ASSIUT UNIVERSITY
FACULTY OF ENGINEERING
DEPT. OF ELECTRICAL ENG.

CIRCUIT THEORY

First Term Examination, 2009/2010

2nd Year Elect.
جميع الطلبة (لائحة ٢٠٠٤، ١٩٩٧)
Time: 3 Hours

الامتحان مكون من أربع صفحات، الإجابة فى نفس ورقة الأسئلة، النهاية العظمى ١٠٠ درجة.
الإجابة النهائية يجب أن تكون مكتوبة فى المكان المخصص لها ولن يلتفت لغير ذلك.

Question 1:

a) The op-amp in the circuit of Fig.a is ideal. Calculate the following: (10 Marks)

I_1	**0.4 mA**
I_2	**0**
I_3	**0.5 mA**
I_4	**0.9 mA**
V_o	**- 3.7 V**

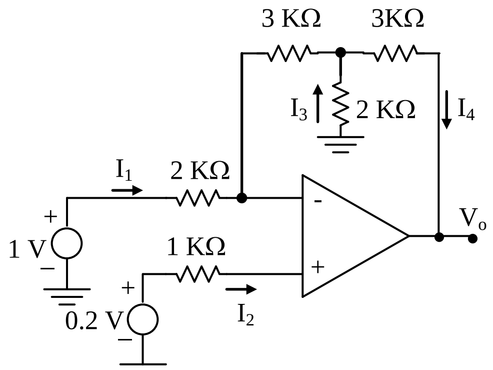


Fig. (a)

b) The switch in the circuit of Fig. (b) has been in position a for a long time. At t=0 it moves to position b. Calculate the following: (10 Marks)

$v_C(0^+)$	**26 V**
$i_L(0^+)$	**0.5 mA**
$v_o(0^-)$	**20 V**
$v_o(0^+)$	**22 V**
$i_c(0^+)$	**- 0.5 mA**

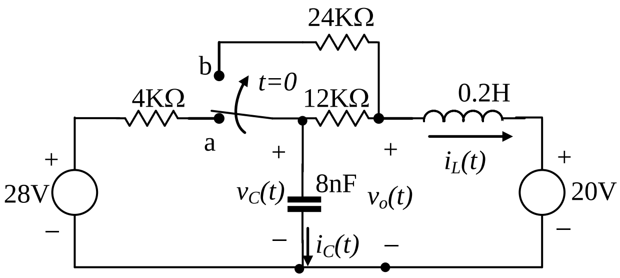


Fig. (b)

c) The circuit of Fig. (c) operates at radian frequency ω = 100 rad/sec. Find the mutual inductance M, the reflected impedance $\boldsymbol{Z_r}$ and the input impedance at port a-b. (6 Marks)

M	**1.5 H**
Z_r	**27-j36 = 45∠-53.1°Ω**
Z_{in}	**154.4∠30.3°Ω**

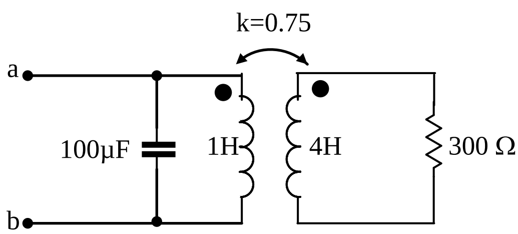


Fig. (c)

Question 2:

a) The switch in the circuit shown in Fig.a has been closed for a long time before it opens at $t = 0$. Find $v(t)$ for $0 \leq t \leq \infty$. (10 Marks)

$i_L(0^+) =$ **2 A**

$v(0^+) =$ **- 12 V**

$v(\infty) =$ **0**

$\tau =$ **30 mS**

$v(t) =$ $-12e^{-\frac{t}{30}}$ **V**

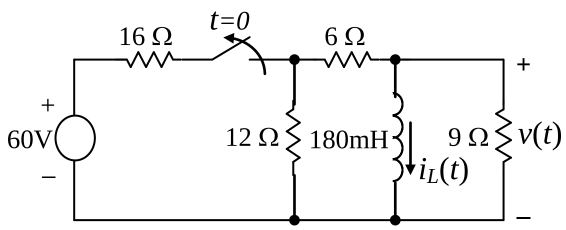


Fig. a

b) A balanced Y-connected load having an impedance of 18Ω/phase is connected in parallel with a balanced Δ-connected load having an impedance of 36Ω/phase. The parallel loads are fed from lines having an impedance of 2Ω/line. The magnitude of the line-to-neutral voltage at the Y-load is 720 V. Calculate the following: (10 Marks)

The magnitude of the line current	**100 A**
The magnitude of the phase current in the Δ- load	**$20\sqrt{3}$ = 34.6 A**
The magnitude of the phase current in the Y- load	**40 A**
The magnitude of the line voltage at the sending end	**$920\sqrt{3}$= 1593.5 V**
The total power dissipated in the loads	**216 KW**

c)For the two-port of Fig. (c), Calculate: (8 Marks)

$z_{11} =$ **6.8 Ω**

$a_{21} =$ **0.714 S**

$h_{12} =$ **0.3**

$y_{22} =$ **0.378 S**

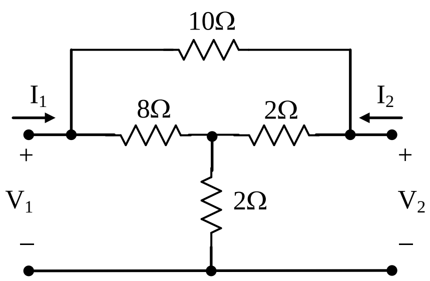


Fig. (c)

Question 3:

a) Find the first four Fourier coefficients of the voltage waveform of Fig.(a). (8 Marks)

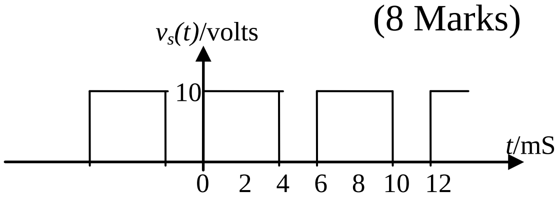


Fig. (a)

a_o = 6.7

C_1 = 5.5 ∠150°

C_2 = 2.76 ∠30°

C_3 = 0

b) The voltage waveform of Fig.(a) is applied to the circuit of Fig. (b). Find the Fourier coefficients of the output voltage v_{ld}. (8 Marks)

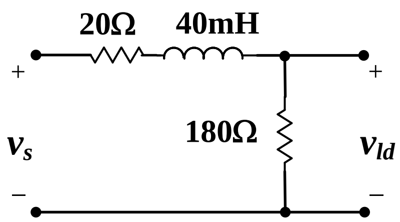


Fig. (b)

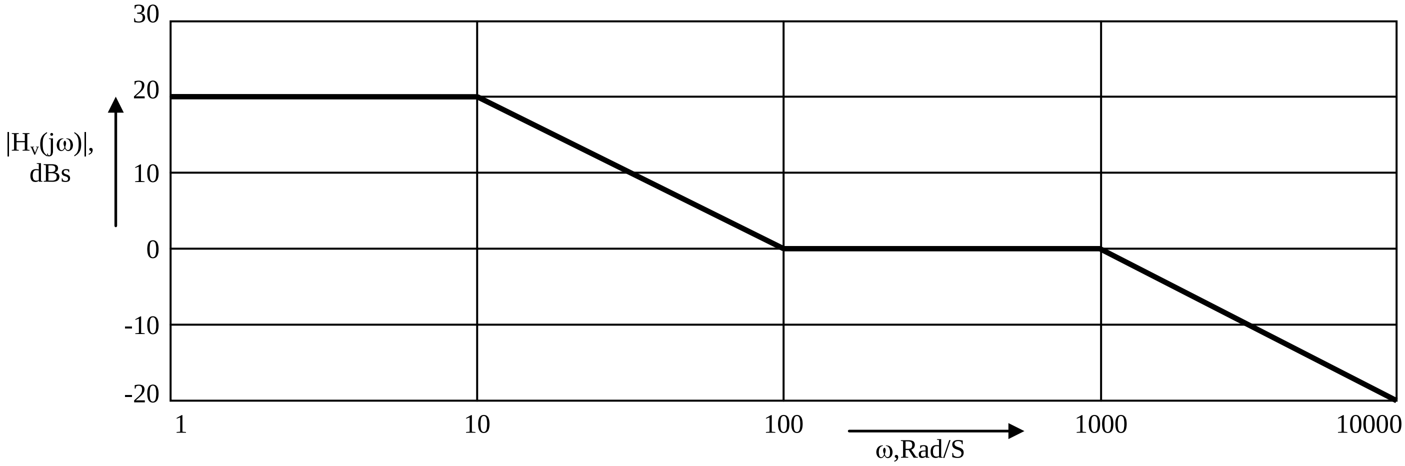
V_{ldo} = 6 V

V_{ld1} = 4.85 ∠138.2° V

V_{ld2} = 2.29 ∠7.3° V

V_{ld3} = 0

c) Sketch the Bode Diagram of the voltage transfer function: $H_v(s) = \dfrac{1000(s+100)}{(s+10)(s+1000)}$ (8 Marks)



