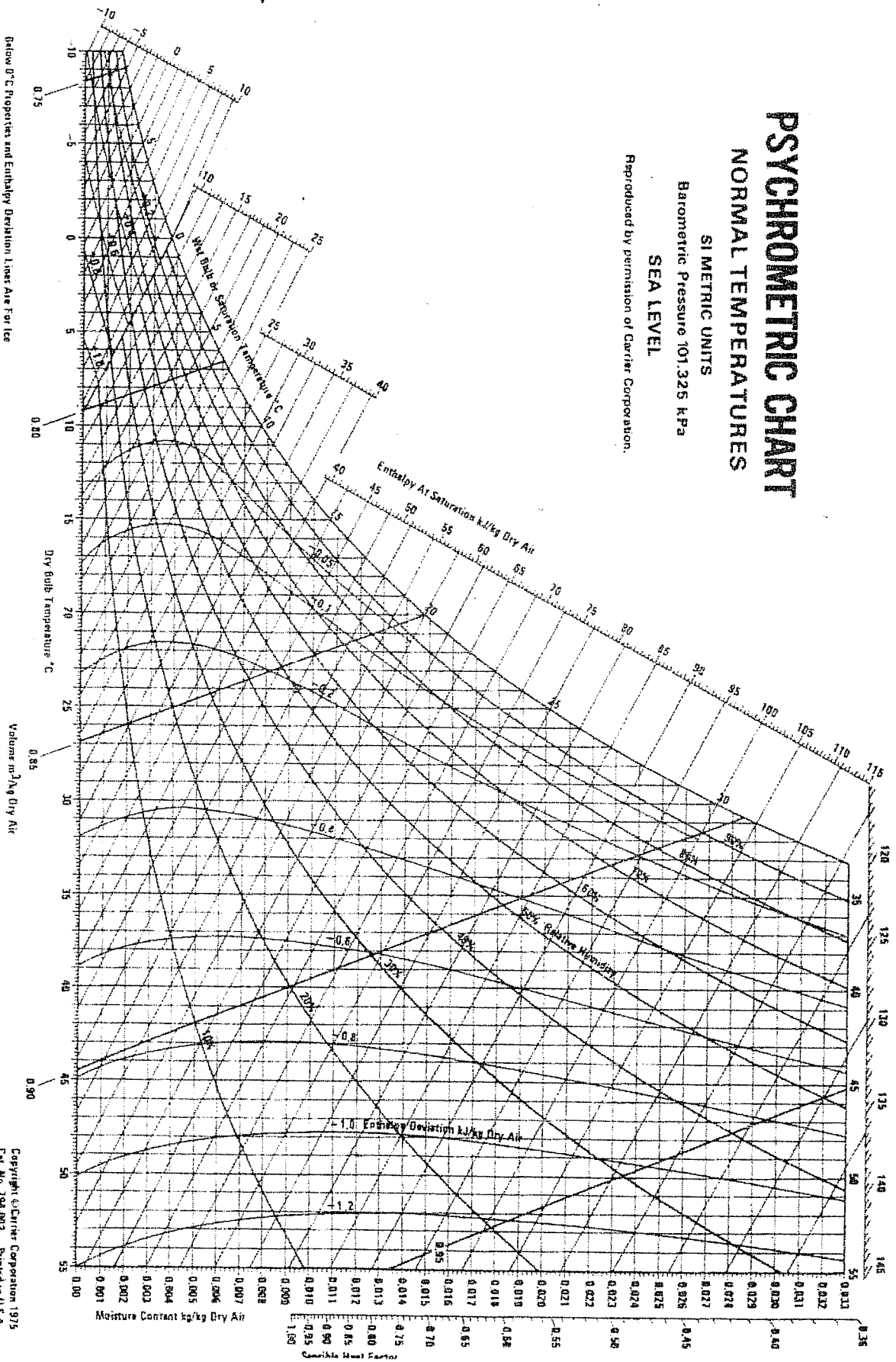
## NORMAL TEMPERATURES

SI METRIC UNITS

Barometric Pressure 101.325 kPa

SEA LEVEL

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