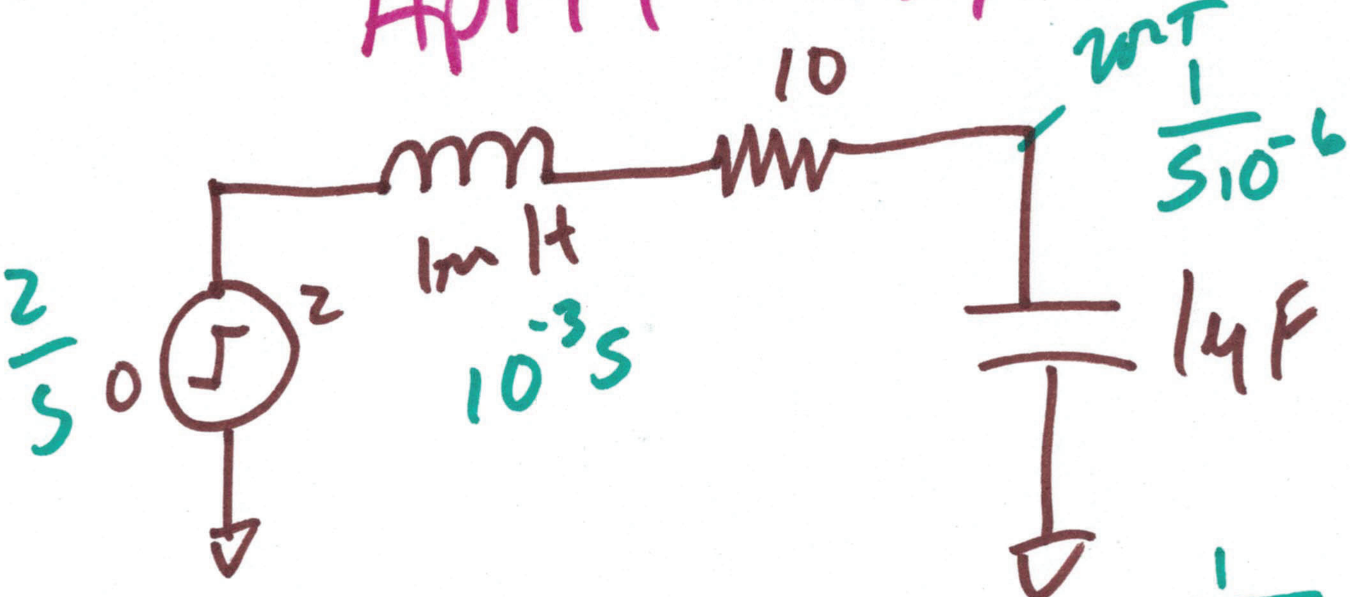
Midterm 2 study session

April 13, 2021



$$v_{OUT} = \frac{2}{s} \cdot \frac{\frac{1}{s \cdot 10^{-6}}}{\frac{1}{s \cdot 10^{-6}} + 10 + 10^{-3}s}$$

1)

$$V_{out}(s) = \frac{2}{s} \cdot \frac{1}{1 + s \cdot 10^{-5} + s^2 \cdot 10^{-9}}$$

$$= \frac{2 \cdot 10^9}{s\left(s^2 + s \cdot 10^4 + 10^9\right)} = \frac{2 \cdot 10^9}{s(s-p_1)(s-p_2)}$$

$$\frac{2 \cdot 10^9 \cdot \cancel{s}}{\cancel{s}(\cancel{s}^{0}-p_1)(\cancel{s}^{0}-p_2)} = \frac{A \cdot \cancel{s}}{\cancel{s}} + \frac{\cancel{B}^{0} \cdot \cancel{s}^{0}}{\cancel{s}-p_1} + \frac{\cancel{C}^{0} \cdot s}{\cancel{s}-p_2}$$

multiply through by s, $s = 0$

$$A = \frac{2 \cdot 10^9}{(-p_1)(-p_2)}$$

$s^2 + 5\cdot 10^4 + 10^9$

$$P_1, P_2 = \frac{-10^4 \pm \sqrt{10^8 - 4\cdot 10^9}}{2}$$

$$= -5k \pm j31.25k$$

$$P_1 = -5k + j31.25k = 31.65k \angle -81$$

$$P_2 = -5k - j31.25k = 31.65k \angle 81$$

$$\frac{2\cdot 10^9 \cancel{(s-p_1)}}{s\cancel{(s-p_1)}(s-p_2)} = \frac{A(s-p_1)}{s} + \frac{B\cancel{(s-p_1)}}{\cancel{s-p_1}} + \frac{C(s-p_1)}{s-p_2}$$

