Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2016/2017

COURSE NAME	:	ENERGY MANAGEMENT & CONSERVATION
COURSE CODE	:	BDE 40203
PROGRAMME	:	4 BDD
EXAMINATION DATE	:	DECEMBER 2016/JANUARY 2017
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE(5)** OF SIX (6) QUESTIONS

THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

Q1 (a) To promote the efficient utilisation of energy and reduce non-productive patterns of energy consumption, Tenaga Nasional Berhad has introduced a new electricity tariff known as Enhanced Time of Use (ETOU). This tariff is an extension to the present Time of Use (TOU) tariff, and designated as C2 tariff. Using illustration, differentiate between these two tariffs and discuss the advantages of newly introduced ETOU tariff.

(12 marks)

(b) Efficient Management of Electrical Energy Regulations 2008 (EEMER 2008) gives authority to Energy Commission (EC) to direct premises using a total of 3×10^6 kWh of electrical energy in a period of six consecutive months to appoint a registered electrical energy manager (REEM). Describe the roles of REEM under this regulation.

(8 marks)

Q2 (a) Commercial tariff includes charges for maximum demand in addition to charges on electricity usage. Briefly discuss:

(i) how maximum demand is determined; and
(ii) how consumer can minimize the maximum demand charges.

(8 marks)

(b) Electrical energy usage from 1st to 7th October 2016 for Kolej Kediaman Tun Fatimah (KKTF) is given in **Figure Q2 (b)**. Based on the information in **Figure Q2 (b)** and **Table Q2 (b)**, determine the electricity bill for KKTF from 1st to 7th October 2016 using:

(i) C1 tariff;
(ii) C2 tariff; and
(iii) which tariff gives advantage to KKTF residents

(12 marks)

Q3 (a) Describe what are the puposes of Malaysian Standard MS1525?

(6 marks)

(b) A plan view of trapezoid-shaped research building is shown in **Figure Q3 (b)**. The opaque walls of the building were made by various materials with properties as in **Table Q3 (b, i)** while the solar corerction factor is given in **Table Q3 (b, ii)**. The north and west facing walls have 2 units of 2 m x 1 m windows with a shading co-efficient of 0.4, while the other two walls have 3 units of the same window type but with shading co-efficient of 0.5. If the solar absorptivity, α of the opaque wall is 0.5 while the thermal transmittance value of all windows are 2.1 W/m^{2}K, determine:

(i) the building's Overall Thermal Transfer Value (OTTV); and
(ii) total wall heat load.

(14 marks)

Q4 (a) Architectural and passive design strategy has been proven to reduce overall energy consumption in buildings. Briefly discuss three (3) of passive design strategies.

(6 marks)

(b) **Figure Q4 (b)** shows E14 lecture room with 3 skylights on each section of the roof facing east and west. The roof is inclined 35° from horizontal plane. The opaque roof and skylight consist of several components shown in **Table Q4 (b, i)** and **Table Q4 (b, ii)**. The shading co-efficient (SC) of skylight is 0.4 while the equivalent temperature difference is 20 K. If the temperature inside the building is maintained at 24°C while the ambient temperature outside is 33°C, calculate:
(i) the Roof Thermal Transfer Value (RTTV); and
(ii) total roof heat load

(14 marks)

Q5 (a) As a maintenance engineer in a factory, you have been asked to evaluate an energy efficiency project involving replacement of 985 T12 bulbs and 40 T8 bulbs as tabulated in **Table Q5 (a)**. Taking the burnt out rate of the lights as 12% for T12 bulbs and 5% for T8 bulbs,

(i) determine the total energy cost for lighting using tariff B as in **Table Q2 (b)**;
(ii) compare the monthly electrical energy cost if all the bulbs were replaced with T5 bulbs with specification given in **Table Q5 (a)**; and
(iii) calculate the simple payback period of the project.

