Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2021/2022

COURSE NAME	:	ENERGY MANAGEMENT IN BUILDING
COURSE CODE	:	MDL 10703
PROGRAMME CODE	:	MDL
EXAMINATION DATE	:	JANUARY/ FEBRUARY 2022
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **FOUR (4)** QUESTIONS **ONLY** 2. THIS FINAL EXAMINATION IS AN **ONLINE** ASSESSMENT AND CONDUCTED VIA **OPEN BOOK**

THIS QUESTION PAPER CONSISTS OF **TEN (10)** PAGES

Q1 **(a)** The energy requirements of a building are largely dependent on the needs of the building occupants and the activities conducted in the building. The provision of comfort for the occupants is the primary function of the building. Classify and elaborate the main **THREE (3)** aspects of comfort in a building.

(6 marks)

(b) Zero-energy building (ZEB) is a new next-generation design concept that combines the ideas of traditional green building and renewable energy generation. Distinguish the difference between these ZEB technologies with related examples:

(i) Passive building energy saving technologies; and

(ii) Energy-efficient building service systems.

(7 marks)

(c) Select **FOUR (4)** significant passive design strategies with suitable elaboration to be implemented in Malaysia building for sustainable building design.

(12 marks)

Q2 **(a)** Overall Thermal Transfer Value (OTTV) is a sum of heat conduction through walls, windows and solar heat gain through windows. Choose related approaches that can be carried out to reduce OTTV.

(5 marks)

(b) **Figure Q2 (b)** shows a light (below 50 kg/m^2) weight roof composition with the thickness and thermal conductivity values, as shown in **Table Q2 (b)**. Given that the thermal resistance for external surface and internal surface are 0.040 m^2. K/W and 0.130 m^2. K/W respectively.

(i) Calculate the roof U-value in W/m^2. K unit, and evaluate the compliance of the calculated roof U-value with MS 1525 standard; and

(3.5 marks)

(ii) Elaborate on suitable suggestions to be implemented on the existing building in order to comply with the roof U-value according to MS 1525 standard.

(4.5 marks)

(c) Differentiate the following process with adequate elaboration:

(i) Capacitor; and

(6 marks)

(ii) Transformer

(6 marks)

Q3 **(a)** In an air-handling unit, re-circulated air from an industrial building at 30 °C dry-bulb temperature, 50% relative humidity and 5 kg/s flow rate is first mixed with outdoor air at 15 °C dry-bulb temperature and 70% relative humidity at a mass ratio of 3:2.

(i) Calculate the mass mixing ratio required for adjusting the relative humidity to 60%. Determine the corresponding dry-bulb temperature of the mixture;
(ii) If the conditions of the return air to the building are then adjusted to 20 °C and 30% relative humidity, indicate on the psychrometric chart provided in **Figure Q3 (a)** what further processing of the air need to be undertaken; and
(iii) Calculate the rates of heat transfer required for these processes.

(20 marks)

(b) Chiller plant efficiency is measured using Coefficient of Performance (COP), ratio of cooling effect to energy input. If the COP of chiller system in Q3 (a) is 3.5 and building operates 8 hours/day, 20 days/month, calculate the monthly electricity cost. Given Electricity Tariff (D), RM 0.38/kWh. Propose an initiative to save the cost.

(5 marks)

Q4 **(a)** **Table Q4 (a)** indicates the level of proficiency of key staff of the organization. Select and justify the appropriate person to be in Energy Management Committee as Chairperson, Secretary, **TWO (2)** Technical Staffs and **TWO (2)** Administrative Staffs. Sketch the organizational structure.

(8 marks)

(b) In 2019, Pertiwi Steel Sdn Bhd produces 375 kton of steel with total energy consumption of 77, 446 MWh. **Table Q4 (b)** presents a set of production data and energy consumption of the company.

(i) Plot a scatter diagram- Energy Consumption versus Production using a graph sheet in **Figure Q4 (b, i)**. Estimate how much energy been consumed when no production; and
(ii) Demonstrate variation of Energy Efficiency Index (EEI) over a period of one year in a graph sheet provided in **Figure Q4 (b, ii)**. Discuss the nature of energy consumption to indicate the best performance and lower performance.

