KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2017/2018 ACADEMIC YEAR

FOURTH YEAR SECOND SEMESTER
SPECIAL/SUPPLIMENTARY EXAMINATIONS

FOR THE DEGREE OF
B.SC (RENEWABLE ENERGY AND BIOFUELS TECHNOLOGY)

COURSE CODE: PRD 472

COURSE TITLE: POWER PLANT ENGINEERING

DURATION: 2 HOURS

DATE: 08/10/2018 **TIME:** 11:30-1:30PM

INSTRUCTIONS TO CANDIDATES

(i) Answer **Question 1 (Compulsory)** and any other **TWO** questions
(ii) All symbols have their usual meaning
(iii) Use steam tables provided

This paper consists of **4** printed pages. Please Turn Over

QUESTION ONE (Compulsory) – 30 Marks

a) The peak load of a thermal power plant of 60MW capacity is 50MW at an annual load factor of 40%. The loads having maximum demands of 25MW, 20MW, 8MW and 5MW are connected to the power plant.
Calculate the:

i) Average load **(3 Marks)**

ii) Diversity factor **(3 Marks)**

b) Calculate the stoichiometric A/F ratio for a sample of coal whose composition by mass is 80% C, 12% H_2, and 8% Ash. **(5Marks)**

c) Briefly outline four methods of reducing cavitation in hydro-plants. **(4 Marks)**

d) State three methods of disposing radioactive waste material from a Nuclear Power Plant. **(3 Marks)**

e) Explain two methods of treating impure feed-water. **(4 Marks)**

f) Give four merits of a water-tube boiler over a fire-tube boiler. **(4 Marks)**

g) Briefly explain two methods under which waste heat is utilized. **(4 Marks)**

QUESTION TWO – 20 Marks

An internal combustion engine power plant working on an Otto cycle has a volume compression ratio of 8, and an air/fuel ratio of 15:1. The pressure and temperature at the beginning of a compression stroke is 1 bar and 60^0C respectively. The calorific value of the fuel is 44 MJ/kg, and the index of compression is 1.32. The specific heat at constant volume of the products of combustion is given by,

$$c_v = (0.678 + 0.000137T)\ kJ/kgK$$

Determine the maximum:

a) Temperature **(16 Marks)**

b) Pressure **(4 Marks)**

QUESTION THREE – 20 Marks

A hydro-electric power plant is to be used as a peak load at an annual load factor of 40%. The electrical energy generated annually is 85×10^6 KWh. The capital cost of the plant is Kshs 890 million. The life span is 35 years at the end of which the value of the plant will be Kshs 40 million.

a) Determine the Maximum Demand **(4 Marks)**

b) If the plant capacity factor is 27%, find the Reserve Capacity of the plant **(10 Marks)**

c) Use the sinking fund method to calculate the amount of money to be saved annually for the replacement of the plant if the annual compound interest is 4.5% **(6 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)**

QUESTION FIVE – 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 42000 kJ/kg, R is 0.287 kJ/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)