Question 4:

a) Find the voltage transfer function and its poles and zeros for the circuit of Fig.a. (10 Marks)

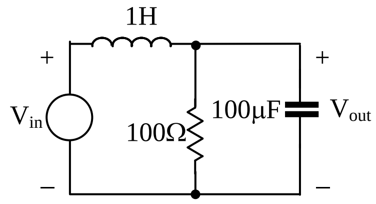


Fig.(a)

$$H_v(s) = \frac{10^4}{s^2 + 100s + 10^4}$$

Poles: -50 + j 86.6, -50 - j 86.6

Zeros: ∞, ∞

b) The switch in the circuit shown in Fig.b has been opened for a long time before it closes at $t = 0$. Find $v_c(t)$ for $t \geq 0$. (12 Marks)

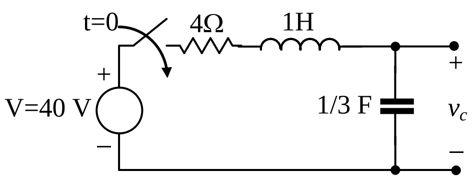


Fig. (b)

$$V_C(s) = \frac{120}{s(s^2 + 4s + 3)}$$

$$= \frac{120}{s(s+1)(s+3)}$$

$$= \frac{40}{s} - \frac{60}{s+1} + \frac{20}{s+3}$$

$$v_C(t) = [40 - 60e^{-t} + 20e^{-3t}]u(t)\ V$$

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E222 CIRCUIT THEORY

First Term Examination, 2010/2011

2nd Year Elect.
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Time: 3 Hours

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Question 1:

a) The voltage waveform v_g shown in Fig.(a-1) is applied to the circuit of Fig.(a-2). Sketch v_o and v_1 versus t, assuming ideal op-amp. (10 Marks)

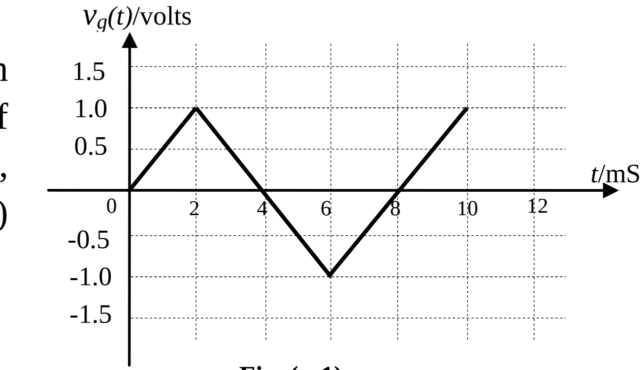


Fig. (a-1)

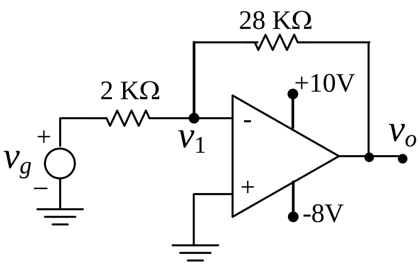
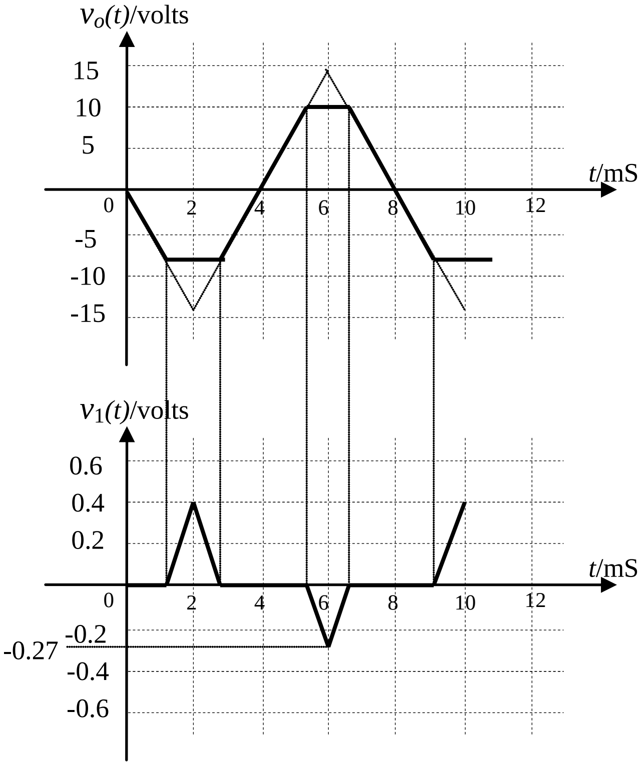


Fig. (a-2)



b) The switch in the circuit shown in Fig.b has been opened for a long time before it closes at $t = 0$. Find $i_o(t)$ for $0 \le t \le \infty$. (10 Marks)

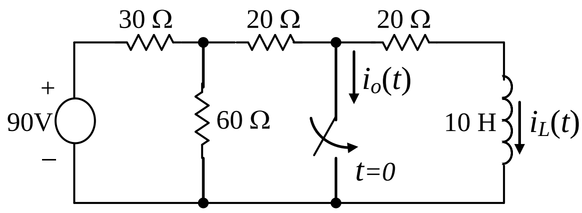


Fig. b

$i_L(0^+) =$ **1 A**

$i_o(0^+) =$ **0.5 A**

$i_o(\infty) =$ **1.5 A**

$\tau =$ **0.5 S**

$i_o(t) =$ **$1.5 - e^{-2t}$ A, $0 \le t \le \infty$**

Question 2:

a) i) Write the two mesh equations for the circuit of Fig.(a) and solve them to find I_1, I_2, and the power dissipated in R_L. (10 Marks)

ii) Find the Thevenin equivalent circuit at the output port, hence find the value of R_L that consumes maximum power, and the value of this power. (6 Marks)

The first mesh equation

$80\,I_1 - 20\,I_2 + V_1 = 400$

The second mesh equation

$-20\,I_1 + 105\,I_2 - V_2 = 0$

I_1 = 0.25 A

I_2 = 1A

P_L = 85 W

R_{Th} = 15Ω

V_{Th} = 100 V

P_{max} = 166.7 W

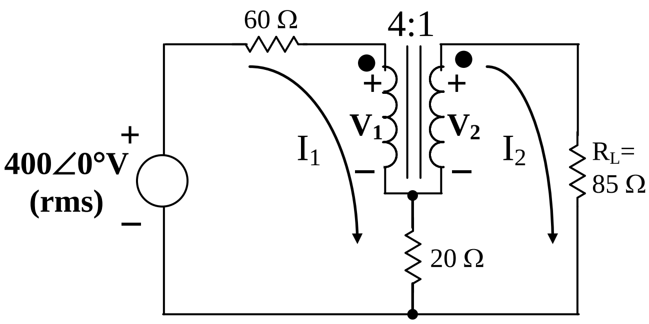


Fig. (a)

b) A three-phase Y-connected +ve sequence source having the phase voltage $\boldsymbol{V_a}$=220∠0°V. The source resistance is 2 Ω/Phase. The source supplies a balanced Δ-connected load having a load impedance of 36∠30°Ω/Phase. The three lines connecting the source to the load have a resistance of 1 Ω/Line. Find the following: (10 Marks)

The magnitude of the line current	15 A
The magnitude of the phase current in the Δ- load	8.66 A
The magnitude of the line voltage at the sending end	334.5 V
The magnitude of the line voltage at the load	312 V
The total active power dissipated in the load	7015 W

