(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

MAIN UNIVERSITY EXAMINATIONS

2023/2024 ACADEMIC YEAR

FOURTH YEAR FIRST SEMESTER EXAMINATIONS

FOR THE DEGREE OF

BSC IN MECHANICAL AND INDUSTRIAL ENGINEERING

BSC IN RENEWABLE ENERGY AND BIOFUELS TECHNOLOGY

COURSE CODE: MIE 471

COURSE TITLE: REFRIGERATION AND AIR CONDITIONING

DATE: 15TH DECEMBER 2023   **TIME: 08:00 – 10:00 AM**

Instructions to Candidates
1. Answer **Question 1 (compulsory)** and any other **TWO** Questions.
2. All symbols have their usual meaning.
3. Steam tables and psychrometric charts are provided.

DURATION: 2 Hours

MMUST observes ZERO tolerance to examination cheating

QUESTION ONE (Compulsory) - (30 MARKS)

a) State Gibbs-Dalton law.

(3 Marks)

b) Define the following terms:
(i) Relative humidity.

(2 Marks)

(ii) Specific humidity.

(2 Marks)

(iii) Humidification.

(2 Marks)

(iv) Sensible cooling.

(2 Marks)

c) Draw and label a schematic diagram of a summer air conditioning system.

(8 Marks)

d) Use a Steady Flow Energy Equation to analyse the processes in a vapour compression refrigeration cycle.

(4 Marks)

e) Show from basic principles that the Carnot coefficient of performance of a refrigerator is a function of the system temperatures.

(7 Marks)

QUESTION TWO (20 MARKS)

a) In the design of an air conditioning system, the performance characteristic of a centrifugal fan is expressed by:

$$H_D = a + bQ + cQ^2$$

where,

H_D is the head (m) developed by the fan

Q is the discharge (m³/s)

a, b, and c are constants

The fan is connected to a ducting system whose pressure head loss (H_L) is $0.035Q^2$.

Taking a, b and c to be 104, -0.08 and -0.005 respectively, determine the following:

i) Discharge.

(12 Marks)

ii)   Head developed.

(2 Marks)

b) The fan in (a) runs at 1500rpm during which the power requirement is 30kW.
    If the head is to be increased by 60%, determine the required:

i)   Speed.

(2 Marks)

ii)   Discharge.

(2 Marks)

iii)   Power.

(2 Marks)

QUESTION THREE (20 MARKS)

A vapour compression plant uses R134a and has a suction pressure of 2.4335 bar and a condenser pressure of 13.174 bar. The vapour is dry saturated on entering the compressor and there is no undercooling of the condensate. The compression is carried out in two stages and a flash chamber is used at an inter-stage pressure of 4.8833 bar.

Calculate the:

a) Amount of vapour bled off at the flash chamber.

(6 Marks)

b) State of the vapour at the inlet to the second stage of compression.

(4 Marks)

c) Refrigerating effect per kg of refrigerant in the condenser.

(2 Marks)

d) Work done per kg of refrigerant in the condenser.

(7 Marks)

e) Coefficient of performance.

(1 Mark)

QUESTION FOUR – 20 MARKS

Air at 10^0C DBT and 90% RH is to be heated and humidified to 35^0C DBT and 22.5^0C WBT. The air is pre-heated sensibly before passing to the air washer in which water is re-circulated. The RH of air coming out of the air washer is 90%. Air is again re-heated sensibly to obtain the final desired condition.

a) Outline the procedure for plotting points on the psychrometric chart

(7 Marks)

b) Temperature to which air should be pre-heated

(1 Mark)

c) Find the total heating that is required

(5 Marks)

d) Determine the make-up water that is added to the air washer

(3 Marks)

e) Calculate the humidifying efficiency of the air washer

(4 Marks)