



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

MSSET 8202: ENERGY MANAGEMENT AND STANDARDS

DATE: 15th December, 2023

Time: 18:00-20:30 Hours

Instructions

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

QUESTION ONE

(Total: 20 Marks)

- a. Briefly discuss how an industry, nation, or globe could benefit from energy efficiency programs? (*discuss 2 points for each category*) (3 Marks)
- b. Table 1 shows the cash flows of two projects; A and B.

Table 1

Investment	Ksh. (100,000)	Ksh. (100,000)
Savings in Year	Cash Flow of A	Cash flow of B
1	50,000	20,000
2	30,000	20,000
3	20,000	20,000
4	10,000	40,000
5	10,000	50,000
6	–	60,000

- i. Evaluate the viability of project A & B by determining the simple payback period and net present value (NPV). *Assume discount rate is 10%*. (8 Marks)
 - ii. List two limitation of using simple payback period in energy economics analysis. (1 Mark)
 - iii. Highlight two main advantages with NPV criterion? (1 Mark)
 - iv. Compare the results in b(i) above to justify the limitations of simple payback period. (2 Marks)
- c. Assume CO₂ equivalent emission by the use of a 60 W incandescent lamp is of the order of 0.29 kg/kWh. What will be the equivalent CO₂ emissions per hour if the lamp is replaced by a 5 W LED lamp? (3 Mark)
 - d. An energy audit carried out on a dairy processing plant indicated a lot of energy inefficiencies in compressed air and refrigeration system. Highlighting two possible energy conservation measures each for these systems. (2 Marks)

QUESTION TWO

(Total: 15 Marks)

- a. “Energy is sustainable if it meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable energy solutions seek to provide universal access of clean, safe, reliable, and affordable energy.” Discuss this statement in relation to the environment to underscore the relationship between sustainable development goals, energy, and environment. (4 Marks)
- b. Energy production, distribution, and consumption are the three sectors to consider when evaluating energy systems in terms of environmental impact. Discuss two points of concern in each of these three areas of interest. (6 Marks)
- c. Highlight four ways of estimating your organizations’ carbon footprint (2 Marks)
- d. A 9 watt light-emitting diode (LED) bulb produces the same light output as a 43 watt incandescent light bulb. Assuming an average daily bulb use of 3 hours per day and an average of 0.29 Kg of CO₂ emissions per kWh, determine carbon dioxide emissions reduced per light bulb by switched from an incandescent bulb to a light-emitting diode bulb. (3 Marks)

QUESTION THREE

(Total: 15 Marks)

- a. Economic indicators provide a realistic projection of the financial viability of a proposed measure over time. Answer the following energy economics related questions
- What are the major limitations with Return on Investment technique? (1 Mark)
 - List two main disadvantages of Net Present Value criterion? (1 Mark)
 - What is the limitation with internal rate of return figure? (1 Mark)
 - Highlight two reasons for carrying out energy accounting. (1 Mark)
- b. Calculate the present value of tax cash flow from a Ksh. 100,000 investment towards 5 hp energy efficient motor with 30% declining balance depreciation rate, 50% tax rate and 10% interest rate. (3 Marks)
- c. Calculate net present value for an investment towards an LED lighting. The following table gives investment and cash flow. (3 Marks)
- | | |
|------------------------|-----------------------|
| Investment: | Ksh.400/- |
| <i>Savings in year</i> | <i>Cash flow, Ksh</i> |
| Year # 1 | 1000 |
| Year # 2 | 1000 |
| Discount rate (k): | 10% |
| Life of the LED (t): | 2 years |
- d. An office building has 50 employees and is occupied for 250 work days a year. It is estimated that each employee uses, on the average, 1 gallon of hot water per day for hand washing. The hot water temperature required is 48.89°C and the water supplied to the building is 15.56°C. Calculate the amount of annual energy required to heat this water. *Show your working* (5 Marks)

QUESTION FOUR

(Total: 15 Marks)

- a. Lighting, motors and drives, pumps and pumping systems, heating ventilation and cooling (HVAC) systems, compressed air systems, building envelop system and diesel generators are the most common areas to look into when carrying out energy audits. Select one system from this list and answer the following questions;
- i. Discuss the process of carrying out energy audit for the systems selected above. (3 Marks)
 - ii. Highlight major challenges that can be encountered when carrying out energy audits in this system. (2 Marks)
 - iii. Illustrate/discuss how you will evaluate the efficiency of this system. Use examples to illustrate. (3 Marks)
 - iv. What are some of the conservation measures that can be taken to improve the efficiency of the chosen system? Discuss three of them. (3 Marks)
- b. An electric heater draws 5 kW of power for continuous hot water generation in an industry. How much quantity of water in litres per min can be heated from 30°C to 85°C ignoring losses? Show your working. (*Specific heat capacity of water $C_p = 4.2 \text{ kJ/kg}^{\circ}\text{C}$ and the density of water $\rho = 1 \text{ kg/L}$*) (4 Marks)