NAME SOLUTION

ECE 202

EXAM II

JULY 28, '06

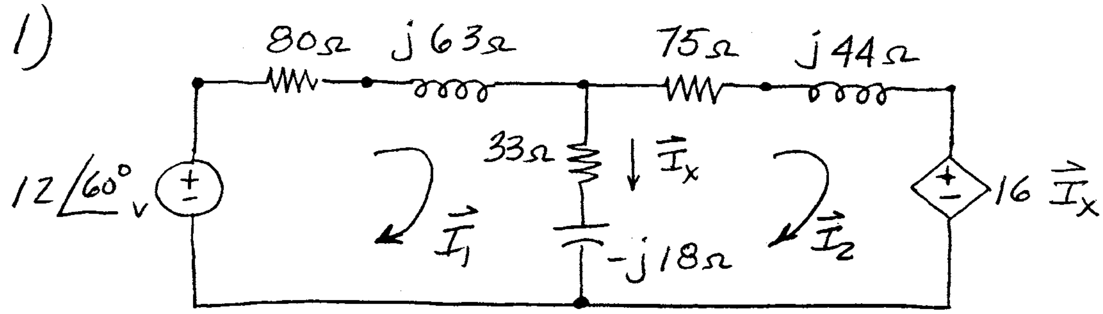
PROBLEM	POINTS	SCORE
1	24	
2	25	
3	26	
4	25	
	100	

NOTE:

1) YOU MUST PLACE YOUR ANSWERS ON THE LINES PROVIDED.
2) SOME ANSWERS MAY HAVE LITTLE OR NO PARTIAL CREDIT. PLEASE CHECK YOUR WORK.
3) SOME ANSWERS MAY HAVE PARTIAL CREDIT, SO PLEASE SHOW YOUR WORK.
4) THIS EXAM HAS 4 PROBLEMS. CHECK TO SEE YOU HAVE 4 PROBLEMS.
5) ALL ANSWERS THAT HAVE UNITS MUST BE INDICATED. ALL ANSWERS MUST BE IN DECIMAL FORM AND IN ENGINEERING NOTATION.
6) WHEN YOU STAND-UP TO TURN-IN YOUR EXAM, YOU WILL NOT BE ALLOWED TO CHANGE YOUR ANSWERS.

NAME ____________________

1)



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FORM THE MESH EQUATIONS BY INSPECTION IN TERMS OF ONLY $\vec{I}_1$ AND $\vec{I}_2$ AS UNKNOWNS. DO NOT SOLVE FOR $\vec{I}_1$ AND $\vec{I}_2$. EXPRESS FINAL ENTRIES AS A SINGLE COMPLEX NUMBER IN RECTANGULAR FORM.

$$12\angle 60^\circ = 6 + j\,10.39$$

$$\begin{bmatrix} 6+j10.39 \\ -16\vec{I}_x \end{bmatrix} = \begin{bmatrix} 80+j63+33-j18 & -33+j18 \\ -33+j18 & -j18+33+75+j44 \end{bmatrix} \begin{bmatrix} \vec{I}_1 \\ \vec{I}_2 \end{bmatrix}$$

$$16\vec{I}_x = 16\vec{I}_1 - 16\vec{I}_2$$

$$\begin{bmatrix} 6+j10.39 \\ 0 \end{bmatrix} = \begin{bmatrix} 113+j45 & -33+j18 \\ -33+j18+16 & 108+j26-16 \end{bmatrix} \begin{bmatrix} \vec{I}_1 \\ \vec{I}_2 \end{bmatrix}$$

$$\underbrace{\begin{bmatrix} 6+j\,10.39 \\ 0+j\,0 \end{bmatrix}}_{V} = \underbrace{\begin{bmatrix} 113+j\,45 & (-33)+j\,18 \\ (-17)+j\,18 & 92+j\,26 \end{bmatrix}}_{\Omega} \begin{bmatrix} \vec{I}_1 \\ \vec{I}_2 \end{bmatrix}$$