Question 3:

a) Find the mean value, RMS value, period, and fundamental frequency in Hz, for the voltage waveform of Fig.(a). (8 Marks)

Mean value = **6.67 V**

RMS value = **8.165 V**

Period = **6 mS**

Fundamental frequency = **166.7 Hz**

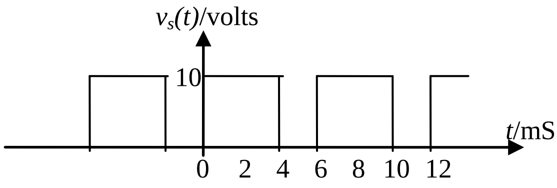


Fig. (a)

b) i) What is the type of filter shown Fig.(b)? (2 Marks)

ii) Write the voltage transfer function $H_v(s)$ of that filter. (2 Marks)

iii) Find the filter cut-off frequency f_c. (2 Marks)

iv) What is the maximum value of $H_v(s)$? (2 Marks)

v) At what frequency will $|H_v(s)|$ equals half its maximum value? (2 Marks)

type of filter **High pass filter**

$H_v(s) = \frac{0.9}{s + 10^4}$

$f_c =$ **1592 Hz**

$H_v(s)|_{max} =$ **0.9**

Frequency of ½ max value = **919 Hz**

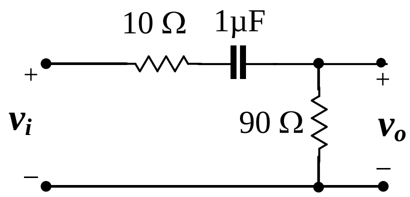
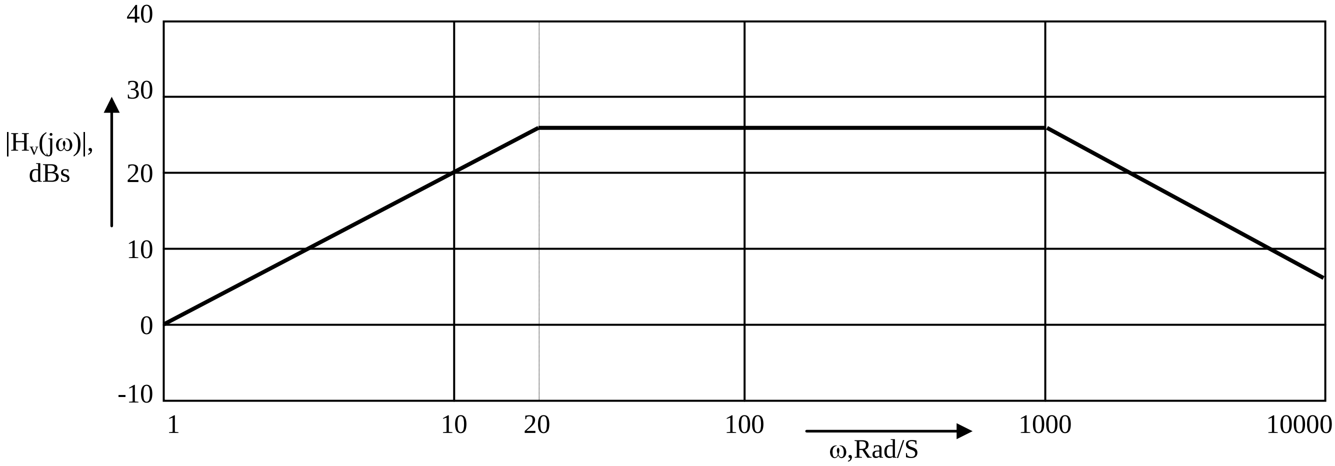


Fig. (b)

c) Sketch the Bode Diagram of the voltage transfer function: $H_v(s) = \frac{20000\,s}{(s+20)(s+1000)}$ (6 Marks)



Question 4:

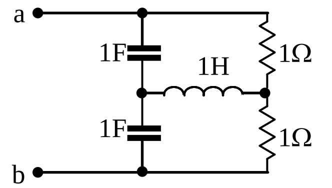


Fig.(a)

a) Find the s-domain expression of the input impedance seen looking into the terminals a, b of the circuit of Fig.(a). Find also the poles and zeros of that impedance. (10 Marks)

$Z_{in}(s) =$	$\frac{2s^2+3s+1}{2s(s^2+s+1)}$
Poles	**0, (-0.5 + j 0.866), (-0.5 - j 0.866)**
Zeros	**-0.5, -1, ∞**

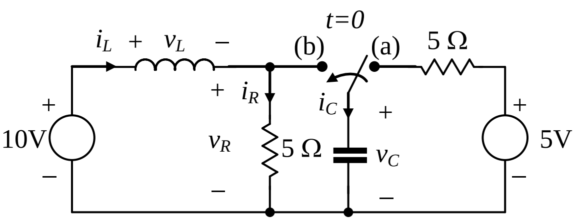


Fig. (b)

b) The switch in the circuit of Fig. (b) is moved from (a) to (b) at t = 0. Find the following currents and voltages: (12 Marks)

$i_R(0^-)$	**2 A**
$i_R(0^+)$	**1 A**
$i_c(0^+)$	**1 A**
$i_L(0^+)$	**2 A**
$v_L(0^+)$	**5 V**
$v_R(\infty)$	**10 V**

c) The *a*-parameters of a certain two-port are a_{11}= 3, a_{12}= 10 Ω, a_{21}= 0.5 S, a_{22}= 2. Find the *h*-parameters. (8 Marks)

$h_{11} =$	**5 Ω**	$h_{12} =$	**-0.5**
$h_{21} =$	**0.5**	$h_{22} =$	**0.25 S**

******************** أطيب التمنيات بالتوفيق ********************

أ.د. مجدى مفيد دوس

ASSIUT UNIVERSITY
FACULTY OF ENGINEERING
DEPT. OF ELECTRICAL ENG.

E222 CIRCUIT THEORY

First Term Examination, 2011/2012

2nd Year Elect.

جميع الطلبة (لائحة ١٩٩٧،٢٠٠٤)

Time: 3 Hours

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الإجابة النهائية يجب أن تكون مكتوبة فى المكان المخصص لها ولن يلتفت لغير ذلك.

Question 1:

a) The op-amp in the non-inverting amplifier of Fig.a is ideal. Find the i_1, i_2, v_1, i_3, v_o, and i_o.

(12 Marks)

i_1 = 0.1 mA
i_2 = 0.2 mA
v_1 = 4 V
i_3 = 0.2 mA
v_o = 8 V
i_o = 0.4 mA

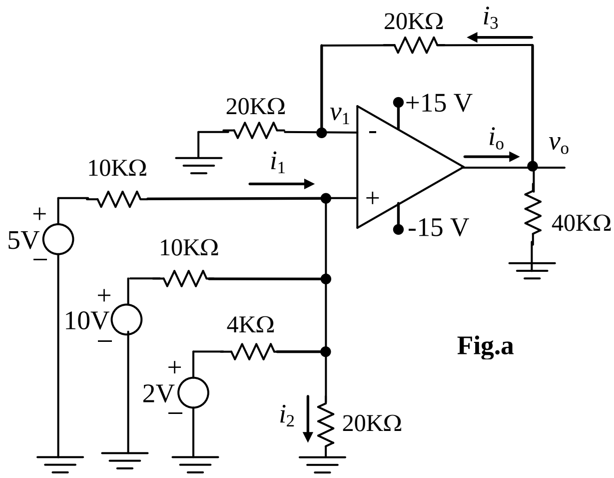


Fig.a

b) The switch in the circuit shown in Fig.b has been in position (a) for a long time before it moves to (b) at $t = 0$. After 5 mSec, the inductance current i_L dropped to 80% of its initial value. Find the value of L.

