CHUKA UNIVERSITY

UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEENG 464: POWER GENERATION

STREAMS: BSC EENG **TIME:2 HOURS**

DAY/DATE: FRIDAY 20/12/2024 **8.30 A.M. –10.30 A.M**

INSTRUCTIONS:

Answer question ONE and any other TWO questions

Do not write on the question paper

QUESTION ONE (30 MARKS)

a) Discuss the factors that need to be taken into account while selecting the site for a nuclear power station. (4 Marks)

b) A steam power station has an overall efficiency of 20% and 0·6 kg of coal is burnt per kWh of electrical energy generated. Calculate the calorific value of fuel. (3 Marks)

c) A thermal station has the following data : Max. demand = 20,000 kW ; Load factor = 40% Boiler efficiency = 85% ; Turbine efficiency = 90% Coal consumption = 0·9 kg/kWh ; Cost of 1 ton of coal = Ksh.450
Determine
   i). thermal efficiency (1 Mark)
   ii). Coal bill per annum. (2 Marks)

d) Outline the advantages of MHD generators over steam power plants. (2 Marks)

e) What is the power ouput of a 92U 235 reactor if it takes 30 days to use up 2 kg of fuel? Given that energy released per fission is 200 MeV and Avogadro's number = 6·023 × 1026 per kilomole. (4Marks)

f) Wind at a speed of 10 meters per second passed through a wind turbine with a blade radius of 30m. What is the theoretical power available and the maximum fraction of power available? (3Marks)

i). Briefly explain the working principle a fuel cell (2Marks)
ii). Highlight the application of fuel cells (2Marks)

g) Water for a hydro-electric station is obtained from a reservoir with a head of 100 metres. Calculate the electrical energy generated per hour per cubic metre of water if thehydraulic efficiency be 0·86 and electrical efficiency 0·92. (4Marks)

h) Describe the different types of fuel cell technologies. (3Marks)

QUESTION TWO (20 MARKS)

a) A steam power station spends Ksh.4.5 Milllion per annum for coal used in the station. The coal has a calorific value of 5000 kcal/kg and costs Ksh.450 per ton. If the station has thermal efficiency of 33% and electrical efficiency of 90%, find the average load on the station. (5 Marks)

b) Describe the schematic arrangement of a thermal power station. Briefly explain the functions of the components. (5 Marks)

c) Discuss the merits and demerits of wind energy. (4 Marks)

d) The following data for a 2200 kW diesel power station was given .The peak load on the plant is 1600 kw and its load factor is 45% .Capacity cost/kw installed =Ksh.15000, Annual costs=15% of capital , Annual Maintenance cost=Fixed Ksh.100000 and a Variable cost Ksh.200000 , annual operating cost=Ksh.600000 , Cost of Fuel=Ksh.0.8 per kg,cost of lubricating oil=Ksh.40 per kg, C.V of Fuel=40000 kj/kg , consumption of fuel =0.5kg/kwh , Consumption of Lubricating oil=1/400 kg/kwh. Determine:

i). The annual energy produced
ii). Cost of generation per kwh
iii). Efficiency (6 Marks)

QUESTION THREE (20 MARKS)

a) Highlight the functions of a Surge tank in hydroelectric in hydroelectric power plant design. (2 Marks)

b) The generating station has a maximum demand of 20 MW, a load factor of 60%, a plant capacity factor of 48% and a plant use factor of 80%. Calculate

i). The daily energy produced. (2 Marks)
ii). The reserve capacity of plant. (3 Marks)
iii). The maximum energy that could be produced daily if the plant was running all the time. (1 Marks)
iv). The maximum energy that could be produced daily if the plant was running fully loaded and operating as per schedule. (1 Marks)

c) A hydro-electric power station has a reservoir of area 2·4 square kilometres and capacity 5×10^6 m^3. The effective head of water is 100 metres. The penstock, turbine and generation efficiencies are respectively 95%,90% and 85%.

(i) Calculate the total electrical energy that can be generated from the power station. (3 Marks)

(ii) If a load of 15,000 kW has been supplied for 3 hours, find the fall in reservoir level

(5 Marks)

d) Describe Three hydroelectric Power plant classifications (3 Marks)

QUESTION FOUR (20 MARKS)

a) Define the following terms used in Solar Energy generation.
   i). Insolation (1Marks)
   ii). Irradiaton (1Marks)

b) Consider a 100-cm^2 photovoltaic cell with reverse saturation current $I_0 = 10^{-12}$ A/cm2 . In full sun, it produces a shortcircuit current of 40 mA/cm^2 at 25◦C.
   i). Find the open-circuit voltage at full sun and again for 50% sunlight. (4Marks)
   ii). Plot I-V graph of the photovoltaic cell. (3Marks)
   iii). From I-V graph explain the I_{sc} and V_{oc} variation with Sunlight Intensity. (3Marks)

c) Describe the working Principle of an MHD generator using diagrams and illustriations, (5Marks)

d) Outline THREE drawbacks of Fuel Cells. (3Marks)