(12 marks)

(b) An electrical components manufacturing facility records monthly electrical energy consumption of 200,000kWh with reactive energy consumption of 250,00kVArh. The facility uses tariff C1 as in **Table Q2 (b)**. If TNB imposes a 1.5% surcharge of total bill for power factor between 0.85 to 0.75 and 3% surcharge for power factor below 0.75, calculate the total payable bill by the facility to TNB.

(8 marks)

Q6 (a) **Figure Q6 (a)** shows a typical daily electrical energy consumption in KAFF Synergy Sdn. Bhd. Based on the load profile, calculate the load factor and propose methods to improve the load factor.

(8 marks)

(b) Upon energy audit, an office building in Johor Bahru was found to have excessive amount ventilation air provided. This results result in higher amount of energy consumption in the air-conditioning system. Based on the audit data provided in **Table Q6 (b)**, evaluate the:
(i) amount of excess air provided for ventilation;
(ii) possible amount of electrical energy reduction; and
(iii) total saving (RM) in a year if the building operates 300 days/year and 8 hours/day if the amount of excess air avoided

(12 marks)

- END OF QUESTION –

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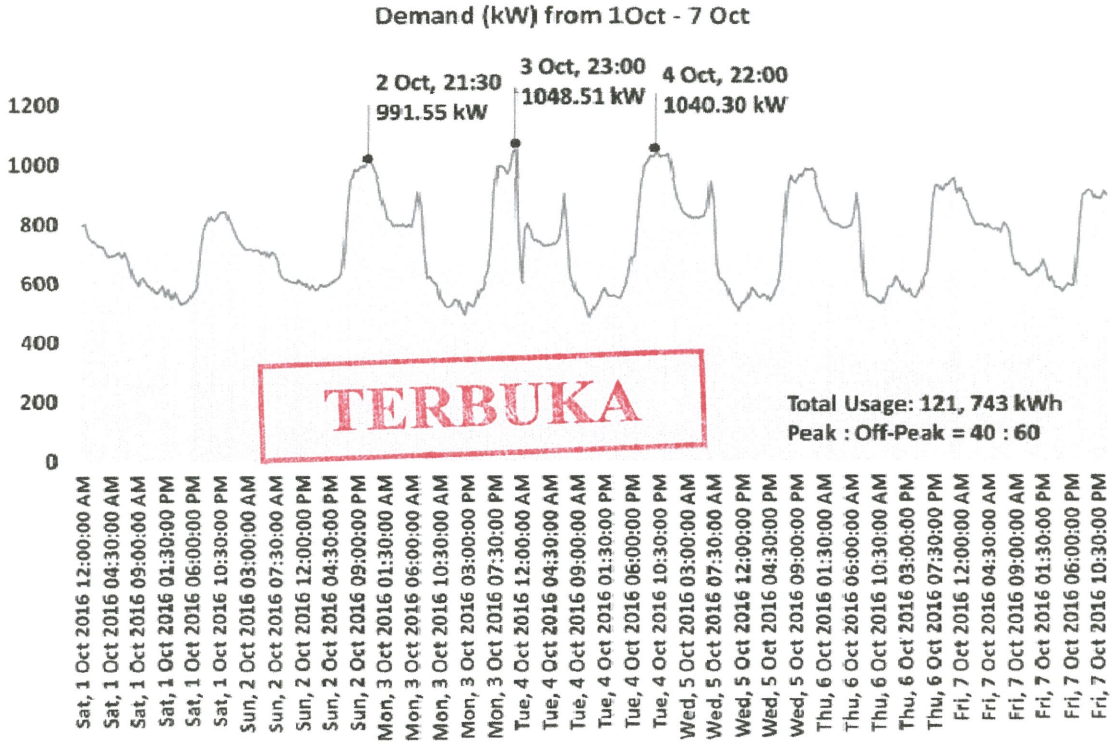