(12 Marks)

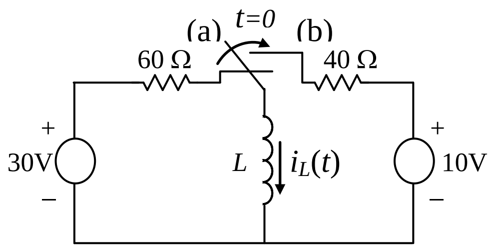


Fig. b

$i_L(0^+)$ = 0.5 A

$i_L(\infty)$ = 0.25 A

$$i(t) = 0.25 + 0.25e^{-t/\tau}$$

$$i(5mS) = 0.25\left(1 + e^{-\frac{5}{\tau}}\right) = 0.4\ A$$

τ = 9.788 mS

L = 392 mH

Question 2:

a) A three-phase Δ-connected +ve sequence source having the phase voltage $\boldsymbol{V_{ab}}=220\angle 0°$V. The source resistance is 1 Ω / Phase. The source supplies an unbalanced Δ-connected resistive load having R_{ab} = 10Ω, R_{bc} = 9Ω and R_{ca} = 21Ω. The three lines connecting the source to the load have negligible resistance. The load power is measured using the two wattmeter method. The first wattmeter W_1 is connected between lines A and B, while the second one W_2 is connected between lines C and B. Find the following: (12 Marks)

The phase current $\overline{I_{AB}}$ at the load =	**20∠0° A**
The Line current $\overline{I_A}$ =	**26.46∠-19.1° A**
The line voltage $\overline{V_{AB}}$ at the load =	**200∠0° V**
The reading of W_1 =	**5 KW**
The reading of W_2 =	**5.35 KW**
The total power dissipated in the load =	**10.35 KW**

b) i) Find the voltage transfer function of the circuit of Fig.(b). (6 Marks)

ii) Find the poles and zeros of the transfer function. (4 Marks)

iii) Find the magnitude of the transfer function at ω = 5 Rad/Sec. (2 Marks)

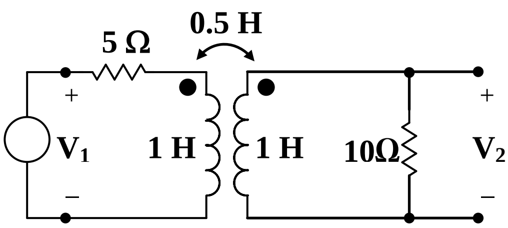


Fig. (b)

$$(2s + 10)I_1 + s\, I_2 = 2\, V_1$$

$$S\, I_1 + (2s + 20)I_2 = 0$$

$$H_v(s) = \frac{20s}{3s^2 + 60s + 200}$$

Poles: **- 4.23 , - 15.77 S^{-1}**

Zeros: **0, ∞**

$|H_v(j5)|$ = **0.308**

Question 3:

a) Find the first four non-zero terms of the Fourier series of the periodic voltage waveform shown in Fig.(a). (8 Marks)

$$b_n(t) = \frac{2}{T}\int_{-\frac{T}{2}}^{\frac{T}{2}} 5t.\sin(n\omega_o t)dt = -\frac{10}{n\omega_o T}\int_{-\frac{T}{2}}^{\frac{T}{2}} t.d\cos(n\omega_o t)$$

$$= -\frac{5}{n\pi}\left[t.\cos(n\omega_o t) - \frac{1}{n\omega_o}\sin(n\omega_o t)\right]_{-\frac{T}{2}}^{\frac{T}{2}}$$

$$= -\frac{5}{n\pi}\left[t.\cos(n\omega_o t) - \frac{1}{n\omega_o}\sin(n\omega_o t)\right]_{-\frac{T}{2}}^{\frac{T}{2}} = -\frac{20}{n\pi}\cos(n\pi)$$

$b_1 = 20/\pi$, $b_2 = -10/\pi$, $b_3 = 20/3\pi$, $b_4 = -5/\pi$,

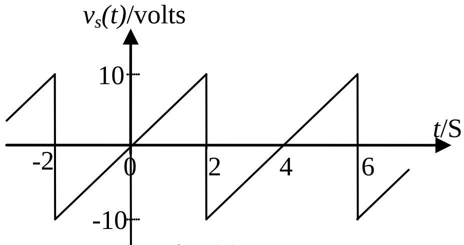


Fig. (a)

b) There is no energy stored in the circuit of Fig.b at the time the switch is closed:

i) Write the two mesh equations of the circuit. (4 Marks)

ii) Find $I_1(s)$ and $I_2(s)$. (4 Marks)

iii) Find $i_1(t)$ and $i_2(t)$. (4 Marks)

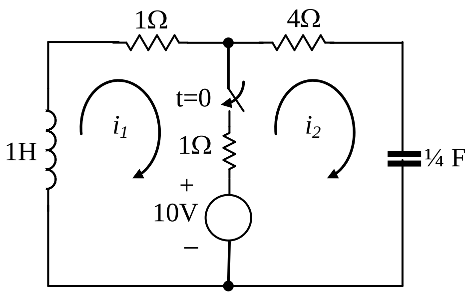


Fig. (b)

The first s-domain mesh equation:

$$(s^2 + 2s)\, I_1 - s\, I_2 = -10$$

The second s-domain mesh equation:

$$- s\, I_1 + (5s + 4)\, I_2 = 10$$

***$I_1(s)$* =** $\frac{-8}{s(s+1.6)} = \frac{5}{s+1.6} - \frac{5}{s}$

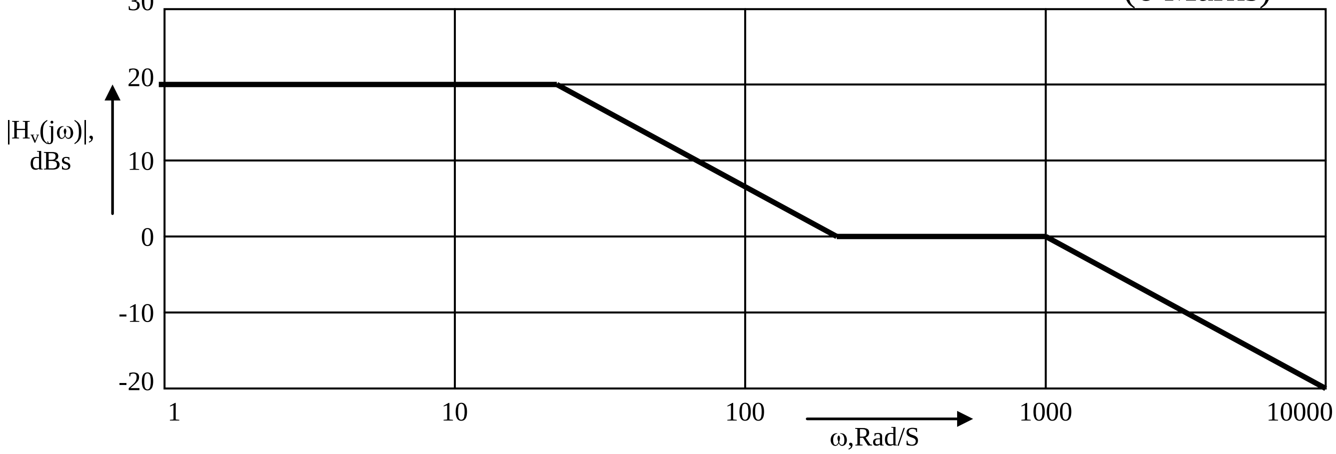
***$I_2(s)$* =** $\frac{2}{s+1.6}$

***$i_1(t)$* =** $[-5 + 5e^{-1.6t}]u(t)\mathrm{A}$

***$i_2(t)$* =** $2e^{-1.6t}u(t)\mathrm{A}$

c) Sketch the Bode Diagram of the voltage transfer function: $H_v(s) = \frac{1000\,(s+200)}{(s+20)(s+1000)}$

(6 Marks)



Question 4:

a) The switch in the circuit of Fig. (a) has been open a long time before closing at $t = 0$.

i) Find $i_L(0^+)$, $i_L(\infty)$, $v_L(0^+)$, $\frac{di_L}{dt}(0^+)$. (8 Marks)

ii) Write the differential equation of $i_L(t)$. (2 Marks)

iii) Write the characteristic equation and find its roots. (4 Marks)

iv) The constants in the solution for $i_L(t)$. (2 Marks)

v) Find $i_L(t)$ for $t \geq 0$. (2 Marks)

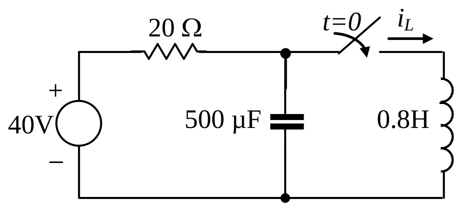


Fig. (a)

