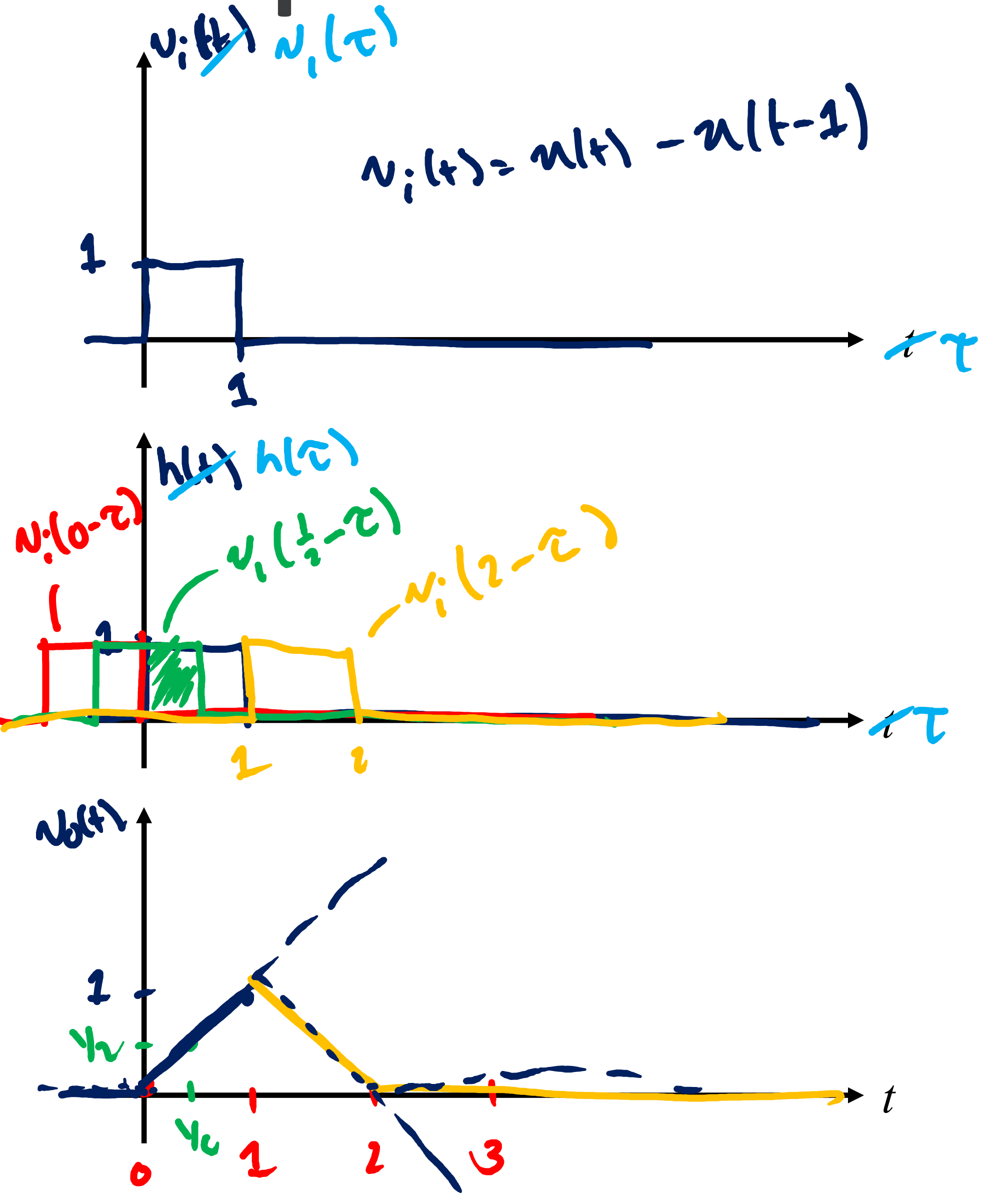
Graphical Convolution

$v_i(t) = u(t) - u(t-1)$



$$v_o(t) = \int_0^{\infty} v_i(t-\tau)\,h(\tau)\,d\tau$$

$$v_o(t) = \begin{cases} 0, & t \le 0 \\ 0, & t \ge 2 \\ \int_0^t 1\,dt, & 0 < t \le 1 \\ \int_{t-1}^{1} 1\,dt, & 1 < t \le 2 \end{cases}$$

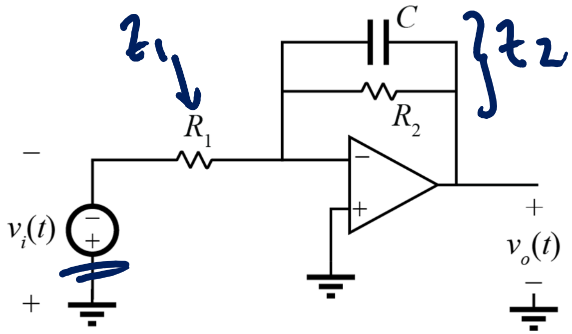
$$v_o(t) = r(t) - 2r(t-1) + r(t-2)$$

$$V_I(s) = \frac{1}{s} - \frac{1}{s}e^{-s} = H(s)$$

$$V_o(s) = V_I(s)H(s) = \frac{1}{s^2} + \frac{1}{s^2}e^{-2s} - 2\frac{1}{s^2}e^{-s}$$

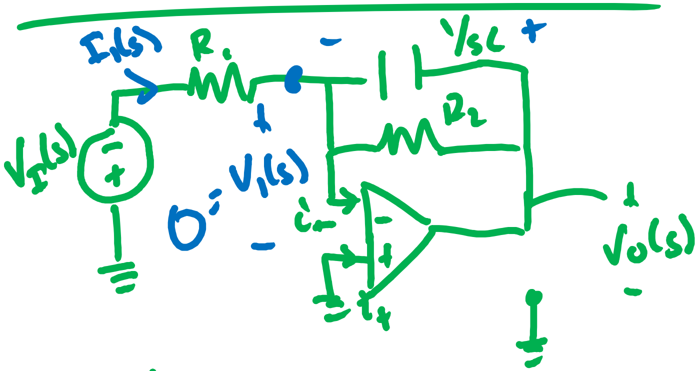
$$v_o(t) = r(t) - 2r(t-1) + r(t-2)$$

Example Problem



from 201: inverting op-amp

$$V_o(s) = -\left(-\frac{Z_2}{Z_1}\right) V_I(s)$$



Ideal op-amp assumptions

(1) virtual short $v_+ = v_-$

(2) $i_+ = i_- = 0$

$$I_1(s) = \frac{-V_I(s)}{R_1} \leftarrow Z_1$$

Z_2 ↓

$$V_o(s) = 0 + (-I_1(s))\left(\frac{1}{sC} \| R_2\right)$$

$$= \frac{1}{R_1} V_I(s) \frac{R_2/sC}{R_2 + \frac{1}{sC}}$$

$$= \frac{1}{R_1} \frac{R_2}{R_2 sC + 1} V_I(s)$$