



(University of Choice)

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

MAIN CAMPUS

MAIN UNIVERSITY EXAMINATIONS

2021/2022 ACADEMIC YEAR

FOURTH YEAR FIRST SEMESTER MAIN 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: 28-4-2022

TIME: 15.00-17.00HRS

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) Define the following terms:

(i) Air conditioning

(2 Marks)

(ii) Refrigeration

(2 Marks)

(iii) Humidification

(2 Marks)

(iv) Sensible heating

(2 Marks)

b) State Gibbs-Dalton law

(3 Marks)

c) Draw and label a schematic diagram of a vapour compression refrigeration system

(8 Marks)

d) Differentiate between the following:

i) Primary refrigerants

(2 Marks)

ii) Secondary refrigerants

(2 Marks)

e) Show that in adiabatic mixing of two air streams,

$$\frac{m_1}{m_2} = \frac{h_3 - h_2}{h_1 - h_3} = \frac{\omega_3 - \omega_2}{\omega_1 - \omega_3}$$

(7 Marks)

QUESTION TWO – 20 MARKS

A refrigerator which uses R717 has an evaporator pressure of 1.902 bar and a condenser pressure of 12.37 bar. Dry saturated vapour is delivered to the compressor, and the liquid is undercooled by 10K after condensation.

Calculate the:

a) Refrigerating Effect per kg of refrigerant

(10 Marks)

b) COP_r

(10 Marks)

QUESTION THREE (20 Marks)

A restaurant with a capacity of 100 persons is to be air-conditioned to 23°C DBT and 55% RH. The outside conditions are 30°C DBT and 70% RH. The quantity of air supplied is 0.5m³ per minute per person. The desired conditions are achieved by cooling, dehumidifying and then heating. The surface temperature of the heating coil is 35°C.

a) Show the processes on the psychrometric chart.

(6 Marks)

b) Determine the following:

(i) Capacity of the cooling coil in TR.

(7 Marks)

(ii) Capacity of heating coil.

(2 Marks)

(iii) Amount of water removed by the dehumidifier.

(3 Marks)

(iv) By-pass factor of the heating coil.

(2 Marks)

QUESTION FOUR – 20 MARKS

In an air cooling system of a jet aircraft, air is bled from the engine compressor at 3 bar, and is cooled in a heat exchanger to 105°C. It is expanded to 0.6 bar in an air turbine, the isentropic efficiency being 85%. The air is then delivered to the cockpit and leaves the aircraft at 27°C.

a) Calculate the temperature at which the air enters the cockpit

(11 Marks)

b) Determine the mass flow rate of air if the refrigerating effect is 4kW

(5 Marks)

c) If the air turbine is used to help to drive auxiliaries, calculate its contribution in power

(4 Marks)