$i_L(0^+)$	0
$i_L(\infty)$	2 A
$v_L(0^+)$	40 V
$\frac{di_L}{dt}(0^+)$	$\frac{V_L(0^+)}{L} = 50\ \mathrm{A/S}$

the differential equation of $i_L(t)$

$$\frac{d^2i}{dt^2} + \frac{1}{RC}\cdot\frac{di}{dt} + \frac{1}{LC}\cdot i = \frac{2}{LC}$$

the characteristic equation

$$s^2 + 100\,s + 2500 = 0$$

roots of the characteristic equation

$$s_1 = s_2 = -50$$

The constants

$$D_1 = -50,\ D_2 = -2$$

$$i_L(t) = 2 - (50\,t + 2)\,e^{-50t}$$

b) Find the h parameters of the circuit shown in Fig.(b). (8 Marks)

$h_{11} =$	60 Ω	$h_{12} =$	0.333
$h_{21} =$	-0.21	$h_{22} =$	8.8 mS

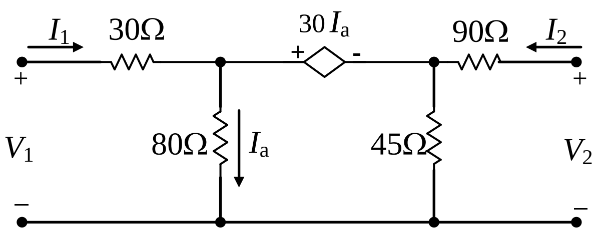


Fig.(b)

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2nd Year Elect.

Time: 3 Hours

الامتحان مكون من أربع صفحات، الإجابة فى نفس ورقة الأسئلة، النهاية العظمى ١٠٠ درجة.

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Question #1: (12 Points)

The two op amps in the circuit in Fig.1 are ideal. Calculate v_{o1}, v_{o2}, i_{o1} and i_{o2}.

v_{o1} = 2.125 V
v_{o2} = 2.5 V
i_{o1} = 0.25 mA
I_{o2} = 1.75 mA

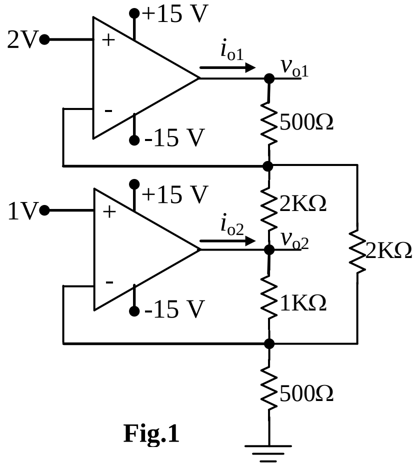


Fig.1

Question #2: (16 Points)

The voltage waveform shown in Fig.2(a) is applied to the circuit of Fig.2(b). The initial voltage on the capacitor is zero. Calculate and sketch $v_o(t)$.

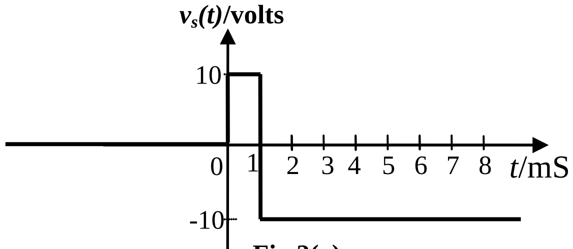


Fig.2(a)

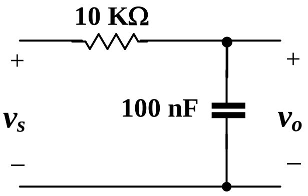
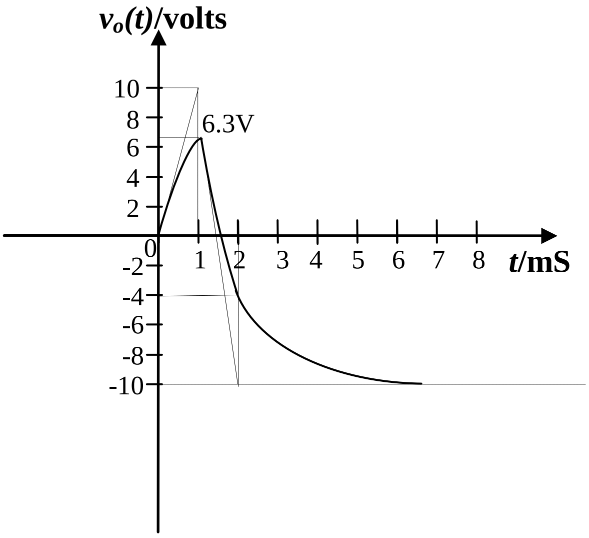


Fig.2(b)

$v_o(0^+) = 0$
$v_o(\infty)_1 = 10$ V
τ = 1 mS
$v_o(t) = 10(1 - e^{-t})$ V   0 <= t <= 1 mS
$v_o(1mS) = 6.3$ V
$v_o(\infty) = -10$ V
$v_o(t) = -10 + 16.3\, e^{-(t-1)}$ V   1mS <= t <= ∞



Question #3: (10 Points)

The voltage response for the circuit in Fig.3 is known to be $v(t) = D_1 te^{-500t} + D_2 e^{-500t}$, $t \geq 0$.
The initial current in the inductor (I_o) is -10 mA, and the initial voltage on the capacitor (V_o) is 8 V. The inductor has an inductance of 4 H.

a) Find the values of R, C, D_1 and D_2.

b) Find $i_C(t)$ for $t \geq 0^+$.

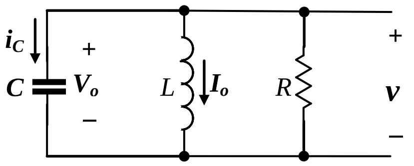


Fig.3

R = 1 KΩ

C = 1 μF

D_1 = 6000 V/S

D_2 = 8 V

$i_C(t) = -3\,t\,e^{-500t} + 2\text{x}10^{-3}\,e^{-500t}$ A

Question #4: (12 Points)

A three-phase Y-connected +ve sequence source having the phase voltage $\boldsymbol{V_a}$=260∠0°V. The source resistance is 1 Ω/Phase. The source supplies a balanced Δ-connected load having an impedance of (27 + j15) Ω/Phase. The three lines connecting the source to the load have a resistance of 2 Ω/Line. Find the following:

The Line current $\overline{I_A}$ =	**20∠-22.6° A**
The phase current $\overline{I_{AB}}$ at the load =	**11.55∠7.4° A**
The line voltage $\overline{V_{AB}}$ at the load =	**356.7∠36.4° V**
The phase voltage $\overline{V_a}$ at the source terminals =	**241.7∠1.8° V**
The line voltage $\overline{V_{ab}}$ at the source terminals =	**418.6∠31.8° V**
The total power dissipated in the load =	**10.8 KW**

Question #5: (12 Points)

The sinusoidal voltage source in the circuit of Fig.5 is operating at a frequency of 200 Krad/s. The coefficient of coupling is adjusted until the peak amplitude of i_1 is pure real.

a) What is the value of k?

b) What is the peak amplitude of i_1 if $v_g = 112 \cos(2 \times 10^5\, t)$ V ?

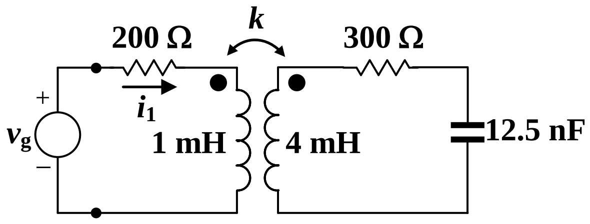


Fig.5

$Z_r = 64\, k^2(3 - j4)$

$$i_1 = \frac{v_g}{200 + j200 + 64k^2(3 - j4)}$$

$4 \times 64\, k^2 = 200$

k = 0.88

$i_{1(peak)}$ = 0.32 A

Question #6: (12 Points)

Find the voltage transfer function and its poles and zeros for the circuit of Fig.6. If we consider this circuit as a bandpass filter, find approximate values for its magnitude transfer function at ω = 0 and at its central frequency. Find also the value of its bandwidth.

