Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2015/2016

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

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) 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)

(b) One of the important components of energy management is to conduct energy audit to evaluate energy consumption in a premise. Briefly discuss the three (3) levels of energy audit commonly practiced in the industry.

(12 marks)

Q2 (a) Calculate the thermal efficiency of a medium-sized boiler, given the operating parameters as following:

- steam output 97,200 kg/h at 40 bar, with $h_g = 2800$ kJ/kg;
- feed water temperature at 91.76°C, with $h_f = 384.44$ kJ/kg;
- fuel consumption of 2.67 m^3/s (natural gas with calorific value 36,000 $kJ/m^{3)}$

(8 marks)

(b) Water at 20°C ($\rho = 999.1$ kg/m^3 and $\mu = 1.002 \times 10^{-3}$ kg/m · s) is flowing steadily in a 30-m-long and 0.5-cm-diameter horizontal steel pipe at a rate of 0.1 L/s. Assuming laminar flow, determine the pumping power required to overcome the pressure drop.

(12 marks)

Q3 (a) A small factory operating in two shifts of 8 hours each uses 600 kW per hour for the morning shift, and 400 kW per hour for the night shift. Determine the load factor for this operation.

(4 marks)

(b) Consider the following data: power = 100 kW, current = 500 A, voltage = 240 V. Calculate the power factor if the voltage type is:
(i) Single phase;
(ii) Three phase

(4 marks)

(c) A daily electrical energy usage in an office building is given in **Table Q3 (c)**. Based on the table, determine:
(i) the total electricity usage in a month (kWh);
(ii) monthly electricity bill (RM) assuming the premise is subjected to a tariff of 36.5sen/kWh; and
(iii) Payback period if the office building owner decides to install an energy saving device costing RM 5,000.00 which can reduce the electricity consumption by 15% in a month

(12 marks)

Q4 (a) Describe the puposes of Malaysian Standard MS1525?

(6 marks)

(b) A cubical building (10 m x 10 m x 10 m) with glass window on every side of the wall is shown **FigureQ4 (b)**. The opaque wall is made by various materials with properties as in **Table Q4(b, i)**and **Table Q4(b, ii)**. If the solar absorptivity, α of the opaque wall is 0.5 while the shading co-efficient (SC) of the glass window is 0.4, determine:
(i) the building's Overall Thermal Transfer Value (OTTV); and
(ii) total wall heat load.

(14 marks)

Q5 (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 Q5 (b)** shows a flat office building roof sketch with 3 skylights. The opaque roof and skylight consist of several components shown in **Table Q5 (b, i)** and **Table Q5 (b, ii)**. The shading co-efficient (SC) of skylight is 0.5 while the equivalent temperature difference is 16°K. Calculate:

(i) the Roof Thermal Transfer Value (RTTV); and

(ii) total roof heat load

(14 marks)

Q6 (a) MS1525 specifies the need for controlling lighting and air conditioning in non-residential buildings. Why is it necessary to have controls?

(6 marks)

(b) An hotel with a capacity to accommodate 100 peoples has the following data which was obtained from recent energy audit. If the average occupancy rate is 70%, calculate:

(i) the amount of excess air provided for ventilation;

(ii) the possible amount of electrical energy reduction; and

(iii) the total saving (RM) in a year if the building operates 300 days/year and 8 hours/day

Energy audit data of the building:

- Outside/Inside air temperature = 35°C / 25°C
- Outside/Inside Relative Humidity = 70% / 50%
- Required ventilation/person = 5 litres/s
- Floor area = 500 m^2
- Ventilation duct area = 0.12 m^2
- Incoming air velocity = 2.40 m/s
- COP of the air cond. system = 3.5
- Electricity tariff = RM 0.365/kWh

(14 marks)

-End of Questions-

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Item	Appliance / Equipment	Power rating (Watt)	Usage duration (hour)	Quantity	Days used every month
1	Refrigerator	2,500	22	1	30
2	Air Conditioning	1,500	8	2	24
3	CFL	10	8	32	24
4	Air compressor	20,000	3	1	4
5	Dehumidifier	3,000	4	1	4
6	Industrial Heater	5,000	8	1	4
7	Ceiling Fan	180	8	12	24