Figure Q2(b) Electrical energy usage for Kolej Kediaman Tun Fatimah

TARIFF CATEGORY	CURRENT RATES(1 JAN 2014)
TARIFF B - LOW VOLTAGE COMMERCIAL TARIFF	
For the first 200 kWh (1 -200 kWh) per month	43.5 sen/kWh
For the next kWh (201 kWh onwards) per month	50.9 sen/kWh
The minimum monthly charge is RM7.20	
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	

Table Q2 (b) Electricity Tariff

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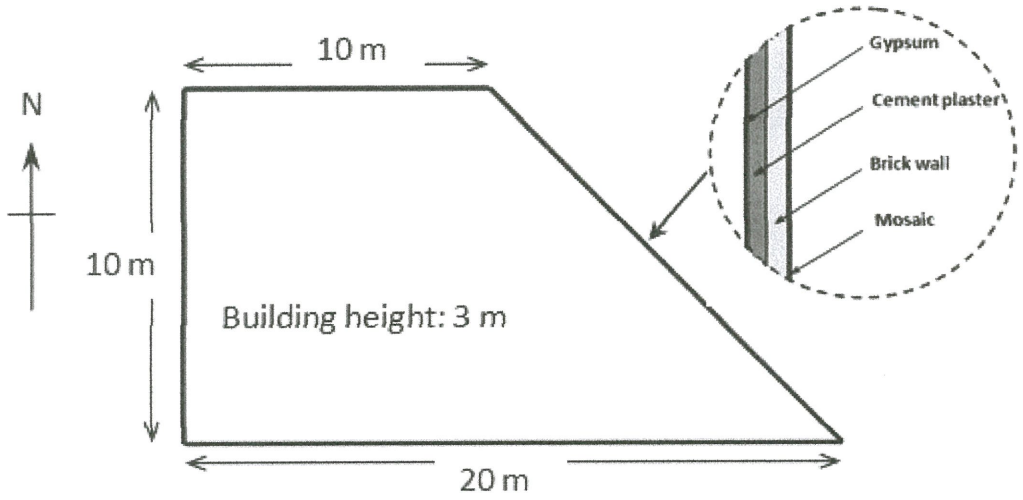

Figure Q3 (b) Building's plan view

Component	R (m^2K/W)
Outside air film	0.051
Gypsum	0.071
Cement Plaster	0.031
Brick wall	0.141
Mosaic	0.011
Inside air film	0.121

Table Q3(b, i) Wall properties

Orientation	N	NE	E	SE	S	SW	W	NW
CF	0.90	1.09	1.23	1.13	0.92	0.90	0.94	0.90

Table Q3(b, ii) Solar Correction Factor

Individual wall:

$$OTTV_i = 15\alpha(1 - WWR)U_w + 6(WWR)U_f + (194 \times CF \times WWR \times SC)$$

Overall:

$$OTTV = \frac{A_1 \times OTTV_1 + A_2 \times OTTV_2 + \ldots A_n \times OTTV_n}{A_1 + A_2 + \ldots A_n}$$

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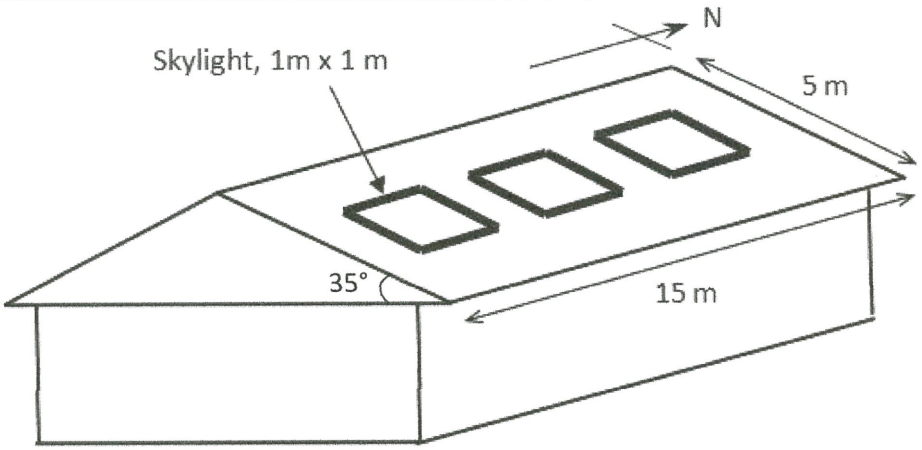

