TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology
Department of Mechanical & Automotive Engineering
UNIVERSITY EXAMINATION FOR:
BSc. Mechanical Engineering
EMG 2510 : REFRIGERATION AND AIRCONDITIONING
END OF SEMESTER EXAMINATION
SERIES: DECEMBER 2016
TIME: 2 HOURS
DATE: Pick Date **December 2016**

INSTRUCTIONS TO CANDIDATES

1. 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
2. This paper consists of **FIVE** Questions.
3. Answer **ANY THREE** Questions.
4. All questions carry equal marks.
5. **This paper consists of FOUR printed pages.**

Question 1

a) Give concise definitions of the following terms used in the study of solar radiation:

   i. Direct radiation

      (2 Marks)

   ii. Reflected radiation

      (2 Marks)

   iii. Diffuse radiation

      (2 Marks)

   iv. Reflectivity

      (2 Marks)

   v. Absorptivity

      (2 Marks)

   vi. Transmissivity

      (2 Marks)

b) Solar radiation is incident on a masonry wall which has a glass pane window. With the aid of diagrams (plan and/or elevation) of the wall and the window, explain in details what happens to the solar radiation incident on the wall and the window.

   (13 Marks for wall + 11 Marks for glass)

c) Solar radiation is transmitted into a room through a glass pane. Explain how the radiation transmitted is converted to thermal heat load.

   (4 Marks)

Question 2

a) Figure Q2 depicts a vapour compression refrigeration system with a chilling compartment and freezing compartment.

Write down the names of the components labelled A to K.

(12 Marks)

b) Assuming the refrigerant in part a) above is R – 134a, I is the freezing compartment (Load = 1.5 kW), J is the chilling compartment (Load = 1.0 kW) and the following other data:

P_7 = 15.0 bar P_2 = 1.0 bar

t_7 = 80^{0}C t_5 = 20^{0}C

i. Show the states of the refrigerant and the processes on the A3 p – h diagram provided. (Do not alter the identities of the states shown on Figure Q2).

(14 Marks)

ii. Calculate the refrigerant mass flow rate (kg/sec) in the freezing compartment.

(5 Marks)

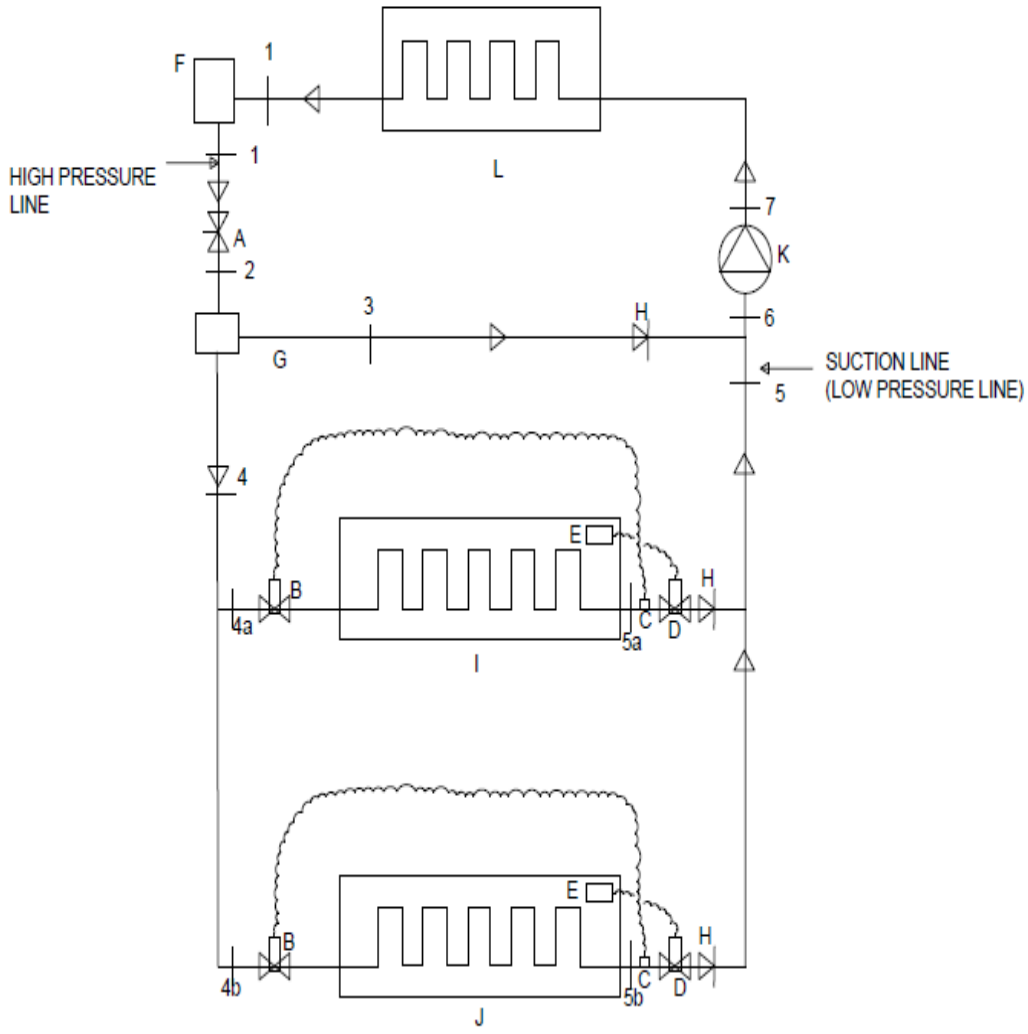
iii. Calculate the refrigerant mass flow rate (kg/sec) in the chilling compartment.

