



UNIVERSITY EXAMINATIONS
FOURTH YEAR EXAMINATION FOR THE AWARD OF THE
DEGREE OF BACHELOR OF SCIENCE
SECOND SEMESTER 2022/2023
[JANUARY-APRIL, 2023]

PHRE 423: ENERGY MANAGEMENT

STREAM: Y4S2

TIME: 2 HOURS

DAY: THURSDAY, 12:00 – 2:00 PM

DATE: 06/04/2023

INSTRUCTIONS

- 1. Do not write anything on this question paper.***
- 2. Answer question ONE and any other TWO questions.***

QUESTION ONE

- What is energy management? [1mark]
- What Are Greenhouse Gases? [1mark]
- State and explain the three lighting control technologies [3marks]
- Briefly explain what is de-lamping and re-lamping. [2marks]
- State three objectives of energy management. [3mark]
- What is an energy audit? [1mark]
- State three things that the type of audit to be performed depends on. [3marks]
- Detailed energy auditing is carried out in three phases. Briefly discuss the steps. [3marks]
- State any three factors that should be taken into account during the procurement of fuels for energy efficiency and economics. [3marks]
- State any four factors that are involved in deciding the final cost of purchased electricity. [4marks]
- State any three key instruments that should be used during an energy audit. [3marks]
- State any three measures that could be put in place to optimize the energy input requirements. [3marks]

QUESTION TWO

- a. State and explain the three primary ways of saving energy from boilers. [6marks]
- b. “Once the energy usage and sources are matched properly, the next step is to operate the equipment efficiently through best practices in operation and maintenance as well as judicious technology adoption”. Give some four illustrations in this context. [4marks]
- c. State two examples of energy substitution. [2marks]
- d. State and explain the three modes of heat transfer and state any one way that we can minimize any one of them [4 marks]
- e. State any four comparative factors which need to be looked into when doing external energy benchmarking. [4marks]

QUESTION THREE

- a. Discuss the eight reasons why group relamping is the most efficient and economical way of relamping strategies than spot relamping. [8 marks]
- b. An office building contains some small (400 ft^2) rooms, each of which has four two-lamp fluorescent fixtures. Every time a maintenance person changes lamps, they must bring a ladder into the room and clear away furniture. It takes the person 15 minutes to replace one lamp. It takes 25 minutes to replace all the lamps in a room and clean the luminaires if all the work is done at one time. The lamps cost *Shs* 85 each, and labor costs are *Kshs*1000/hour. The lamps are used for about 2000 hours/per year. The average lamp life is 20,000 hours. Determine whether group relamping with $I = 0.8$ is preferable to spot relamping for this building. Assume that an aluminium-Jacketed fiberglass insulation 1 inch thick is added so that it covers the tank. Determine the new heat loss, heat saved, and percentage saved. [4 marks]
- c. Calculate the annual savings from replacing 40-watt F40T12/Workshop lamps with 34-Watt energy-saving lamps in two hundred (200) 4-lamp fixtures that are operated continuously. Assume the following: The F40T12/Workshop lamps cost *Ksh*100 each and last for 12,000 hours. The 34-Watt F40T12 lamps cost *Ksh*150 each and last for 20,000 hours. Electric energy costs *Ksh*5 per kWh. The demand charge is *Kshs*550 per kW per month. The facility is not air-conditioned. [8 marks]

QUESTION FOUR

- a. Jumbo Industries has a 50-hp air compressor that operates at full-load, all day for 365 days per year. If the motor for the air compressor cost Kshs140,000, the motor efficiency is 90%, and electricity costs Kshs700/kW/month and Kshs5/kWh, how much does it cost to operate the air compressor for one year? (assume that if the motor were 100% efficient, there would be an electric load of 0.746 kW/hp) [6marks]
- b. How much money will be spent to operate the air compressor over ten years? [2marks]
- c. Jumbo Industries has been experiencing a period of rapid growth in the success of its products, and it has the plan to expand its production capacity by building a second plant nearby. They determine that they need another 50-hp air compressor which will also run continuously at full load. They can purchase either the Standard or the Deluxe Model air compressor with the difference being that the Deluxe Model has a high-efficiency motor. The motor efficiency for the Standard Model is 91.5%, and for the Deluxe Model, it is 93.8%. The additional cost for the Deluxe Model is Kshs 47,000. Is this a good investment for Jumbo Industries? [7marks]
- d. Jumbo Industries also wants to know what kind of “cushion” they have on this decision since their forecast for new business could be too optimistic. If the new air compressor is only run for two shifts a day, for a total of 5000 hours per year, is the additional investment still worthwhile? [5 marks]

QUESTION FIVE

- a. What do you understand by the term fuel substitution? Give examples. [1marks]
- b. State the five functions of the Energy Action Committee [5marks]
- c. Name eight types of information that should be collected during the audit visit. [8marks]
- d. State any two things that technical feasibility should address during the auditing process. [2marks]
- e. State and explain the four basic operating rules in improving the operation of the heating, ventilating, and air conditioning systems. [4marks]