Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2017/2018

COURSE NAME	:	UTILISATION OF ELECTRICAL ENERGY
COURSE CODE	:	BEF 33203
PROGRAMME CODE	:	BEV
EXAMINATION DATE	:	JUNE/JULY 2018
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

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

Q1 (a) Electrical power is delivered to the users through several distribution levels. Draw and label the block diagram that represents **four (4)** distribution levels with standard voltage rating.

(4 marks)

(b) **Table Q1(b)(i)** provides the consumption data in April 2018 for medium voltage industrial consumer. The electricity bill for this industry will be totaled based on these data. Its corresponding monthly load factor is 70%. The tariff rate imposed on the bill calculation is as shown in **Table Q1(b)(ii).** Analyze:

(i) The monthly maximum demand of this consumer.

(4 marks)

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

(10 marks)

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

(1 mark)

(c) A three phase circuit breaker is installed in a 415Y/240V panelboard to serve the following load as shown in **Table Q1(c)**.

(i) Calculate the total connected load and the total demand load.

(4 marks)

(ii) Evaluate the amperage demand for the panel board.

(2 marks)

Q2 (a) There are four types of current in electrical system which are normal, overload, short-circuit and ground-fault current. Compare **two (2)** different conditions between short-circuit current and ground-fault current.

(4 marks)

(b) **Figure Q2(b)** shows a three-phase industrial distribution system. A balanced three-phase fault had occurred at *F2*.Calculate:

(i) The root mean square (r.m.s) fault current.

(15 marks)

(ii) The root mean square (r.m.s) instantaneous asymmetrical short circuit magnitude.

(3 marks)

(iii) The root mean square (r.m.s) half-cycle asymmetrical short circuit magnitude.

(3 marks)

Q3 (a) Power quality is basically related to the quality of voltage, current and frequency of a power system. Describe in brief of this statement and give an appropriate example that related to these three electrical parameters.

(5 marks)

(b) A factory is facing poor power factor problem in its plant. The main electrical loads of this factory are tabulated in **Table Q3(b)**. The factory is installed with 50 Hz,
415 V and running 5 days/week basis. Assuming 30 days a month,

(i) Identify the total energy consumption per month in kWh + jkVAr.

(5 marks)

(ii) Analyse the average power factor per month.

(1 mark)

(iii) If the factory is decided to reduce the total power losses by 45%, analyse the desired corrected power factor.

(3 marks)

(iv) Investigate the total kVAr of capacitor bank that is to be injected into the power system in achieving the desired corrected power factor.

(2 marks)

(v) The closest available rating of capacitor bank in the market is 525 V, examine the value of capacitance in fulfilling the case at Q3(b)(iii) if the capacitors are to be connected in delta.

(3 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-on of the additional load.

(6 marks)

Q4 (a) (i) One of the method used in primary lightning protection is meshed cage or Faraday cage. Explain in brief the principle of any of these methods.

(2 marks)

(ii) In general, any cable put into service requires two kinds of protections. List the required 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 60 A fuse having a fusing factor of 1.5. A fault occurs in an appliance causes a current of 97 A flowing through the earth continuity path. Due to poor contact of lock nut and bush that connecting steel conduit to metal box, the resistance of this conduit connection alone is measured as 0.75 Ω.

(i) State whether the fuse will rupture by giving appropriate justification.
(2 marks)

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

(iii) Estimate the degree of risk rate, if any, of a fire is developing.
(1 mark)

(c) A squared exhibition hall with the width of 12 m is to be illuminated to a level of 350 Lux. The utilisation and the maintenance factors are to be taken as 0.60 and 0.80 respectively. Estimate the power required to illuminate the hall if:

(i) Using energy-saving T5 fluorescent lamp, having an efficacy of 65 lm/ W.
(3 marks)

(ii) Using LED lighting, having an efficacy of 90 lm/ W.
(3 marks)

(d) A car park is measuring as 60 m x 40 m. The illumination is to be provided by 2 X 36 W luminaires that having an efficacy of 60 lm/W and a spacing-height ratio of 1.2. The luminaires are suspended 3.5 m above the working surface. The utilisation factor is 0.75 and the light loss factor is 0.55.