(17 marks)

Q5 **(a)** Elaborate the principles of following technologies to save energy and cost in buildings:

(i) Solar photovoltaic; and
(ii) Rain water harvesting.

(8 marks)

(b) Conduct a life-cycle cost analysis to decide which AC electric motors, between Motor A and B, should be selected for 20 years of usage. Motor A is a premium rated, whereas Motor B is an inexpensive standard choice. Given economic data and operating efficiencies of both motors in **Table Q5 (b)**.

(17 marks)

- END OF QUESTIONS -

FINAL EXAMINATION

SEMESTER/SESSION: SEMESTER I 2021/2022 PROGRAMME : MDL

COURSE NAME : ENERGY MANAGEMENT IN BUILDING COURSE CODE : MDL 10703

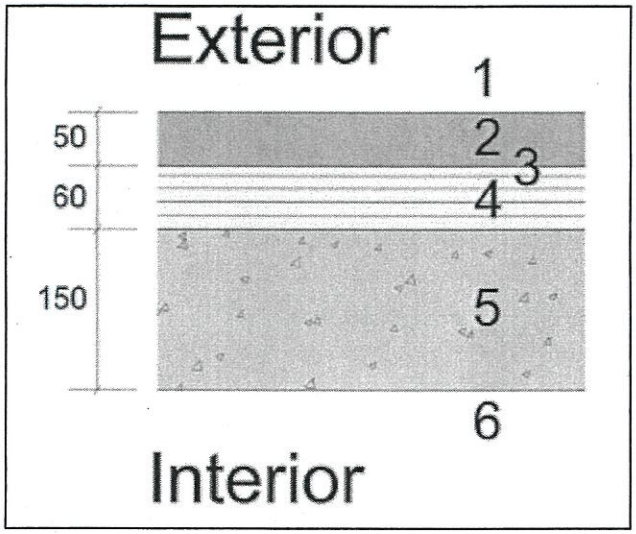

Figure Q2(b): Roof Composition

Table Q2(b): Roof Thickness and Thermal Conductivity Values

Item	Material	Thickness (mm)	Thermal Conductivity (W/m. K)
1	External surface	-	-
2	Cement Screed	50	0.45
3	Waterproof membrane	1	0.23
4	Expanded polystrene	70	0.05
5	RC Slab	150	2.35
6	Internal Surface	-	-

