2019/2020 S2 ET0050

1a) Voltage = 22kV

Phase : 3 phase

Number of wires: 3-wire

Earthing system : TNS

$$\text{Max Current} = \frac{3\times10^{6}}{22\times10^{3}\times\sqrt{3}} = 78.73 \text{ A}$$

$$\text{Max Power} = 3\times10^{6}\times 0.85 = 2\,550\,000 \text{ W}$$

$$= 2550 \text{ kW}$$

b) Electrical separation uses an isolating transformer where the secondary is not earthed to prevent an electric shock through contact with exposed conductive parts which might be energised by a fault in the basic insulation of the cable.

The power supply to the 13A switched socket outlet is supplied by an isolating transformer. Therefore, a fault on the equipment connected to the switched socket outlet will not result in an electric shock through direct contact with the exposed conductive parts.

Q2. The 50A must be totally enclosed with all live parts totally protected from direct contact. Socket outlets must be equipped with MCB and RCCB.

110V — yellow

230V — blue

400V — red

Maximum number of 16A 2-pole and earth socket outlets that can be fed from a 32A, single phase, 230V source is 6 nos.

(Q3a) Figure Q3(a)(i) Open Ring

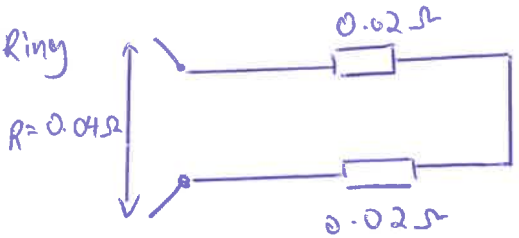
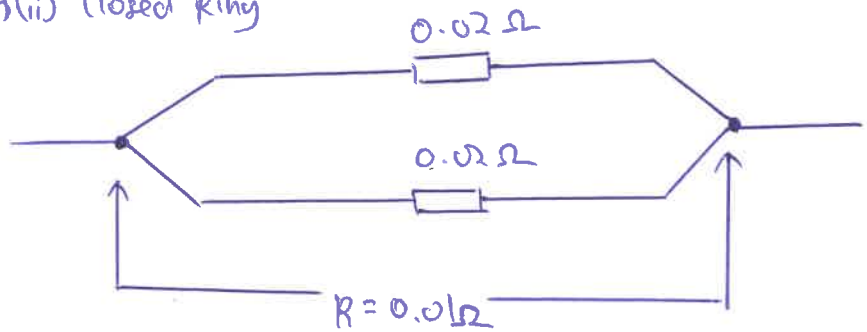


Figure Q3(a)(ii) Closed Ring



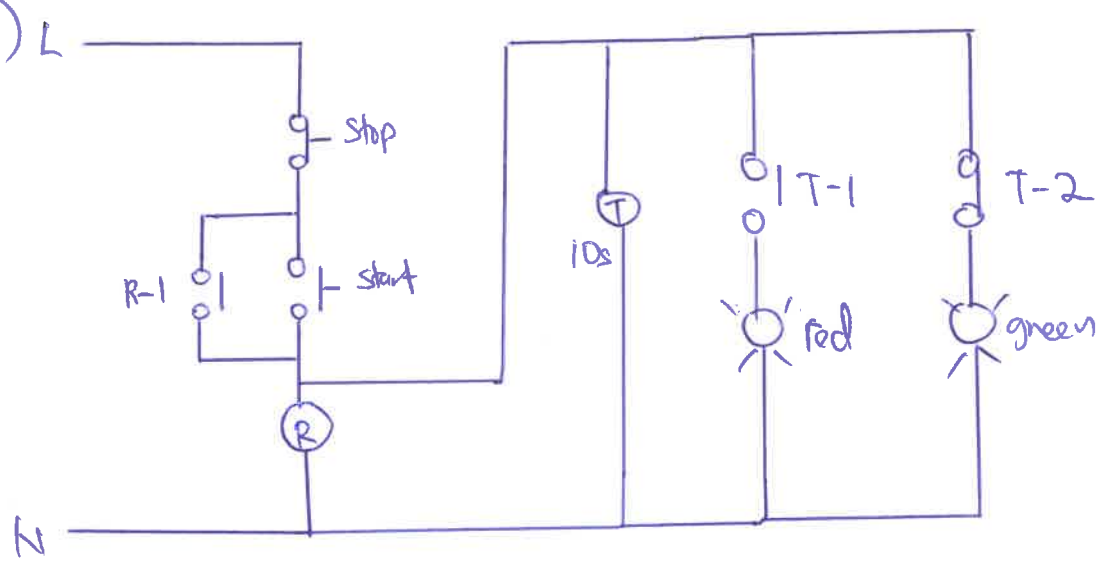
$$\frac{1}{R} = \frac{1}{0.02} + \frac{1}{0.02}$$