(i) Recommend the number of luminaires required for this installation.
(8 marks)

(ii) Analyse the general level of illumination produced in Lux.
(3 marks)

– END OF QUESTIONS –

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Table Q1(b)(i)

Time (Hour)	Electricity Consumption per month (kWh)	Reactive Power Consumption per month (kVArh)
8.00am – 12.00pm	45,155	75,400
12.00pm – 4.00pm	48,650	60,800
4.00pm – 8.00pm	70,655	78,900
8.00pm – 10.00pm	48,780	55,600
10.00pm – 5.00am	27,540	40,600
5.00am- 8.00am	59,750	65,050

Table Q1(b)(ii)

Tariff E1 - Medium Voltage General Industrial Tariff	
For each kilowatt of maximum demand per month	29.60 RM/kW
For all kWh	33.70 sen/kWh
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	A supplementary charge of 3% of the bill for that month for each one-hundredth (0.01).

Table Q1(c)

No	Load	Connected Load		Demand Load	
		P (kW)	Q (kVAr)	P (kW)	Q (kVAr)
1	Air conditioning	6.16	j3.325	6.16	j3.325
2	Water heater	5.00	0	5.00	0
3	Lighting	11.4	j3.747	14.25	j4.684
4	Kitchen	2.70	j1.307	1.755	j0.85
5	Spare capacity	9.00	j4.359	9	j4.359
6	Motor	14.00	j14.283	10.5	j10.712
7	Capacitance load	0	-j5.00	0	-j5

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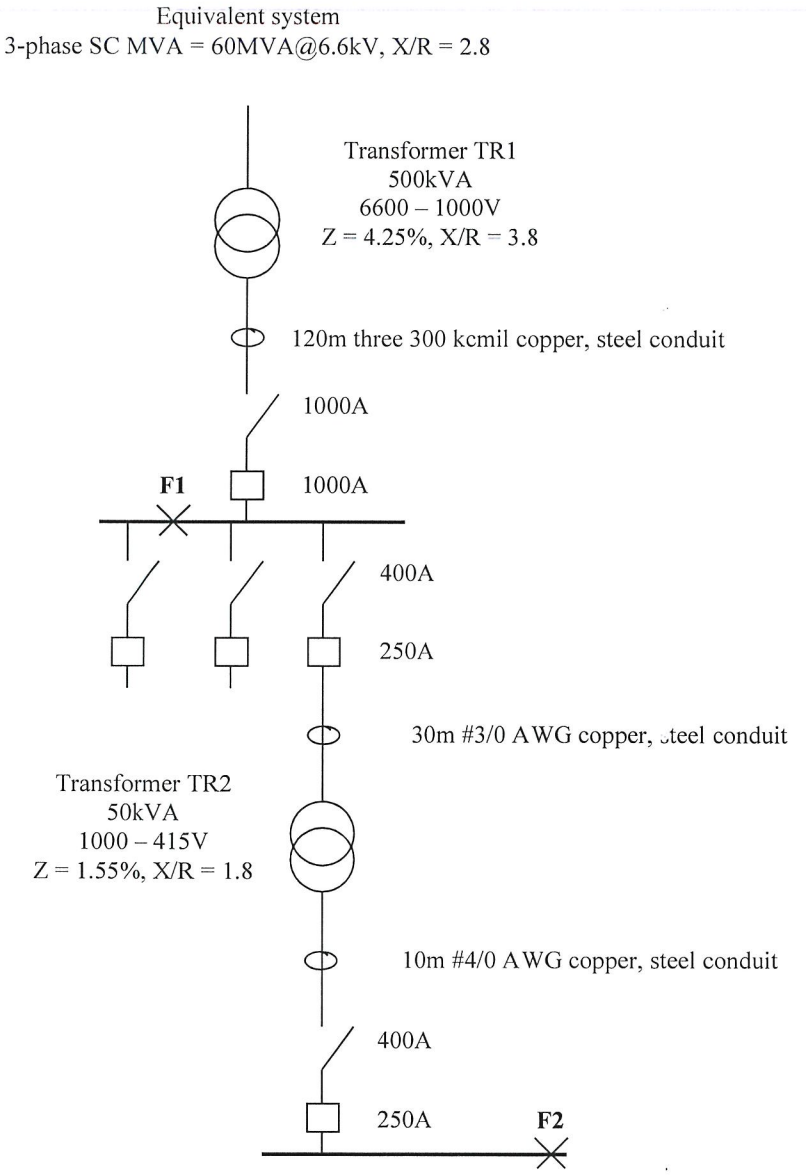

