TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology
Department of Mechanical & Automotive Engineering
UNIVERSITY EXAMINATION FOR:
BSc. Mechanical Engineering
EMG 2510 : Refrigeration and Air-conditioning
SPECIAL/SUPPLEMENTARY EXAMINATION
SERIES: SEPTEMBER 2018
TIME: 2 HOURS
DATE: Pick Date **September 2018**

<u>**Instructions to Candidates:**</u>

You are required to have the following for this examination:
- Answer Booklet
- A Non-Programmable Scientific Calculator
- Thermodynamic and Transport Properties of Fluids (SI Edition) by Y.R Mayhew and G.F.C Rogers
- p-h diagram for R-134a (A3 size)
- Chart for friction pressure drop for circular ducts

This paper consists of **FIVE** Questions. Answer **ANY THREE** Questions. All questions carry equal marks.

Maximum marks for each part of a question are as shown.

Do not write on the question paper.

<u>**Question ONE**</u> **(40 Marks)**

a) Give brief definitions of the following terms used in the study of solar energy:

    i.   Direct solar radiation (3 Marks)

    ii.   Diffuse solar radiation (3 Marks)

    iii.   Reflected solar radiation (3 Marks)

iv.   Refraction (3 Marks)

b) A room has one masonry wall exposed to solar radiation. This wall is provided with a glass window. Give full accounts of what happens to:

i.   Solar radiation incident on the masonry wall(16 Marks)

ii.   Solar radiation incident on the glass window (7 Marks)

c) Give two (2) methods of reducing heat transfer to the room through the above masonry wall. (2 Marks)

d) Give three (3) methods of reducing heat transfer to the room through the above glass window. (3 Marks)

Question TWO (40 Marks)

a) The following terms are used in the study of airconditioning:
   i.   Comfort airconditioning
  ii.   Industrial airconditioning
 iii.   Inside design conditions
  iv.   Shading
   v.   Sensible heating/cooling
  vi.   Latent heat load
 vii.   Thermal insulation
    Write brief explanations of the meaning of each term.

(16 Marks)

b) List five (5) important components of internal heat load for a space used for processing or manufacturing goods. (5 Marks)

c) List three (3) important components of external heat load for a residential building. (3 Marks)

d) Explain how each of the following affect the temperature of the indoor air:
   i.   Solar radiation incident on an exterior wall (3 Marks)
  ii.   Solar radiation transmitted through window glass (3 Marks)

Question THREE (40 Marks)

a) With the aid of a labeled T-s diagram and suitable explanations of the processes shown thereon, give the definitions of the following terms:
   3 + 4 = 7 Marks for T-s diagram and explanations
   i.   Dry bulb temperature (2 Marks)
   ii. Dew point temperature (2 Marks)
   iii. Wet bulb temperature (2 Marks)
   iv. Saturation vapor pressure (3 Marks)
   v.   Adiabatic saturation temperature (4 Marks)
b) The barometric air pressure reading in a room is 1.00 bar, while the dry bulb and the relative humidity 30^0 C and 30%, respectively

   Determine:
   i.   the partial pressure of each component (4 Marks)
   ii. the specific volume of each component (based on total pressure) (9 Marks)
   iii. the dew point temperature (7 Marks)

Question FOUR (40 Marks)

a) Give 7 desirable properties of a refrigerant (7 Marks)
b) A vapor compression refrigeration plant using R-134a is required to operate as follows:

   i) State 1 is inlet to the compressor. $P_1 = 0.4\ bar$ and t_1 is 5^0 C above saturation temperature.
   ii) Heat water from 20^0 C to 45^0 C at the rate of 0.2 kg / sec.
   iii) Condenser pressure of 10 bar with 10^0 C superheating at the entry to the condenser and 5^0 C of under cooling at the entry to the throttling valve.
Show the arrangement of the components of this cycle and also show the cycle on T-s and p-h diagrams. (4 + 2+ 2 = 8 Marks)

