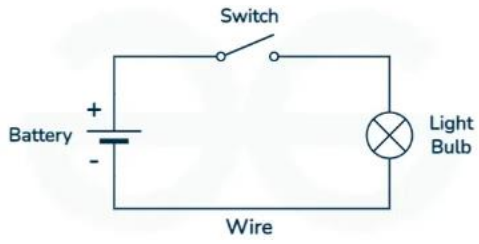
MARKING GUIDE FOR CAT FOR ELECTRICAL CIRCUIT ANALYSIS

SECTION A:

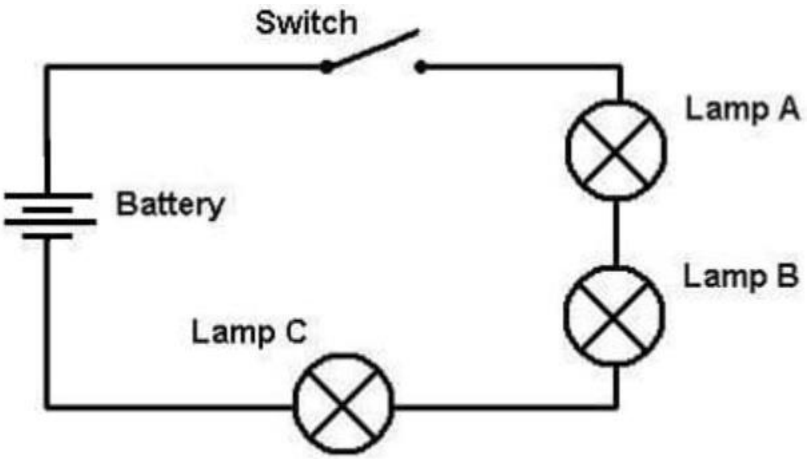
1. A)

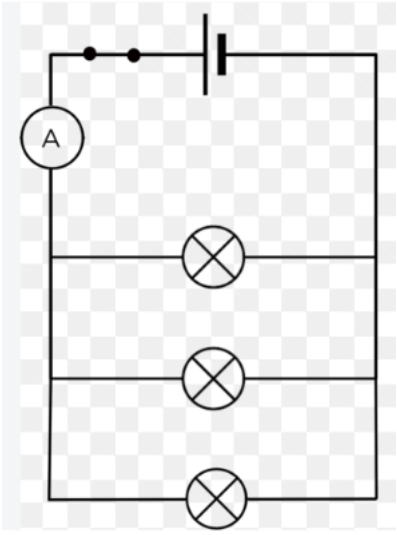


(/2 marks)

B) If the switch is placed on the negative terminal of the battery, when it is switched off, the bulb will be switched off, but the current will continue to reach the bulb. This is why sometimes you can touch the bulb socket and be electrified while is off. It also creates heat in the bulb, which results in damage or reduction of its lifespan. **(/3 marks)**

1.





For series connection, if lamp 1 is damaged, it creates an open circuit (discontinuity), so the other lamps can't be on. Equivalent resistance is also higher for series connection than for parallel, which requires higher voltage in series than in parallel **(/6 marks)**

2. By applying KVL to the two meshes, we get
   5 I1 + 2(I1- I2)=10 10 I2 + 2(I2- I1)=-50.
   Solving the above equations gives.... I1 = 0.25 A and I2 = -4.25 A.

   The negative sign for the current I2 indicates that it flows in the opposite direction to that assumed in the loop two. **(/4 marks)**

3. The number of hours of a light bulb =6 hours per day*30=180 hours.

$$\text{KWh consumed during the month} = \frac{1}{1000} 400 * 1800kwH = 72kwh$$

Amount to pay per month $= 72 * 310$ RWF $= 22{,}320$ RWF **(/5marks)**

SECTION B:

1. Step(1): Here the current source exists between mesh(2) and mesh(3).Hence, super mesh is the combination of mesh(2) and mesh(3).
Applying KVL to the super mesh (combination of mesh 2 and mesh 3 after removing the branch with the current source of 2 A and resistance of 3 Ω) **(/1.5 marks)**

we get:
10(I2– I1) + 2.I2 + I3 + 5(I3 – I1) = 0 -15.I1 +12 I2 + 6.I3 = 0.....(1) **(/1.5 marks)**

Step (2): Applying KVL first to the normal mesh 1 we get : 10(I1 – I2) + 5(I1 – I3) = 50 15.I1 – 10. I2 – 5.I3 = 50.....(2) **(/1.5 marks)**

Step (3): We can get the third equation from the relation between the current source of 2 A, and currents I2 & I3 as: I2 - I3 = 2 A.....(3) **(/1.5 marks)**

Step (4): Solving the above three equations for I1, I2 and I3 we get I1 = 19.99 A I2 = 17.33 A and I3 = 15.33 A The current in the 5 Ω resistance = I1 - I3 = 19.99 - 15.33 = 4.66 A **(/1.5 marks)**

2. In the given circuit 24uF,12uF and 8uF are in series. The equivalent capacitance of this three capacitors is

$$\frac{1}{C_s} = \frac{1}{24\ \mu\text{F}} + \frac{1}{12\ \mu\text{F}} + \frac{1}{8.0\ \mu\text{F}} \qquad \text{or} \qquad C_s = 4.0\ \mu\text{F}$$

This 4.0μF capacitance is in parallel with the 4.0μF capacitance. Then the equivalent capacitance is

$$C_p = 4.0\ \mu\text{F} + 4.0\ \mu\text{F} = 8.0\ \mu\text{F}$$

This 8.0μF,5.0uF and 6.0uF are in series .Hence , the overall equivalent capacitance is

$$\frac{1}{C_s} = \frac{1}{5.0\ \mu\text{F}} + \frac{1}{8.0\ \mu\text{F}} + \frac{1}{6.0\ \mu\text{F}} \qquad \text{or} \qquad C_s = \boxed{2.0\ \mu\text{F}}$$

(/7.5 marks)

SECTION C

Inductive Reactance, X_L.

$$X_L = 2\pi fL = 2\pi \times 50 \times 0.15 = 47.13\Omega$$

Capacitive Reactance, X_C.

$$X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 50 \times 100 \times 10^{-6}} = 31.83\Omega$$

1.

Circuit Impedance, Z

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$Z = \sqrt{12^2 + (47.13 - 31.83)^2}$$

$$Z = \sqrt{144 + 234} = 19.4\Omega$$

Circuits Current, I.

$$I = \frac{V_S}{Z} = \frac{100}{19.4} = 5.14 \text{Amps}$$

Voltages across the Series RLC Circuit, V_R, V_L, V_C.

$$V_R = I \times R = 5.14 \times 12 = 61.7 \text{ volts}$$

$$V_L = I \times X_L = 5.14 \times 47.13 = 242.2 \text{ volts}$$

$$V_C = I \times X_C = 5.14 \times 31.8 = 163.5 \text{ volts}$$

Circuits Power factor and Phase Angle, θ.

$$\cos\phi = \frac{R}{Z} = \frac{12}{19.4} = 0.619$$

(/10marks)