$$R = 0.01\,\Omega$$

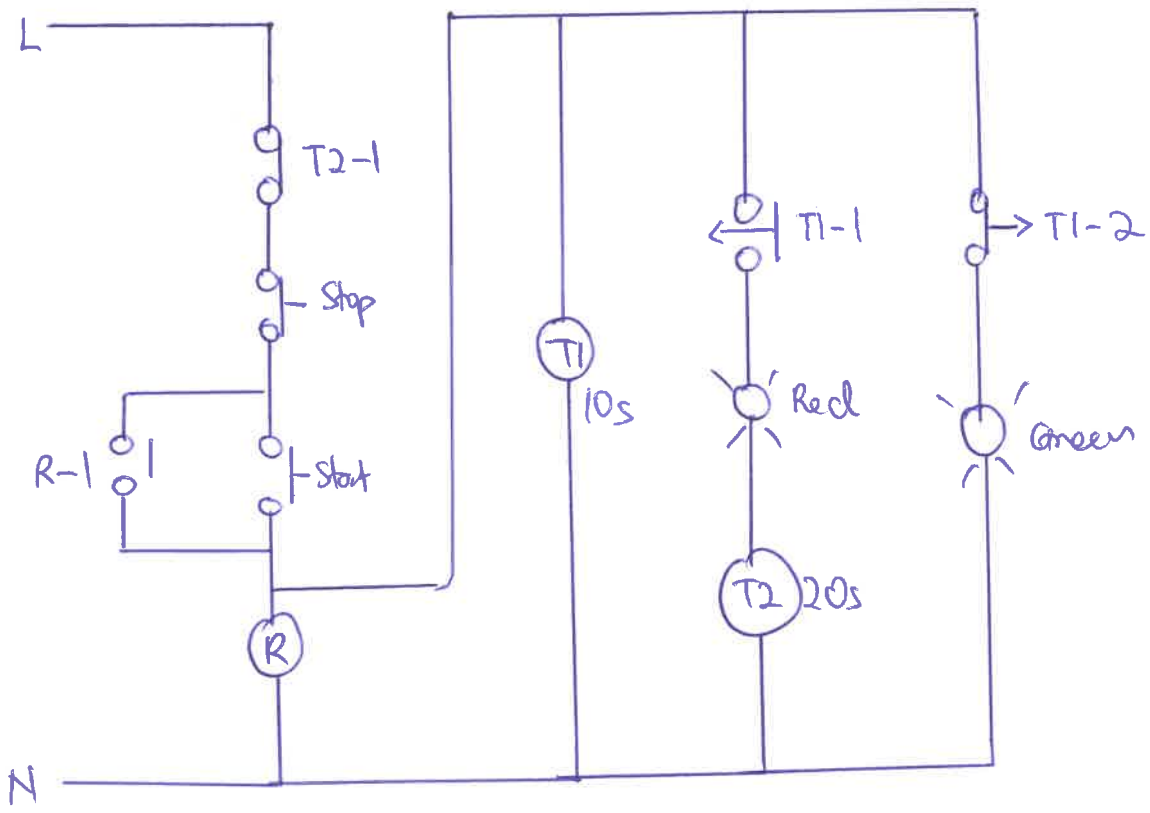
Resistance of closed Ring to mid point value = $0.01\,\Omega$

3b) Double insulated equipment shall not be earthed as doing so could bring in fault voltage from other circuits and causing danger to the user of the double insulated equipment when the fault happens in other circuits.

4a)



4b)



Q5) i) 23 s. Yes, discrimination is achieved.

ii) 15 s. Yes, discrimination is achieved

iii) 1.7 s. Yes, discrimination is achieved

Q6. $Z_{Total} = \frac{V}{I} = \frac{230}{20} = 11.5\ \Omega$

Earth Fault Loop Impedance $= 11.5 - 10.0$

$= 1.5\ \Omega$

For 32A Type B MCB, max earth fault loop impedance base on table 41B2 (2) is 1.43 Ω.

∴ Earth fault loop Impedance of 1.5Ω is not acceptable.

We can use a larger CPC (circuit protective conductor) size.

B1.

