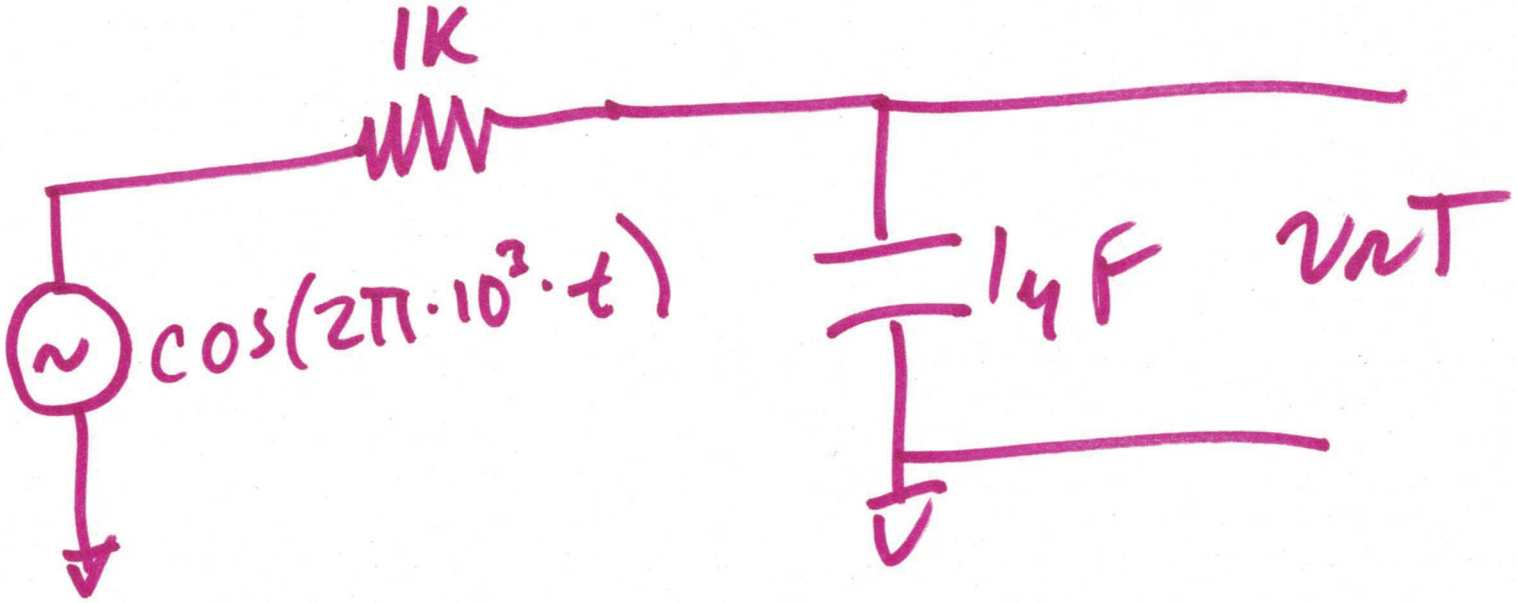
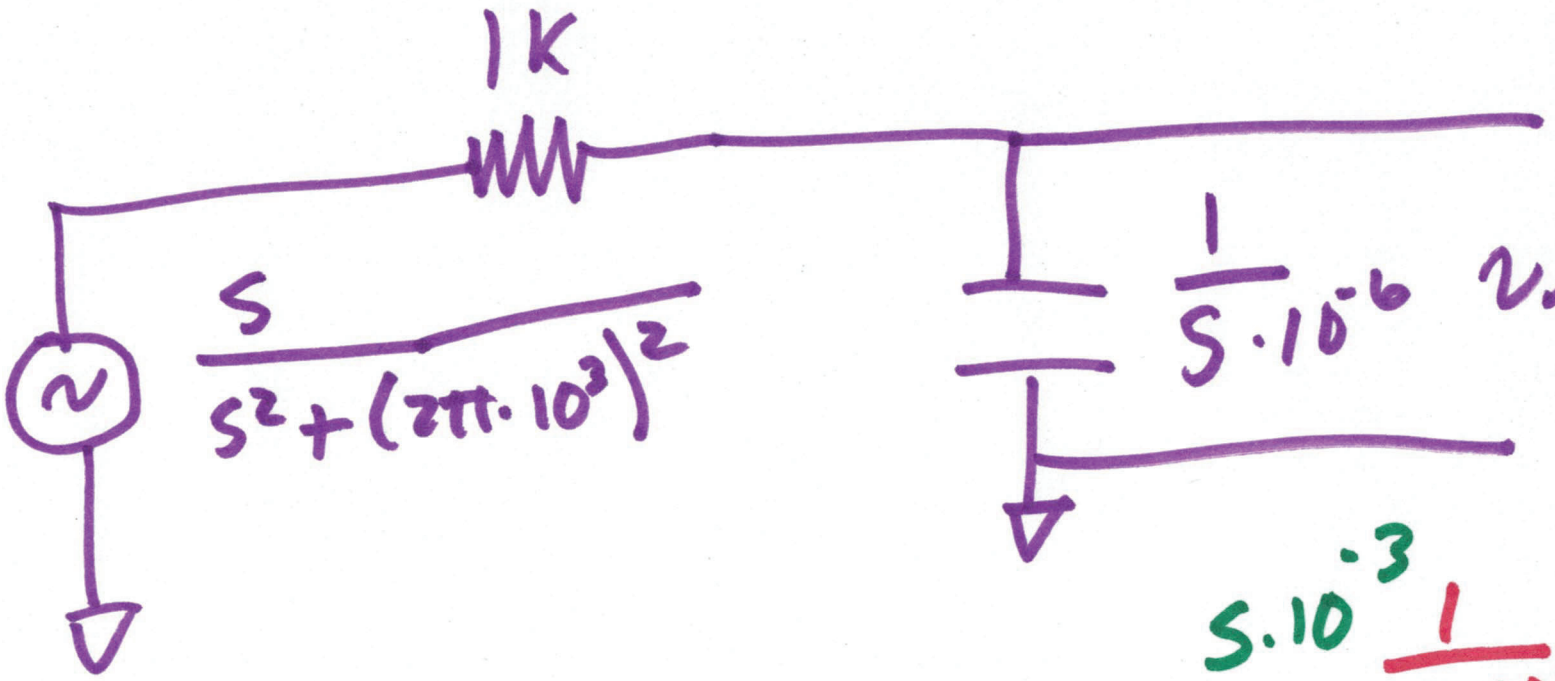
EE 221 Circuits II

