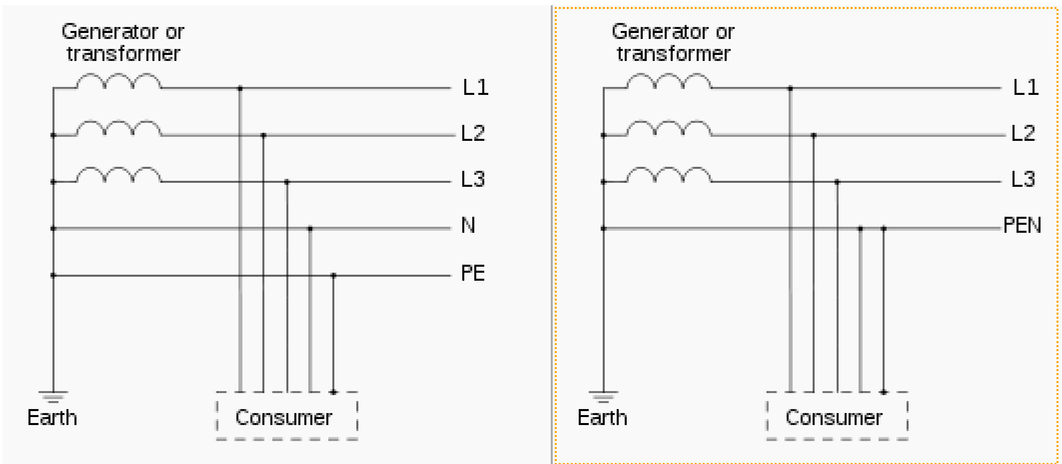
Answers

Q1)

a)

i)



TN-S: separate protective earth (PE) and neutral (N) conductors from transformer to consuming device, which are not connected together at any point after the building distribution point.	**TN-C:** combined PE and N conductor all the way from the transformer to the consuming device.

Since earth fault currents are combined with neutral currents in the TN-C system, it becomes difficult to detect fault currents and operate protective devices at the consumer's installation

b) TT system does not provide a low impedance metallic conductor between enclosures and supply return. Therefore fault current is small. But TN-C-S system provide low impedance metallic conductor between enclosures and supply return. Therefore fault current is large compared to the TT.

c)

i) a) The disconnection time should be according to the regulation

b) $R_A x I_{\Delta n} \leq 50\ V$

ii) $I_f = \frac{230}{30} = 7.7\ A$

iii) $U_f = 7.7 * 20 = 154\ V$

Q2)

a) You must draw the characteristic curve of fuse and mcb in a same graph. Then you can find the operation of both.

b)

- Heaters : $\frac{2000}{230} + \frac{7500}{230} * .75 = 33.16\ A$
- Cooker :$\frac{5000}{230} = 21.7\ A$
- Socket outlet : 30 A
- Water heater=13 A
- Lighting: $\frac{2500}{230} * 0.9 = 9.8\ A$
- Assumed maximum demand= 33.16+21.7+30+9.8=107.7 A

c)

From Table 9A 4mm^2 ($r1$) has a resistance of 4.61mΩ/m and 1.5mm^2 ($r2$) has a resistance of (24.20-12.10)= 12.10 mΩ/m.

36 m will have resistance of: 16.71×36×1.2/1000= 0.72Ω (multiplier 1.2 for temperature correction)

Then Zs = Ze + (R1 + R2)= 0.23 + 0.72 = 0.95Ω

Maximum earth fault current:

$$I_f = \frac{230}{0.95} = 242.1\ A$$

Now use I_f to calculate disconnection time using characteristic curve of the fuse. It will be just below 5 s.

A 70C^0 thermoplastic cable with a copper conductor has a K value of 115.

Now carry out the adiabatic equation to ensure that c.p.c. is large enough.

$$S = \frac{\sqrt{I^2 * t}}{K} = \frac{\sqrt{242.1^2 * 5}}{115} = 4.72\ mm^2$$

This shows that the c.p.c. is too small

- Now use $4mm^2/2.5mm^2$

Now R1 + R2= 12.02 mΩ/m

Total resistance= 12.02×36×1.2/1000=0.52Ω

Then Zs = Ze + (R1 + R2)= 0.23 + 0.52 = 0.75Ω

Now we must calculate maximum earth fault current:

$$I_f = \frac{230}{0.75} = 306\ A$$

Now check disconnection time in Fig 3.3B

Disconnection time is now 3 seconds.

$$S = \frac{\sqrt{I^2 * t}}{K} = \frac{\sqrt{306^2 * 3}}{115} = 4.61\ mm^2$$

This proves 2.5 mm^2 c.p.c. is not enough.

- Now use $4mm^2/4mm^2$

Now R1 + R2= 9.22 mΩ/m

Total resistance= 9.22×36×1.2/1000=0.40Ω

Then Zs = Ze + (R1 + R2)= 0.23 + 0.4 = 0.63Ω

Now we must calculate maximum earth fault current:

$$I_f = \frac{230}{0.63} = 366\ A$$

Now check disconnection time in Fig 3.3B

Disconnection time is now 1.4 seconds.

$$S = \frac{\sqrt{I^2 * t}}{K} = \frac{\sqrt{366^2 * 1.4}}{115} = 3.76\ mm^2$$

This proves 4 mm^2 c.p.c. is suitable.

Q3)

a) See the lecture notes

b) $R = \frac{\rho}{2\pi l} \ln l/r = \frac{100}{2\pi * 2} * \ln \frac{2}{25*10^{-3}} = 34.87\ \Omega$

c)

Electrodes in parallel
Adding chemicals to the soil eg salt
Sharpening the tip of the electrode
Putting gravel stone layer

d) Voltage drop in AB= 0.55*150*50/1000=4.125 V (Phase to phase)

$= \frac{4.125}{\sqrt{3}} = 2.38\ V$ (phase to neutral)

Voltage drop in any one of the lighting circuits= 18*20*0.02=7.2 V

Total voltage drop as a percentage = (7.2+2.38)/230*100=4.2%