(5 Marks)

iv. Calculate the refrigerant mass flow rate (kg/sec) in the compressor.

(4 Marks)

Figure Q2



Question 3

a) An airconditioned room has both controlled/intentional and uncontrolled/unintentional air entry/exit routes.

i. List three (3) uncontrolled/unintentional routes.

(3 Marks)

ii. List three (3) controlled/intentional routes

(3 Marks)

b) A centralized air conditioning system consists of a fresh air duct, a return air duct and a supply air duct.

Draw a diagram of this duct system and show the following items in their logical locations:

i. Intake duct: grill, filter and volume damper.

ii. Return air duct: volume damper and filter

iii. Fan

iv. Airconditioning unit/air handling unit

v. Heating battery

vi. Supply air duct

(Quality of diagram 12 Marks)

(Labelling 12 Marks)

c) Explain the purpose of the items i) to vi) in section b) above.

(10 Marks)

Question 4

a) Give the general definition of the term mean hydraulic depth (m).

(3 Marks)

b) Show that m is given by the following expressions:

i. Circular duct: m = d/4 where d is the diameter.

(2 Marks)

ii. Rectangular duct: m = H x W/ 2(H +W) where H and W are the height and width respectively.

(3 Marks)

c) Briefly describe the concept of equivalent length of a duct fitting as used in the analysis of air flow in ducts.

(4 Marks)

d) Figure Q4 depicts a circular duct system in which air flows from point A (fan exit) to diffusers located at the ends of duct branches.

Schedule Q4 is the data sheet for this system.

Fill in the missing data (V, A, d, and f) using the friction charts provided.

Minor losses in duct fittings and across diffusers may be neglected.

(28 Marks)

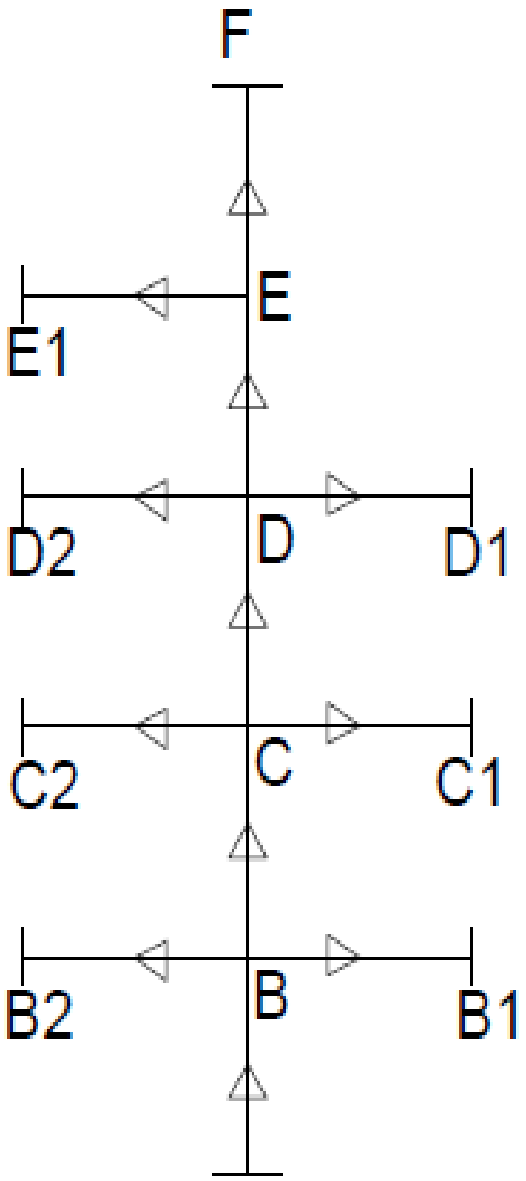


Figure Q4

Schedule Q4

Sector	L m	V m^3/s	C m/s	A m^2	d m	f	h mm Water
A-B	6.00		5.00				
B-B1	3.00	0.50	2.50				
B-B2	3.00	0.50	2.50				
B-C	6.00		5.00				
C-C1	3.00	0.50	2.50				
C-C2	3.00	0.50	2.50				
C-D	6.00		5.00				
D-D1	3.00	0.50	2.50				
D-D2	3.00	0.50	2.50				
D - E	6.00		5.00				
E – E1	3.00	0.50	2.50				
E - F	4.00	0.50	2.50				

Question 5

A cold storage room is constructed such that the roof and walls are exposed to interior conditions while the floor is installed on a concrete slab. The dimensions of the room are L x W x H = 3.0 x 3.0 x 3.0 m. The average U – valve for all 6 sides is 0.140W/m^2 – K.

The cold room is to be maintained at -5^{0}C when the exterior average temperature and relative humidity are 25^{0}C and 10%, respectively.

The cold room air is changed 6 times in an hour.

Meat at 25^{0}C is placed in the cold room.

Calculate:

i. Heat transferred to the room through the walls, ceiling and floor.
(7 Marks)

ii. Heat removed from the air due to air changes.
(18 Marks)

iii. Heat removed from 100kg of meat above the freezing point (-2^{0}C) and below freezing point. The respective specific heats are 0.856kJ/kg – ^{0}C and 0.846kJ/kg – ^{0}C.
(10 Marks)

iv. List 5 other sources of heat load which may be considered.
(5 Marks)