Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2014/2015

COURSE NAME	:	UTILISATION OF ELECTRICAL ENERGY
COURSE CODE	:	BEF 33203
PROGRAMME	:	3 BEV
EXAMINATION DATE	:	DECEMBER 2014 / JANUARY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **TWELVE (12)** PAGES

Q1 (a) Prudent and efficient use of electricity is not only kinder to the environment, but also kinder to the business, saving money and bringing more profits to the consumers. Suggest **one (1) energy** saving method in lighting system.

(2 marks)

(b) **Table Q1(b)** gives the connected loads for a new constructed single-storey semi-detached house. The incoming supply is taken from 240 V_{LN}, 50 Hz.

(i) Analyse the maximum demand for this domestic installation. Consider 70% of diversity factor.

(2 marks)

(ii) Recommend the proper rating of residual current operated circuit breakers (RCCB) and main switch. Refer to **Table Q1(b)(ii)**. Note that two RCCB must be considered, that is for general lighting / fan circuit and power circuit applications.

(6 marks)

(iii) Analyse the proper rating of each miniature circuit breaker (MCB) used in accordance with the information shown in **Table Q1(b)(ii)**. The wiring rule is restricted to the followings;

- One outgoing MCB serving 10 lighting / fan point
- One outgoing MCB serving 3 SSO 13 A / 15 A
- One outgoing MCB serving 1 air conditioning / water heater point

(10 marks)

Q2 (a) During starting, an asynchronous motor will cause voltage drop at the main system and / or inside motor circuit itself. Voltage drop can happen during the motor running. Give **one (1)** possible problem condition at the following sides so as the voltage drop happened during the motor running;

(i) Mains.

(1.5 marks)

(ii) Motor driven ends.

(1.5 marks)

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

Analyse:

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

(14 marks)

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

(1.5 marks)

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

(1.5 marks)

Q3 (a) Recommend **one (1)** way of improving power factor lagging in inductive load power system circuit.

(2 marks)

(b) Analyse the initial power factor level for 415 V, 480 W balanced three phase load systems which has been improved to 0.98 by using 825.32 kVAr capacitor bank rated at 550 V.

(4 marks)

(c) An industrial plant in Shah Alam 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 to be at 150 MVA with an X/R ratio of 2.5. The transformer supplying the plant is rated at 1500 kVA, 11 kV – 415 V wye connected circuit, with the R = 0.5 % and X = 5.0 %. The corresponded one line diagram of the industrial plant is given in **Figure Q3 (c)**. Justify the condition of parallel resonant frequencies produced in the circuit when its 415 V bus power factor level is corrected with following capacitor bank:

(i) 130 kVAr.

(8 marks)

(ii) 500 kVAr.

(3 marks)

(iii) 750 kVAr.

(3 marks)

Q4 (a) Summarise the meaning of solidly earthed or bolted earthed earthing condition.

(2 marks)

(b) A good earthing arrangement ensures the lines to be protected during abnormal system condition. Typically, the arrangement can be either as TT, TN or IT. Propose a general circuitry connection and logical conditions of three phase lines that using the TT earthing arrangement.

(7 marks)

(c) The spotlights illuminated the Palapes's marching field area nearby UTHM's Sultan Ibrahim Mosque are considered using the metal halide type lamps. The rough layout is given in **Figure Q4 (c)**. The approximate height of the spotlight tower is 30 m. The average brightness receives at point "C" should be 1000 lux as supplied from the light sources of L1, L2, L3 and L4.

Analyse:

(i) The total number of lamps used if the following information are considered:

- Lamp wattage = 500 Watts
- Luminous efficacy = 80 lumen / Watt
- Utilisation and maintenance factor = 50 %

(9 marks)

(ii) The total electricity bill charge if the area is occupied for 4 hours. Consider the utility charge to be at RM 0.35 for every single kWh usage.

(2 marks)

Q5 (a) Summarise the effect of harmonics disturbances on the electrical and electronic devices.

(2 marks)

(b) A "stiff" 33 kV three-phase system serves a distribution line with an impedance of 2.5 + j8 ohms. If the voltage at the sending end remains 33 kV, determine the percentage voltage drop magnitude in the line due to a balanced 3-phase load of 15 + j5 ohms per phase.