Using the p – h chart for R – 134a provided and assuming ideal processes, calculate:

   i)   the temperature at the beginning of each process (6 Marks)
   ii)   the refrigerant flow rate in kg/sec(7 Marks)
   iii)   the refrigeration effect in kW(3 Marks)
   iv)   the compressor work in kW(3 Marks)

v)   the coefficient of performance of the refrigeration(3 Marks)

vi)   the coefficient of performance of the heat pump(3 Marks)

Question FIVE

a) Give brief descriptions of the meaning and application of the following terms used in the study of ventilation systems in airconditioning:

i.   Fan power (2 Marks)

ii.   Air power (2 Marks)

iii. Coefficient of resistance for duct fittings (2 Marks)

iv.   Grills (1 Mark)

v.   Diffusers (1 Mark)

vi.   Volume dampers (1 Marks)

vii. Filters (1 Mark)

b) The circular duct system shown on Figure Q5 is to be used to distribute air in a building. The length of the ducts and some of the flow rates and allowable velocity in each run is indicated on the figure. Calculate:

i) the flow rate in each duct run (3 Marks)

ii) the cross-sectional area of each section of duct system (9 Marks)

iii) the diameter of each section of duct system (4.5 Marks)

iv) friction coefficient for each sector of the duct (9 Marks)

v) the pressure drop in each sector of duct (assume minor losses are negligible) (4.5 Marks)

The frictional pressure drop can be calculated from the following equation and values of f taken from the charts provided:

$h = (fC^2 L) / (2 g m)$ (mm of Aqua)

Figure Q5
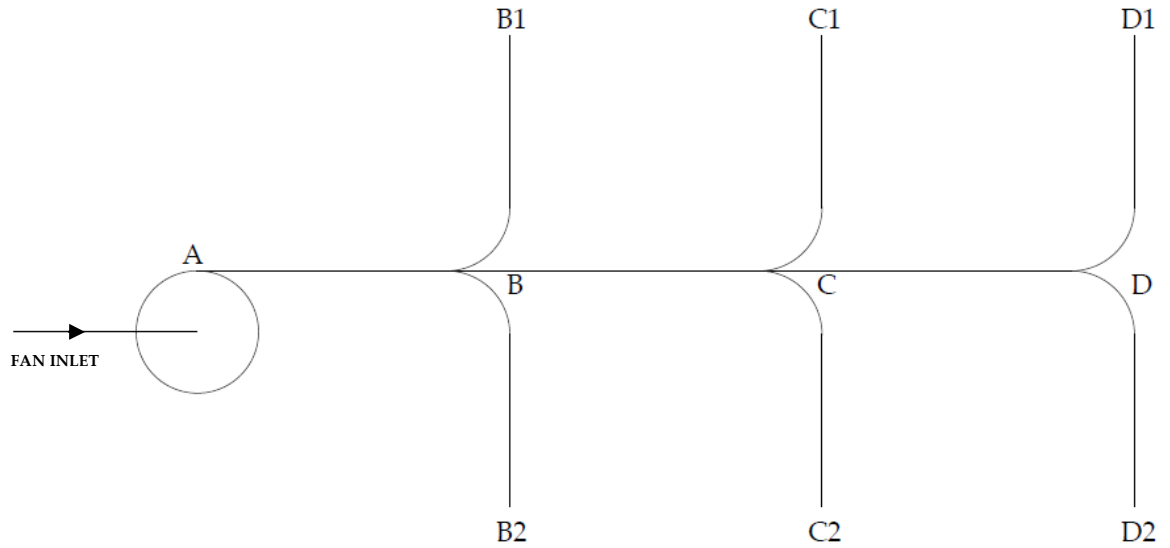
Sector	Length m	Flow Rate m³/s	Allowable Velocity m/s	A m²	d m	f	h mm Aqua
A-B	5.00		7.5				
B-B1	3.00	0.5	3.5				
B-B2	3.00	0.5	3.5				
B-C	5.00		5.0				
C-C1	3.00	0.5	3.5				
C-C2	3.00	0.5	3.5				
C-D	5.00		5.0				
D-D1	3.00	0.5	3.5				
D-D2	3.00	0.5	3.5				