UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2010/2011

COURSE	:	UTILISATION OF ELECTRICAL ENERGY
COURSE CODE	:	BEE 4213
PROGRAMME	:	4 BEE
EXAMINATION DATE	:	APRIL/MAY 2011
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER ALL QUESTIONS

THIS EXAMINATION SHEET CONSISTS OF 12 PAGES

Q1 (a) The current ratings of circuit breakers are normally specified into two values Describe in brief the definition of these values.

(4 marks)

(b) A medium voltage industrial consumer having the following data for its monthly electricity bill:

Total electricity consumption in kWh - 183, 672 units
The reactive power consumption in kVArh - 244, 896 units
The monthly load factor - 71%
Electricity usage during 10 pm to 8 am every day

The tariff rate (Tariff E2 – TNB) is shown in Table Q1(b). Analyse the followings by considering 30 days per month and 4 weeks per month.

(i) The monthly maximum demand for this consumer (assuming 30 days/month).

(5 marks)

(ii) The average power factor for this consumer and calculate the total penalty charge due to the poor power factor if any.

(8 marks)

(iii) The total monthly bill charge for this consumer.

(3 marks)

(c) At the end of a power distribution system, a certain feeder supplies three distribution transformers as shown in Table Q1(c), each one supplying a group of customers whose connected loads. If the diversity factor among the transformers is 1.3, analyses the maximum load on the feeder.

(5 marks)

Q2 (a) Impedance is a vital factor in voltage drop and short circuit analysis. Define the application of impedance in both type of analysis with its related equation. State two major variables that will give direct effect to impedance.

(4 marks)

(b) A simplified one-line-diagram of a commercial installation is depicted in Figure Q2(b), consisting of a 3-phase motor circuit and two 1-phase load circuits. The details for each component is given in Table Q2(b). Analyse the voltage level received at Load 1 and Load 2 terminals by considering the voltage drop effect. Assume balance 3-phase load at MDP.

(13 marks)

(c) Compare the symmetrical and asymmetrical short circuit currents for a 3-phase fault occurring at *F1* as shown in Figure Q2(b). The asymmetrical short circuit current is referring to the instantaneous peak and half-cycle rms short circuit currents. Ignore all voltage drop effect.

(8 marks)

Q3 (a) Voltage flicker is one of the common power quality problems in electrical system. Give an example solution to this power quality event.

(4 marks)

(b) Figure Q3(b) shows the utilisation of a group of induction motor drives in a factory.

(i) Determine the average power factor due to the utilisation of the motors.

(ii) Propose a proper power factor correction (PFC) scheme to improve the average power factor to 0.95 lagging. The PFC must be delta-connected. Assume 525 V capacitor will be used in the PFC design due to the presence of harmonics in the 50-Hz system.

(iii) Analyse the percentage of power loss reduction and the percentage of the system voltage rise due to the installation of PFC in Q3(b)(ii).

(14 marks)

(c) Figure Q3(c) illustrates a 3-phase 11 kV distribution network and a new installed additional 3-phase load. Evaluate the percentage of voltage sag magnitude in the line owing to the sudden switch-in of the additional load.

(7 marks)

Q4 (a) In general, any cable put into service required two kinds of protection. List the protection and briefly describe how the protection is achieved in a 3-phase, 415 V system as mentioned.

(2 marks)

(b) A single phase circuit is protected by a 60A fuse having a fusing factor of 1.5. A fault occurs in an appliance causes a current of 75 amperes to flow through the earth continuity path. As a result of poor contact due to a lock nut and bush connecting a steel conduit to a metal box, the resistance of this conduit connection alone is 0.75 Ω. Regulation D22 regarding the basic earthing requirements is given in Table Q4(b).

(i) State whether the fuse will rupture

(ii) Determine the amount of heat produced at the metal box

(iii) Rate the degree of risk, if any, of a fire developing

(4 marks)

(c) An incandescent-filament lamp suspended 2.5m above a work bench is fitted with a reflector to give a polar curve which has the shape of a circle with a circumference passing through the centre of the light source and giving a luminous flux of 500 lumens vertically below the lamp. Determine

(i) the illumination on the bench vertically below the lamp.

