KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2019/2020 ACADEMIC YEAR

FOURTH YEAR SECONDSEMESTER
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: 2/02/21 ~~2020~~ **TIME:** 2-4 Pm

INSTRUCTIONS TO CANDIDATES

(i) Answer Q**uestion 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 TWO – 20 Marks

Determine the percentage change in efficiency of a Diesel power plant having a compression ratio of 18 and cut-off taking place at 6% of the stroke, when the specific heat at constantvolume increases by 2%. Take:

$$c_v = 0.717\ kJ/kgK\ , R = 0.287\ kJ/kgK\ and\ \eta = 1 - \frac{(\beta^\gamma - 1)}{\gamma(\beta - 1)r_v^{\gamma-1}}$$

(20 Marks)

QUESTION THREE – 20 Marks

A combined cycle plant has a gas turbine unit and a steam turbine unit. The exhaust from thegas turbine is supplied to the steam turbine to generate electricity. For the gas turbine; thepressure ratio is 8, the temperature of air to the inlet of the compressor is 17^0C, and the maximum cycle temperature is 900^0C. For the steam turbine; steam conditions at entry toturbine are 2MN/m^2 and 400^0C, condenser pressure is 5000N/m^2, and the temperature of gasesleaving the steam generator is 180^0C. Total power output of the plant is 60MW. Isentropic efficiencies of the air compressor, the gas turbine, and the steam turbine are 79%, 83%, and 80% respectively. For combustion gases; C_p = 1.11kJ/kgK, and γ = 1.33, while for air; C_p = 1.005KJ/kgK, and γ = 1.4. Assume that the mass flow rate of fuel, feed pump work, andall pressure losses are negligible.

a) Draw and label a schematic diagram of the plant

(3 Marks)

b) Calculate the cycle efficiency of the gas turbine

(6 Marks)

c) If the heat supplied to the steam generator were by an external source, determine the efficiency of the steam cycle

(6 Marks)

d) Calculate the mass flow rate of air to the gas turbine, and the mass flow rate of steam to the steam turbine

(3 Marks)

e) Determine the overall efficiency of the combined cycle

(2 Marks)

QUESTION FOUR – 20 Marks

A hydro-electric power station is to be designed for a catchment area of 300 km^2, and the available rainfall per year is 1300mm. The head available is 30m. 20% of the total rainfall is lost through evaporation. Penstock efficiency is 92%, turbine efficiency is 81%, generator efficiency is 86%, andtheload factor is 40%.Density of water is 1000 kg/m^3

a) Determine the plant capacity of the station.

(14 Marks)

b) Suggest suitable turbines to be used

(6 Marks)

QUESTION FIVE – 20 Marks

A steam power plant has the following data:

- Installed capacity = 120MW
- Capital cost of the plant = Kshs 3500 per kW
- Interest and depreciation = 15%
- Fuel consumption = 1kg/kWh
- Fuel cost = Kshs 50 per 1000kg
- Peak load = 100MW
- Load factor = 60%
- Salaries, wages, repairs and other operating costs per year = Kshs 10 million

Determine the generation cost per unit of energy for the steam plant.

(20 Marks)