



**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER II  
SESSION 2015/2016**

COURSE NAME : ELECTRICAL SYSTEM DESIGN  
COURSE CODE : BEF45303  
PROGRAMME CODE : BEV  
EXAMINATION DATE : JUNE/JULY 2016  
DURATION : 3 HOURS  
INSTRUCTION : ANSWER ALL QUESTIONS

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

# CONFIDENTIAL

BEF45303

- Q4**
- (a) Suggest the alternative for an unearthed installation so that the impact of earth fault will be reduced to such a level as not to cause danger.  
(4 marks)
- (b) Distinguish the lighting quantity at positions **X** and **Y** as shown in **Figure Q4(b)**.  
(4 marks)
- (c) Consider the lighting arrangement for two exhibition tables, **X** and **Y** as depicted in **Figure Q4(c)**.
- (i) Analyse the illuminance received at **X** and **Y**, respectively if both lamp **A** and lamp **B** having the same lamp flux as 5250 lumens  
(4 marks)
- (ii) Analyse the illuminance at **X** and **Y**, respectively if both exhibition tables are being shifted 1 m to the right  
(8 marks)
- Q5**
- (a) List 4 basic information required in a lighting design for commercial premise.  
(4 marks)
- (b) A 20 m x 8 m office area is to be illuminated and the illuminance required is 400 lux. Assuming a maintenance factor of 0.8 and utilisation factor of 0.65 for the lighting scheme design. The recommended luminaire for this installation is 2 x 28W T5 fluorescent lamps (total lamp flux is 5250 lumen) comes with high frequency electronic ballasts (with total power consumption of 6 W).
- (i) Analyse the total unit of 2 x 28 W T5 fluorescent lamp required  
(9 marks)
- (ii) Estimate the total power consumed by this installation  
(3 marks)
- (iii) Draw a scale plan for this office area with proper lamps arrangement  
(4 marks)

- END OF QUESTIONS -

CONFIDENTIAL

**FINAL EXAMINATION**

SEMESTER/SESSION : SEM II/ 2015/2016

PROGRAMME : 4 BEV

COURSE NAME : ELECTRICAL SYSTEM DESIGN

COURSE CODE : BEF45303

**TABLE Q1(b)**

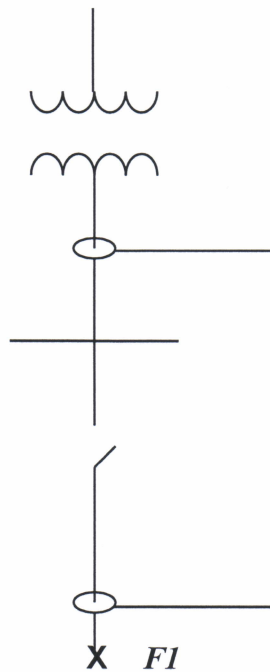
	Type	Load in kW	% of Diversity Factor	Group Diversity Factor
1.	Residential lighting	1000	60	3.0
2.	Commercial lighting	300	75	1.5
3.	Street lighting	50	100	1.0
4.	Domestic power	300	50	1.5
5.	Industrial power	1800	55	1.2

