UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2012/2013

COURSE NAME	:	ELECTRICAL ENERGY UTILISATION
COURSE CODE	:	BEE 4213 / BEX 42803
PROGRAMME	:	BEE
EXAMINATION DATE	:	JUNE 2013
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) A three phase circuit breaker is installed in a 415Y/240 V panelboard to serve the following load:

Air conditioning (15 kVA, PF=0.9) with demand factor 1.
Water heating (8 kW) with demand factor 1.
Lighting (5 kVA, PF=0.85) with demand factor 1.25.
Kitchen (5 kVA, PF=0.9) with demand factor 0.8.
Spare capacity (20 kVA, PF=0.8) with demand factor 1.

Estimate the minimum rating of the circuit breaker for that panelboard

(18 marks)

(b) A single phase 240 V, 25 kW 50 Hz motor operating at 0.9 power factor lagging is protected by a 300 ampere cartridge fuse. A fault occurs in the circuit causes a current of 350 ampere to flow through the earth continuity path. Evaluate whether the fuse will rupture, use IEE Regulation D22

(7 marks)

Q2 Figure Q2 shows a three-phase industrial distribution power system. If a three-phase fault occurring at F1, evaluate the RMS symmetrical current, the peak instantaneous and the RMS asymmetrical short circuit current

(25 marks)

Q3 A following three-phase, balanced loads are connected across a three-phase, wye connected source (3-Φ, 415 V and 50 Hz). The natures of the three loads are described as follows:

Load #1: Wye-connected load with 30 kVA (3-phase) at 0.8 PF lag;
Load #2: Wye-connected load with 6 kW (3-phase) at 0.6 PF lead;
Load #3: Delta-connected load, with 20 A phase current and 0.7 PF lag.

(i) Determine the total complex power (3-phase) consumed by the three loads, the total line current and the total power factor
(ii) Determine the capacitor value per phase required to be connected in delta to correct the power factor to 0.9 PF lagging

(25 marks)

Q4 (a) Explain briefly the definition of grounding versus bonding in power system

(3 marks)

(b) State four types of voltage surge

(2 marks)

(c) The lecture hall with dimension of 15 m length and 12 m width is to be illuminated with illuminance required of 350 Lux. Assuming a depreciation factor of 1.2 and utilisation factor of 0.6 for the lighting scheme design. If 36W fluorescent lamps (75 lumens/watt) were to be used,

(i) Calculate the number of fluorescent lamps required
(ii) Sketch a scale plan of the lecture hall lamps arrangement

(10 marks)

(d) A lamp producing 2000 lumens is suspended 3m above a workbench

(i) Calculate the illumination on the bench if it is placed directly under the state down lamp
(ii) Estimate the horizontal distance of the bench from the above position where the illumination will be one-third of the value found in Q4(d)(i)

(10 marks)

- END OF QUESTION -

Equivalent system
Three-phase: MVA = 65MVA@11kV, X/R = 5

Transformer
100kVA
11000 – 415V
Z = 5.7%
X/R = 3

Service
40ft #4/0 AWG copper,
Steel conduit

50ft #12 AWG AL, PVC
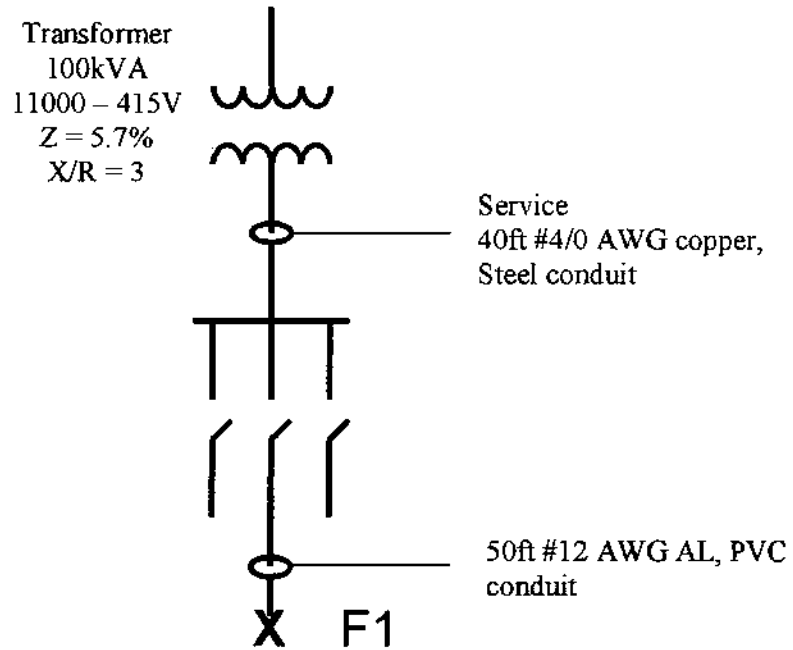conduit

X   F1

FIGURE Q2

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

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

Ohms to Neutral per Kilometer / Ohms to Neutral per 1000 Feet

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Table- Asymmetrical Factors Based on X/R Ratio or Short-Circuit Power Factor
(Source: Electrical System Design, Theodore R. Bosela)

System X/R Ratio	Instantaneous Peak Factor	Half-Cycle Factor	Time of Peak, t_p (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