FINAL EXAMINATION

SEMESTER/SESSION: SEMESTER I 2021/2022 PROGRAMME : MDL

COURSE NAME : ENERGY MANAGEMENT IN BUILDING COURSE CODE : MDL 10703

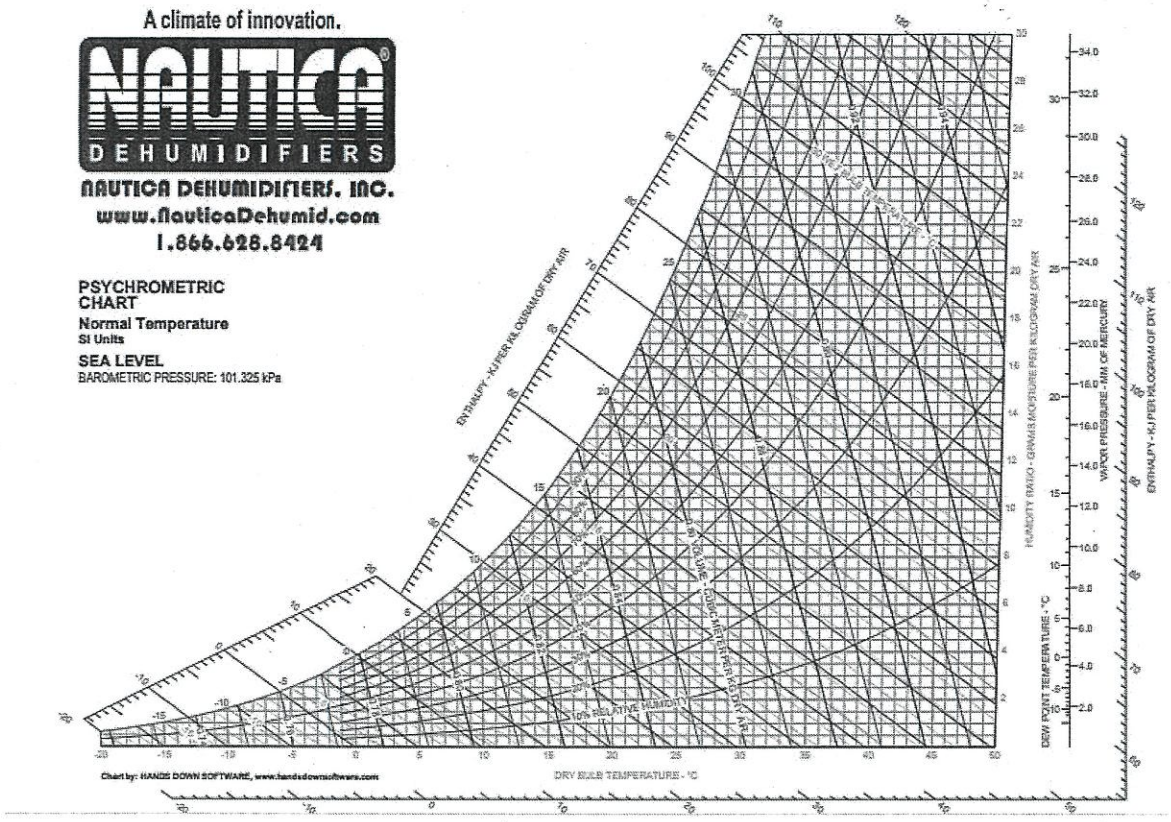

Figure Q3 (a): Psychrometric Chart

FINAL EXAMINATION

SEMESTER/SESSION: SEMESTER I 2021/2022 PROGRAMME : MDL

COURSE NAME : ENERGY MANAGEMENT IN BUILDING COURSE CODE : MDL 10703

Table Q4 (a): Level of Proficiency of Key Staff

	Authority	Management Skill	Technical Skill - Operation	Technical Skill - Utility	Finance Skill	Communication Skill
Board of director						
▪ Share holder	H	M	L	L	H	L
▪ Director	H	H	L	L	M	L
▪ President	H	H	L	L	M	L
Management team						
▪ Managing director	H	H	L	L	H	L
▪ General manager	H	H	M	L	M	H
▪ Division manager - production	L	H	H	M	L	M
▪ Division manager - facility	L	H	M	H	L	H
▪ Division manager - marketing	L	M	L	L	L	M
▪ Division manager – administration and finance	L	M	L	L	M	H
Operation staff						
▪ Production division – production line leader	L	M	M	M	L	L
▪ Production division – process engineer	L	L	M	M	L	M
▪ Facilities division – utility section head	L	M	M	M	L	L
▪ Facilities division – inventory section head	L	M	L	L	L	M
▪ Facilities division – utility engineer	L	L	M	M	L	M
▪ Marketing division – marketing officer	L	L	L	L	L	H
▪ Marketing division – sales representative	L	L	L	L	L	H
▪ HR division – public relation officer	L	L	L	L	L	H
▪ HR division – human resource officer	L	L	L	L	L	H
▪ Administrative and finance division - accountant	L	L	L	L	H	L
▪ Administrative and finance division – financial officer	L	L	L	L	H	M

**Note: Level of proficiency, H – High, M – Medium and L – Low*

FINAL EXAMINATION

SEMESTER/SESSION: SEMESTER I 2021/2022 PROGRAMME : MDL

COURSE NAME : ENERGY MANAGEMENT IN BUILDING COURSE CODE : MDL 10703

Table Q4 (b): Production and Energy Consumption Data

Month	Production (ton)	Energy Consumption (kWh)
Jan-19	29,000	6,230,000
Feb-19	30,000	6,330,000
Mar-19	29,000	6,400,000
Apr-19	33,000	6,800,000
May-19	31,000	6,430,000
Jun-19	32,000	6,340,000
Aug-19	29,000	6,400,000
Sep-19	33,000	6,343,000
Oct-19	30,000	6,213,000
Nov-19	32,000	6,560,000
Dec-19	33,000	6,450,000
Total	**375,000**	**77,446,000**