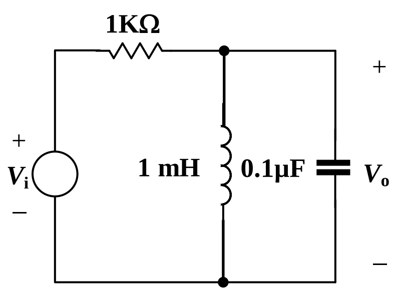


Fig.6

$H_v(s)$ = $$\frac{10^4 s}{s^2 + 10^4 s + 10^{10}}$$

Poles: $-5 \pm j\, 99.87$ Krad/s

Zeros: $0, \infty$

$|H_v(0)|$ = 0

$|H_v(j\omega_o)|$ = 1

BW = 10^4 rad/s

<u>Question #7</u>: (12 Points)

There is no energy stored in the circuit of Fig.7 at the time the current source is energized. Use the Laplace Transform to find the nodal voltages.

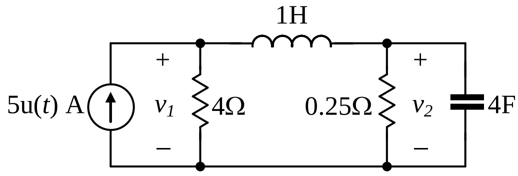


Fig.7

Eq. (1): $(s + 4)V_1 - 4V_2 = 20$

Eq. (2): $-V_1 + (4s^2 + 4s + 1)V_2 = 0$

$V_1(s) = \dfrac{20(s^2 + s + 0.25)}{s(s^2 + 5s + 4.25)}$ $\qquad V_2(s) = \dfrac{5}{s(s^2 + 5s + 4.25)}$

$v_1(t) = 1.18 - 16.38e^{-1.09t} + 35.2e^{-3.91t}$ $\qquad v_2(t) = 1.18 - 1.63e^{-1.09t} + 0.45e^{-3.91t}$

<u>Question #8</u>: (6 Points)

A periodic voltage having a period of 10π μS is given by the following Fourier series:

$$v_g = 150\sum_{n=1,3,5,\ldots}^{\infty} \frac{1}{n}\sin\frac{n\pi}{2}\cos n\omega_o t \text{ V}$$

This periodic voltage is applied to the circuit shown in Fig.8. Find the amplitude and phase angle of the first three components of v_o.

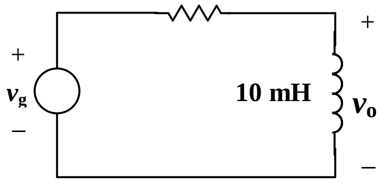


Fig.8

$\omega_o = 2\pi/T = 200$ **Krad/s**

$v_g = 150\cos\omega_o t - 50\cos 3\omega_o t + 30\cos 5\omega_o t$

$$v_o = \frac{j2n}{6 + j2n}v_g$$

$V_{o1} = 47.43\angle 71.6°$ V $\qquad V_{o3} = 35.34\angle -135°$ V $\qquad V_{o5} = 25.73\angle 31°$ V

<u>Question #9</u>: (8 Points)

Find the s-domain expressions for the *a* parameters of the two-port circuit shown in Fig.9.

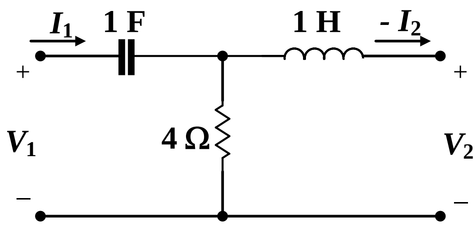


Fig.9

$a_{11} = 1 + \dfrac{1}{4s}$ $\qquad a_{12} = s + \dfrac{1}{4} + \dfrac{1}{s}$

$a_{21} = \dfrac{1}{4}$ $\qquad a_{22} = \dfrac{s}{4} + 1$

******************** أطيب التمنيات بالتوفيق ********************

أ.د. مجدى مفيد دوس

ASSIUT UNIVERSITY
FACULTY OF ENGINEERING
DEPT. OF ELECTRICAL ENG.

E222 CIRCUIT THEORY

First Term Examination, 2013/2014

2nd Year Elect.

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Attempt all questions, full mark: 100 Points **Time: 3 Hours**

Question #1: (12 Points)

The nonlinear device (D) used in the circuit of Fig.1 has a characteristic given by:

$i_d = Ie^{\alpha v_d}$, where $v_d > 0$ and $i_d > 0$.

Assuming ideal operational amplifier, and that the nonlinear device is operating with positive values of v_d and i_d,

a) find an expression relating v_{out} to v_{in}. (8 Points)

b) if $I = 0.5$ μA, $\alpha = 40$ V^{-1} and $R = 1$ KΩ, find v_{out} for $v_{in} = 5$ V. (4 Points)

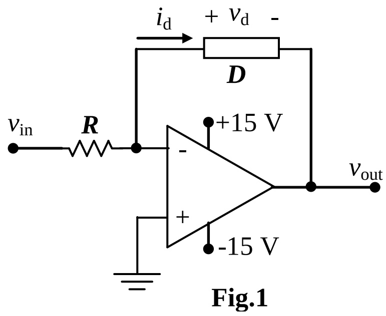


Fig.1

$$v_{out} = -\frac{1}{\alpha}\ln\frac{v_{in}}{RI}$$

v_{out} (for v_{in} = 5 V) = - 230 mV

Question #2: (14 Points)

The two switches (a) and (b) in the circuit of Fig.2 operate simultaneously. Prior to t=0 switch (a) was open and switch (b) was close for a long time. At t=0, switch (a) is closed and switch (b) is opened.

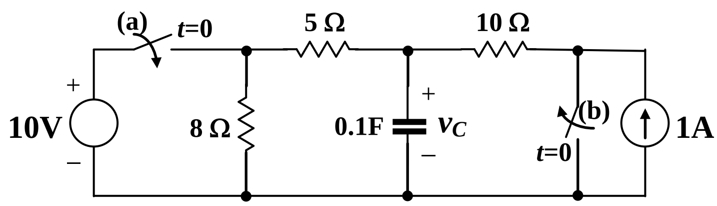


Fig.2

a) Find $v_C(0^+)$, $i_C(0^+)$, $v_C(\infty)$, $i_C(\infty)$, and the time constant τ. (10 Points)

b) Find $v_C(t)$ and $i_C(t)$ for $t \geq 0$. (4 Points)

Hint: use the superposition theorem.

$v_C(0^+) = 0$	$v_C(\infty) = 15$ V
$i_C(0^+) = 3$ A	$i_C(\infty) = 0$
$\tau = 0.5$ S	

$v_C(t) = 15(1- e^{-2t})$ V

$i_C(t) = 3\ e^{-2t}$ A

Question #3: (12 Points)

Consider the circuit in Fig.3 with two inputs $v(t)=4\delta(t)$ V and $i(t)= 2\delta(t)$ A. The inductor and capacitor have zero initial state, i.e. $v_C(t=0^-) = 0$ and $i_L(t=0^-) = 0$.

a) Draw the s domain equivalent circuit. (2 Points)
b) Find the capacitor voltage $v_c(t)$, for $t \geq 0$.(6 Points)
c) What are the inductor current i_L and the capacitor voltage v_C at $t=0+$? (4 Points)

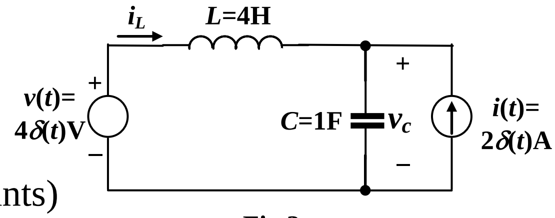
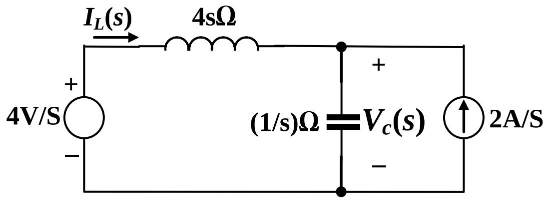