(5 marks)

(c) **Figure Q5(c)** shows a simple electrical schematic of three different load sections located inside the Evergreen pallet production plant. Each of the loads is connected from the main source feeder using single-phase 3-core wire enclosed in the metal trunking.

Analyse:

(i) The maximum total load current magnitude in kA measured at feeder busbar.

(7 marks)

(ii) The correct ratings for the circuit breakers to be placed for load A, B, and C.

(3 marks)

(iii) The appropriate cable size to supply the electricity to load A, B, and C.

(3 marks)

– END OF QUESTIONS –

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TABLE Q1(b)

No.	Load Type	Quantity (No)
1	Down light point (Take 50 W per Nos)	13
2	Wall light point (Take 50 W per Nos)	3
3	Ceiling fan point (Take 80 W per Nos)	6
4	SSO 13 A (Take 300 W per Nos)	14
5	SSO 15 A (Take 500 W per Nos)	3
6	1.5 kW water heater point	2
7	Air conditioning point (1 HP)	2
8	Air conditioning point (1.5 HP)	1

TABLE Q1(b)(ii)

Type of Protective Device	Standard Rating (A)
MCB	1, 3, 6, 10, 16, 20, 25, 32, 40, 50, 63
RCCB/ Main switch	40, 63

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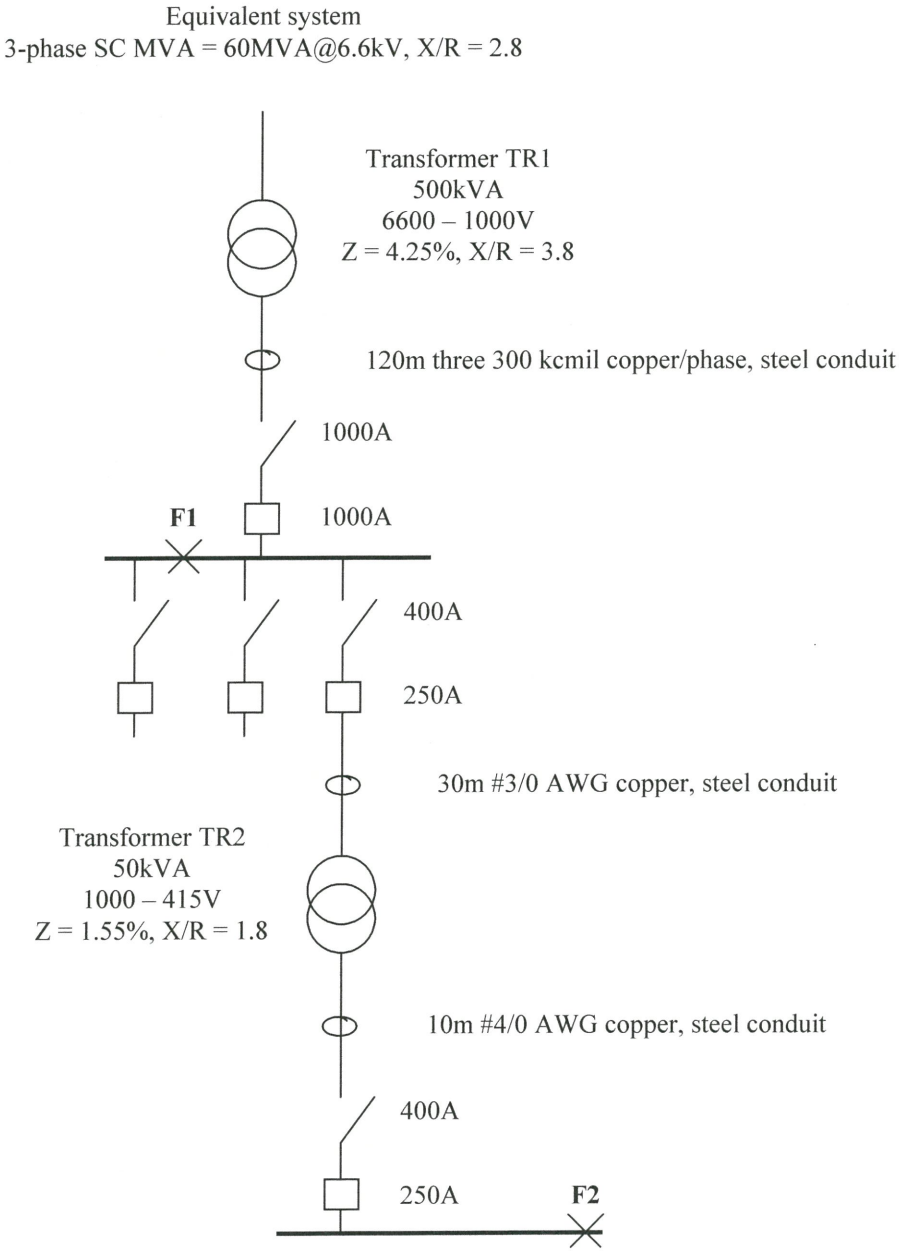

