ECE 214 — Exam 2

Estimated time for completion: $\leq$ 1.25 hour
25 April 2017

Rules of the Exam

Rule 1: The examination period begins at 9:30am on Tuesday 25 April 2017 and ends at 10:45am on Tuesday 25 April 2017.

Rule 2: The exam is 15% of your grade.

Rule 3: There are a total of 15 answers. All answers are worth 1 point unless otherwise indicated. Circle the **most correct** answer.

Rule 4: The exam is closed book and closed notes. You may use your ECE 214 Laboratory Notebook, a ruler, and a calculator.

Rule 5: Have fun!

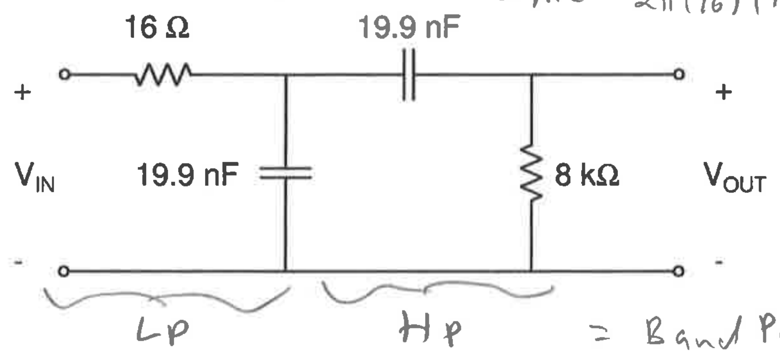
Answer Key
Name

Problem 1: Filter

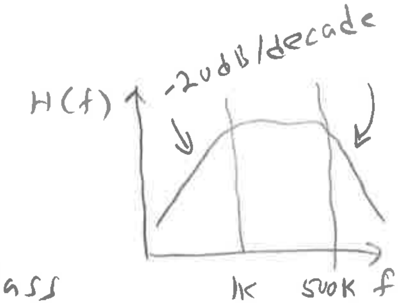
Consider the filter shown below:

High Pass $f_c = \frac{1}{2\pi RC} = \frac{1}{2\pi(8\times10^3)(19.9\times10^{-9})} = 1\text{KHz}$

Low Pass $f_c = \frac{1}{2\pi RC} = \frac{1}{2\pi(16)(19.9\times10^{-9})} = 500\text{KHz}$



= Band Pass



1. $V_{IN} = 10\cos(20{,}000\pi t)$ and $V_{OUT} = A\cos(40{,}000\pi t)$. What is the value of A?

   (a) 0 V
   (b) 0.5 V
   (c) 1 V
   (d) 2 V
   (e) 3.2 V
   (f) 5 V
   (g) 7 V
   (h) 10 V
   (i) none of the above

   A = 0 (There are no frequency components at $w = 40{,}000\pi$)

2. $V_{IN} = 10\cos(40{,}000\pi t)$ and $V_{OUT} = A\cos(40{,}000\pi t)$. What is the value of A?

   (a) 0 V
   (b) 0.5 V
   (c) 1 V
   (d) 2 V
   (e) 3.2 V
   (f) 5 V
   (g) 7 V
   (h) 10 V
   (i) none of the above

   $f = \frac{w}{2\pi} = 20\text{KHz}$ (In the pass band)

3. $V_{IN} = 10\cos(2,000\pi t)$ and $V_{OUT} = A\cos(2,000\pi t)$. What is the value of A?

(a) 0 V
(b) 0.5 V
(c) 1 V
(d) 2 V
(e) 3.2 V
(f) 5 V
(g) 7 V
(h) 10 V
(i) none of the above

$f = \frac{\omega}{2\pi} = 1KHz$ (at the cutoff freq)

$A = (-3dB) \times 10 \Rightarrow \frac{A}{10} = -3dB$

$20\log\left(\frac{A}{10}\right) = -3 \Rightarrow \frac{A}{10} = 10^{-3/20} = 0.7$

$A = 7V$

4. $V_{IN} = 10\cos(200\pi t)$ and $V_{OUT} = A\cos(200\pi t)$. What is the value of A?