Fig.3

$$V_C\left(s+\frac{1}{4s}\right)=2+\frac{1}{s}$$

$$V_C(s)=\frac{2s+1}{s^2+0.25}$$

$$v_C(t)=2\cos 0.5t+2\sin 0.5t$$



$$v_C(t)=2\sqrt{2}\cos(0.5t+45°)$$

$v_C(0^+) = 2$ V

$i_L(0^+) = 1$ A

Question #4: (12 Points)

a) A three-phase Y-connected +ve sequence source having the phase voltage $V_a=240\angle 0°$V and negligible source resistance. The source supplies a balanced Δ-connected load having an impedance of $60\angle 30°$ Ω/phase. The three lines connecting the source to the load have negligible resistance. The load power is measured using the two wattmeter method. The first wattmeter W_1 is connected between lines A and B, while the second one W_2 is connected between lines C and B. Find the following:

The phase current $\overline{I_{AB}}$ at the load =	$6.928\angle 0°$ A
The Line current $\overline{I_A}$ =	$12\angle -30°$ A
The line voltage $\overline{V_{AB}}$ at the load =	$415.69\angle 30°$ V
The reading of W_1 =	2.494 KW
The reading of W_2 =	4.988 KW
The total power dissipated in the load =	7.482 KW

Question #5: (14 Points)

Consider the circuit of Fig.5, the operational amplifier is ideal. It is required to:

a) Find an expression for the voltage transfer function $H_v(s) = V_{out}(s)/V_{in}(s)$. (6 points)

b) Compute the numerical values of poles and zeros of the transfer function. (4 points)

c) If the input is a sinusoidal waveform given by: $v_{in}(t) = 10\cos(10^4 t + 30°)$ V; give the expression for the output $v_{out}(t)$. (4 points)

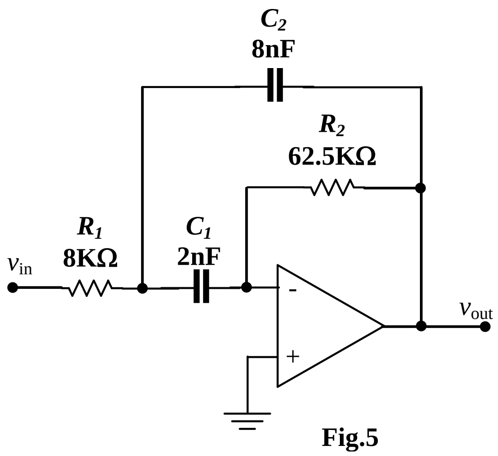


Fig.5

$H_v(s) =$ $$\frac{-\frac{1}{R_1C_2}s}{s^2+\frac{1}{R_2}\left(\frac{1}{C_1}+\frac{1}{C_2}\right)s+\frac{1}{R_1R_2C_1C_2}} = \frac{-1.5625\times10^4 s}{s^2+10^4 s+1.25\times10^8}$$

Poles: - 5 – *j* 10 Krad/S, - 5 + *j* 10 Krad/S

Zeros: 0, ∞

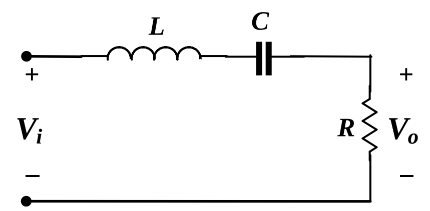
$V_{out}(t) =$ 15.1585 cos($10^4 t$ - 135.96°) V

Question #6: (12 Points)

a) A series *RLC* band-pass filter has a center, or resonant, frequency of 50 kHz and a quality factor of 4. Find the band-width, the upper cutoff frequency, and the lower cut-off frequency. (6 Points)

b) Use a 5 nF capacitor to design the filter. Draw the circuit diagram and specify the values of *R* and *L*. (6 Points)

The circuit diagram



BW = 12.5 KHz

$f_1 =$ 44.14 KHz

$f_2 =$ 56.64 KHz

R = 159.2 Ω

L = 2.026 mH

<u>Question #7</u>: (12 Points)

a) Find the first four Fourier coefficients of the voltage waveform of Fig.7(a). (4 Marks)

b) The voltage waveform of Fig.7(a) is applied to the circuit of Fig.7(b). Find the Fourier coefficients of the output voltage v_{ld}. (4 Marks)

c) Find the *RMS* values of the source voltage and the load voltage. (4 Marks)

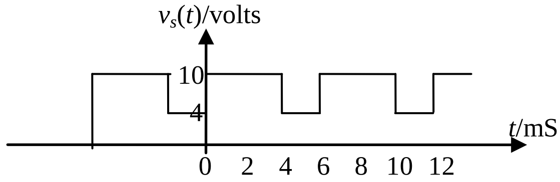


Fig.7(a)

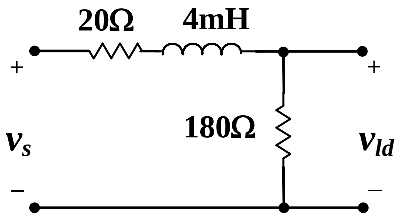


Fig.7(b)

$a_o =$	**8 V**	$V_{ldo} =$	**7.2 V**
$C_1 =$	**3.308∠120° V**	$V_{ld1} =$	**2.377∠83° V**
$C_2 =$	**1.645∠60° V**	$V_{ld2} =$	**0.8227∠3.55° V**
$C_3 =$	**0**	$V_{ld3} =$	**0**
$V_{s(RMS)} =$	**8.49 V**	$V_{ld(RMS)} =$	**7.42 V**

<u>Question #8</u>: (12 Points)

a) Find the transmission parameters of the two-port network of Fig.8. (8 Points)

b) A voltage source V_s = 75∠0° V and source impedance Z_s = 1∠0° Ω is applied to the input port, and a load Z_L = 10∠0° Ω is connected to the output port, find V_2. (4 Points)

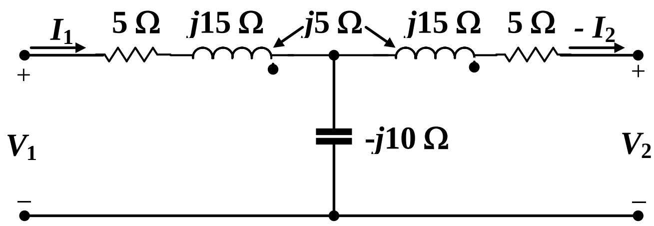


Fig.8

$a_{11} =$	**- 1/3 + *j*(1/3)**	$a_{12} =$	**- 10/3 + *j*5 Ω**
$a_{21} =$	***j*(1/15) S**	$a_{22} =$	**- 1/3 + *j*(1/3)**
$V_2 =$	**8.01∠-85.7° V**		

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Attempt all questions, full mark: 100 Points **Time: 3 Hours**

Question #1: (12 Points)

The circuit shown in Fig.1 is used to measure the change in resistance experienced by strain gages.

a) Derive an expression for the output voltage V_{out} in terms of the resistance values and the reference voltage V_{ref}, assuming ideal op-amp and neglecting ΔR^2 w.r.t. R^2. (8 Points)

b) If $R = 160\ \Omega$, $\Delta R = 1\ \Omega$, $R_f = 1.2\ \text{K}\Omega$, and $V_{ref} = 8$ V; find the value V_{out}. (4 Points)

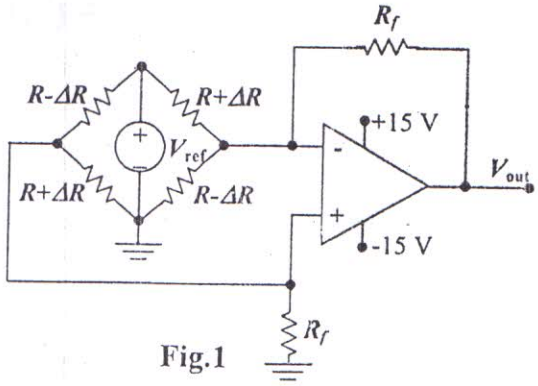


Fig.1

Expression for V_{out}:

V_{out} =

Value of V_{out}:

V_{out} =

Question #2: (16 Points)

In the circuit shown in Fig.2, the initial currents in inductors L_1 and L_2 are 8A and 1A respectively. The switch is opened at $t = 0$.

a) Find $i(t)$, for $t \geq 0$. (8 Points)

b) Find $v(t)$, for $t \geq 0$. (2 Points)

c) Find $i_1(t)$ and $i_2(t)$, for $t \geq 0$. (4 Points)

d) Determine the total energy stored in the inductors as $t \to \infty$. (2 Points)

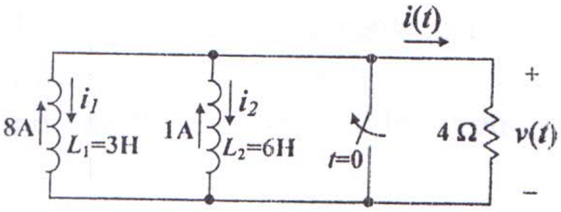


Fig.2

$i(0^+)$ =

$i(\infty)$ =

τ =

$i(t)$ =

$v(t)$ =

$i_1(t)$ =

$i_2(t)$ =

Energy stored in the inductors as $t \to \infty$ =

Question #3: (12 Points)

The switch in the circuit shown in Fig.3 has been in position (a) for a long time. At $t = 0$, it moves to position (b). Find $i(0^+)$, $v_c(0^+)$, $di(0^+)/dt$, the roots of the characteristic equation s_1, s_2 and $i(t)$ for $t \geq 0$.

