Unit Exam II: Problem #1 (Spring '19)



The circuit shown has reached equilibrium.

- (a) Find the equivalent capacitance C_{eq} .
- (b) Find the charges Q_1 , Q_2 , Q_3 , Q_4 on the four capacitors.
- (c) Find the voltages V_1 , V_2 , V_3 , V_4 across the four capacitors. C



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Solution:

(a)
$$C_{34} = C_3 + C_4 = 2\text{pF}, \quad C_{eq} = \left(\frac{1}{C_1} + \frac{1}{C_{34}} + \frac{1}{C_2}\right)^{-1} = \frac{1}{2}\text{pF}.$$

(b) $Q_1 = Q_2 = Q_{34} = C_{eq}(6\text{V}) = 3\text{pC}, \quad Q_3 = Q_4 = \frac{1}{2}Q_{34} = 1.5\text{pC}.$
(c) $V_1 = \frac{Q_1}{C_1} = 1.5\text{V}, \quad V_2 = \frac{Q_2}{C_2} = 3\text{V}, \quad V_3 = \frac{Q_3}{C_3} = 1.5\text{V}, \quad V_4 = \frac{Q_4}{C_4} = 1.5\text{V}.$



The circuit shown is in a steady state with the switch S either open or closed.

- (a) Find the equivalent resistance R_{eq} when the switch is open.
- (b) Find the currents I_1 and I_2 when the switch is open.
- (c) Find the equivalent resistance R_{eq} when the switch is closed.
- (d) Find the currents I_1 and I_2 when the switch is closed.





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- (a) Find the currents I_1 and I_2 when the switch is open.
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- (c) Find the currents I_1 and I_2 when the switch is closed.
- (d) Find the voltage $V_a V_b$ when the switch is closed.



Solution:

(a)
$$I_1 = I_2 = \frac{4V + 6V}{1\Omega + 4\Omega} = 2A.$$

(b) $V_a - V_b = -(1\Omega)(2A) + 4V = 2V, \quad V_a - V_b = -6V + (4\Omega)(2A) = 2V.$
(c) $I_1 = \frac{6V - 2V}{4\Omega} = 1A, \quad I_2 = \frac{4V + 2V}{1\Omega} = 6A.$
(d) $V_a - V_b = -2V.$