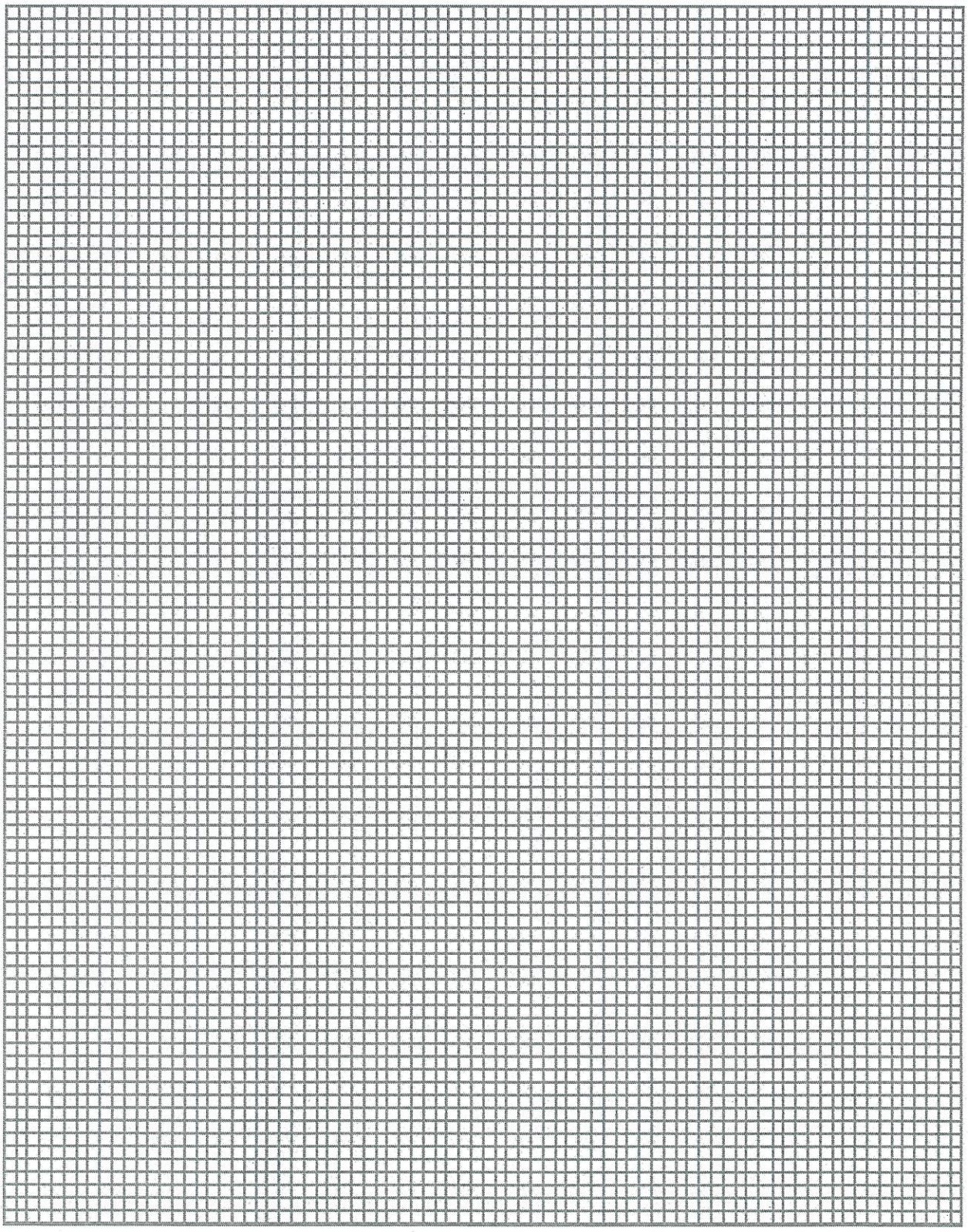

Figure Q4 (b)(i): Graph Sheet for Energy Consumption versus Production

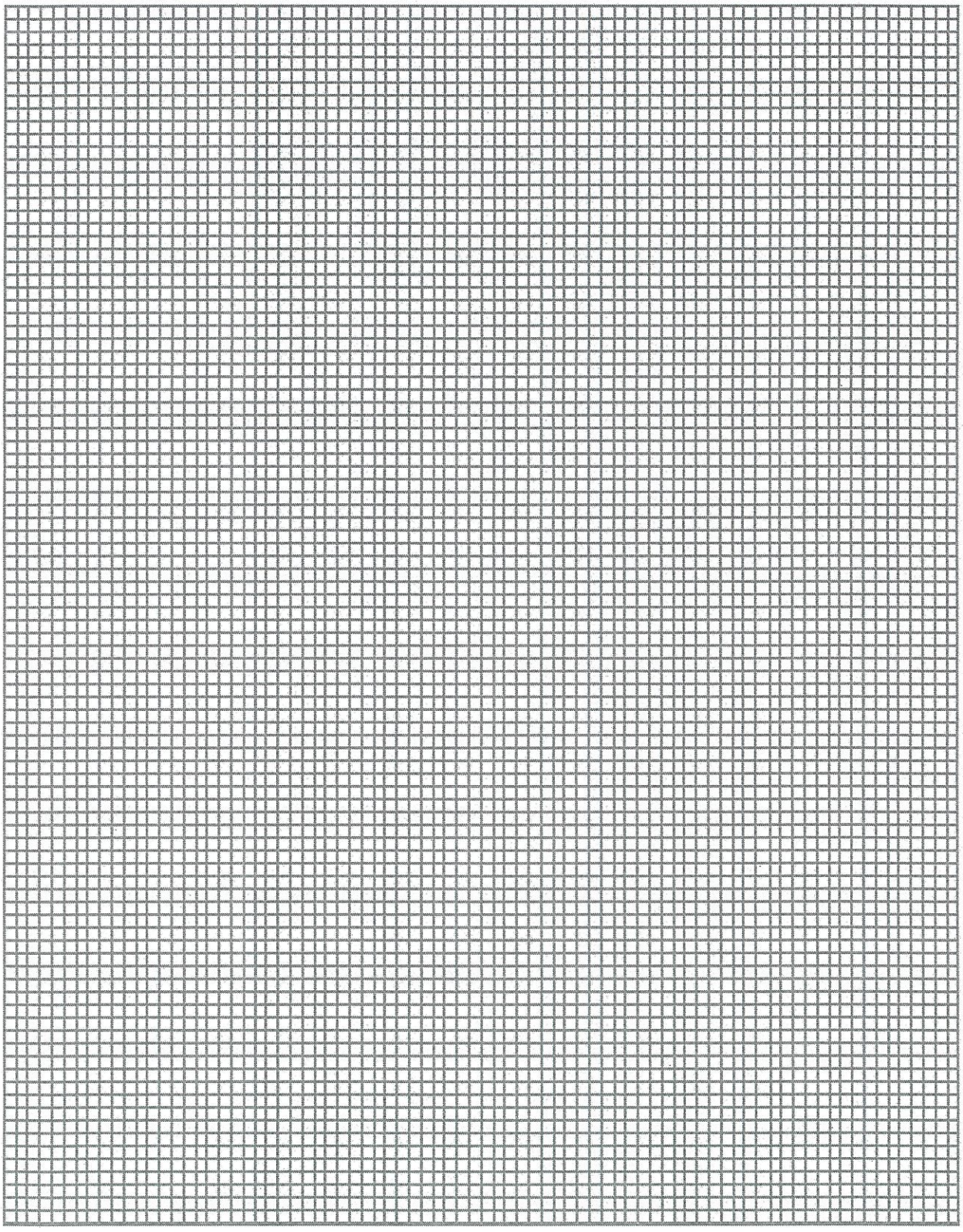

Figure Q4 (b)(ii): Graph Sheet for Variation of Energy Efficiency Index (EEI)

Table Q5 (b): Economic Data and Operating Efficiencies of Motors

Motor Properties	Motor A	Motor B
Output rating	7.5 kW (10 hp)	7.5 kW (10 hp)
Efficiency	85%	91.7%
Initial cost	$450.00	$993.00
Replacement life	8 years	20 years
Salvage value	$150.00	$330.00
Annual maintenance	$100.00	$100.00
Operating time	8 hours/day, 22 days/month	8 hours/day, 22 days/month
Electricity cost	$0.10/kWh	$0.10/kWh