(a) 0 V
(b) 0.5 V
(c) 1 V
(d) 2 V
(e) 3.2 V
(f) 5 V
(g) 7 V
(h) 10 V
(i) none of the above

$f = \frac{\omega}{2\pi} = 100Hz$ (one decade below cutoff freq)

$\frac{A}{10} = -20dB$

$20\log\left(\frac{A}{10}\right) = -20 \Rightarrow \log\frac{A}{10} = -1 \Rightarrow \frac{A}{10} = 0.1$

$A = 1V$

5. $V_{IN} = 10\cos(2,000,000\pi t)$ and $V_{OUT} = A\cos(2,000,000\pi t)$. What is the value of A?

(a) 0 V
(b) 0.5 V
(c) 1 V
(d) 2 V
(e) 3.2 V
(f) 5 V
(g) 7 V
(h) 10 V
(i) none of the above

$f = \frac{\omega}{2\pi} = 10^6 Hz \leftarrow$ Twice the cutoff freq

$A \cong 10 \times \left(-20\frac{dB}{decade}\right)(\log(2))$

$= 10 \times (-6dB)$

$\frac{A}{10} = -6dB$

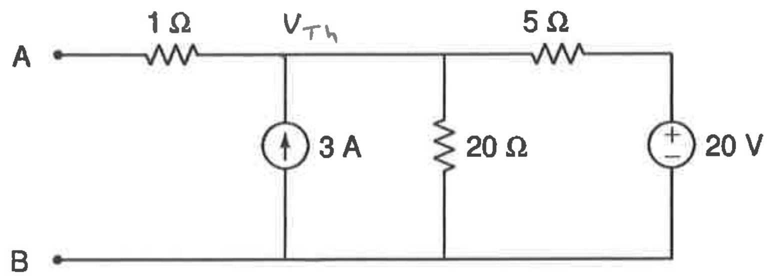
$-6 = 20\log\left(\frac{A}{10}\right)$

$\log\left(\frac{A}{10}\right) = -\frac{1}{3} \Rightarrow \frac{A}{10} = 10^{-\frac{1}{3}} = 0.46$

$A = 4.6V \approx 5V$

Problem 2: Consider the circuit shown below:

Resistance



$5 \| 20 = 4$

$R = 5\Omega$

1. What is the Thévenin Equivalent Voltage with respect to terminals A and B? (2 points)

   (a) 6.3 V
   (b) 10 V
   (c) 12.6 V
   (d) 14 V
   (e) 18 V
   (f) 28 V
   (g) None of the above

$$\frac{V_{Th}}{20} + \frac{V_{Th} - 20}{5} - 3 = 0$$

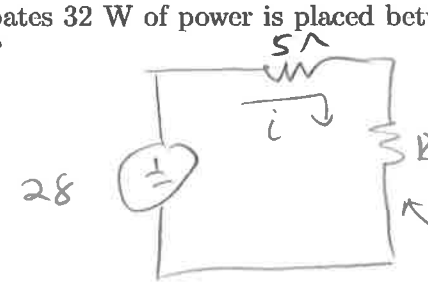
$$V_{Th} = 28\text{ V}$$

2. What is the Thévenin Equivalent Resistance with respect to terminals A and B? (2 points)

   (a) 1 Ω
   (b) 4 Ω
   (c) 5 Ω
   (d) 6 Ω
   (e) 12 Ω
   (f) 15 Ω
   (g) None of the above

3. A resistor that dissipates 32 W of power is placed between terminals A and B. What is the value of this resistor?

   (a) 1 Ω
   (b) 1 Ω or 12.5Ω
   (c) 2 Ω
   (d) 2 Ω or 12.5Ω
   (e) 37 Ω
   (f) 37 Ω or 12.5Ω
   (g) None of the above



