



UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER I
SESSION 2017/2018**

COURSE : UTILISATION OF ELECTRICAL ENERGY
COURSE CODE : BEF 33203
PROGRAMME CODE : BEV
EXAMINATION DATE : DECEMBER 2017 / JANUARY 2018
DURATION : 3 HOURS
INSTRUCTION : ANSWER ALL QUESTIONS

TERBUKA

THIS QUESTION PAPER CONSISTS OF EIGHT (8) PAGES

CONFIDENTIAL

Q1 (a) Utility company must plans for the electricity demand in advance for a distribution system:

(i) Define the load factor. (1 mark)

(ii) Explain the diversity factor. (1 mark)

(b) A three phase circuit breaker is installed in a 415Y/240V panel board to serve the following load as shown in **Table Q1(b)(i)** and the standards given in **Table Q1(b)(ii)**:

(i) Calculate the total connected load of the factory. (11 marks)

(ii) Analyse the total demand load. (6 marks)

(iii) Evaluate the minimum rating of the circuit breaker for the panel board. (6 marks)

Q2 (a) (i) Describe the important of X/R ratio consideration in low voltage short circuit studies. (1 mark)

(ii) Explain **one (1)** cause of largest asymmetrical fault current occurs. (2 marks)

(b) A lecture hall has been installed with 60 fluorescent lamps, each with 40 Watts capacity output power (inclusive ballast consumption) using a 35 m length of 1.5 mm² cable. Single phase 240 V_{r.m.s} voltage and the average power factor for this lighting system is at 0.95 lagging is used from the public low distribution system. Consider the voltage drop standard (17th Edition of IEE Wiring Regulations) such as specified in **Table Q2(b)** is generated. By referring to **Appendix A**:

(i) Calculate the voltage drop in the cable for this installation. (5 marks)

(ii) Analyse the new cable size and voltage drop percentage to ensure voltage drop is lower than the allowable value of 3%. (13 marks)

TERBUKA

CONFIDENTIAL

- (c) (i) A three phase 65 HP motor code letter K (locked-rotor kVA / HP ratio ranging from 8.0 – 9.0 for induction motor is to be started using three- phase 415 V_{r.m.s} supply voltage, that is taken from the panel distribution board using a 30 m length, 35 mm² three-core cable. Evaluate the percentage of voltage drop in the cable during the motor starting with the locked-rotor power factor is at 0.40 lagging by referring to **Appendix A**.

(3 marks)

- (ii) Conclude what happen to the low voltage distribution system if the voltage drop is lower than 5 %.

(1 mark)

- Q3** (a) Illustrate schematic diagram of the Static VAR Compensator (SVC).

(4 marks)

- (b) Analyse the initial power factor level for 415 V_{r.m.s}, 300 kW balanced three-phase load systems which has been improved to 0.98 by using 80 kVAr, 550 V_{r.m.s}. capacitor bank.

(5 marks)

- (c) A 500 kVA, three-phase 415 V_{r.m.s} power system supplied to the UTHM library was having a harmonic interferences generated from the nonlinear loads. Its total impedance $Z_{sys} = 0.025 + j\omega 10\mu\text{H } \Omega$. **Table Q3(c)** specifies the harmonic spectrum produced in the system.

- (i) Calculate the root sum squares (RSS) and the total harmonic distortion (THD) single-phase voltages produced in the system without the power factor correction connected.

(6 marks)

- (ii) Calculate the new root sum squares (RSS) and the total harmonic distortion (THD) single-phase voltages produced in the system with the power factor correction connected.

(10 marks)



TERBUKA

CONFIDENTIAL

- Q4** (a) Define the meaning of solidly earthed or bolted earthed earthing condition. (2 marks)
- (b) A Sharp Roxy factory in Batu Pahat receives 11 kV, 50 Hz three phase power lines from Tenaga Nasional Berhad (TNB) by multi-grounded distribution feeder. The short circuit data from the TNB indicates the apparent power of the short circuit, $MVA_{SC} = 100$ MVA at the ratio, $X/R = 1.5$. The transformer supplying the factory is rated at 1.5 MVA, 11 kV – 415 V wye connected circuit, with the impedance, $R = 0.5\%$ and $X = 5.0\%$. The corresponded one line diagram of the factory is given in **Figure Q4(b)**. Justify the harmonic order of parallel resonant frequencies, f_r produced in the circuit when its 415 V bus power factor level is corrected with 150 kVAr rated capacitor bank. (8 marks)
- (c) Sketch a schematic layout and summarise a logical condition of three phase lines that are using the “*Earthed Neutral*” (TT) type earthing arrangement. (5 marks)
- (d) The spotlights illuminated at UTHM Stadium field area are considered using the metal halide type lamps. The layout is given in **Figure Q4(d)**. The approximate height of the spotlight tower is 40 m. The average brightness receives at point “C” should be 1600 lux as supplied from the light sources of L1, L2, L3 and L4.
- (i) Examine the total number of lamp used if the following information are considered:
- Lamp wattage = 500 Watts
 - Luminous efficacy = 50 lumen / Watt
 - Utilisation and maintenance factor = 10 % each
- (8 marks)
- (ii) Examine the total electricity bill charged if the area is occupied for 5 hours at night. Consider the utility charge to be at RM 0.30 for every single kWh usage. (2 marks)

TERBUKA

– END OF QUESTIONS –

CONFIDENTIAL**FINAL EXAMINATION**

SEMESTER/SESSION : SEM I / 2017/ 2018

PROGRAMME CODE : BEV

COURSE : UTILISATION OF ELECTRICAL ENERGY

COURSE CODE : BEF 33203

Table Q1(b)(i)

