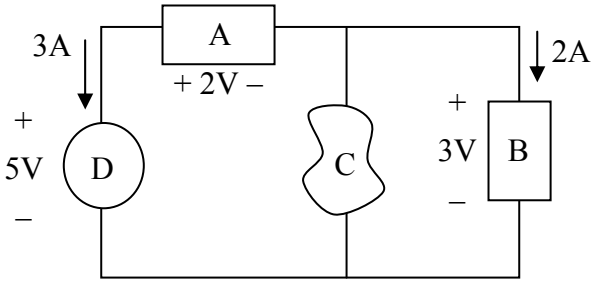
1. There are four fundamental SI units, m, kg, s, and A. Based on these fundamental units, some derived units are often used in electrical circuit analysis, such as J(joule), W(watt), V(volt), C(coulomb), Ω(ohm), and F(farad). Please write the SI units of J, W, V, C, Ω, and F.

Sol:

$$J := \frac{kg \cdot m^2}{s^2}, \quad W := \frac{kg \cdot m^2}{s^3}, \quad V := \frac{kg \cdot m^2}{s^3 \cdot A}, \quad C := A \cdot s, \quad \Omega := \frac{kg \cdot m^2}{s^3 \cdot A^2}, \quad F := \frac{s^4 \cdot A^2}{kg \cdot m^2}$$

2. Determine p_A, p_B, p_C, and p_D, the powers absorbed by the devices in the circuit below.

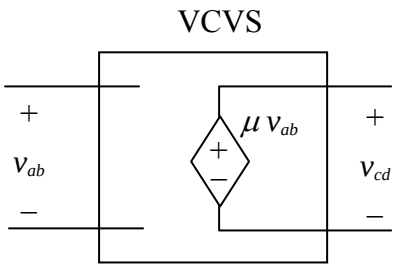


Sol:

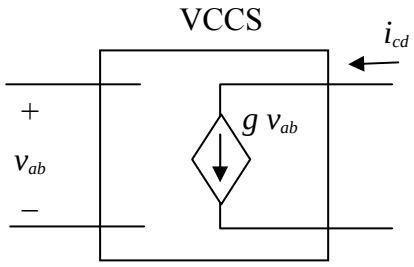
$$p_A = (-3)\cdot 2 = -6\text{W}, \quad p_B = 2\cdot 3 = 6\text{W}, \quad p_C = (-3-2)\cdot 3 = -15\text{W}, \quad p_D = 3\cdot 5 = 15\text{W}$$

3. There are four dependent sources, voltage-controlled voltage source (VCVS), voltage-controlled current source (VCCS), current-controlled voltage source (CCVS), and current-controlled current source (CCCS). Please write their component symbols and control equations.

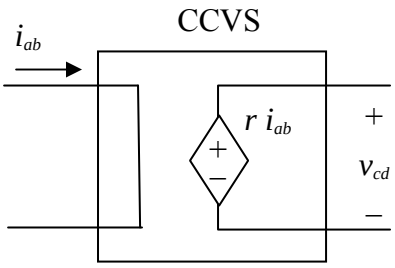
Sol:



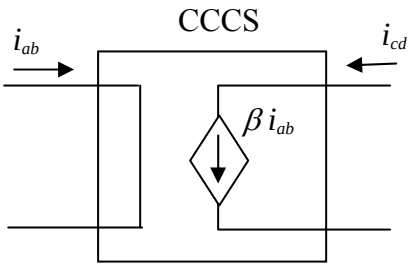
$v_{cd} = \mu\, v_{ab}$



$i_{cd} = g\, v_{ab}$

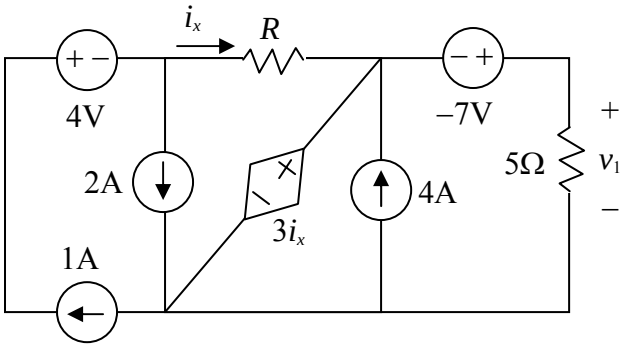


$v_{cd} = r\, i_{ab}$



$i_{cd} = \beta\, i_{ab}$

4. Given the following network, find i_x, v_1, and the power absorbed by the dependent voltage source.



Sol:

$i_x = 1 - 2 = -1\,\text{A}, \quad v_1 = -7 + 3i_x = -10\,\text{V}$

The power absorbed by the dependent voltage source is $(i_x + 4 - \frac{v_1}{5}) \cdot 3i_x = -15\,\text{W}$

5. Determine the capacitance current i_{ab} for $t>0$ if the capacitance is 2μF and the voltage v_{ab} in volts is given as $v_{ab}(t) = 1 - 12e^{-3(t-1)} + 5\sin 2t$ for $t \geq 0$.

Sol:

$$i_{ab}(t) = C\frac{dv_{ab}(t)}{dt} = 2\times10^{-6}\left(36e^{-3(t-1)} + 10\cos 2t\right) = 7.2\times10^{-5}\,e^{-3(t-1)} + 2\times10^{-5}\cos 2t \ \text{A}$$

6. Determine the capacitance voltage v_{ab} for $t \geq 0$ if the capacitance is 3μF, $v_{ab}(0)$ is 1V, and the current i_{ab} in amperes is given as $i_{ab}(t) = 3 + 18e^{-3t} - 6\cos 2t$ for $t \geq 0$.

Sol:

$$v_{ab}(t) = v_{ab}(0) + \frac{1}{C}\int_0^t i_{ab}(\tau)\,d\tau = 1 + \frac{1}{3\times10^{-6}}\left[3\tau - 6e^{-3\tau} - 3\sin 2\tau\right]_0^t$$
$$= 1 + 10^6 \cdot \left(2 + t - 2e^{-3t} - \sin 2t\right)\ \text{V}$$