00116

The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Mechanical Engineering

Study Programme	Master of Energy Management (MEM)
Name of the Examination	Final Examination
Course Code and Title	**DMX9404 HVAC and Building Lighting**
Academic Year	2020
Date	21st August 2020 (Friday)
Time	14.00 hours– 17.00 hours **(IST)**
Duration	**03 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Five (5)** questions. **Answer all questions.**
3. All questions carry equal marks
4. **Answer for each question should commence from a new page.**
5. **Relevant charts are provided.**
6. This is a Closed Book Test (CBT).
7. Answers should be in clear handwriting.
8. Do not use Red color pen.

QUESTION 01 (20 marks)

(a) Define the term "adiabatic cooling". (2 marks)

(b) State four observations (i.e. increase, decrease, or remain constant) of properties of moist air that undergoes an adiabatic cooling process. (4 marks)

(c) Adiabatic saturation process is used to determine the relative humidity of moist air. **Figure Q1** shows the schematic diagram of this process indicating the inlet and exit properties of air and water streams with usual notations. Show that the exit enthalpy of moist air is given by following equation, (6 marks)

$$\mathbf{h_2 = h_1 + (\omega_2 - \omega_1)h_f}$$

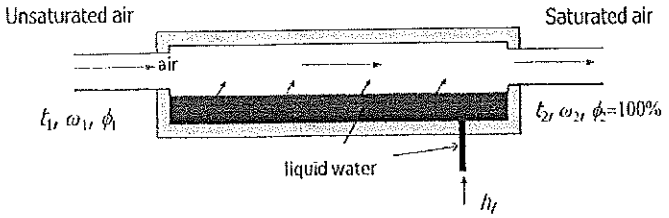


Figure Q1

(d) An evaporative cooler is used to condition the air in a room. Air at temperature of 32 °C and 30% relative humidity enters the cooler at a volume flow rate of 5 m^3/min. (8 marks)

(i) Determine the mass flow rate of water of the cooler if the temperature of air is to be reduced to 22 °C.

(ii) What is the value of relative humidity of the cooled air?

Assume adiabatic cooling in the cooler and use the psychrometric chart provided.

QUESTION 02 (20 marks)

(a) What are the three modes that energy may transfer in an open system? (3 marks)

(b) State three moisture transfer mechanisms through a building envelop. (3 marks)

(c) Discuss at least six types of moisture damages that can occur in buildings due to transfer of moisture into the building. (6 marks)

(d) A house is built in a place having outdoor dry bulb temperature of -30°C and 100% relative humidity. The indoor condition is maintained at 21°C dry bulb temperature and 50% relative humidity. The building designer used an insulated wall having a thermal resistance of 0.3 Km^2/W. The surface heat transfer coefficient for inside and outside surfaces are 8.3 W/m^2K and 34.4W/m^2 K respectively. If the atmospheric pressure is 101 kPa, evaluate whether this wall can eliminate the condensation of water vapor on the inner surface of the wall. (8 marks)

QUESTION 03 (20 marks)

(a) Briefly explain the following. (3 marks)

i. Solar radiation
ii. Solar irradiance
iii. Solar irradiation

(b) Briefly explain the three components of solar irradiance on tilted surface. (6 marks)

(c) Briefly explain the different types of shading methods that can be used for reduction of solar heat gain trough fenestrations. (5 marks)

(d) Draw a neat sketch indicating four basic mechanisms of energy flows through a fenestration system of a building. (6 marks)

QUESTION 04 (20 marks)

(a) Name the four major types of ducting that can be used in an "all-air" type Heating Ventilation and Air Conditioning (HVAC) system. (4 marks)

(b) Describe two types of air handling systems commonly used in HVAC air distribution. (4 marks)

(c) Briefly describe main components of an air-handling unit indicating the function of each component. (5 marks)

(d) Describe why we need ducting in an HVAC system indicating the advantages and the disadvantages. (7 marks)

QUESTION 05 (20 marks)

(a) What are the two approaches of cooling load estimation? (2 marks)

