2019/2020 SEMESTER ONE MID-SEMESTER TEST

ELECTRICAL INSTALLATION DESIGN Time Allowed : 1.5 Hour

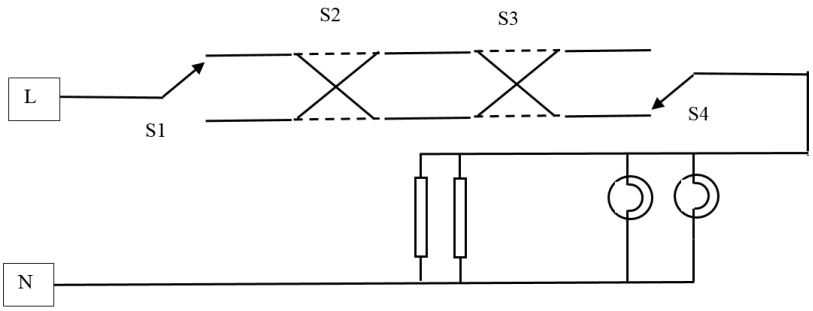
SECTION A: [12 Marks Each]

1 (a) A shopping complex requires 1770 kW of electricity supply at 0.85 power factor. State the voltage, frequency and number of wires that will be provided by the SP Services Ltd. What will be the maximum current that can be drawn at 1770 kW at the supply voltage? (8 marks)

22 kV, 50 Hz, 3-wire, 54.6 A

(b) What is maximum allowable percentage fluctuation for the supply voltage and frequency in Singapore? Voltage +/- 6% , Frequency +/- 1% (4 marks)

2 (a) A large convention hall has 4 entrances/doors as shown in the Figure Q2 below. A control switch, located at each entrance, controls a pair of filament lamps and another pair of fluorescent lamps for lighting up the hall. Design a lighting control diagram that allows the user to control the lamps from any one of the four doors. Two pieces of 2-way switches and two pieces of Intermediate switches are provided. (9 marks)



(b) An inexperienced installer made a wrong connection by wiring the pair of filament lamps in series. Explain what will happen to the filament lamps. (3 marks)

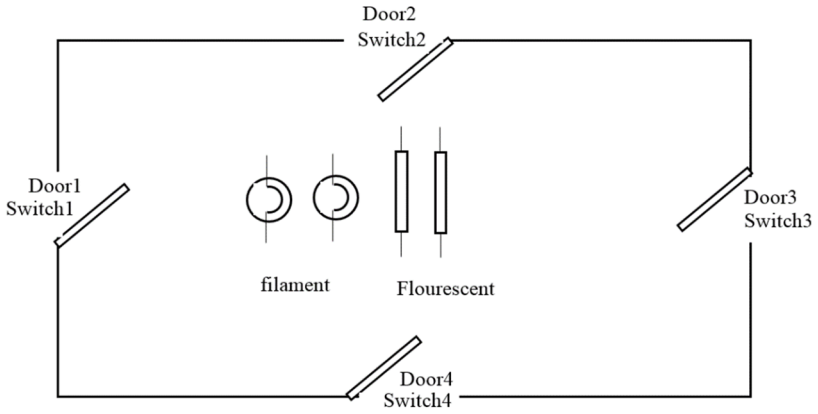


Figure Q2

3 Based on the single-line diagram as shown in Figure Q3. Determine the tripping times obtained from the Time/Current curve of the protective devices when

(i) a short circuit current of 160A between live and neutral occurs at point A. (0.1 Sec) (4 marks)

(ii) an overload current of 75A flows in Load B (35 to 45 Secs) (4 marks)

(iii) an overload current of 60A flows in Load C (20 Secs) (4 marks)

Please note only Time/Current curve of Type B MCBs is provided.