Figure Q2(b)

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Table Q3(b)

No.	Electrical Loads	Descriptions
1	Production line	40 induction motors: each one is rated at 0.75 HP, 82% efficiency and 0.7 PF. Operating 8 hours per day.
2	Heating chamber with blower	20 kVA, 75% efficiency and 0.9 PF lagging. Operating 4 hours per day.
3	Ventilation system 1	25 kW + j 30 kVAr, 90% efficiency. Operating 10 hours per day.
4	Water pump	75 HP induction motor with 92% efficiency and 0.6 PF. Operating 3 hours per day.
5	Miscellaneous loads	15 kVA, 85% efficiency and 0.88 PF lagging. Operating 8 hours per day.

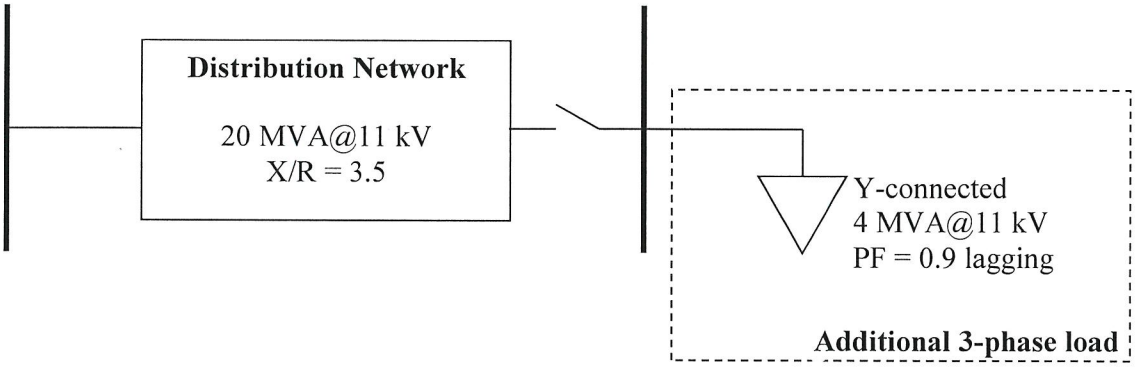

Figure Q3(c)

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Appendix A

Alternating-Current Resistance and Reactance for 600-Volt Cables, 3-Phase, 75°C (167°F) – Three Single Conductors in Conduit