$$B = \frac{2\cdot 10^9}{p_1\cdot(p_1-p_2)}$$

$$C = \frac{2\cdot 10^9}{p_2(p_2-p_1)}$$

$$V_{OUT}(s) = \frac{A}{s} + \frac{B}{s-p_1} + \frac{C}{s-p_2}$$

$$v_{OUT}(t) = A\,u(t) + B e^{p_1 t} u(t) + C e^{p_2 t} u(t)$$

$$A = \frac{2 \cdot 10^9}{(-p_1)(-p_2)} = \frac{2 \cdot 10^9}{(31.65k \angle -81)(31.65k \angle 81)}$$

$$\boxed{A = 2}$$

$$B = \frac{2 \cdot 10^9}{31.65k \angle -81 \cdot \left(-5k + j31.25k - \left(-5k - j31.25k\right)\right)}$$

$$= \frac{2 \cdot 10^9}{31.65k \angle -81 \cdot (j31.25k)(2)}$$

$$= \frac{2 \cdot 10^9}{31.65k \angle -81 \cdot 62.5k \angle 90}$$

$$\boxed{B = 1 \angle -9}$$

$B = 1e^{-j9}$

$$C = \frac{2 \cdot 10^9}{P_2(P_2 - P_1)} = \frac{2 \cdot 10^9}{31.65k\angle 81 \cdot ((-5k - j31.25k) - (-5k + j31.25k))}$$

$$C = \frac{2 \cdot 10^9}{31.65k\angle 81 \cdot (-j62.5k)}$$

$$= \frac{2 \cdot 10^9}{31.65k\angle 81 \cdot 62.5k\angle -90}$$

$$\boxed{C = 1\angle 9} = 1e^{j9}$$

Euler's theorem $x + jy = A\angle\theta = Ae^{j\theta}$

$$Ae^{j\theta} = A\cos\theta + Aj\sin\theta$$

$$\angle = \tan^{-1}\frac{im}{Re} = \tan^{-1}\frac{A\sin\theta}{A\cos\theta}$$

$$= \tan^{-1}\tan\theta$$

$$= \theta$$

$$|\,| = \sqrt{(A\cos\theta)^2 + (A\sin\theta)^2}$$

$$= \sqrt{A^2\cdot(\cos^2\theta + \sin^2\theta)}$$

$$= A\cdot\sqrt{\cos^2\theta + \sin^2\theta}$$

$$= A$$

UNLV | ELECTRICAL & COMPUTER ENGINEERING

CMOSedu.com

$$v_{\Omega T} = 2 \cdot u(t) + B e^{p_1 t} \cdot u(t) + C e^{p_2 t} \cdot u(t)$$

$$= 2u(t) + e^{-j9} e^{(-5k + j31.25k)\cdot t} \cdot u(t)$$

$$+ e^{+j9} \cdot e^{(-5k - j31.25k)\cdot t} \cdot u(t)$$

$$= 2 + e^{(-5kt + j31.25kt - j9)} + e^{(-5kt - j31.25kt + j9)}$$

$5k = \frac{1}{200\mu}$

$$\cos x = \frac{e^{jx} + e^{-jx}}{2}$$

$$e^{(a+x)} + e^{(a+y)}$$

$$= e^{a} \cdot (e^{x} + e^{y})$$

a)

$$v_{OUT}(t) = 2 + 2e^{-\frac{t}{200\mu}} \cdot \left(\frac{e^{j31.25Kt - j9} + e^{-j31.25Kt + j9}}{2} \right)$$

$$\frac{e^{j(31.25Kt - 9)} + e^{-j(31.25Kt - 9)}}{2} \rightarrow \cos(31.25Kt - 9)$$

