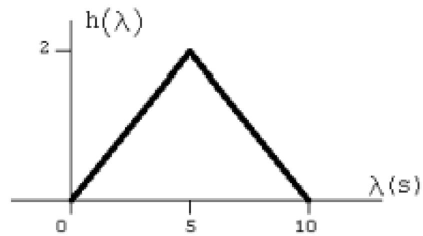
EENG382 HW06 – AUTHOR'S SOLUTIONS

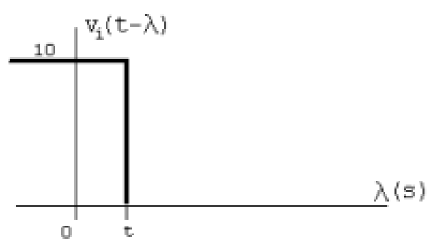
NOTE: I have not yet verified that the author's solutions are, in fact, correct.

Prob 13.68

P 13.68 **[a]** $h(\lambda) = \frac{2}{5}\lambda \qquad 0 \le \lambda \le 5$

$$h(\lambda) = \left(4 - \frac{2}{5}\lambda\right) \qquad 5 \le \lambda \le 10$$





$0 \le t \le 5$:

$$v_o = 10\int_0^t \frac{2}{5}\lambda\,d\lambda = 2t^2$$

$5 \le t \le 10$:

$$v_o = 10\int_0^5 \frac{2}{5}\lambda\,d\lambda + 10\int_5^t \left(4 - \frac{2}{5}\lambda\right)\,d\lambda$$

$$= \frac{4\lambda^2}{2}\Big|_0^5 + 40\lambda\Big|_5^t - \frac{4\lambda^2}{2}\Big|_5^t$$

$$= -100 + 40t - 2t^2$$

$10 \le t \le \infty$:

$$v_o = 10\int_0^5 \frac{2}{5}\lambda\,d\lambda + 10\int_5^{10} \left(4 - \frac{2}{5}\lambda\right)\,d$$

Prob 13.68 (Cont'd)

$$= \frac{4\lambda^2}{2}\Big|_0^5 + 40\lambda\Big|_5^{10} - \frac{4\lambda^2}{2}\Big|_5^{10}$$

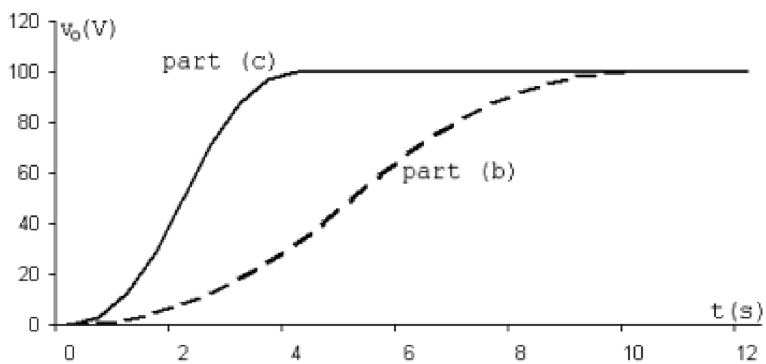
$$= 50 + 200 - 150 = 100$$

$$v_o = 2t^2\,\text{V} \qquad 0 \le t \le 5$$

$$v_o = 40t - 100 - 2t^2\,\text{V} \qquad 5 \le t \le 10$$

$$v_o = 100\,\text{V} \qquad 10 \le t \le \infty$$

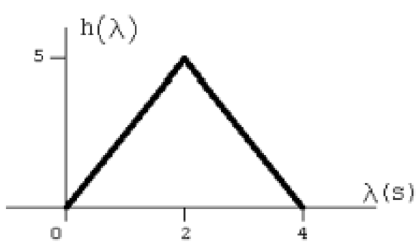
[**b**]



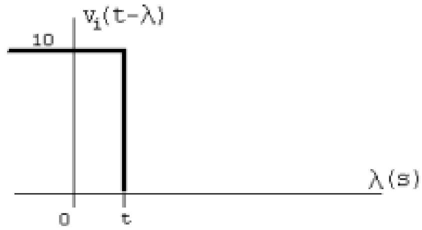
[**c**] Area $= \frac{1}{2}(10)(2) = 10 \quad \therefore \quad \frac{1}{2}(4)h = 10 \quad \text{so} \quad h = 5$

$$h(\lambda) = \frac{5}{2}\lambda \qquad 0 \le \lambda \le 2$$

$$h(\lambda) = \left(10 - \frac{5}{2}\lambda\right) \qquad 2 \le \lambda \le 4$$



Prob 13.68 (Cont'd)



