KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

Electrical Engineering Department

EE-205 Electric Circuits II

Spring 2009/2010(092) First Major Exam

Duration : 90 min.

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Name : Key **ID #** **Section #**

Question	Grade
1 (10 points)	
2 (10 points)	
3 (10 points)	
Total (30 points)	

Notes :

1) Read the question very carefully.
2) Use a sketch to help you understand the question.
3) Write neatly.

Final

Question 1

Write the correct answer in the box shown. Only answers in the box below will be graded

Answers' Box

1. a	2. d	3. e	4. c
5. d	6. b	7. b	

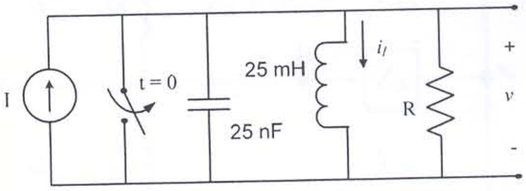
<u>Do NOT Circle or Mark</u> the answer in the questions. If you do so, it is considered cheating.
(Parts 1 to 4: 1 points each; Parts: 5 to 7 two points each)
(*only one answer is correct)*

1) **In a three-phase balanced system, if I_{aA} is 17+j10 A, then for a negative sequence I_{cC} will be:**
   a) $19.72\angle -89.53^{o}$
   b) 17-j10
   c) $19.72\angle 30.46^{o}$
   d) -17+j10
   e) None of the above is correct

2) **In a three phase balanced positive sequence Y-Y connected system, if V_{AN} is $120\angle 0^{o}$ V at the load, then (*for a negligible line impedance*) V_{bc} at the source will be:**
   a) $1/\sqrt{3}$ times in magnitude but leading by 90
   b) $\sqrt{3}$ times in magnitude but lagging by 150^{o}
   c) $\sqrt{3}$ times in magnitude but leading by 120^{o}
   d) $\sqrt{3}$ times in magnitude but lagging by 90^{o}
   e) None of the above is correct

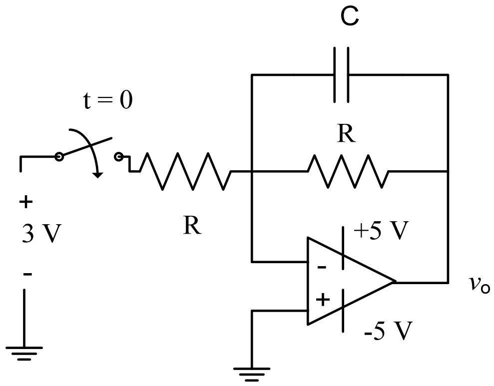
3) **The complete solution for the voltage across the capacitor in a series RLC circuit of the step response with a DC source consists of:**
   a) The function of the same form as the natural response
   b) The final value of the response function
   c) The function of the same form as the natural response and the final value of the response function if R is greater than C
   d) The function of the same form as the natural response and the final value of the response function if R is equal to C
   e) None of the above is correct

4) **Assume the parallel RLC circuit of the step response shown, with $I = 24$ mA. The solution for $i_l(t)$ is**
   a) Over damped if $R = 625\ \Omega$
   b) Under-damped if $R = 400\ \Omega$
   c) Critically-damped if $R = 500\ \Omega$
   d) All of the above are correct
   e) None of the above is correct



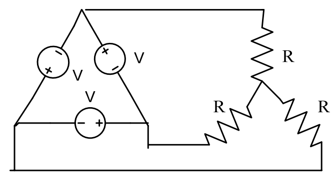
5) For the ideal Op-Amp circuit shown assume no energy in the capacitor before the switch is closed at $t = 0$. For $t \geq 0$, the Op-Amp

a) will saturate in 3 seconds
b) will saturate in 5 seconds
c) will saturate only if R is greater than C
d) will never saturate
e) None of the above is correct