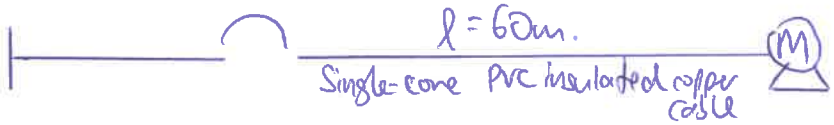
Description	Connected Load	D.F.	Current Demand
10 nos. 2x32W fluorescent lamps	$\frac{(10 \times 2 \times 32 \times 1.8)}{230} = 5.01A$	66%	3.306 A
13A SSO (Largest ckt)	$\frac{3.5 \times 10^3}{230} = 15.22A$	100%	15.22A
13A SSO (Remaining ckts)	$\frac{2 \times 3 \times 10^3}{230} = 26.09A$	40%	10.43A
1st instaneous water heater	$\frac{3 \times 10^3}{230} = 13.04A$	100%	13.04A
2nd instaneous water heater	$\frac{3 \times 10^3}{230} = 13.04A$	100%	13.04A
3rd instaneous water heater	$\frac{3 \times 10^3}{230} = 13.04A$	40%	5.217A
1st storage water heater	$\frac{1.5 \times 10^3}{230} = 6.522A$	100%	6.522A
2nd storage water heater	$\frac{1.5 \times 10^3}{230} = 6.522A$	100%	6.522A
Cooker with SSO	$\frac{5.5 \times 10^3}{230} = 23.91A$ excess = 13.91A SSO = 5 A	1st 10A 30%	10A 4.173A 5 A
			92.47A (1-ϕ)
9.5 kw air-conditioning unit	$\frac{9.5 \times 10^3}{400 \times \sqrt{3} \times 0.85 \times 0.86} = 18.76A$	100%	18.76A (3-ϕ)

i) Three Phase max demand = $\frac{92.47}{3} + 18.76 = 49.58A$.

ii) Suitable Size = $49.58 \times 1.1 = 54.54A$.

∴ Choose 63A TPN MCB.

B2(a)



Ambient temp = 40°C
In trunking with one other circuit (2)

pf = 0.85 lag ; eff = 90% = 0.90

i) $I_B = \frac{9 \times 10^3}{\sqrt{3} \times 400 \times 0.85 \times 0.90} = 16.98\,A$

For motor circuits $I_N \geq 2 \times I_B$

$I_N \geq 2 \times 16.98$

$I_N \geq 33.96\,A$

∴ we will choose 40A TPN MCB

ii) From Table 4B1, $C_g = 0.8$ (2 circuits)

From Table 4C1, $C_a = 0.87$

$C_i = 1.00$

$I_t \geq \frac{I_B}{C_a \times C_g \times C_i}$ (for motor)

$I_t \geq \frac{16.98}{0.8 \times 0.87 \times 1.00}$

$I_t \geq 24.40\,A$

From Table 4D1A, Column 5, we will choose $4mm^2$ cable with current carrying capacity of 32A.

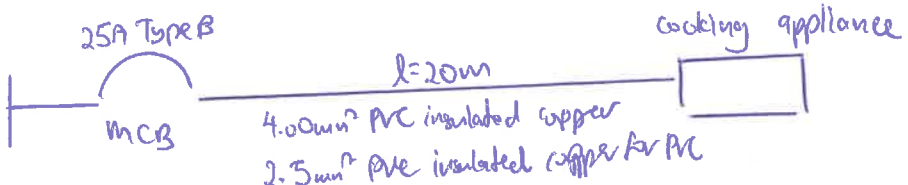
iii) $V_{drop} = \frac{V_{cc} \times I_B \times l}{1000} = \frac{9.5 \times 16.98 \times 60}{1000} = 9.679\,V$

$= 2.42\% < 4\%$ of 400V

$V_{cc} = 9.5$ from Table 4D1B,

The cable size of $4mm^2$ selected can meet the CPS requirement

B2b)



$Z_E = 0.8\,\Omega$

From Table 17A, $R_1 + R_2 = 12.02\ m\Omega/m$

$$Z_s = Z_E + (R_1 + R_2)$$

$$= 0.8 + 1.38\,\frac{(12.02)(20)}{1000}$$

$$= 1.132\,\Omega$$

For 25A Type B MCB, max earth fault loop impedance from Table 41B2 is 2.3Ω.

Since $Z_{s\,(max)} \leq Z_{s\,(a)}$, the 2.5mm² PVC insulated cable meets the shock protection requirement.

$$I_f = \frac{230}{1.132} = 203.2\,A$$

$$k^2S^2 \geq I^2t$$

$$(115^2)(S^2) \geq (203.2^2)(0.1)$$

$$S \geq 0.5588\ mm^2$$

∴ The 2.5mm² CPC meets the thermal constraint requirements.