+2/ANSWER

NAME

2) FIND THE WAVEFORM $f(t)$ FROM $F(s)$ BY DOING A PFE

A) $$F(s) = \frac{11(s+3)}{s(s+4)} = \frac{k_1}{s} + \frac{k_2}{s+4}$$

$$k_1 = \cancel{s} \cdot \frac{11(s+3)}{\cancel{s}(s+4)}\Bigg|_{s=0} = \frac{11(0+3)}{(0+4)} = \frac{33}{4} = 8.25$$

$$k_2 = (\cancel{s+4})\frac{11(s+3)}{s(\cancel{s+4})}\Bigg|_{s=-4} = \frac{11(-4+3)}{-4} = \frac{11}{4} = 2.75$$

$$F(s) = \frac{8.25}{s} + \frac{2.75}{s+4}$$

$$f(t) = \left(8.25 + 2.75\,e^{-4t}\right)u(t)$$

$$f(t) = \underline{\left(8.25 + 2.75\,e^{-t/250m}\right)u(t)}$$

3 3 3 1 (10)

B) $$F(s) = \frac{(s+7)}{(s+6)(s^2+6s+25)}$$ ← 2 ROOTS $= \frac{-6 \pm \sqrt{36-4(25)}}{2} = \frac{-6 \pm j8}{2}$

$= -3 \pm j4$

$$F(s) = \frac{k_1}{s+6} + \frac{k_2}{s+3-j4} + \frac{k_2^*}{s+3+j4}$$

$$k_1 = (\cancel{s+6})\frac{(s+7)}{(\cancel{s+6})(s^2+6s+25)}\Bigg|_{s=-6} = \frac{-6+7}{36-36+25} = \frac{1}{25} = 40m$$

$$k_2 = (\cancel{s+3-j4})\frac{(s+7)}{(s+6)(\cancel{s+3-j4})(s+3+j4)}\Bigg|_{s=-3+j4}$$

$$= \frac{-3+j4+7}{(-3+j4+6)(j8)} = \frac{4+j4}{(3+j4)(j8)} = \frac{4+j4}{-32+j24} = \frac{5.66\angle 45^\circ}{40\angle 143.1}$$

$$= 141.5m\angle -98.13^\circ$$

$$f(t) = \left[40m\,e^{-6t} + 2(141.5m)\,e^{-3t}\cos(4t-98.13^\circ)\right]u(t)$$

$$f(t) = \underline{\left[40m\,e^{-t/166m} + 283m\,e^{-t/333m}\cos(4t-98.13^\circ)\right]u(t)}$$

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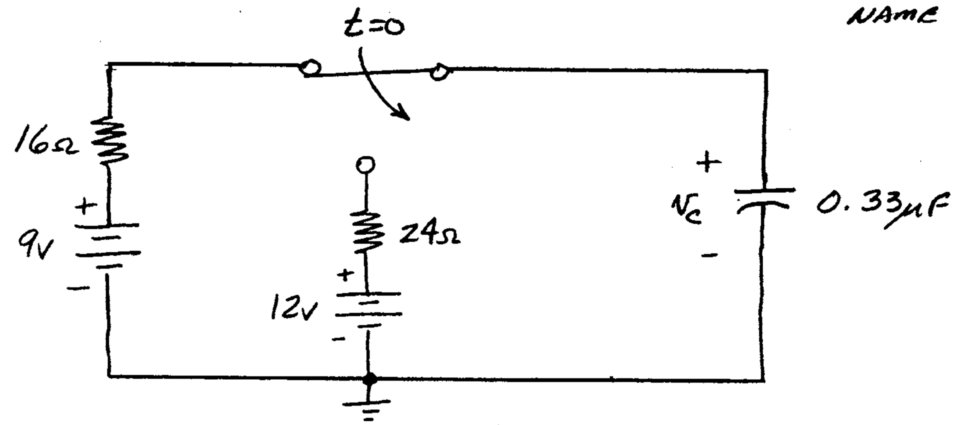
NAME

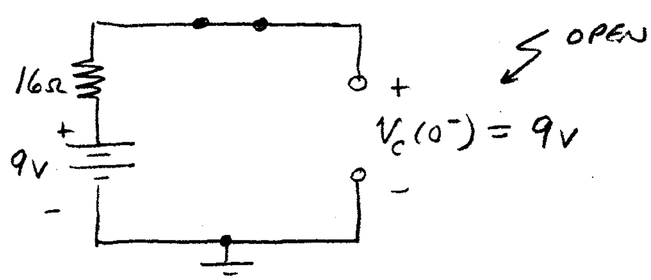
3)



USE LAPLACE TRANSFORMS AND A PFE TO FIND $V_c(t)$.

