KENYATTA UNIVERSITY
EXAMINATION FOR THE DEGREE OF MASTER OF SCIENCE

(RENEWABLE ENERGY TECHNOLOGY)

SET 801: ENERGY MANAGEMENT

1ST SEMESTER 2023/2024 TIME: 3 Hours

**INSTRUCTIONS:**

Answer Question One (1) and any other TWO Questions

***Useful expressions***

i. $\Sigma y = m\Sigma x + cn$

ii. $\Sigma xy = m\Sigma x^2 + c\Sigma x.$

iii. $Q = m_l c_l (t_1 - t_2) = UA_0(LMTD)K$

iv. $LMTD = \frac{\Delta t_1 - \Delta t_2}{ln\left(\frac{\Delta t_1}{\Delta t_2}\right)}$

**QUESTION 1 - 30 MARKS (COMPULSORY)**

[a] Define Energy efficiency *(3 Marks)*

[b] Discuss Two (2) types of scenarios *(4 Marks)*

[c] Discuss the Four (4) main pillars in energy resource management (national level) *(6 Marks)*

[d] Give at least four (4) forms of Useful Energy (UE) enjoyed by common household *(2 Marks)*

[e] Sketch a McKelvey's Diagram and use it to differentiate Reserves from Resources *(6 Marks)*

[f] An audit report serves to document findings of an energy survey exercise. Give an outline of typical energy audit report. *(6 Marks)*

[g] Explain your understanding of Cradle-to-Gate, Cradle-to-Cradle and Well-to-Wheel and variants of LCA *(3 Marks)*

## *QUESTION 2 – (20 MARKS)*

[a] During an audit, the auditing firm proposed a purchase of a generator to reduce on expensive grid electricity. Determine the total cost of the diesel generator operating over a 6-year period. Assume that the capital cost of the generator is KShs. 1,725,000, the annual output is 219 MWh and the maintenance costs are KShs. 57,500 per annum. The cost of producing each unit of electricity is KShs. 25/kWh *(7 Marks)*

[b] A certain school posted the following energy consumption in year 2019-20

| *FE* | *Quantity* | *FE* | *Quantity* |
|---|---|---|---|
| Electricity | 21,500 kWh | Gasoline | 5,600 l |
| Hydrogen | 10 $m^3$ | Diesel | 98,000 l |
| Gas | 60 $m^3$ | Firewood | 54 $m^3$ |

i. Determine the school's annual energy consumption in kWh and the percentage share from each FE. Use the given conversion factors (Gas = 9.97 kWh/$m^3$, Hydrogen = 3.0 kWh/$m^3$, Diesel = 10 kWh/l, Gasoline = 8.8 kWh/l, Firewood = 1883.12 kWh/$m^3$) *(8 Marks)*

ii. If the cost per unit in KShs. for the six FEs is as follows; 18/kWh, 65/$m^3$, 200/$m^3$, 101/l, 115/l and 3000/$m^3$, respectively, determine the annual cost of energy. *(5 marks)*

## *QUESTION 3 – (20 MARKS)*

[a] Linear regression analysis is a very useful tool for quantitative energy analysis. A linear relation can be established for example between two parameters (dependent and independent variables) in the form; $y = mx + c$. Given a set of values (n) of the two parameters, the following two expressions hold to be true;

$$\Sigma y = m\Sigma x + cn \text{ and } \Sigma xy = m\Sigma x^2 + c\Sigma x.$$

If the gas consumption for space heating in a particular facility is as outlined below;

| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Degree days per month (x) | 75 | 88 | 90 | 116 | 160 | 200 | 234 | 255 | 285 | 298 | 325 | 342 |
| Gas consumption per month (kWh) (y) | 480 | 520 | 624 | 575 | 675 | 863 | 913 | 947 | 1017 | 1216 | 1030 | 1141 |

i. Deduce the resulting suitable/respective equations for this facility *(10 Marks)*

ii. Determine the best-fit expression for the linear straight line graph for the facility *(4 Marks)*

[b] Discuss Energy Conservation Opportunity (ECO) *(6 Marks)*

***QUESTION 4 – (20 MARKS)***

[a] Discuss Three (3) stages in the entire Energy Auditing process *(10 Marks)*

[b] Consider an external wall whose elements have the following properties; decorative mazerras – 55 mm, thermal foam – 50 mm, ndarugu stones – 200 mm and plaster – 12 mm. Their respective conductivities are; 0.840, 0.032, 0.250 and 0.500 W/mK. Determine the overall U value of the wall. *(5 marks)*

[c] The number of luminaire fittings required for a regular room is given by, $n = \frac{E_{av} \times A}{\emptyset \times UF \times MF}$. Discuss the last two terms, UF (utilization factor) and MF (maintenance factor) in the denominator. *(5 marks)*

***QUESTION 5 – (20 MARKS)***

[a] Beyond energy auditing, it becomes imperative to conduct energy monitoring and set targets for continual improvements. Discuss the key elements of monitoring and targets *(10 Marks)*

[b] Discuss at least four (4) accounting and financial appraisal techniques developed to help managers make correct and objective decisions on energy investments *(10 Marks)*