$0 \le t \le 2$:

$$v_o = 10 \int_0^t \frac{5}{2}\lambda \, d\lambda = 12.5t^2$$

$2 \le t \le 4$:

$$v_o = 10 \int_0^2 \frac{5}{2}\lambda \, d\lambda + 10 \int_2^t \left(10 - \frac{5}{2}\lambda\right) \, d\lambda$$

$$= \frac{25\lambda^2}{2} \Big|_0^2 + 100\lambda \Big|_2^t - \frac{25\lambda^2}{2} \Big|_2^t$$

$$= -100 + 100t - 12.5t^2$$

$4 \le t \le \infty$:

$$v_o = 10 \int_0^2 \frac{5}{2}\lambda \, d\lambda + 10 \int_2^4 \left(10 - \frac{5}{2}\lambda\right) \, d\lambda$$

$$= \frac{25\lambda^2}{2} \Big|_0^2 + 100\lambda \Big|_2^4 - \frac{25\lambda^2}{2} \Big|_2^4$$

$$= 50 + 200 - 150 = 100$$

$v_o = 12.5t^2 \text{ V} \qquad 0 \le t \le 2$

$v_o = 100t - 100 - 12.5t^2 \text{ V} \qquad 2 \le t \le 4$

$v_o = 100 \text{ V} \qquad 4 \le t \le \infty$

[d] The waveform in part (c) is closer to replicating the input waveform because in part (c) $h(\lambda)$ is closer to being an ideal impulse response. That is, the area was preserved as the base was shortened.

Prob 13.78

P 13.78 $$V_o = \frac{50}{s+8000} - \frac{20}{s+5000} = \frac{30(s+3000)}{(s+5000)(s+8000)}$$

$$V_o = H(s)V_g = H(s)\left(\frac{30}{s}\right)$$

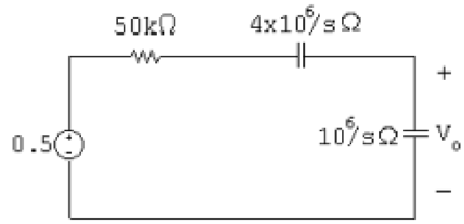
$$\therefore \quad H(s) = \frac{s(s+3000)}{(s+5000)(s+8000)}$$

$$H(j6000) = \frac{(j6000)(3000+j6000)}{(5000+j6000)(8000+j6000)} = 0.52\underline{/66.37^\circ}$$

$$\therefore \quad v_o(t) = 61.84\cos(6000t + 66.37^\circ)\,\text{V}$$

Prob 13.89

P 13.89 [a]



$$V_o = \frac{0.5}{50{,}000 + 5\times 10^6/s}\cdot\frac{10^6}{s}$$

$$\frac{500{,}000}{50{,}000s + 5\times 10^6} = \frac{10}{s+100}$$

$$v_o = 10e^{-100t}u(t)\,\text{V}$$

[b] At $t = 0$ the current in the $1\,\mu$F capacitor is $10\delta(t)\,\mu$A

$$\therefore \qquad v_o(0^+) = 10^6\int_{0^-}^{0^+} 10\times 10^{-6}\delta(t)\,dt = 10\,\text{V}$$

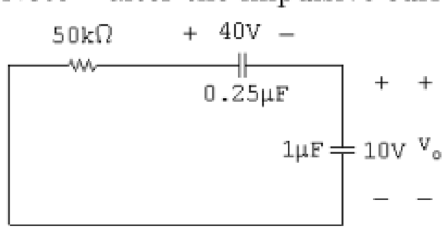
After the impulsive current has charged the $1\,\mu$F capacitor to 10 V it discharges through the 50 kΩ resistor.

$$C_e = \frac{C_1C_2}{C_1+C_2} = \frac{0.25}{1.25} = 0.2\,\mu\text{F}$$

$$\tau = (50{,}000)(0.2\times 10^{-6}) = 10^{-2}$$

$$\frac{1}{\tau} = 100 \text{ (checks)}$$

Note – after the impulsive current passes the circuit becomes



The solution for v_o in this circuit is also

$$v_o = 10e^{-100t}u(t)\,\text{V}$$