FIGURE Q2(b)

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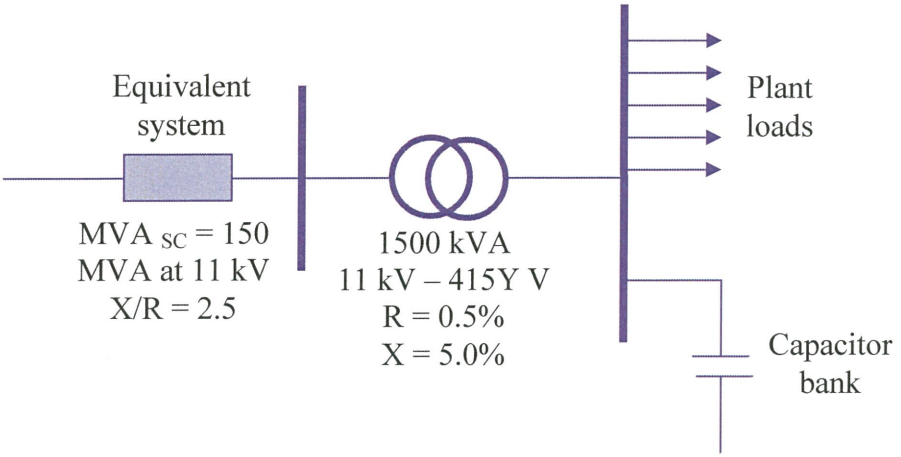

FIGURE Q3(c)

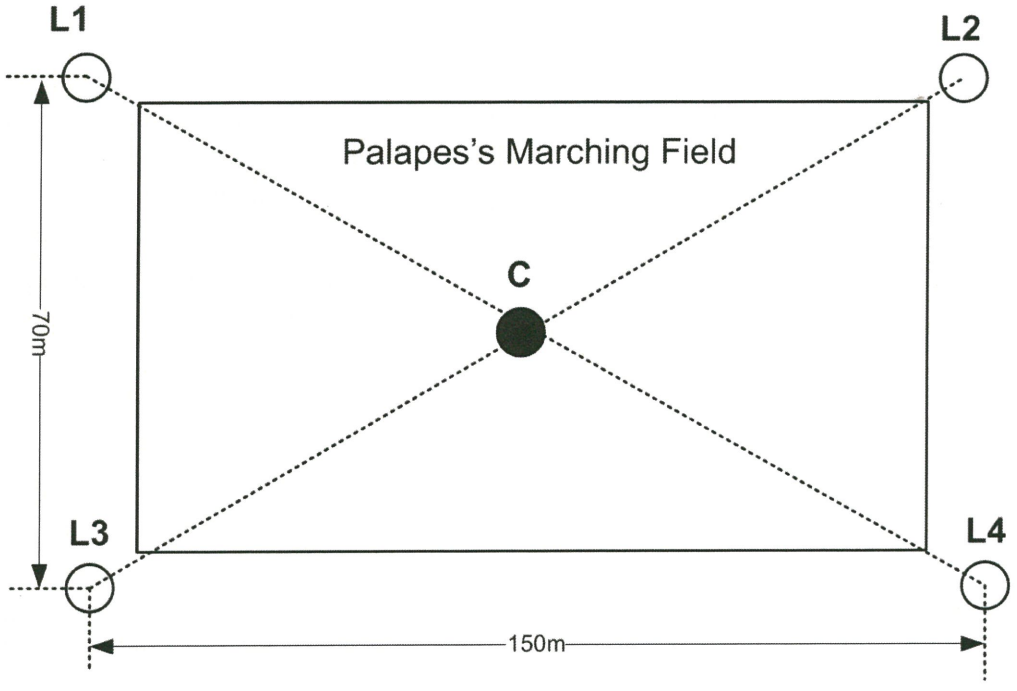

FIGURE Q4(c)