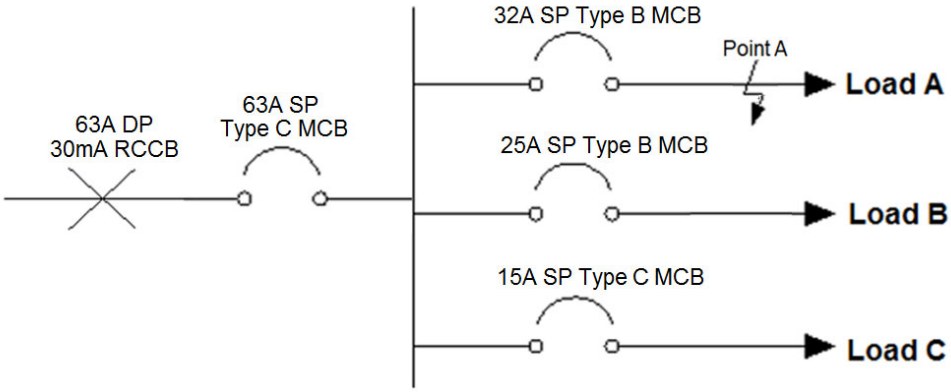


Figure Q3

4. A star-connected resistive load of 18kW is connected to a three-phase 400V, 50Hz supply. Determine:

i) the phase voltage 230 V (2 marks)

ii) the phase current flowing in the star-connected resistive load (25.98 A) (4 marks)

iii) the phase current flowing in the load when re-connected in delta (45 A) (6 marks)

5 Determine the size of a 4.6m long conduit with two 90° bend needed to accommodate the following circuits. (Use the cable factor method.)

- 2 numbers of single-phase circuit using 1.5 mm^2 single core PVC-insulated cables with 1.0mm^2 single core PVC insulated cables for the protective conductors.
- 1 no. of three-phase 3-wire circuit using 4.0 mm^2 single-core PVC-insulated cables for phase and 2.5 mm^2 single core PVC-insulated stranded cable for the protective conductor. (12 marks)

No. & Types of Ccts	No. of cables	Cable Factor	Total cable factor
2 nos single phase circuits of 1.5$mm^2$and	2 x 2	22	88
1.0mm^2 cpc	2 x 1	16	32
1 nos. 3-phase 3-wire circuits of 4.0mm^2 with	1x 3	43	123
2.5mm^2 cpc	1	30	30
			273
Hence select conduit with factor 358, Two bends 5 m (4.6m) i.e. 25mm diameter-			

6 (a) Before March 2009 four colours were used to denote three phase and neutral cables. Name these colours and also state the **corresponding colours** that are now used in place of these colours. If double-insulated cables which have external sheath of grey colour are used, what should be done to make it acceptable for the new colour code? (8 marks)

	old colours	new colours
L1	red	brown
L2	yellow	black
L3	blue	grey
NEUTRAL	black	blue

(b) What are the two most common measures used in Singapore for protection against indirect contact? (4 marks)

If double insulated cable is used, colour sleeve with brown, black gray or markings with L1, L2 and L3 and N need to be used at the end of each cable.

SECTION B: [28 Marks]

B1 A bungalow at Sentosa connected to a 400V/230V 3-phase supply has the following loads:

- 18 nos. of 2 x 32 W fluorescent light fittings
- 20 nos. of 50W, 50V tungsten halogen lamps
- **1 no**. of 32A ring **circuit** connected to a total of 15 numbers of 13A switched socket outlets (Estimated demand of this circuit is 5.0kW.)
- 3 nos. of 20A radial circuits connected to total 24 numbers of 13A switched socket outlets (Estimated demand of each circuit is 3.0 kW)
- 1 no. of multi-split air-conditioning unit where the electrical load can be considered as a 3-phase 400V motor rated 9 kW with efficiency of 0.9 and power factor of 0.9.
- 1 no. 8.8 kW cooker with no socket outlet
- 2 nos. of instantaneous water heater each rated 3.0kW.
- 2 nos. of storage water heater (thermostatically controlled) each rated 1.5kW
- A 2.8kW Expresso vending machine taking supply from a 13A switched socket outlet.

Draw a load list table as per sample below (2 marks)

Description	Connected Load	D.F.	Current Demand
Total Single Phase MD			103.64

Assuming the loads are distributed evenly over the three-phases and allowing 15% for future expansion, determine a suitable current rating for the main circuit breaker after applying the appropriate diversity factors. (Standard MCB ratings are 16A, 20A, 32A, 40A, 50A, 63A, 80A, 100A) (58.2 A / 63 A) (26 marks)

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Table 12C
Cable factors for long straight runs or runs incorporating bends
(Single core PVC cables)

Type of Conductor	Conductor cross-sectional area (mm2)	Factor
Solid or stranded	1	16
	1.5	22
	2.5	30
	4	43
	6	58
	10	105