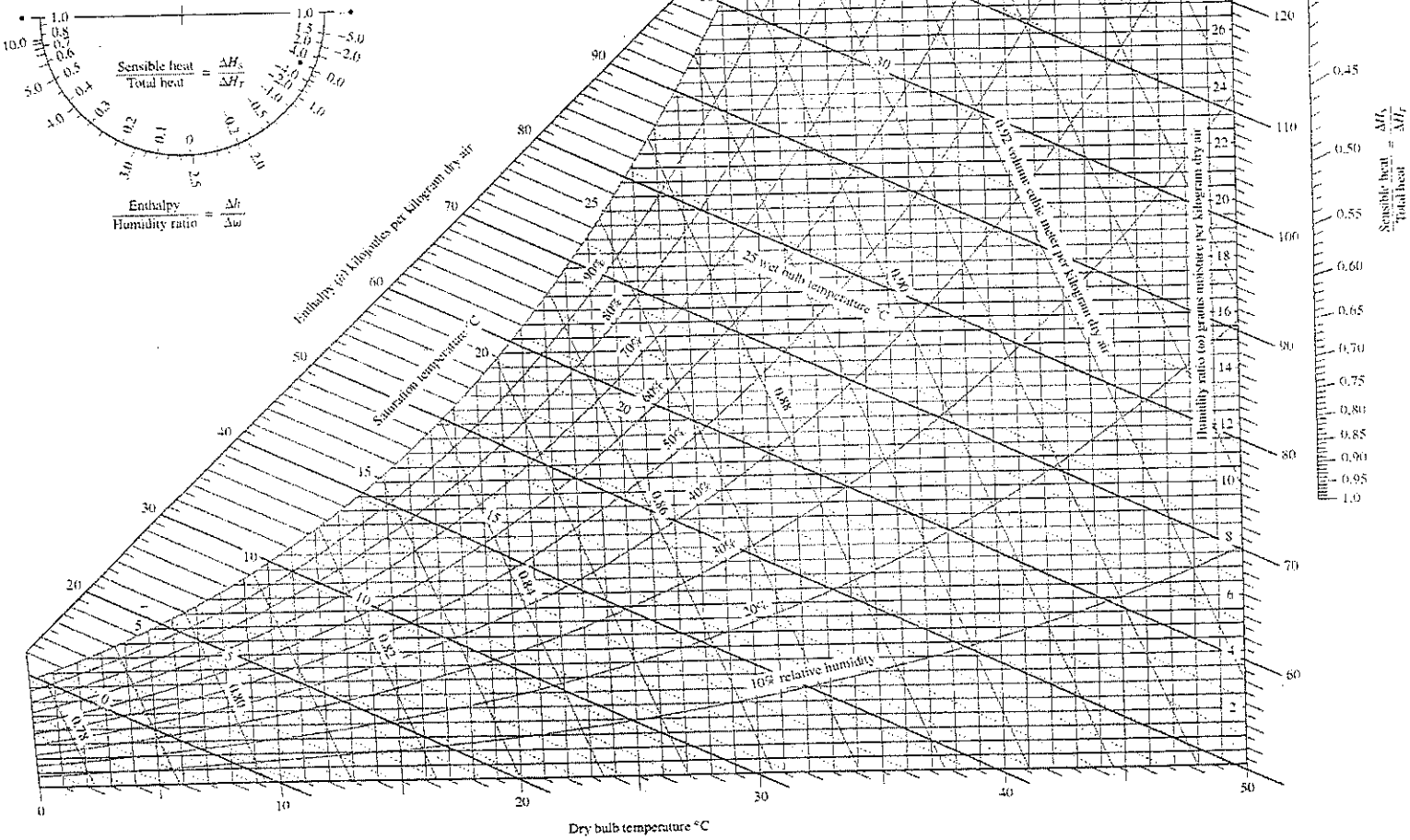
(b) State six main applications of building air conditioning. (6 marks)

(c) What are the outdoor design conditions that shall be used in three climatic zones as defined by Energy Efficient Building Code in Sri Lanka, 2008? (6 marks)

(d) Describe the importance of conducting a building survey before starting cooling or heating load estimation. (6 marks)

ASHRAE Psychrometric Chart No. 1
Normal Temperature
Barometric Pressure: 101.325 kPa

Sea Level



Prepared by Center for Applied Thermodynamic Studies, University of Idaho.