$$i = \frac{28}{5+R}$$

$$\text{Power} = i^2 R = 32\text{ W}$$

$$\text{Power} = \left(\frac{28}{5+R}\right)^2 R = 32$$

$$(28)^2 R = 32(5+R)^2$$

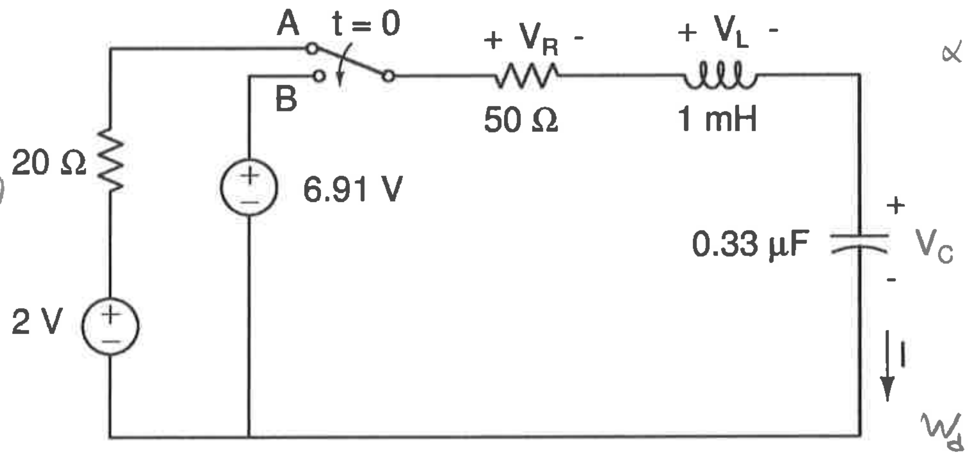
$$= 32(25 + 10R + R^2)$$

$$32R^2 + (320 - 784)R + 800 = 0$$

$$R = 2 \text{ or } 12.5$$

Problem 3: In the series RLC circuit shown below, the switch has been in position 'A' for a very long time and moves to position 'B' at t=0.

Underdamped
$\alpha < \omega_d$



$\alpha = \frac{R}{2L}$

$= 25{,}000$

$\omega_0 = \frac{1}{\sqrt{LC}}$

$= 55048.2$

$\omega_d = (\omega_0^2 - \alpha^2)^{\frac{1}{2}}$

$= 49043.9$

$t < 0$ $\quad V_c = 2V$

$i = 0$

$V_R = 0$

$V_L = 0$

$t = 0^+$ $\quad V_c = 2V$

$V_R = 0$

$i = 0$

$V_L = 4.91$

1. What is $V_C(0^+)$?

   (a) 0 V
   (b) 1.1 V
   (c) 1.7 V
   (d) 2.0 V
   (e) 4.91 V
   (f) 6.91 V
   (g) None of the above

2. What is $V_L(0^+)$?

   (a) 0 V
   (b) 1.1 V
   (c) 1.7 V
   (d) 2.0 V
   (e) 4.91 V
   (f) 6.91 V
   (g) None of the above

3. What is $V_R(0^+)$?

   (a) 0 V
   (b) 1.1 V
   (c) 1.7 V
   (d) 2.0 V
   (e) 4.91 V
   (f) 6.91 V
   (g) None of the above

4. What is $V_R(\infty)$?

   (a) 0 V
   (b) 1.1 V
   (c) 1.7 V
   (d) 2.0 V
   (e) 4.91 V
   (f) 6.91 V
   (g) None of the above

5. What is $V_R(40\mu)$?

   (a) 0 V
   (b) 1.1 V
   (c) 1.7 V
   (d) 2.0 V
   (e) 4.91 V
   (f) 6.91 V
   (g) None of the above

$$i(t) = \overset{0}{\overset{\downarrow}{i(\infty)}} + B_1 e^{-\alpha t}\cos(\omega_d t) + B_2 e^{-\alpha t}\sin(\omega_d t)$$

$$i(0) = 0 = B_1$$

$$i(t) = B_2 e^{-\alpha t}\sin(\omega_d t)$$

$$\left.\frac{di(t)}{dt}\right|_{t=0^+} = \frac{v_L(0^+)}{L} = 4.91\times10^3 = B_2 \omega_d$$

$$B_2 = \frac{4.91\times10^3}{\omega_d} = 0.1$$

$$i(t) = 0.1 e^{-\alpha t}\sin(\omega_d t)$$

$$i(40\mu s) = 34 mA$$

$$V_R(40\mu s) = 50 \times 34 mA = 1.7 V$$

Extra Credit:

1. What is the part number of the transistor used in Lab #9?
   (a) IRFD113
   (b) IRFD400
   (c) IRFD100
   (d) 2N7801
   (e) 2N7000
   (f) 2N7001
   (g) None of the above
2. What is the part number of the inductor used in Lab #6?
   (a) 32102C
   (b) L1000
   (c) L1mltd
   (d) h1298d
   (e) 21C098
   (f) 420d2
   (g) None of the above