



(University of Choice)

**MASINDE MULIRO UNIVERSITY OF
SCIENCE AND TECHNOLOGY
(MMUST)**

MAIN CAMPUS

MAIN UNIVERSITY EXAMINATIONS

2021/2022 ACADEMIC YEAR

**FOURTH YEAR FIRST SEMESTER SPECIAL/SUPPLIMENTARY
EXAMINATIONS**

FOR THE DEGREE OF

BACHELOR OF SCIENCE IN MECHANICAL AND INDUSTRIAL ENGINEERING

**BACHELOR OF SCIENCE IN RENEWABLE ENERGY AND BIOFUELS
TECHNOLOGY**

COURSE CODE: MIE 471

COURSE TITLE: REFRIGERATION AND AIR CONDITIONING

DATE: 3 – 10 - 2022

TIME: 3:00 PM – 5:00 PM

Instructions to Candidates

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

DURATION: 2 Hours

MMUST observes ZERO tolerance to examination cheating

QUESTION ONE (Compulsory) – 30 MARKS

- a) State Leduc's law **(2 Marks)**
- b) Define the following terms as applied to air conditioning engineering:
- (i) Specific humidity **(2 Marks)**
 - (ii) Relative humidity **(2 Marks)**
 - (iii) Dehumidification **(2 Marks)**
 - (iv) Sensible cooling **(2 Marks)**
- c) To show that the specific humidity of an air mixture can be expressed as:
- $$\omega = 0.622 \frac{P_s}{P_a}$$
- (6 Marks)**
- d) Give any 4 desirable properties of refrigerants. **(8 Marks)**
- e) Draw and label a schematic diagram of a VCR system. **(6 Marks)**

QUESTION TWO (20 MARKS)

- a) In a heating application, moist air enters a steam heating coil at 10°C and 50% RH, and leaves at 30°C.
- i) Determine the sensible heat transfer if the mass flow rate of air is 100 kg of dry air (da) per second **(6 Marks)**
 - ii) Determine the steam mass flow rate if steam enters saturated at 100°C, and the condensate leaves at 80°C **(3 Marks)**
- b) 1 kg of air at 40°C dry bulb temperature (t_d) and 50% RH is mixed with 2 kg of air at 20°C t_d and 20°C dew point temperature (t_{dp}).

Calculate for this mixture, the:

- i) Specific humidity (8 Marks)
- ii) Temperature (2 Marks)

QUESTION THREE (20 MARKS)

Air is supplied at a rate of $250\text{m}^3/\text{min}$ from outdoor conditions of 40°C DBT and 26°C WBT to an air-conditioned room. The air is dehumidified first by a cooling coil having a by-pass factor of 0.32 and a dew point temperature of 15°C ; and then by a chemical dehumidifier where air leaves at 30°C DBT. The air then passes over a cooling coil whose surface temperature is 15°C and a by-pass factor of 0.26.

- a) Outline the procedure of determining the states on the psychrometric chart (3 Marks)
- b) Show the processes on the psychrometric chart (4 Marks)
- c) Calculate the capacities of the:
 - (i) First cooling coil (in TR) (7 Marks)
 - (ii) Second cooling coil (in TR) (3 Marks)
 - (iii) Dehumidifier (3 Marks)

QUESTION FOUR (20 MARKS)

A refrigerator has an evaporator pressure of 1.826 bar and a condenser pressure of 10.84 bar. Dichlorodifluoromethane is used as the working fluid.

- a) Determine the following for the corresponding saturation temperatures:
 - i) Ideal COP (5 Marks)
 - ii) Ideal refrigerating effect (3 Marks)
- b) If 1 kg of wet saturated vapour is delivered to the condenser after isentropic compression, and there is no undercooling of the condensed liquid, determine the:
 - i) Refrigerating effect (9 Marks)
 - ii) COP_r (3 Marks)