(ii) the position along the bench where the illumination will be half the value found in Q4(c)(i)

(9 marks)

(d) An industrial plant having a production area of 48m by 22m is to be illuminated to a level of 200 Lux.

(i) If 1 x 36 W fluorescent lamp with efficacy of 75 Lumens/Watt is to be used as lighting load, estimate the number of fluorescent lamps required. Assume the utilisation factor is 0.55 and the maintenance factor is 0.8.

(ii) Calculate the energy savings and payback period if all the fluorescent lamps in Q4(d)(i) are to be replaced by 1 x 12 W compact fluorescent lamps (CFLs) with efficacy of 228 Lumens/Watt. Assume lighting is required for 4000 hours/year and the cost of electricity is RM 0.218 per kWh. Replacement cost is RM 15.50 per unit CFL.

(10 marks)

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TABLE Q1(b)

(a) Tariff E2 (Medium Voltage Peak/ Off Peak Industrial Tariff)	**Unit**	**Rates**
For each kilowatt of maximum demand per month	RM/kW	29.30
For all kWh during peak hour	Sen/kWh	28.1
For all kWh during off peak hour	Sen/kWh	17.3
The minimum monthly charge is RM600.00		
(b) Power Factor Penalty Rate		
Below 0.85 and up to 0.75 lagging	1.5% of the bill for that month for each one-hundredth (0.01).	
Below 0.75 lagging, in addition to the charge payable under sub-paragraph (a) above,	A supplementary charge of 3% of the bill for that month for each one-hundredth (0.01).	

TABLE Q1(c)

No.	**Transformer**	**Load**	**Demand Factor**	**Diversity of groups**
1.	Transformer No.1	10kW	0.65	1.5
2.	Transformer No.2	12kW	0.60	3.5
3.	Transformer No.3	15kW	0.70	1.5

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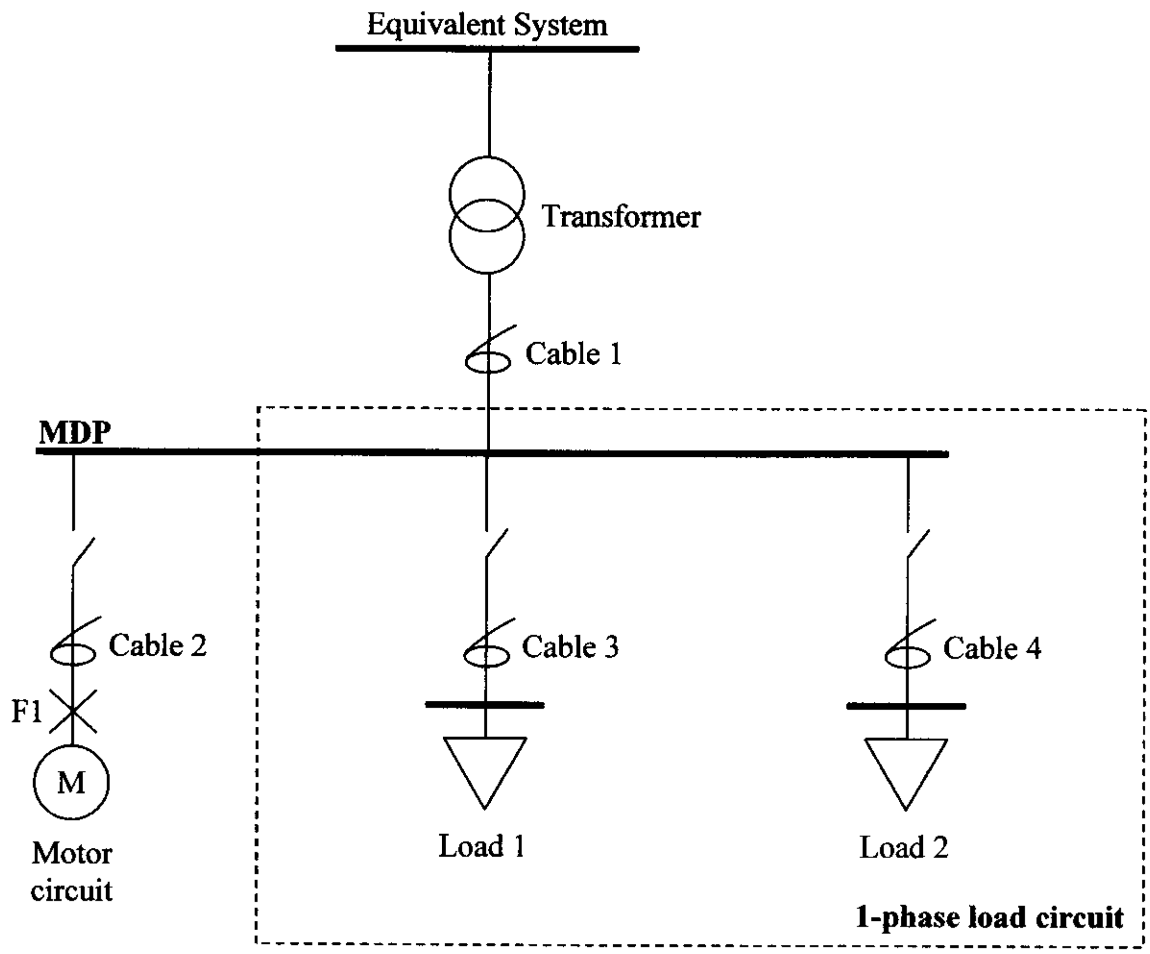