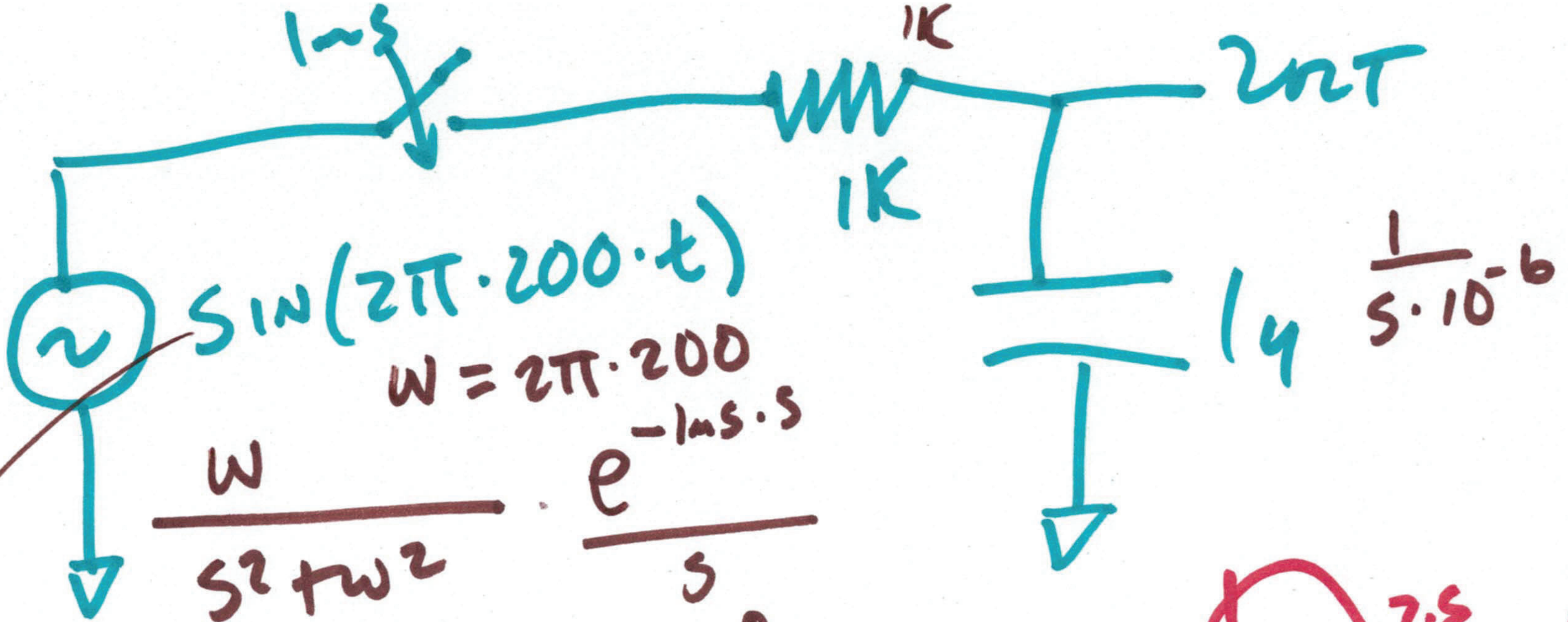
$$\boxed{v_{OUT}(t) = \left(2 + 2e^{-t/200\mu} \cdot \cos(31.25Kt - 9)\right) \cdot u(t)}$$

$$5K = \frac{31{,}250}{2\pi}$$

UNLV | ELECTRICAL & COMPUTER ENGINEERING

CMOSedu.com

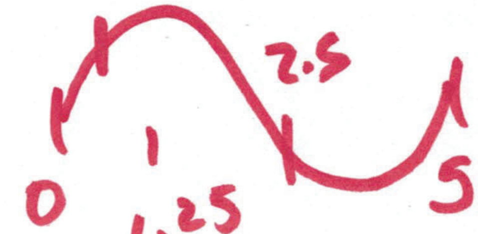
10)



$\omega = 2\pi\cdot 200$

$$\frac{\omega}{s^2+\omega^2}\cdot\frac{e^{-1ms\cdot s}}{s}$$

$$\sin(2\pi\cdot 200\cdot t)\cdot u(t-1ms)$$



$$v_{out}(s) = \frac{\omega}{s^2+\omega^2}\cdot\frac{e^{-1ms\cdot s}}{s}\cdot\frac{\frac{1}{s\cdot10^{-6}}}{\frac{1}{s\cdot10^{-6}}+10^3}$$

$$= \frac{\omega}{s^2+\omega^2} \cdot \frac{e^{-1ms}}{s} \cdot \frac{1}{1+s\cdot 10^{-3}} \cdot \frac{10^3}{10^3}$$

