UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME : ENERGY EFFICIENCY AND MANAGEMENT

COURSE CODE : BNE 44303

PROGRAMME CODE : BNE

EXAMINATION DATE : JULY 2024

DURATION : 3 HOURS

INSTRUCTIONS :
1. ANSWER **ALL** QUESTIONS
2. THIS FINAL EXAMINATION IS CONDUCTED VIA
   ☐ Open book
   ☒ Closed book
3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

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Q1   (a)   Explain how activities such as burning fossil fuels, deforestation, and industrial processes contribute to the increase in greenhouse gas emissions and subsequent global warming. Provide **ONE (1)** example for each activity to support your explanation.

(6 marks)

(b)   Illustrate the concept of Energy Pyramid by drawing the pyramid and explaining the action at each level.

(5 marks)

(c)   Consider a scenario where a manufacturing plant aims to improve its energy management practices. Propose a comprehensive roadmap outlining the procedural steps for implementing an Energy Management System (EnMS) tailored to suit the facility's specific requirements.

(10 marks)

(d)   Identify **FOUR (4)** primary goals of energy management.

(4 marks)

Q2   (a)   Describe **THREE (3)** various additional charges that might be included in utility bills apart from basic consumption charges.

(6 marks)

(b)   At Voltex Industrial Solutions Ltd., a machine with a power rating of 20 kW was run continuously for 24 hours throughout the year. The owner has chosen tariff C2 for calculating energy consumption charges. In the first year of operation, the machine was used without any energy efficiency technology. However, in the second year, the owner decided to employ variable speed drives alongside the machine. This allows the machine's speed to be adjusted as needed during peak and off-peak hours. The relevant data is presented in **Table Q2.1**.

Table Q2.1

Machine Operation Condition	Without VSD (Year 1)	With VSD (Year 2)	
Capacity of the machine (kW)	16	i.	15
		ii.	9
Hours of usage/day	24	i.	14 (peak)
		ii.	10 (off-peak)

Assume maximum demand, MD for both Year = 504 kW

i.   Determine bill charges of the commercial building for Year 1 and Year 2 of operation.

(4 marks)

ii.   Which year gives the lowest annual bill charges and justify your answers.

(2 marks)

iii. Calculate bill charges for Year 2 using tariff C1.

(2 marks)

iv. Compare Year 2 bill charges in **Q2(b)(i)** and **Q2(b)(iii)** and discuss why the bill charges are different, and which tariff rate gives more saving to the owner?

(2 marks)

The tariff table is given in **Table Q2.2.**

Table Q2.2

TARIFF C1 – MEDIUM VOLTAGE GENERAL COMMERCIAL TARIFF	
For each kilowatt of maximum demand per month	30.3 RM/kW
For all kWh	36.5 sen/kWh
The minimum monthly charge is RM600.00	
TARIFF C2 – MEDIUM VOLTAGE PEAK/OFF-PEAK COMMERCIAL TARIFF	
For each kilowatt of maximum demand per month during the peak period	45.1 RM/kW
For all kWh during the peak period	36.5 sen/kWh
For all kWh during the off-peak period	22.4 sen/kWh
The minimum monthly charge is RM600.00	

(c) ElectraTech Industries LLC having the following data for its monthly electricity bill:

Monthly maximum demand = 300 kW
Total electricity consumption in kWh = 200, 000 units
Total reactive power consumption in kVArh = 150,000 units
For each kilowatt of maximum demand per month= RM 22.50/ kW
For all kWh = 30 cents/ kWh

Table Q2.3 specifies the power factor penalty rate used to calculate the electrical bill on this premise.

Table Q2.3

Power Factor Penalty Rate	
Below 0.85 and up to 0.75 lagging	1.5% of the bill for that month
Below 0.75 lagging	A supplementary charge of 3% of the bill for that month

i. Examine the total monthly bill charge for this premise.

(3 marks)

ii. Estimate the total monthly bill charge if the reactive power consumption is increased to 185,000 units.

(3 marks)

iii.   Predict the maximum permissible total reactive power consumption in kVA required to avoid incurring penalty charges on the bill.

(2 marks)

Q3   (a)   Innovate Solutions Group Sdn. Bhd. has an empty department in one of its factories that could be used to expand the production of current products or produce new products. Four proposals from different companies (Company 1, Company 2, Company 3 and Company 4) have been submitted in relation to this department. Each proposal would fully use the empty department but only one of the proposals can be accepted. **Table Q3.1** shows the information obtained from the proposals. The cash flows for year 5 include, where applicable, the sale of the fixed assets purchased (year 0) at residual value. The company's cost of capital is 10%.

Table Q3.1

Cash flows	Proposal			
	Company 1 (RM)	Company 2 (RM)	Company 3 (RM)	Company 4 (RM)
Year 0	120,000	-95,000	-80,000	-160,000
Year 1	80,000	10,000	30,000	30,000
Year 2	60,000	40,000	40,000	50,000
Year 3	40,000	40,000	30,000	90,000
Year 4	20,000	60,000	30,000	80,000
Year 5	-40,000	50,000	20,000	60,000

i.   Calculate payback period and the net present value (NPV) for each project.

(12 marks)

ii.   Based on the answer obtained in **Q3(a)(i)**, identify which project should be selected by the company and the reason why.

(2 marks)

(b)   Discuss **THREE (3)** advantages and disadvantages of Net Present Value (NPV) to evaluate the financial attractiveness of an energy efficiency project.

(6 marks)

(c)   Define the IRR of a project and indicate its limitations and advantages.

(5 marks)

Q4   (a)   The management of the company informed you that they have received notification from the Energy Commission to comply with the "Efficient Management of Electrical Energy Regulations (EMEER) 2008". Advise them on the steps to be taken in order to avoid penalty from the authority.

(6 marks)

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(b) Provide specific examples of energy conservation measures (ECMs) categorized as no/low-cost, medium-cost, and high-cost.

(6 marks)

(c) Discuss Building Energy Index (BEI) and outline **THREE (3)** effectiveness of conducting an energy audit (EA) that impacts the building BEI.

(7 marks)

(d) Analyze the data presented in **Table Q4.1**, which shows the electricity usage of a single floor in the Hospital Segamat building with a gross floor area of 75 m x 100 m over two consecutive years. Demonstrate and support the argument that the Building Energy Intensity (BEI) in 2023 exhibits an improvement compared to the preceding year.

Table Q4.1

Year 2022						
Month	Jan	Feb	Mac	April	May	June
Energy Usage (kWh)	1800342	1573611	1994828	1855462	1646968	1561344
Month	Jul	Aug	Sept	Oct	Nov	Dec
Energy Usage (kWh)	1974983	1964267	1560454	2115004	1656001	1675611

Year 2023						
Month	Jan	Feb	Mac	April	May	June
Energy Usage (kWh)	1757133	1680617	2187953	2071238	1829331	1831845
Month	Jul	Aug	Sept	Oct	Nov	Dec
Energy Usage (kWh)	2123014	1876535	2410113	2761560	2448260	2500000

(6 marks)

- END OF QUESTIONS -

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