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(*University of Choice*)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

MAIN UNIVERSITY EXAMINATIONS

2021/2022 ACADEMIC YEAR

FIFTH/FOURTH YEAR FIRST SEMESTER 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 571/RET 471

COURSE TITLE: POWER PLANT ENGINEERING

DATE: 20-4-2022 **TIME: 12.00-14.00 HRS**

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 THREE – 20 Marks

The compression ratio of an internal combustion power plant working on a diesel cycle is 21, and the air/fuel ratio is 29/1. The temperature at the end of compression is 1000K. The calorific value of the fuel is 42 MJ/kg, R is 287 J/kgK, and the specific heat at constant volume of the products of combustion is given by,

$$c_v = (0.71 + 28 \times 10^{-6}T)\, kJ\ /kgK$$

Determine the percentage of stroke at which the combustion is completed for maximum power production.

(20 Marks)

QUESTION FOUR – 20 Marks

A particular process requires air at 45^0C at a flow rate of 0.4 kg/s, the air leaving the process at 30^0C. The supply of air from the atmosphere is at 10^0C. Currently, the air is heated electrically but it is proposed to replace the electric heater with a heat pump system linking the inlet and exit airstreams. The refrigerant to be used is R12, operating with an evaporator temperature of 25^0C and a condenser temperature of 50^0C. The vapour is saturated at entry to the compressor and there is no under-cooling in the condenser. The mechanical efficiency of the electrical motor of the compressor is 90%.

Assuming that the compression process is isentropic, and neglecting all heat losses:

a) Sketch the schematic layout of the plant and its corresponding t-s diagram

(4 Marks)

b) Calculate the mass flow rate of refrigerant required

(8 Marks)

c) Find the electrical power input required for the electric heater, and for the heat pump

(2 Marks)

d) Determine the temperature of the air leaving the evaporator coils

(4 Marks)

e) What is the percentage saving in running costs when using the heat pump instead of electrical heating?

(2 Marks)