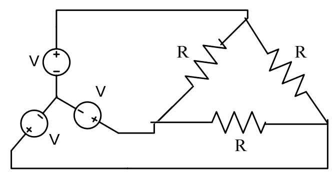


6) Assume two balanced 3-phase systems. System A is a delta source with a phase voltage of V connected to a Y-load with a phase impedance of R . System B is a Y source of phase voltage V connected to a delta load of phase impedance of R. Comparing the total power absorbed by Load A and B, the following is true:

a) The power absorbed by load B is 18 times the power absorbed by load A
b) The power absorbed by load B is 9 times the power absorbed by load A
c) The power absorbed by load B is 6 times the power absorbed by load A
d) The power absorbed by load B is 3 times the power absorbed by load A
e) The power absorbed by load B is the same as the power absorbed by load A.



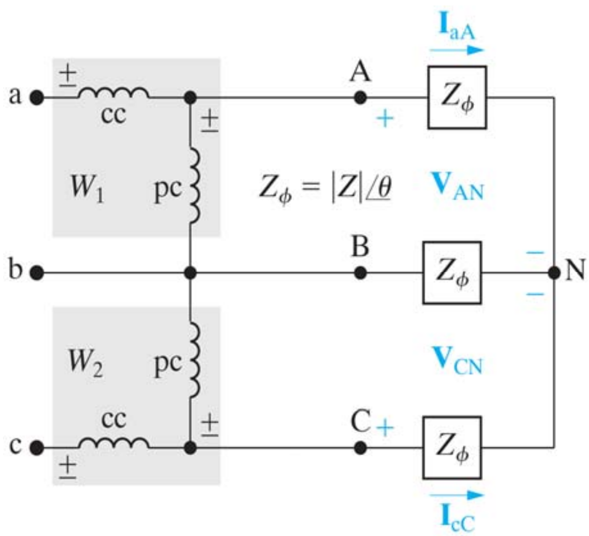
Load A



Load B

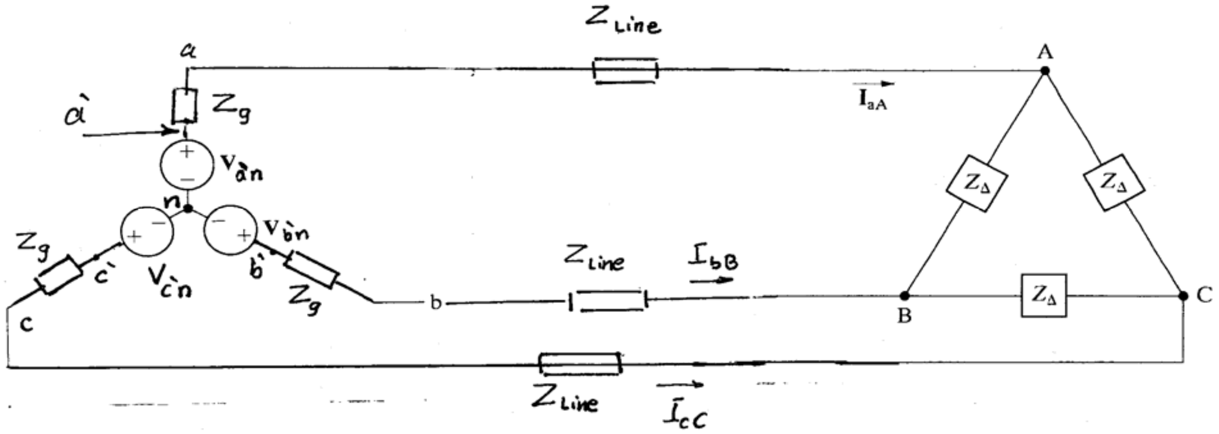
7) Using the two-wattmeter method, calculate the reading of each wattmeter in the given circuit if the phase voltage at the load is 120 V and $Z_\phi = 8 - j6$ Ω.