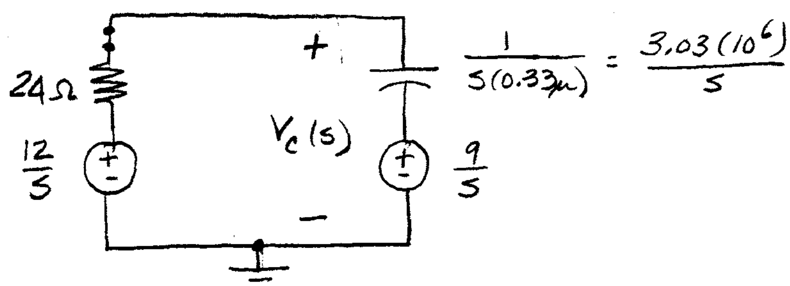
- STEP 1) FIND INITIAL CONDITIONS

FOR $t<0$



- STEP 2) TRANSFORM CIRCUIT TO THE S-DOMAIN

FOR $t>0$



- STEP 3) PERFORM S-DOMAIN ANALYSIS

USING SUPERPOSITION,

$$V_c(s) = V_c'(s) + V_c''(s)$$

NAME

3) ADDITIONAL WORK SPACE

a) $V_C'(s)$ (SET $9/s = 0$)

$$V_C'(s) = \frac{12}{s}\,\frac{\frac{3.03(10^6)}{s}}{24+\frac{3.03(10^6)}{s}} = \frac{12}{s}\,\frac{3.03(10^6)}{24s+3.03(10^6)}$$

$$= \frac{12}{s}\,\frac{126.25K}{s+126.25K}$$

b) $V_C''(s)$ (SET $12/s = 0$)

$$V_C''(s) = \frac{9}{s}\,\frac{24}{24+\frac{3.03(10^6)}{s}} = \frac{9\cdot 24}{24s+3.03(10^6)} = \frac{9}{s+126.25K}$$

c) $$V_C(s) = V_C' + V_C'' = \frac{(12)(126.25K)+9s}{s(s+126.25K)} = \frac{9s+1.515(10^6)}{s(s+126.25K)}$$

- STEP 4) PERFORM A PFE

$$V_C = \frac{k_1}{s} + \frac{k_2}{s+126.25K}$$

$$k_1 = s\,\frac{9s+1.515(10^6)}{s(s+126.25K)}\Bigg|_{s=0} = \frac{1.515(10^6)}{126.25K} = 12$$

$$k_2 = (s+126.25K)\,\frac{9s+1.515(10^6)}{s(s+126.25K)}\Bigg|_{s=-126.25K}$$

$$= \frac{9(-126.25K)+1.515(10^6)}{-126.25K} = \frac{378.75K}{-126.25K} = -3$$

- STEP 5) FIND THE INVERSE LAPLACE TRANSFORM

$$V_C = \frac{12}{s} - \frac{3}{s+126.25K}$$

$$v_C(t) = \left[12 - 3e^{-126.25Kt}\right]u(t)$$

$$v_C(t) = \underline{\left[12 - 3e^{-t/7.92\mu}\right]u(t)\ \text{V}}$$ 26

Name ______________________

4) Answer the following:

A) In your own words and in a complete sentence, what condition is needed for a circuit to be at its resonant frequency?

5 THE INPUT IMPEDANCE MUST BE PURELY REAL FOR A CIRCUIT TO BE AT RESONANCE.

B) If a resistor is dissipating the following amount of power : 80 [4 + $\underbrace{4 \cos (2\pi\, 200\, t)}_{AVE=0}$] watts, what is the average power dissipated?

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$$P_{AVE} = \frac{1}{T}\int_0^T p(t)\,dt = (80)(4)$$

P_{AVE} = 320 W

C) In your own words and in a complete sentence, what condition is needed for a rational function to be improper?

5 A RATIONAL FUNCTION IS IMPROPER WHEN THE ORDER OF THE NUMERATOR POLYNOMIAL EQUALS OR EXCEEDS THE ORDER OF DENOMINATOR POLYNOMIAL

D) What is f(t) if $F(s) = 25/(s^2 + 600)$?

5 $$F(s) = \frac{25}{s^2+600} = \frac{25}{\sqrt{600}}\,\frac{\sqrt{600}}{s^2+600} = 1.021\,\frac{\sqrt{600}}{s^2+600}$$

$$\sqrt{600} = 24.5 \qquad \sin(\beta t) = \frac{\beta}{s^2+\beta^2}$$

f(t) = $1.021 \sin(24.5t)\,u(t)$

E) Sketch $v(t) = 6u(t) - 3u(t - 2) - 3u(t - 4)$ for $0 < t < 8$ sec.

5