FIGURE Q2(b)

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TABLE Q2(b)

No.	Component	Details
1.	Equivalent system	3-phase MVA = 120 MVA@11 kV, R = 0.3 Ω.
2.	Cable 1	90ft, #4/0 AWG, aluminium conductor, steel conduit.
3.	Transformer	100 kVA, 11kV – 415 V, %Z = 5%, X/R = 3.
4.	Cable 2	30ft, #1/0 AWG, copper conductor, steel conduit.
5.	Cable 3	8 meters, 4 mm^2, enclosed in conduit on a wall.
6.	Motor circuit	Motor: Y-connected, 50 HP@ 415 V, PF = 0.82 lagging.
7.	Cable 4	15 meters, 10 mm^2, enclosed in trunking.
8.	Load 1	5 kVA@ 240 V, PF = 0.8 lagging.
9.	Load 2	8 kW@ 240 V, PF = 0.9 lagging.

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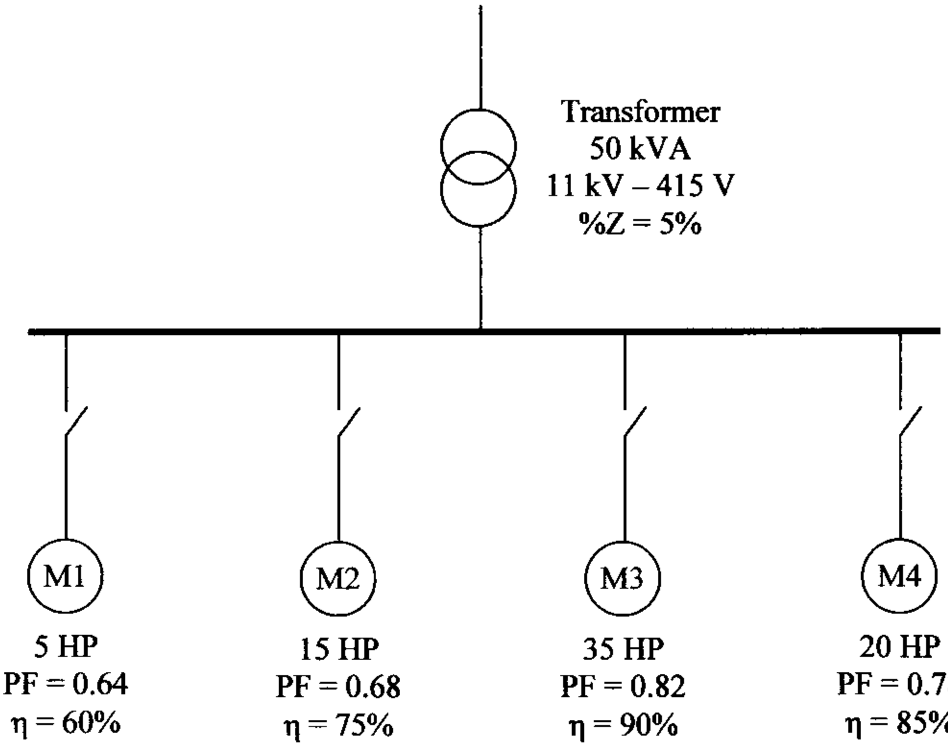