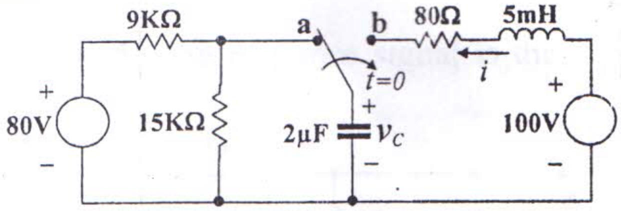


Fig. 3

$i(0^+) =$

$v_C(0^+) =$

$di(0^+)/dt =$

$s_1 =$

$s_2 =$

$i(t) =$

Question #4: (12 Points)

A three-phase Δ-connected -ve sequence source having the phase voltage $V_{ab}=240\angle 0°$V and negligible source resistance. The source supplies a resistive unbalanced Δ-connected load having impedances: $R_{AB}= 60\ \Omega$, $R_{BC}= 40\ \Omega$, and $R_{CA}= 80\ \Omega$. The three lines connecting the source to the load have negligible resistances. The load power is measured using the two wattmeter method. The first wattmeter W_1 is connected between lines A and B, while the second one W_2 is connected between lines C and B. Find the following:

The phase current $\overline{I_{AB}}$ at the load =

The Line current $\overline{I_A}$ =

The Line current $\overline{I_C}$ =

The reading of W_1 =

The reading of W_2 =

The total power dissipated in the load =

Question #5: (14 Points)

The voltage source v_g drives the circuit shown in Fig.5. The response signal is the voltage across the capacitor, v_o.

a) Calculate the numerical expression for the voltage transfer function $H_v(s) = V_o(s)/V_g(s)$. (6 points)

b) Calculate the numerical values for the poles and zeros of the transfer function. (4 points)

c) The circuit is driven by a step voltage source, namely, $v_g = 50u(t)$, find $v_o(t)$. (4 points)

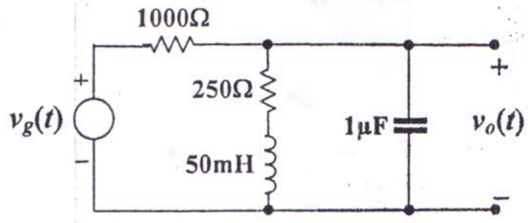


Fig.5

$H_v(s) =$

Poles:

Zeros:

$V_{out}(t) =$

Question #6: (12 Points)

The ideal transformer used in the circuit of Fig.6 has a turns ratio $N_2/N_1 = 3$.

a) Find the reflected impedance at terminals a-b of that transformer. (6 Points)

b) Calculate the value of the currents I_1, I_2, I_3, and I_4. (6 Points)

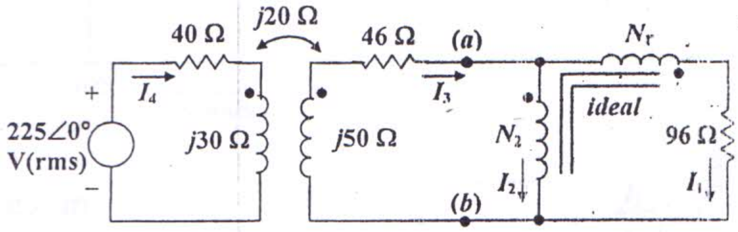


Fig.6

$Z_R =$

$I_1 =$

$I_2 =$

$I_3 =$

$I_4 =$

Question #7: (6 Points)

a) Calculate the impedance of the circuit shown in Fig.7 at radian frequency of 2 Krad/S. (2 Points)

b) At what finite frequency (ω_r) does the impedance of the circuit become purely resistive? What is the impedance at that frequency? (4 Points)

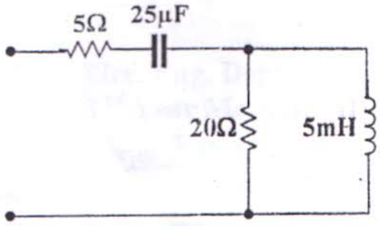
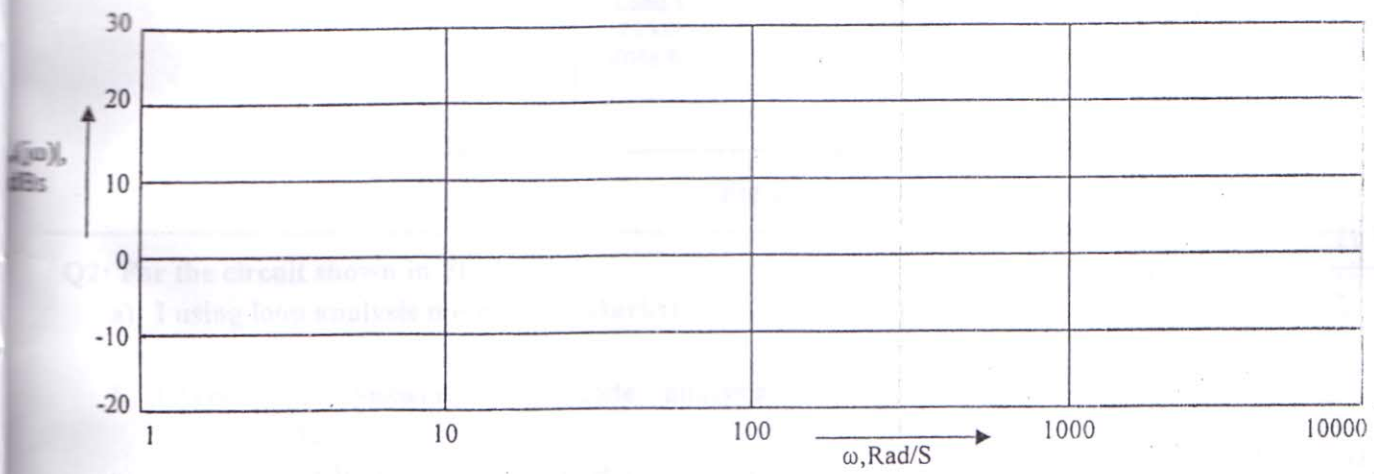


Fig.7

Z(2Krad) =	ω_r =	$Z(\omega_r)$ =

Question #8: (8 Points)

Sketch the Bode Diagram of the voltage transfer function: $H_v(s) = \dfrac{1000(s+100)}{(s+10)(s+1000)}$



Question #9: (8 Points)

The y parameters for the two-port network in Fig.9 are: y_{11}= 2mS, y_{12} = -0.2 mS, y_{21} = 10 mS, and y_{22} = -0.5 mS. Find V_1, V_2, I_1, and I_2.

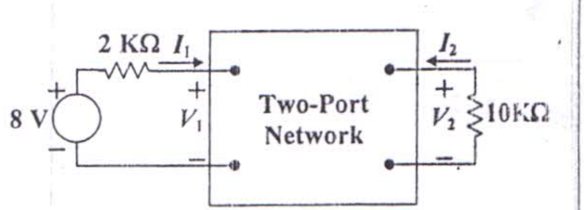


Fig.9

V_1 =	V_2 =
I_1 =	I_2 =

******************** Best Wishes, Prof. Magdy M. Doss ********************