Table Q3(c) Electricity usage in the office building

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Individual wall:

$$OTTV = 19.1 \times \alpha \times (1 - WWR) \times U_w + (194 \times CF \times WWR \times SC)$$

Overall:

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

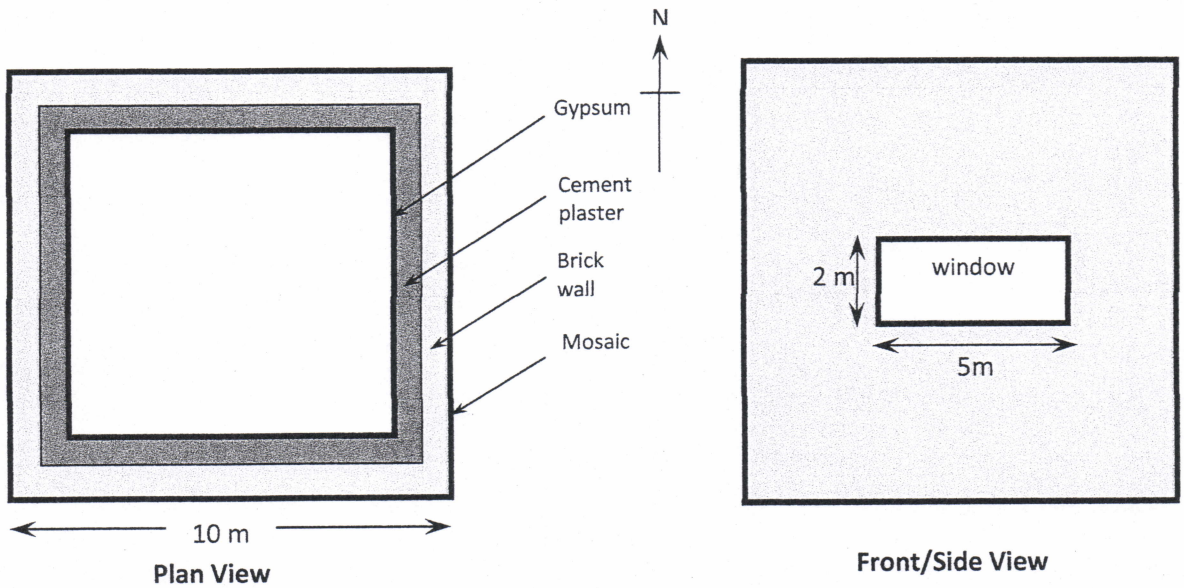

Figure Q4 (b) Building's plan view and side view

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 Q4(b, i) Wall properties

Orientation	N	NE	E	SE	S	SW	W	NW
CF	0.83	1.01	1.15	1.02	0.85	1.02	1.14	0.99

Table Q4(b, ii) Solar Correction Factor

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

$$SF = 323 \times CF$$

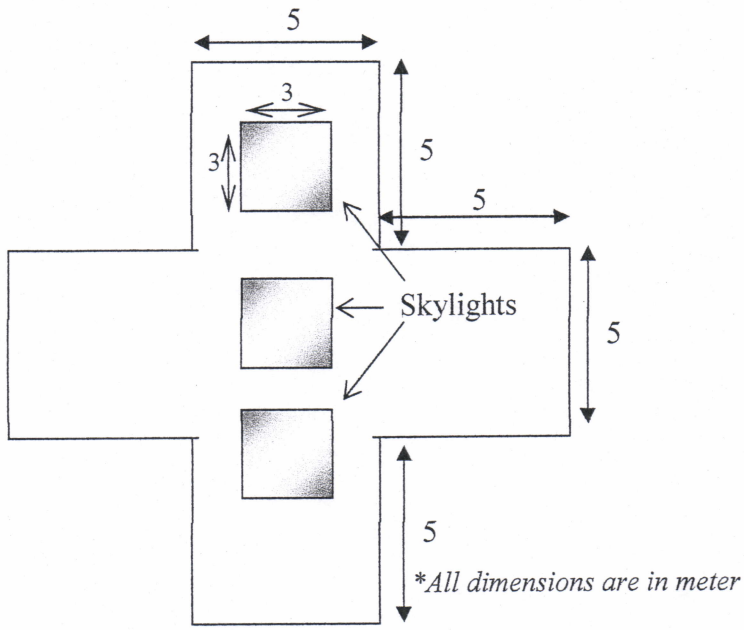

Figure Q5 (b) Flat RC roof of an office building

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 Q5(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 Q5(b, ii) Components of skylight