Table 12D
Conduit factors for runs incorporating bends

Length of run (m)	Conduit diameter (mm)																			
	16	20	25	32	16	20	25	32	16	20	25	32	16	20	25	32	16	20	25	32
	Straight				One bend				Two bends				Three bends				Four bends			
1	Covered by Table 12A and 12B				188	303	543	947	177	286	514	900	158	256	463	818	130	213	388	692
1.5					182	294	528	923	167	270	487	857	143	233	422	750	111	182	333	600
2					177	286	514	900	158	256	463	818	130	213	388	692	97	159	292	529
2.5					171	278	500	878	150	244	442	783	120	196	358	643	86	141	260	474
3					167	270	487	857	143	233	422	750	111	182	333	600				
3.5	179	290	521	911	162	263	475	837	136	222	404	720	103	169	311	563				
4	177	286	514	900	158	256	463	818	130	213	388	692	97	159	292	529				
4.5	174	282	507	889	154	250	452	800	125	204	373	667	91	149	275	500				
5	171	278	500	878	150	244	442	783	120	196	358	643	86	141	260	474				
6	167	270	487	857	143	233	422	750	111	182	333	600								
7	162	263	475	837	136	222	404	720	103	169	311	563								
8	158	256	463	818	130	213	388	692	97	159	292	529								
9	154	250	452	800	125	204	373	667	91	149	275	500								
10	150	244	442	783	120	196	358	643	86	141	260	474								

Table 4B

Allowance for diversity

Purpose of final circuit fed from conductors or switchgear to which diversity applies	Type of premises		
	Individual household installations, including individual dwellings of a block	**Small shops, stores, offices and business premises**	**Small hotels, boarding houses, guest houses, etc.**
1. Lighting	66% of total current demand	90% of total current demand	75% of total current demand
2. Heating and power (but see 3 to 8 below)	100% f.l. of total demand up to 10A + 50% of any current demand in excess of 10A	100% f.l. of largest appliance + 75% f.l. of remaining appliances	100% f.l. of largest appliance + 80% f.l. of 2nd largest appliance + 60% f.l. of remaining appliances
3. Cooking appliances	10A + 30% f.l. of connected cooking appliances in excess of 10A + 5A if socket outlet incorporated in unit	100% f.l. of largest appliances + 80% f.l. of 2nd largest appliance + 60% f.l. of remaining appliances	100% f.l. of largest appliances + 80% f.l. of 2nd largest appliance + 60% f.l. of remaining appliances
4. Motors (other than lift motors which are subject to special consideration)		100% f.l. of largest motor + 80% f.l. of 2nd largest motor + 60% f.l. of remaining motor	100% f.l. of largest motor + 50% f.l. of remaining motor
5. Water heater (instantaneous type)	100% f.l. of largest appliance + 100% f.l. of 2nd largest appliance + 25% f.l. of remaining appliances	100% f.l. of largest appliance + 100% f.l. of 2nd largest appliance + 25% f.l. of remaining appliances	100% f.l. of largest appliance + 100% f.l. of 2nd largest appliance + 25% f.l. of remaining appliances
6. Water heater (thermostatically controlled)	No diversity allowable		
7. Floor warming installations	(Reserved for future use)		
8. Thermal storage space heating installations	(Reserved for future use)		
9. Standard arrangement of final circuits	100% of current demand of largest circuit + 40% of current demand of every other circuit	100% of current demand of largest circuit + 50% of current demand of every other circuit	
10. Socket outlets other than include in 9 above and stationary equipment other than those listed above	100% of current demand of largest point of utilisation + 40% of current demand of every other point of utilisation	100% of current demand of largest point of utilisation + 75% of current demand of every other point of utilisation	100% of current demand of largest point of utilisation + 75% of current demand of every point in main rooms (dining rooms, etc) + 40% of current demand of every other point of utilisation

