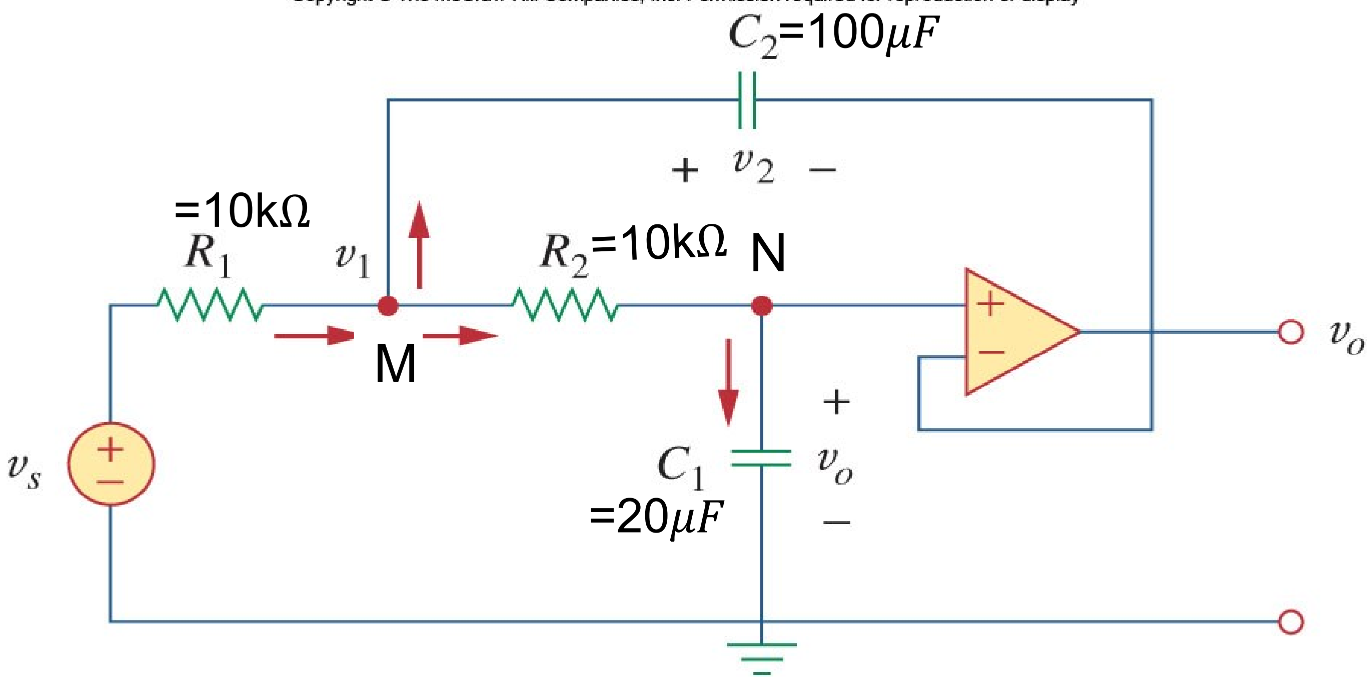
Example of 2nd-order op-amp circuits

- Find v_o for $t > 0$
  when $v_s = 10u(t)mV$.



Initial conditions: $v_o(0^+) = 0$, $C_1 \frac{dv_o(0^+)}{dt} = \frac{v_1(0^+) - v_o(0^+)}{R_2} = \frac{v_2(0^+)}{R_2} = 0$

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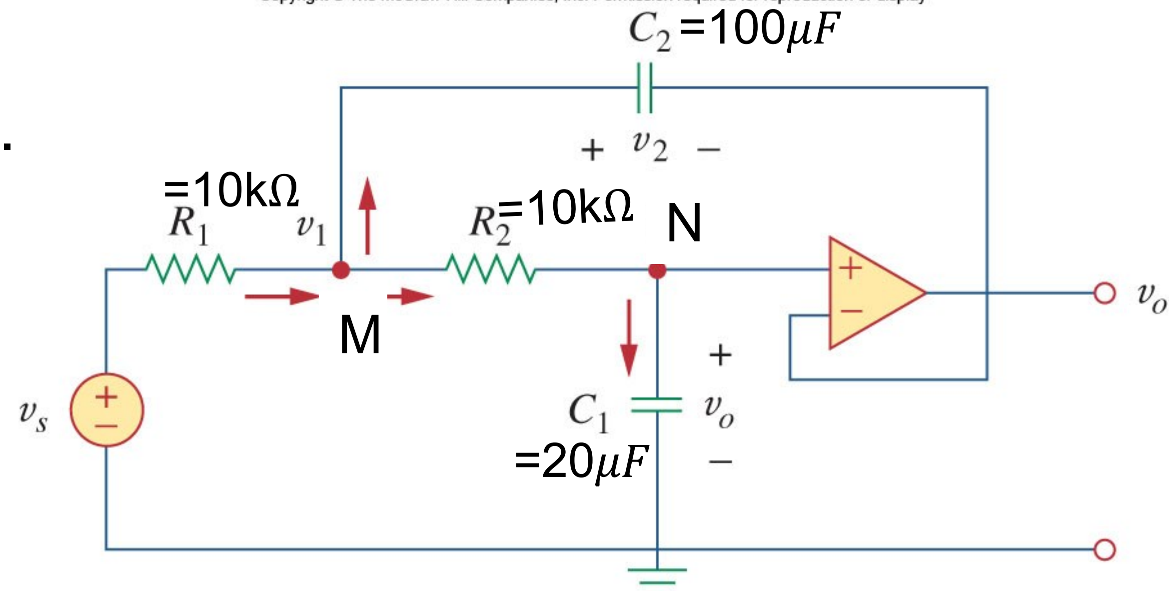

KCL at node M:

$$\frac{v_s - v_1}{R_1} = C_2\frac{dv_2}{dt} + \frac{v_1 - v_o}{R_2}$$

KCL at node N:

$$C_1\frac{dv_o}{dt} = \frac{v_1 - v_o}{R_2}$$

$$and\ we\ have\ v_1 - v_2 = v_o$$

$$\Rightarrow \quad \frac{d^2v_o}{dt^2} + \left(\frac{1}{R_1C_2} + \frac{1}{R_2C_2}\right)\frac{dv_o}{dt} + \frac{v_o}{R_1R_2C_1C_2} = \frac{v_s}{R_1R_2C_1C_2}$$

Example

In the op amp circuit shown in Fig. 8.34, $v_s = 10u(t)$ V, find $v_o(t)$ for $t > 0$. Assume that $R_1 = R_2 = 10\ \text{k}\Omega$, $C_1 = 20\ \mu\text{F}$, and $C_2 = 100\ \mu\text{F}$.