Lecture 19

April 7, 2021



vout =



$$V_{out} = \frac{s}{s^2+(2\pi\cdot10^3)^2} \cdot \frac{s\cdot10^{-3}\cdot\frac{1}{s\cdot10^{-6}}}{s\cdot10^{-3}\cdot10^3+\frac{1}{s\cdot10^{-6}}}$$

$$= \frac{s}{s^2+(2\pi\cdot10^3)^2} \cdot \frac{10^3}{s+10^3}$$

2)

$$s^2 + (2\pi \cdot 10^3)^2 = s^2 + 4\pi^2 \cdot 10^6$$

$$s_{1,2} = \frac{-0 \pm \sqrt{0^2 - 4 \cdot 1 \cdot 4\pi^2 \cdot 10^6}}{2 \cdot 1}$$

$$s_{1,2} = \frac{j4\pi \cdot 10^3}{2}$$

$$s_{1,2} = j2\pi \cdot 10^3$$

3)

$$V_{out} = \frac{5 \cdot 10^3 \quad (s+10^3)}{(s - j2\pi \cdot 10^3)(s + j2\pi 10^3)(s+10^3)}$$

$$= \frac{A}{s - j2\pi \cdot 10^3} + \frac{B}{s + j2\pi \cdot 10^3}$$

$$+ \left| \frac{C\,(s+10^3)}{s+10^3} \right|_{s=-10^3}$$

$$C = \frac{-10^3 \cdot 10^3}{(-10^3 - j2\pi \cdot 10^3)(-10^3 + j2\pi 10^3)}$$

$$C = \frac{-10^6}{10^6 + (2\pi 10^3)^2} = \frac{-1}{1+4\pi^2}$$

$$C = -.025$$

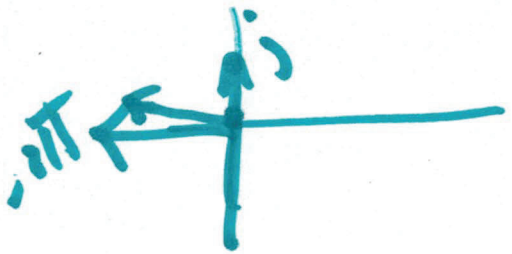
$$\frac{j2\pi\cdot 10^3}{s\cdot 10^3\,(s+j2\pi\cdot 10^3)} = \frac{A}{(s+j2\pi 10^3)(s+10^3)}$$

