



SCHOOL OF COMPUTING AND ENGINEERING SCIENCES
MASTER OF SCIENCE IN SUSTAINABLE ENERGY TRANSITIONS
END OF SEMESTER EXAMINATION

MSSET 8202: ENERGY MANAGEMENT AND STANDARDS

DATE: 12th September, 2022

Time: 2½ Hours

Instructions

1. This examination consists of **FOUR** questions.
2. Answer **Question ONE (COMPULSORY)** and any other **TWO** questions.

Useful Formulas

$$P/A = \frac{(1+i)^n - 1}{i \times (1+i)^n} \qquad A/P = \frac{i \times (1+i)^n}{(1+i)^n - 1}$$

QUESTION ONE

(Total: 20 Marks)

- a. Draw and briefly explain the energy management cycle. (2½ Marks)

- b. A given residential house in Nairobi has the energy consumption profile for the month of January 2022 shown in Table 1. Perform the energy audit by answering the following questions. *(show all your workings)*

Table 1

Equipment	Rating (W)	Pieces	Consumption	
			Days/Month	Hrs/day
Instant Shower	4500	1	Daily	½
Fridge	120	1	Daily	8
Washing Machine	180	1	4 Days	2
Oven	1500	1	2 Days	1
55" LED TV	50	1	Daily	10
Microwave	100	1	Daily	½
Iron Box	1000	1	Daily	½
Laptop	50	1	Daily	1
Water Dispenser	450	1	Daily	¼
Audio System	1000	1	Daily	8
Mobile Phones	25	3	Daily	¼
LED Bulbs	9	15	Daily	5
Incandescent Bulbs	60	2	Daily	5
LED Flood Lights	20	3	Daily	10

- i. Determine the monthly energy consumption for each equipment. (2 Marks)
- ii. Determine the total energy consumed in the month of July. (1 Mark)
- iii. Estimate the average annual energy consumption. (1 Mark)

- iv. Given the cost of electricity is Ksh. 17 per kWh, calculate the annual electricity cost. *Assume consistent energy consumption throughout the whole year.* (1 Marks)
- v. If the house has a conditioned area of 60 m², determine its Energy Use Index (EUI) (2 Marks)
- vi. Determine the demand and load factor for this house. (3 Marks)
- vii. Identify and briefly discuss THREE energy and cost saving measures that can be considered in this house. (3 Marks)
- viii. From a brief research, the owner of the house is convinced that he can save on energy consumption by replacing the instant shower and audio system with alternatives with the ratings of 2500 W and 750 W respectively. The cost of these alternatives is kshs 3,000 and kshs 55,000 respectively. Keeping all the other variables constant, calculate the simple payback period if the two equipments are replaced with these alternatives and comment on the feasibility of this proposal. (4½ Marks)

QUESTION TWO

(Total: 15 Marks)

- a. A given 37.5 kW rated induction motor burns out in a process plant. The financial manager of the plant wants the motor to be rewound for kshs 100,000 to save money, while the Energy Manager is recommending purchasing of a new energy efficient motor for kshs 500,000 after selling burnt out motor for ksh 80,000. The Energy Manager claims that he can save much more money in the next five years than the cost difference of the above two options. Considering the following features;
 - Operating hours/year = 7800
 - Rewound motor efficiency at 75% loading = 89%
 - New energy efficient motor efficiency at 75% loading = 94%
 - Motor loading = 75%
 - Electricity cost = kshs 15 per kWh
 - i. How much money does the energy manager actually save over 5 years? (3 Marks)
 - ii. What is the simple payback period if the motor is replaced with a new one? (3 Marks)
 - iii. The financial manager claims the financial risk is still too high because operating hours may go down drastically from 7,800 to 4,500 hrs in the next 5 years. The energy manager still insists that even if the motor's annual operating hours become 3/4 of the annual 4,500 operating hours as predicted by financial manager, the proposal will still recover the cost difference within next 5 years (*ignoring interest and depreciation*). Do you agree with the energy manager's claim? (*show your working*) (5 Marks)
- b. Having been recently employed as an energy manager, part of your responsibilities include energy conservation and management. Elaborate four building envelop energy conservation measures you will take to reduce heat exchange between the building and the outside environment. (4 Marks)

QUESTION THREE

(Total: 15 Marks)

- a. An energy audit indicated an electrical motor consumption as 4×10^6 kWh per year. By upgrading the motor spares with high efficiency motors, a 10% savings can be realized. The additional cost for these motors is estimated at Ksh 80,000. Assuming a 15 per kWh energy

charge and 20-year life, is the expenditure justified based on a minimum rate of return of 20% before taxes? (*Solve the problem using the present worth, annual cost, and rate-of-return methods*) (11 Marks)

- b. According to Kenyan Energy Management Regulations 2012, any establishment/business that consumes more than 180,000kWh/ 648,000Mj per year is required to conduct an energy audit once every three years. Highlight FOUR energy management requirements as per the regulation. (4 Marks)

QUESTION FOUR

(Total: 15 Marks)

- a. Energy audit process involves three main steps namely; pre-site visit, site visit, and post-site visit. Explain what happens in each of these steps and highlight the purpose/result of each. (6 Marks)
- b. An industry is losing money as penalty on account maintaining a poor power factor of 0.88. The power utility (KPLC) has specified a minimum power factor of 0.9 to avoid penalty. The penalty on energy cost is 1% for every 0.01 power factor less than the minimum prescribed. Also an incentive on energy cost is available @ 1.5% for every 0.01 improvement above 0.95. If the monthly energy bill of the industry is Ksh 900,000, calculate the annual cost saving potential if power factor is improved to unity from the current level. (4 Marks)
- c. A given electric motor used in a chain link making machine consumes 120 watts (a joule per second (J/s)) of power to obtain 90 watts of mechanical power.
- Determine its efficiency? (2 Marks)
 - Highlight two energy reduction measures that can be considered in motors. (1 Mark)
 - Discuss two elements that can be optimized to improve the efficiency of the machine. (2 Marks)