Size (AWG or kcmil)	Ohms to Neutral per Kilometer / Ohms to Neutral per 1000 Feet														Size (AWG or kcmil)
	X_L (Reactance) for All Wires		Alternating-Current Resistance for Uncoated Copper Wires			Alternating-Current Resistance for Aluminum Wires			Effective Z at 0.85 PF for Uncoated Copper Wires			Effective Z at 0.85 PF for Aluminum Wires			
	PVC, Aluminum Conduits	Steel Conduit	PVC Conduit	Aluminum Conduit	Steel Conduit	PVC Conduit	Aluminum Conduit	Steel Conduit	PVC Conduit	Aluminum Conduit	Steel Conduit	PVC Conduit	Aluminum Conduit	Steel Conduit	
14	0.190 0.058	0.240 0.073	10.2 3.1	10.2 3.1	10.2 3.1	- -	- -	- -	8.9 2.7	8.9 2.7	8.9 2.7	- -	- -	- -	14
12	0.177 0.054	0.223 0.068	6.6 2.0	6.6 2.0	6.6 2.0	10.5 3.2	10.5 3.2	10.5 3.2	5.6 1.7	5.6 1.7	5.6 1.7	9.2 2.8	9.2 2.8	9.2 2.8	12
10	0.164 0.050	0.207 0.063	3.9 1.2	3.9 1.2	3.9 1.2	6.6 2.0	6.6 2.0	6.6 2.0	3.6 1.1	3.6 1.1	3.6 1.1	5.9 1.8	5.9 1.8	5.9 1.8	10
8	0.171 0.052	0.213 0.065	2.56 0.78	2.56 0.78	2.56 0.78	4.3 1.3	4.3 1.3	4.3 1.3	2.26 0.69	2.26 0.69	2.30 0.70	3.6 1.1	3.6 1.1	3.6 1.1	8
6	0.167 0.051	0.210 0.064	1.61 0.49	1.61 0.49	1.61 0.49	2.66 0.81	2.66 0.81	2.66 0.81	1.44 0.44	1.48 0.45	1.48 0.45	2.33 0.71	2.36 0.72	2.36 0.72	6
4	0.157 0.048	0.197 0.060	1.02 0.31	1.02 0.31	1.02 0.31	1.67 0.51	1.67 0.51	1.67 0.51	0.95 0.29	0.95 0.29	0.98 0.30	1.51 0.46	1.51 0.46	1.51 0.46	4
3	0.154 0.047	0.194 0.059	0.82 0.25	0.82 0.25	0.82 0.25	1.31 0.40	1.35 0.41	1.31 0.40	0.75 0.23	0.79 0.24	0.79 0.24	1.21 0.37	1.21 0.37	1.21 0.37	3
2	0.148 0.045	0.187 0.057	0.62 0.19	0.66 0.20	0.66 0.20	1.05 0.32	1.05 0.32	1.05 0.32	0.62 0.19	0.62 0.19	0.66 0.20	0.98 0.30	0.98 0.30	0.98 0.30	2
1	0.151 0.046	0.187 0.057	0.49 0.15	0.52 0.16	0.52 0.16	0.82 0.25	0.85 0.26	0.82 0.25	0.52 0.16	0.52 0.16	0.52 0.16	0.79 0.24	0.79 0.24	0.82 0.25	1
1/0	0.144 0.044	0.180 0.055	0.39 0.12	0.43 0.13	0.39 0.12	0.66 0.20	0.69 0.21	0.66 0.20	0.43 0.13	0.43 0.13	0.43 0.13	0.62 0.19	0.66 0.20	0.66 0.20	1/0
2/0	0.141 0.043	0.177 0.054	0.33 0.10	0.33 0.10	0.33 0.10	0.52 0.16	0.52 0.16	0.52 0.16	0.36 0.11	0.36 0.11	0.36 0.11	0.52 0.16	0.52 0.16	0.52 0.16	2/0
3/0	0.138 0.042	0.171 0.052	0.253 0.077	0.269 0.082	0.259 0.079	0.43 0.13	0.43 0.13	0.43 0.13	0.289 0.088	0.302 0.092	0.308 0.094	0.43 0.13	0.43 0.13	0.46 0.14	3/0
4/0	0.135 0.041	0.167 0.051	0.203 0.062	0.220 0.067	0.207 0.063	0.33 0.10	0.36 0.11	0.33 0.10	0.243 0.074	0.256 0.078	0.262 0.080	0.36 0.11	0.36 0.11	0.36 0.11	4/0
250	0.135 0.041	0.171 0.052	0.171 0.052	0.187 0.057	0.177 0.054	0.279 0.085	0.295 0.090	0.282 0.086	0.217 0.066	0.230 0.070	0.240 0.073	0.308 0.094	0.322 0.098	0.33 0.10	250
300	0.135 0.041	0.167 0.051	0.144 0.044	0.161 0.049	0.148 0.045	0.233 0.071	0.249 0.076	0.236 0.072	0.194 0.059	0.207 0.063	0.213 0.065	0.269 0.082	0.282 0.086	0.289 0.088	300
350	0.131 0.040	0.164 0.050	0.125 0.038	0.141 0.043	0.128 0.039	0.200 0.061	0.217 0.066	0.207 0.063	0.174 0.053	0.190 0.058	0.197 0.060	0.240 0.073	0.253 0.077	0.262 0.080	350
400	0.131 0.040	0.161 0.049	0.108 0.033	0.125 0.038	0.115 0.035	0.177 0.054	0.194 0.059	0.180 0.055	0.161 0.049	0.174 0.053	0.184 0.056	0.217 0.066	0.233 0.071	0.240 0.073	400
500	0.128 0.039	0.157 0.048	0.089 0.027	0.105 0.032	0.095 0.029	0.141 0.043	0.157 0.048	0.148 0.045	0.141 0.043	0.157 0.048	0.164 0.050	0.187 0.057	0.200 0.061	0.210 0.064	500
600	0.128 0.039	0.157 0.048	0.075 0.023	0.092 0.028	0.082 0.025	0.118 0.036	0.135 0.041	0.125 0.038	0.131 0.040	0.144 0.044	0.154 0.047	0.167 0.051	0.180 0.055	0.190 0.058	600

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Appendix B

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