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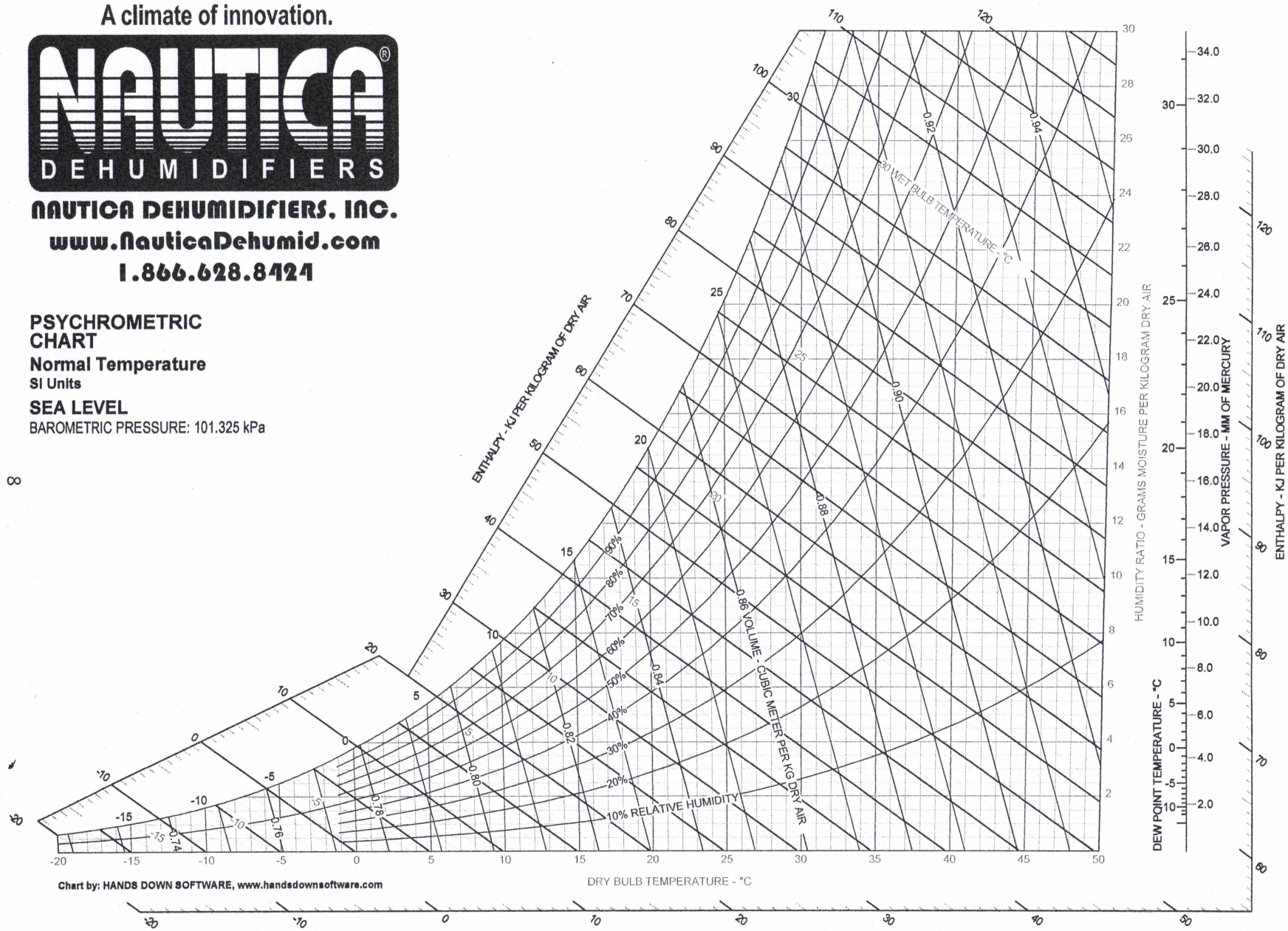

Chart by: HANDS DOWN SOFTWARE, www.handsdownsoftware.com