FIGURE Q3(b)

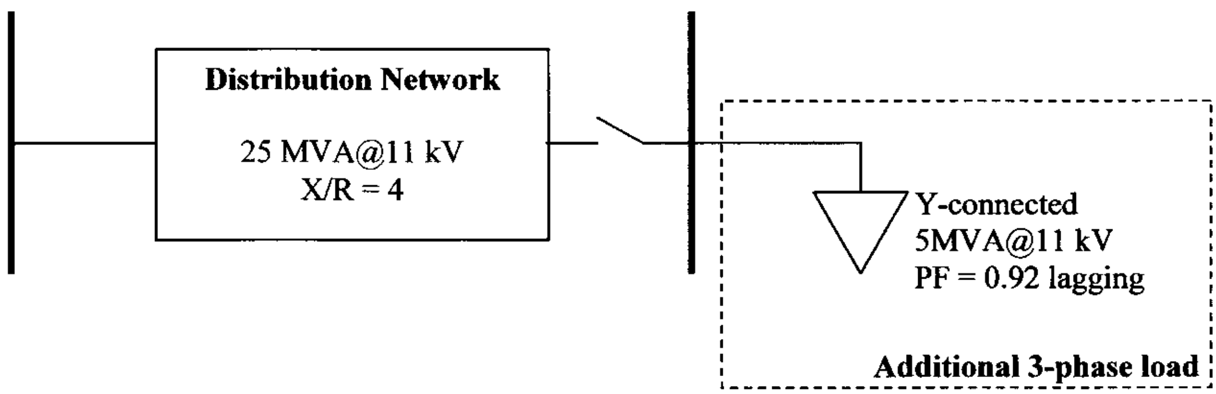

FIGURE Q3(c)

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APPENDIX C

Table of Asymmetrical Current Factors

System X/R Ratio	Instantaneous Peak Factor	Half-Cycle Factor	Time of Peak tp (ms)
0.0	1.4142	1.000	4.2
0.1	1.4142	1.000	4.4
0.2	1.4142	1.000	4.7
0.3	1.4149	1.000	4.9
0.4	1.4181	1.000	5.2
0.5	1.4250	1.000	5.4
0.6	1.4362	1.000	5.5
0.7	1.4511	1.000	5.7
0.8	1.4692	1.001	5.8
0.9	1.4897	1.002	5.9
1.0	1.5122	1.002	6.1
2.0	1.7560	1.042	6.8
3.0	1.9495	1.115	7.1
4.0	2.0892	1.191	7.4
5.0	2.1924	1.263	7.5
6.0	2.2708	1.304	7.6
7.0	2.3323	1.347	7.7
8.0	2.3817	1.381	7.8
9.0	2.4222	1.412	7.8
10.0	2.4561	1.438	7.9
20.0	2.6256	1.570	8.1
30.0	2.6890	1.618	8.2
40.0	2.7224	1.643	8.2
50.0	2.7427	1.662	8.2
100.0	2.7848	1.697	8.3
infinity	2.8284	1.732	8.3