$j2\pi\cdot 10^3$ $\quad$ $j\cdot 2\pi\cdot 10^3$

$$A = \frac{j2\pi\cdot 10^3\cdot 10^3}{(s+j2\pi 10^3)(s+10^3)}$$

$j2\pi\cdot 10^3$ $\quad$ $j2\pi\cdot 10^3$

5)



$$A = \frac{j \cdot 2\pi \cdot 10^6}{-(2\pi \cdot 10^3)^2 + j2\pi 10^6 + \\ -(2\pi \cdot 10^3)^2 + j 2\pi \cdot 10^6}$$

$$\sqrt{(2\pi)^2 + 1^2}$$

$$A = \frac{j \cdot 2\pi \cdot 10^6}{2\left(-(2\pi \cdot 10^3)^2 + j2\pi \cdot 10^6\right)}$$

$$A = \frac{j}{2(-2\pi + j)} = \frac{\frac{1}{2}\angle 90}{6.36\angle 171}$$

6)

$$A = \frac{\frac{1}{2}\angle 90}{6.36\angle 171} = \boxed{78\,mV\angle -81 = A}$$

$$C = -0.025 \cdot \frac{-j \cdot 10^3 \cdot 2\pi}{5 \cdot 10^3}$$

$$B = \frac{-j \cdot 10^6 \cdot 2\pi}{(s - j2\pi \cdot 10^3)(s + 10^3)}$$

$-j2\pi \cdot 10^3$

$-j \cdot 10^3$

$$B = \frac{-j \cdot 10^6 \cdot 2\pi}{(-j2\pi \cdot 10^3 + 12\pi 10^3)(s - j2\pi \cdot 10^3 + 10^3)}$$

7)

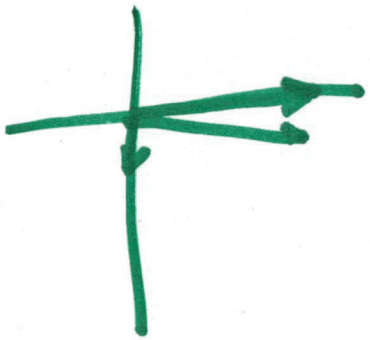
$$B = \frac{-j \cdot 2\pi \cdot 10^6}{(-j2\pi \cdot 10^3 \mp j2\pi 10^3)(-j2\pi \cdot 10^3 + 10^2)}$$

$$B = \frac{-j2\pi \cdot 10^6}{(2\pi \cdot 10^3)^2 - j2\pi \cdot 10^6 + (2\pi 10^3)^2}$$

$$= \frac{-j2\pi 10^6 \quad -j2\pi \cdot 10^6}{2\left((2\pi \cdot 10^3)^2 - (j2\pi \cdot 10^6)\right)}$$

8)

$$B = \frac{-\frac{1}{2}j}{2\pi - j} = \frac{\frac{1}{2}\angle -90^\circ}{6.36\angle -9}$$



$$B = 78\,mV\angle -81^\circ$$

$$V_{out}(s) = \frac{0.078e^{-81j}}{s - j\,2\pi\cdot 10^3} + \frac{0.078e^{j81}}{s + j\,2\pi\cdot 10^3}$$

$$+ \frac{-0.25}{s + 10^3}$$

9)

$$B = \frac{j2\pi \cdot 10^3}{+2j2\pi \cdot 10^3 \left(-j2\pi \cdot 10^3 + 10^3\right)}$$

$$B = \frac{10^3}{2\left(-j2\pi \cdot 10^3 + 10^3\right)}$$

$$= \frac{1}{2\left(1 - j2\pi\right)}$$

$$B = \frac{\frac{1}{2}\angle 0}{6.36\angle -81^\circ} = 78\text{mV}\angle +81^\circ$$

$$v_{OUT}(t) = 78mV\left(e^{j\cdot(-81)}\, e^{-j2\pi\cdot 10^3} + e^{j81}\cdot e^{+j2\pi\cdot 10^3} \right)$$

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

$$- 0.25\, e^{-10^3 t}$$

$$\uparrow\ e^{-t/10^{-3}}$$

$$v_{OUT}(t) = 2\cdot(78mV)\cdot \cos(2\pi\cdot 10^3\cdot t + 81)$$

$$- 0.25\, e^{-10^3\cdot t}$$