Figure Q4 (b) Roof configuration of E14 lecture room

Component	R (m^2K/W)
Outside air film	0.051
Cement plaster	0.031
RC Roof	0.171
Fibreglass	2.141
Gypsum board	0.071
Inside air film	0.141

Table Q4(b, i) Components of opaque roof

Component	R (m^2K/W)
Outside air film	0.051
Glass	0.008
Air space	0.175
Inside air film	0.162

Table Q4(b, ii) Components of skylight

Individual roof:

$$RTTV = \frac{(A_r \times U_r \times TD_{eq}) + (A_s \times U_s \times \Delta T) + (A_s \times SC \times SF)}{A_0}$$

Overall:

$$RTTV = \frac{A_1 \times RTTV_1 + A_2 \times RTTV_2 + \ldots A_n \times RTTV_n}{A_1 + A_2 + \ldots A_n}$$

$$SF = 323 \times CF$$

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Type	Quantity	Watt	Daily Usage (Hour)	Price Per Unit (RM)
T12	985	34	6.5	11
T8	40	32	6.0	16
T5	-	18	-	21

Table Q5 (a) Bulbs specification

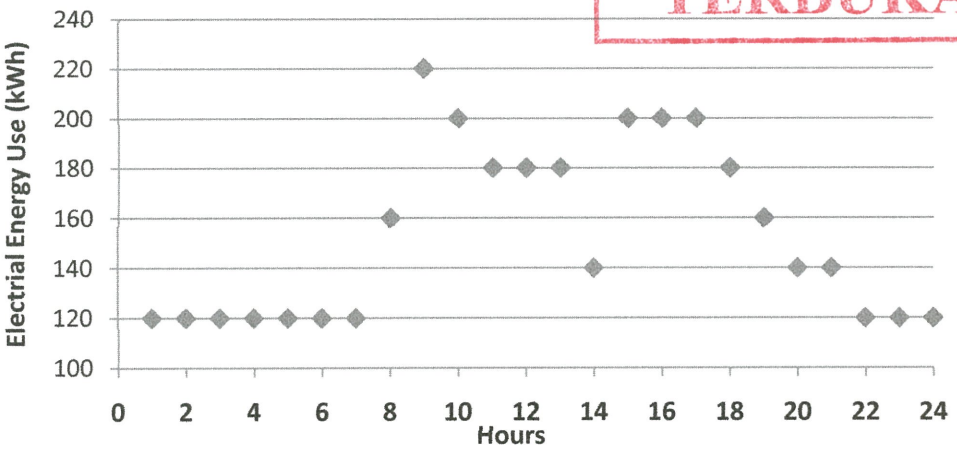

Figure Q6 (a) Load profile for a typical day in KAFF Synergy

Outside air temperature	:	35°C
Inside air temperature	:	25°C
Outside Relative Humidity	:	70%
Inside Relative Humidity	:	50%
Total occupancy	:	80 persons
Required ventilation/person	:	5 litres/person
Floor area	:	525 m^2
Ventilation duct size	:	0.25 m^2
Ventilation air velocity	:	2.5 m/s
COP of air-cond. system	:	3.5
Electricity tariff (C1)	:	RM 0.365/kWh

Table Q6 (b) Energy audit data from office building

$SH = 1.21 \times \dot{Q} \times \Delta T$

$LH = 3 \times \dot{Q} \times \Delta T$