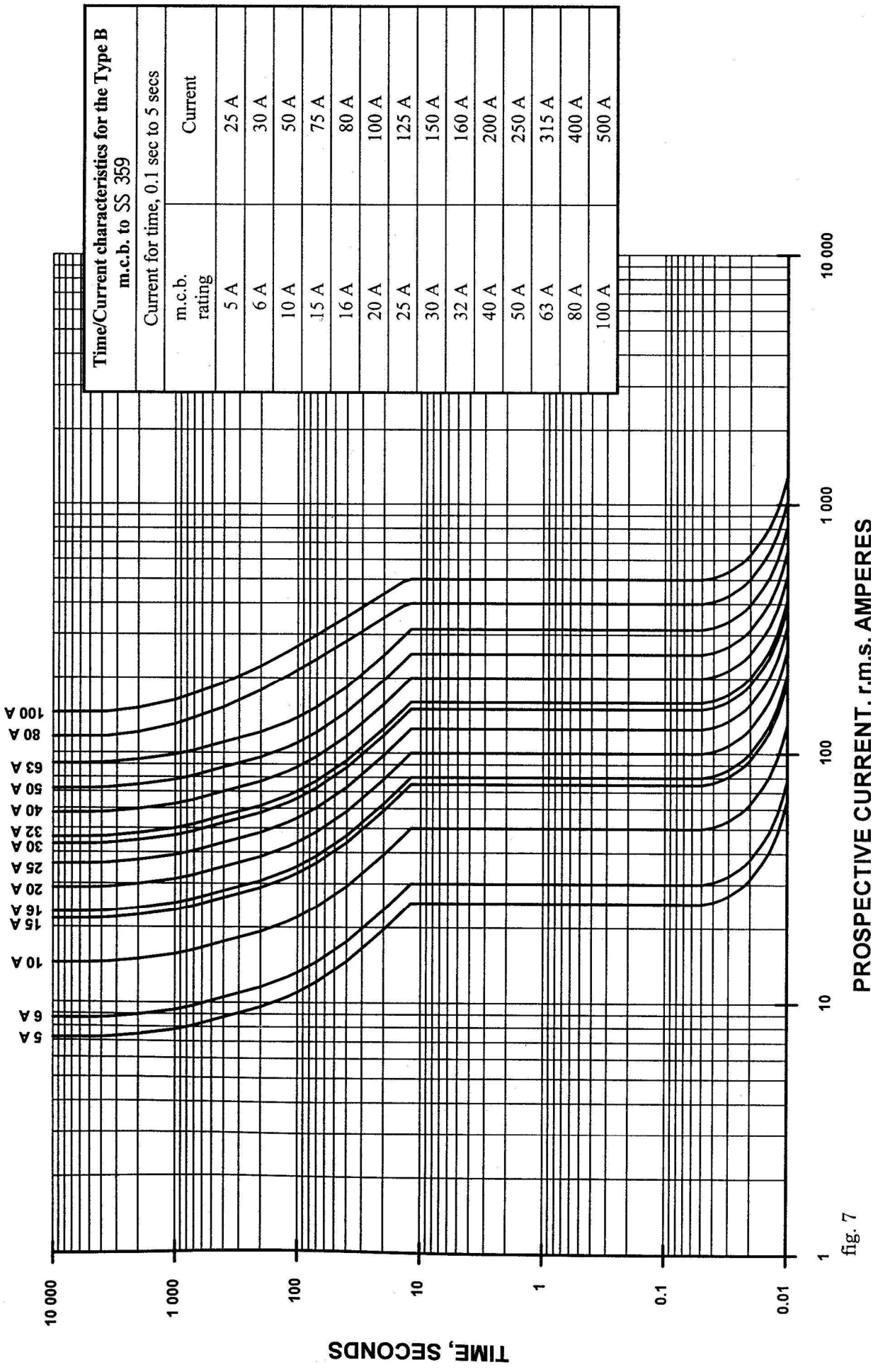
Time/Current characteristics for the Type B m.c.b. to SS 359
Current for time, 0.1 sec to 5 secs
m.c.b. rating
Current
5 A 25 A
6 A 30 A
10 A 50 A
15 A 75 A
16 A 80 A
20 A 100 A
25 A 125 A
30 A 150 A
32 A 160 A
40 A 200 A
50 A 250 A
63 A 315 A
80 A 400 A
100 A 500 A
TIME, SECONDS
10 000
1 000
100
10
1
0.1
0.01
PROSPECTIVE CURRENT. r.m.s. AMPERES
10 000
1 000
100
10
1
5 A
6 A
10 A
15 A
16 A
20 A
25 A
30 A
32 A
40 A
50 A
63 A
80 A
100 A

fig. 7