a) W1= 979.75 W and W2= 2476.25 W
b) W1= 2476.25 W and W2= 979.75 W
c) W1= 565.66 W and W2= 1429.7 W
d) W1= 1429.7 W and W2= 565.66 W
e) None of the above is correct

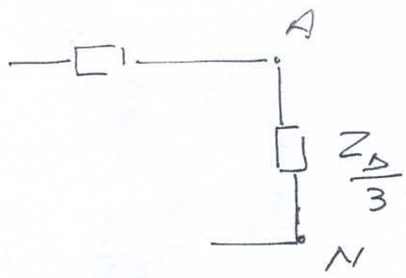


Question 2 In a balanced positive sequence three phase Y-Δ connection shown, the followings are given: Line current $\boldsymbol{I}_{aA}$=12 $\angle 40^o$ Amp., line impedance Z_{line} = 2+j2 ohms, Generator impedance $\mathbf{Z}_g$ = 1+j1 ohms, and the power absorbed per phase is 800 Watts at a power factor = 0.8 lagging. Find:

a) The complex phase voltage $\boldsymbol{V}_{AB}$
b) The complex load impedance $\boldsymbol{Z}_{\Delta}$.
c) The complex open circuit generator voltage $\mathbf{V}_g$ (Equal to $V_{a'n}$).



1- $P = |I_{an}|^2 \frac{|Z_\Delta|}{3} \cos\phi_z$ (2)



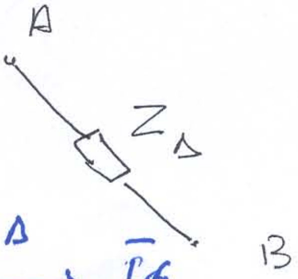
$800 = (12)^2 \frac{|Z_\Delta|}{3} * 0.8$

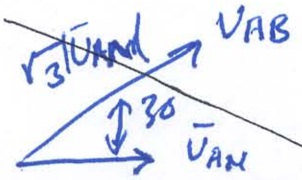
$|Z_\Delta| = 20.833$

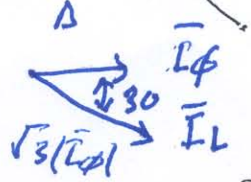
$\phi_z = 36.87^\circ$ (1)

$Z_\Delta = 20.833 \angle 36.87$

$\bar{V}_{AB} = \bar{V}_{AN} \sqrt{3} \angle 30^\circ$







$V_{AN} = I_{aA} \frac{Z_\Delta}{3}$ (2)

$= 12\angle 40 \times \frac{20.833 \angle 36.87}{3}$

$= 83.333 \angle 76.87^\circ$ (1)

$V_{AB} = \sqrt{3}\, V_{AN} \angle 30$ (1)

$= 144.33 \angle 106.87^\circ$

OR

$I_{aA} = I_{AB} \sqrt{3} \angle -30$

$\therefore I_{AB} = \frac{12\angle 40}{\sqrt{3}} \angle 30$ (2)

$= 6.928 \angle 70^\circ$

$\therefore V_{AB} = I_{AB} Z_\Delta$

$= 6.928 \angle 70^\circ \times 20.833 \angle 36.87$

$= 144.33 \angle 106.87$ (2)

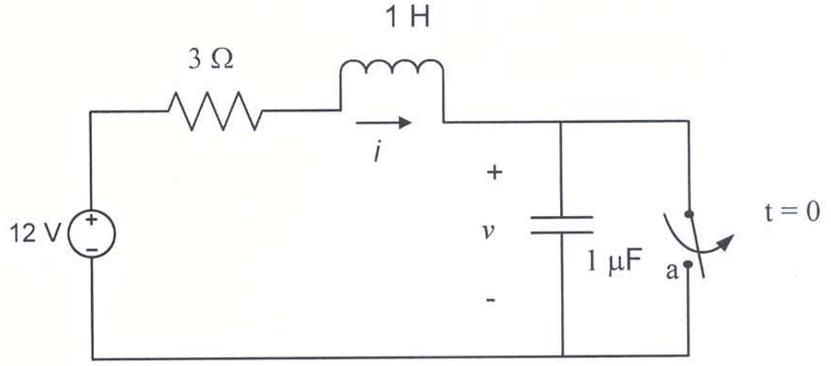
$V_g = I_{aA}\left(Z_g + Z_{Line} + \frac{Z_\Delta}{3}\right)$ (2) or $I_{aA}(Z_g + Z_{Line}) + V_{AN}$