Equivalent system

Three-phase: MVA = 52MVA@6.6kV, X/R = 5

Single-phase:  $I_{LG} = 2kA$ , X/R = 2.4

100kVA  
6600 – 415V  
Z = 5.7%  
X/R = 3



Service  
80m 300kcmil copper,  
Steel conduit

60m #3/0 AWG AL,  
steel conduit

**FIGURE Q2(b)**

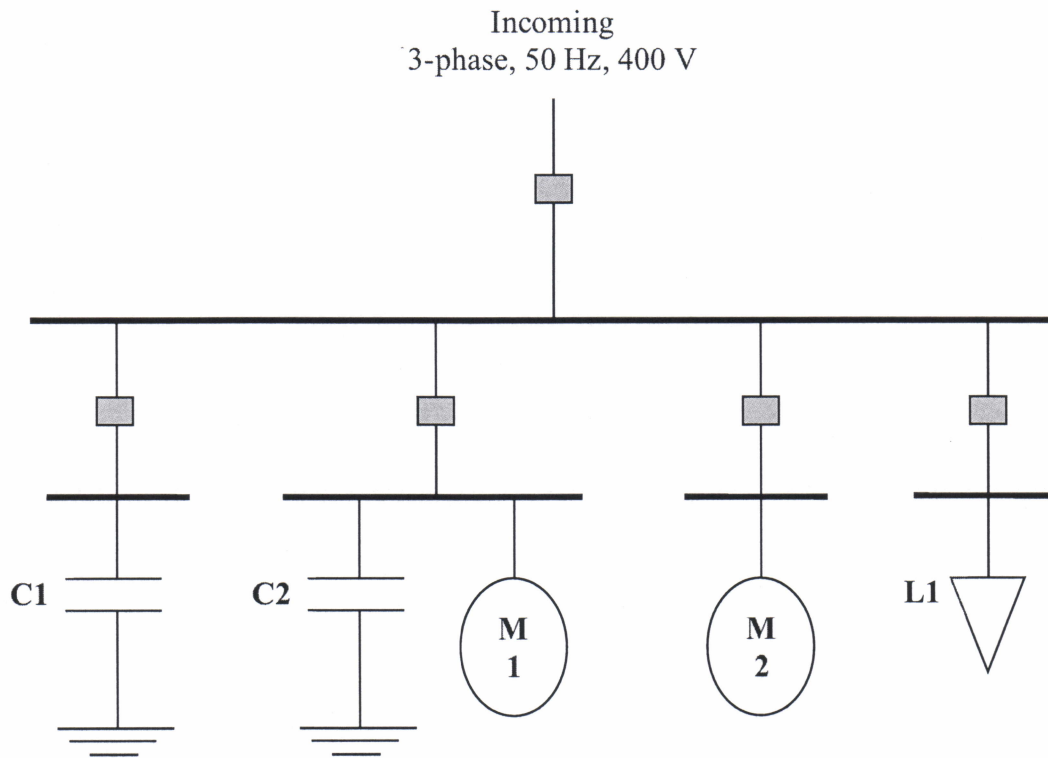
**FINAL EXAMINATION**

SEMESTER/SESSION : SEM II/ 2015/2016

PROGRAMME : 4 BEV

COURSE NAME : ELECTRICAL SYSTEM DESIGN

COURSE CODE : BEF45303



Component	Description
M1	8 units of 3-phase induction motor, each one rated at 2kVA, 0.78 lagging power factor with 88% efficiency.
M2	24 units of single-phase conveyer motor, connected in balance 3-phase coordination, each one rated at 300 W, 0.82 lagging power factor with 78% efficiency.
L1	Lump loads, rated at 10 kVAr, 0.9 lagging power factor.
C1	6 steps power factor corrector with the switching arrangement of (1 : 1 : 2 : 2 : 4 : 4). The unit capacitor used is rated at 525 V, 2 kVAr.
C2	3 steps power factor corrector with the switching arrangement of (1 : 2 : 3). The unit capacitor used is rated at 440 V.