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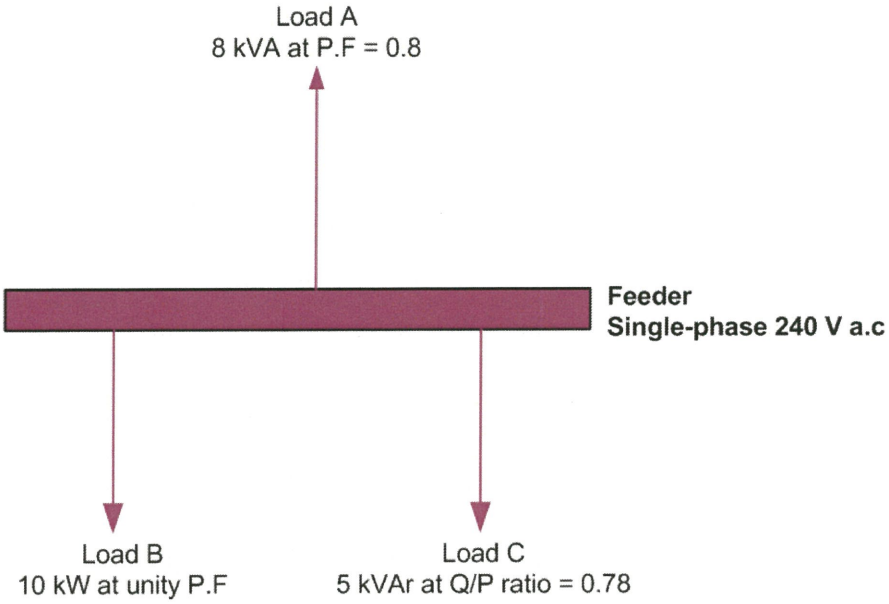

FIGURE Q5(c)

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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

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	Two-core cable, d.c.	Two-core cable, single phase a.c.			Three- or four-core cable, three-phase a.c.		
1	2	3			4		
(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

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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

Appendix D

Table of Standard 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

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Appendix E

Table of standard multicore 70 °C thermoplastic insulated and thermoplastic sheathed cables,
Non-armoured
(COPPER CONDUCTORS)

Ambient temperature: 30 °C

CURRENT-CARRYING CAPACITY (amperes): Conductor operating temperature: 70 °C

Conductor cross-sectonal area	Reference Method A (enlosed in conduit in thermally insulating wall etc.)		Reference Method B (enclosed in conduit on a wall or in trunking etc.)		Reference Method C (clipped directly)		Reference Method E (in free air or on a perforated cable tray etc, horizontal or vertical)	
	1 two-core cable*, single-phase a.c. or d.c.	1 three-core cable* or 1 four-core cable, three-phase a.c.	1 two-core cable*, single-phase a.c. or d.c.	1 three-core cable* or 1 four-core cable, three-phase a.c.	1 two-core cable*, single-phase a.c. or d.c.	1 three-core cable* or 1 four-core cable, three-phase a.c.	1 two-core cable*, single-phase a.c. or d.c.	1 three-core cable* or 1 four-core cable, three-phase a.c.
1	2	3	4	5	6	7	8	9
(mm^2)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)
1	11	10	13	11.5	15	13.5	17	14.5
1.5	14	13	16.5	15	19.5	17.5	22	18.5
2.5	18.5	17.5	23	20	27	24	30	25
4	25	23	30	27	36	32	40	34
6	32	29	38	34	46	41	51	43
10	43	39	52	46	63	57	70	60
16	57	52	69	62	85	76	94	80
25	75	68	90	80	112	96	119	101
35	92	83	111	99	138	119	148	126
50	110	99	133	118	168	144	180	153
70	139	125	168	149	213	184	232	196
95	167	150	201	179	258	223	282	238
120	192	172	232	206	299	259	328	276
150	219	196	258	225	344	299	379	319
185	248	223	294	255	392	341	434	364
240	291	261	344	297	461	403	514	430
300	334	298	394	339	530	464	593	497
400	-	-	470	402	634	557	715	597

* with or without a protective conductor