← move to other side or just Add $u(t-1ms)$ at end

$$= \frac{2\pi \cdot 200 \cdot 10^3}{s^2+(2\pi\cdot 200)^2} \cdot \left(\frac{e^{-1ms}}{s}\right) \cdot \frac{1}{s+10^3}$$

e^{+1ms} scares me :)

$$e^{+1ms\,s} V_{out}(s) = \frac{2\pi\cdot 200\cdot 10^3 \cancel{e^{-1ms\,s} \cdot e^{+1ms}}}{(s-p_1)(s-p_2)\cancel{(s)}(s+10^3)}$$

let $\cancel{x}$ $Y = 2\pi\cdot 200\cdot 10^3$

$$\frac{1}{s^2 + w^2} = \frac{1}{(s - p_1)(s - p_2)} = \frac{1}{(s - jw) \cdot (s + jw)}$$

$$p_{1,2} = \frac{\pm\sqrt{-4w^2}}{2} = \pm jw$$

$$p_1 = jw$$

$$p_2 = -jw$$

$$e^{+1-s} \cdot V_{OUT}(s) = \frac{Y}{(s-p_1)(s-p_2)(s)\cdot(s+10^3)} =$$

$$\frac{A}{s-p_1} + \frac{B}{s-p_2} + \cancel{\frac{C}{s}} + \frac{D}{s+10^3}$$

$$A = \frac{Y}{(p_1-p_2)\cancel{(p_1)}(p_1+10^3)}$$

$$B = \frac{Y}{(p_2-p_1)\cancel{(p_2)}(p_2+10^3)}$$

$$C = \cancel{\frac{Y}{(-P_1)(-P_2)10^3}}$$

$$D = \frac{Y}{(-10^3 - P_1)(-10^3 - P_2)\cancel{(-10^3)}}$$

$P_1 = j\omega = \omega \angle 90$

$P_2 = -j\omega = \omega \angle -90$

$$A = \frac{2\pi \cdot 200 \cdot 10^3}{(jw - (-jw))\,\cancel{(w\angle 90)}\,(jw + 10^3)}$$

$$2w\angle 90 \cdot w\angle 90 \cdot 1605\angle 51.5$$

$$\sqrt{(2\pi \cdot 200)^2 + (10^3)^2} = 1605$$

$$\tan^{-1}\frac{2\pi \cdot 200}{10^3} = 51.5^\circ$$

$$250\mu\angle 129$$

$$A = \frac{\cancel{2\pi \cdot 200 \cdot 10^3}}{2 \cdot \cancel{2\pi \cdot 200} \cdot \cancel{2\pi \cdot 200} \cdot 1605\angle 90\ \cancel{+90}\ +51.5}$$

$$v_{out}(t) = \left(A e^{p_1 t} + B e^{p_2 t} + \cancel{C} + D e^{-t/10^{-3}}\right) \cdot u(t - 1ms)$$

NO

Recalculate

$$A = 250\mu \angle 129 = 250\mu\, e^{j129}$$

$$B = 250\mu\, e^{-j129}$$

$$\cancel{C = \frac{2\pi \cdot 200 \cdot 10^{3}}{(-j\omega)(j\omega) \cdot 10^{?}}} = \cancel{\frac{2\pi\,200}{2\pi \cdot 200 \cdot 2\pi \cdot 200}}$$

$$\cancel{C = 7964}$$

$$D = \frac{2\pi \cdot 200 \cdot \cancel{10^3}}{-\left(-10^3 - j\cdot 2\pi\cdot 200\right)\left(-10^3 - (-j\,2\pi\cdot 200)\right)\cdot \cancel{10^3}}$$

$$= \frac{-2\pi\cdot 200}{10^6 \cancel{- 10^3\cdot j\cdot 2\pi\cdot 200} \cancel{+ 10^3\, j\, 2\pi\cdot 200} + (2\pi\cdot 200)^2}$$

$$D = -\frac{2\pi\cdot 200}{10^6 + (2\pi\cdot 200)^2}$$

$$\boxed{D = -487\mu}$$

$$v_{TT}(t) = \left(250\mu\, e^{j129} \cdot e^{j \cdot 2\pi \cdot 200 \cdot t} + 250\mu\, e^{-j129}\, e^{-j2\pi \cdot 200 \cdot t} + \cancel{796\mu} + (-487\mu)\, e^{-t/10^{-3}}\right) u(t - 1\mu s)$$

$$= \left(500\overset{m}{\mu} \cos(2\pi \cdot 200 \cdot t + 129) + \cancel{796\overset{m}{\mu}} - 487\underset{m}{\mu}\, e^{-\frac{t}{10^{-3}}}\right) u(t - 1\mu s)$$