Load	Rating	Demand Factor
Air conditioning	7.0 kVA, PF=0.88	1.00
Water heating	5.0kW	1.00
Lighting	12.0 kVA, PF=0.95	1.25
Kitchen	3.0kVA, PF=0.90	0.65
Spare Capacity	10.0 kVA, PF=0.90	1.00
Motor	20.0 kVA, PF=0.70	0.75
Capacitance load	5.0 kVAr (leading)	1.00

Table Q1(b)(ii)

Protective Devices

(Source: IEE Wiring Regulations (17th Edition, BS7671: 2008)

Type C circuit-breakers to BS EN 60898 with U_0 of 230 V

Rating, I_n (amperes)	6	10	16	20	25	32	40	50	63	80	100	125
----------------------------	---	----	----	----	----	----	----	----	----	----	-----	-----

TERBUKA**Table Q2(b)**

Tariff E2s – TNB		
Type of Supply	Lighting	Other uses
(i) Low voltage installation supplied directly from a public low voltage distribution system	3%	5%
(ii) Low voltage installation supplied from private LV supply	6%	8%

CONFIDENTIAL

CONFIDENTIAL**FINAL EXAMINATION**

SEMESTER/SESSION : SEM I / 2017/ 2018

PROGRAMME CODE : BEV

COURSE : UTILISATION OF ELECTRICAL ENERGY

COURSE CODE : BEF 33203

Appendix A**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	Two-core cable, d.c. 2	Two-core cable, single phase a.c. 3			Three- or four-core cable, three-phase a.c. 4		
		r	x	z	r	x	z
(mm ²)	(mV/A/m)	(mV/A/m)			(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

TERBUKA**CONFIDENTIAL**

FINAL EXAMINATION

SEMESTER/SESSION : SEM I / 2017/ 2018

PROGRAMME CODE : BEV

COURSE : UTILISATION OF ELECTRICAL ENERGY

COURSE CODE : BEF 33203

Table Q3(c)

Harmonic Order	Line Current Magnitude (A)
3 rd	30
7 th	60
13 th	15

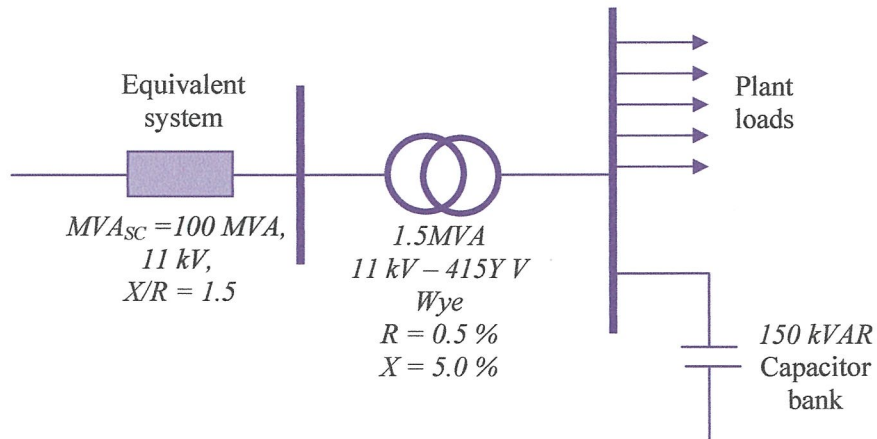


Figure Q4(c)

TERBUKA

FINAL EXAMINATION

SEMESTER/SESSION : SEM I / 2017/ 2018

PROGRAMME CODE : BEV

COURSE : UTILISATION OF ELECTRICAL ENERGY

COURSE CODE : BEF 33203

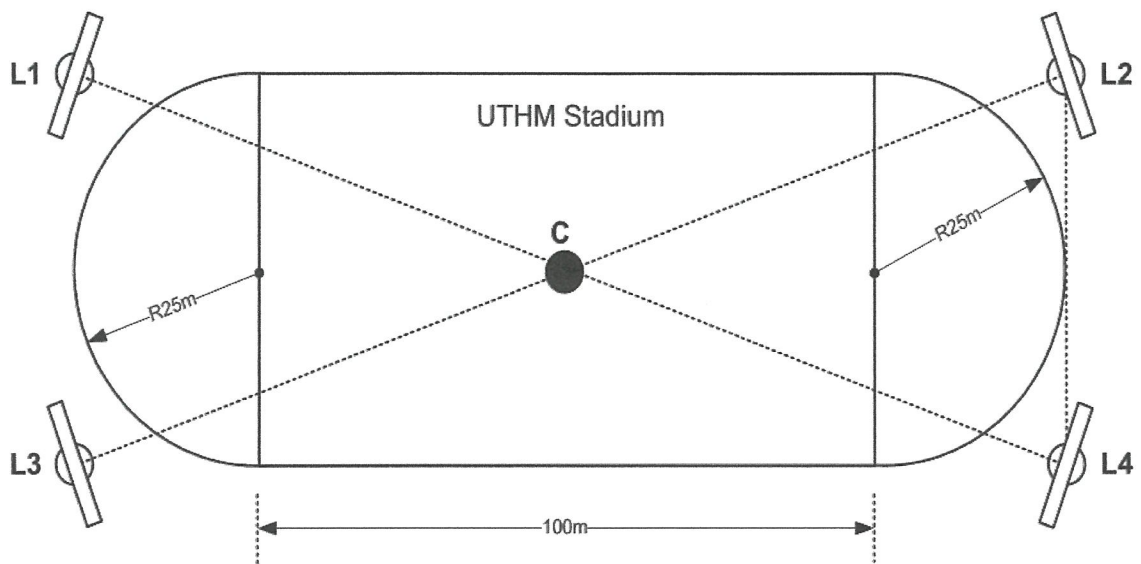


Figure Q4(d)

TERBUKA