$\therefore V_g = 12\angle 40\,(1+j1+2+j2) + 83.333\angle 76.87$

$= 133.9 \angle 79.95^\circ$ (1)

Question 3 For the circuit shown, the switch has been closed for a long time before it is opened at $t = 0$.

(1) a) Find $v(t)$ and $i(t)$ for $t < 0$



1 $\begin{cases} v = 0 \\ i = \frac{12}{3} = 4A \end{cases}$

For $t \geq 0$ find (b to f):

(2) b) The second order differential equation in terms of $v(t)$

KUL $\quad 3i + L\frac{di}{dt} + v = 12$, $\quad i = C\frac{dv}{dt}$

$$3\times10^{-6}\frac{dv}{dt} + 10^{-6}\frac{d^2v}{dt} + v = 12$$

2 $\quad \frac{d^2v}{dt^2} + 3\frac{dv}{dt} + 10^6 v = 12\times10^6$

(1) c) The roots of the characteristic equation that describes the voltage $v(t)$

$\alpha = \frac{3}{2}$, $\omega_0 = \sqrt{10^6} = 10^3$, $\omega_d = \sqrt{\omega_0^2 - \alpha^2} \simeq 10^3$

$s_1 = -\frac{3}{2} + j10^3$, $s_2 = \frac{-3}{2} - j10^3$

(1) d) What is the type of the response? and specify why?

1 The response is underdamped

because $\omega_0^2 > \alpha^2$

$$v(t) = V_f + B_1' e^{-\alpha t}\cos\omega_d t + B_2' e^{-\alpha t}\sin\omega_d t$$

(2) e) Find $v(0^+)$ and $\frac{dv(0^+)}{dt}$

1 $v(0^+) = \cancel{12 + B_1} = 0$

1 $\frac{dv(t)}{dt} = \frac{i(t)}{dt} \Rightarrow \frac{i(0^+)}{C} = \frac{4}{1\times10^{-6}} = 4\times10^{6} = \frac{dv(0^+)}{dt}$

$$\frac{dv(t)}{dt} = B_1'\left(-\alpha e^{-\alpha t}\cos\omega_d t - \omega_d e^{-\alpha t}\sin\omega_d t\right) + B_2'\left(-\alpha e^{-\alpha t}\sin\omega_d t + \omega_d e^{-\alpha t}\cos\omega_d t\right)$$

$$\frac{dv(0^+)}{dt} = -\alpha B_1 + \omega_d B_2'$$

(3) f) Find $v(t)$

$$v(t) = 12 + B_1' e^{-3/2t}\cos 10^3 t + B_2' e^{-3/2 t}\sin 10^3 t$$

1 $v(0^+) = 0 = 12 + B_1'$ (1) $\Rightarrow B_1' = -12$

1 $\frac{dv(0^+)}{dt} = 4\times10^6 = -\alpha B_1' + \omega_d B_2' = -\frac{3}{2}B_1' + 10^3 B_2'$

$$B_2' = \frac{4\times10^6 - 12\times\frac{3}{2}}{10^3} \approx 4{,}000$$

1 $$\boxed{v(t) = 12 - 12e^{-3/2t}\cos 10^3 t + 4{,}000 e^{-3/2t}\sin 10^3 t}$$