Question 1

Draw the corresponding dual circuit of the circuit shown in Fig. 1.

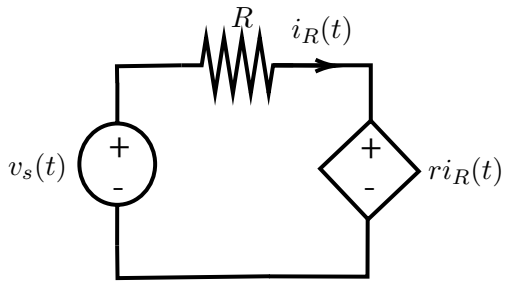

Figure 1: A circuit for which the corresponding dual circuit is required.

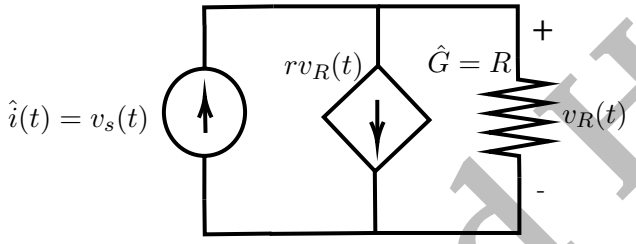

Figure 2: The dual circuit corresponding to the circuit shown in Fig. 1.

The corresponding dual circuit is drawn in Fig. 2. Clearly, for the circuit of Fig. 1, the KVL gives

$$Ri_R(t) + ri_R(t) = v_s(t)$$

while the KCL for the circuit of Fig. 2 yields

$$Rv_R(t) + rv_R(t) = v_s(t)$$

Noting the duality of $v_R(t)$ and $i_R(t)$, the same equation governs both circuits.

Question 2

Consider the circuit graph of Fig. 3 and write KCL and KVL equations for the fundamental cut sets and fundamental loops of a suitable tree. Draw the fundamental cut sets and fundamental loops as well as the tree.

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Question 2 continued on next page...

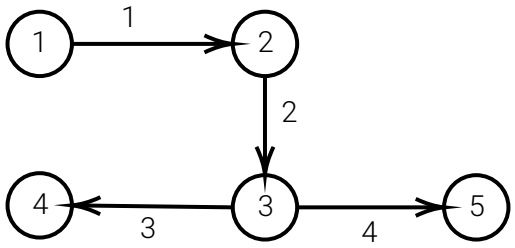

Figure 3: A circuit graph for which the KCL and KVL equations are required.

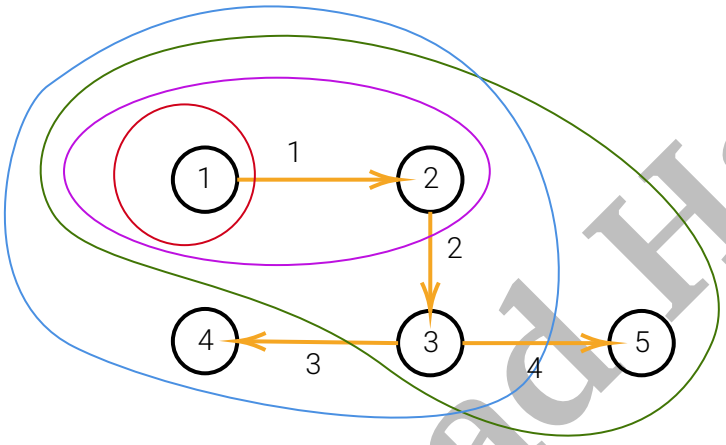

Figure 4: The tree and fundamental cut sets of the circuit graph shown in Fig. 3. There is no fundamental loops.

The graph has a unique tree shown in yellow in Fig. 4. The four cut sets of the tree are shown using colored Gaussian surfaces. Since there is no link branches, no fundamental loop exists. The KCL equations for the fundamental cut sets are

$$j_1 = 0, \quad j_2 = 0, \quad j_3 = 0, \quad j_4 = 0$$

, where $j_i, i = 1, 2, 3, 4$ are branch currents. The KVL equations for the cut set-based description are

$$v_1 = e_1, \quad v_2 = e_2, \quad v_3 = e_3, \quad v_4 = e_4$$

, where $v_i, i = 1, 2, 3, 4$ are branch voltages and $e_i, i = 1, 2, 3, 4$ denote tree branch voltages.

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