**FIGURE Q3(b)**



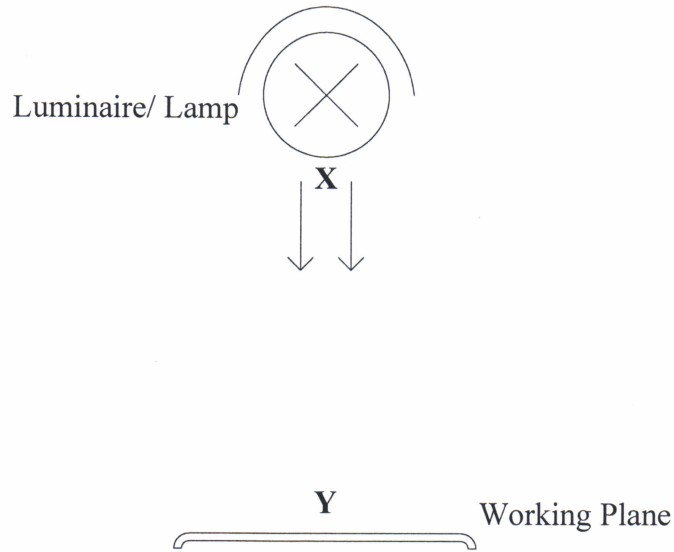
**FINAL EXAMINATION**

SEMESTER/SESSION : SEM II/ 2015/2016

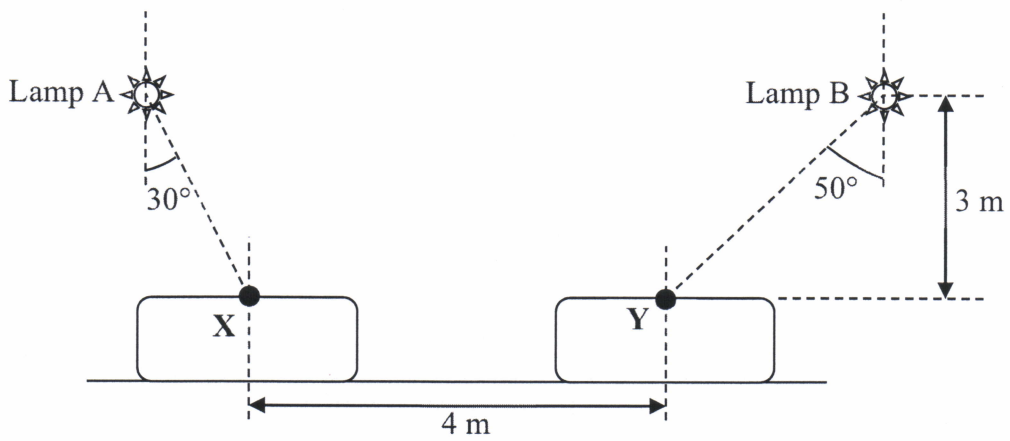
PROGRAMME : 4 BEV

COURSE NAME : ELECTRICAL SYSTEM DESIGN

COURSE CODE : BEF45303



**FIGURE Q4(b)**



**FIGURE Q4(c)**

**FINAL EXAMINATION**

SEMESTER/SESSION : SEM II/ 2015/2016

PROGRAMME : 4 BEV

COURSE NAME : ELECTRICAL SYSTEM DESIGN

COURSE CODE : BEF45303

**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														Size (AWG or kcmil)
	Ohms to Neutral per 1000 Feet														
	X <sub>r</sub> (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

**FINAL EXAMINATION**

SEMESTER/SESSION : SEM II/ 2015/2016

PROGRAMME : 4 BEV

COURSE NAME : ELECTRICAL SYSTEM DESIGN

COURSE CODE : BEF45303

**Appendix B**

**Tabulated Table of Voltage Drop in mV/A/m**

**(Source: IEE Wiring Regulations (17th Edition, BS7671: 2008, Appendix 4, Table 4D2B)**

VOLTAGE DROP (per ampere per metre)

Conductor operating temperature: 70°

Conductor cross-sectional area 1 (mm <sup>2</sup> )	Two-core cable, d.c.	Two-core cable, single phase a.c.			Three- or four-core cable, three-phase a.c.		
	2 (mV/A/m)	3 (mV/A/m)			4 (mV/A/m)		
1	44	44			38		
1.5	29	29			25		
2.5	18	18			15		
4	11	11			9.5		
6	7.3	7.3			6.4		
10	4.4	4.4			3.8		
16	2.8	2.8			2.4		
		r	x	z	r	x	z
25	1.75	1.75	0.170	1.75	1.50	0.145	1.50
35	1.25	1.25	0.165	1.25	1.10	0.145	1.10
50	0.93	0.93	0.165	0.94	0.80	0.140	0.81
70	0.63	0.63	0.160	0.65	0.55	0.140	0.57
95	0.46	0.47	0.155	0.50	0.41	0.135	0.43
120	0.36	0.38	0.155	0.41	0.33	0.135	0.35
150	0.29	0.30	0.155	0.34	0.26	0.130	0.29
185	0.23	0.25	0.150	0.29	0.21	0.130	0.25
240	0.180	0.190	0.150	0.24	0.165	0.130	0.21
300	0.145	0.155	0.145	0.21	0.135	0.130	0.185
400	0.105	0.115	0.145	0.185	0.100	0.125	0.160

**FINAL EXAMINATION**

SEMESTER/SESSION : SEM II/ 2015/2016

PROGRAMME : 4 BEV

COURSE NAME : ELECTRICAL SYSTEM DESIGN

COURSE CODE : BEF45303

Appendix C

**Table of Asymmetrical Current Factors**

<b>System X/R Ratio</b>	<b>Instantaneous Peak Factor</b>	<b>Half-Cycle Factor</b>	<b>Time of Peak tp (ms)</b>
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

