ASSIUT UNIVERSITY
FACULTY OF ENGINEERING
DEPT. OF ELECTRICAL ENG.

# E222 CIRCUIT THEORY (2)

2nd Year Elect.

First Term Examination, 2016/2017

الامتحان مكون من أربع صفحات، الإجابة فى نفس ورقة الأسئلة، النهاية العظمى 100 درجة.
الإجابة النهائية يجب أن تكون مكتوبة فى المكان المخصص لها وخطوات الحل تكون فى الصفحة المقابلة.

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

## Question #1: (8 Points)

Design a difference amplifier (Fig.1) to meet the following criteria: $V_{out} = 3V_b - 4V_a$. The resistance seen by the signal source $V_a$ is 22 kΩ when $V_b$ is zero, and the resistance seen by the signal source $V_b$ is 500 KΩ.

a) Specify the values of $R_a$, $R_b$, $R_c$, and $R_d$. (6 Points)

b) If $V_a$ = 1.25 V and $V_b$ = 4 V, find $I_o$. (2 Points)

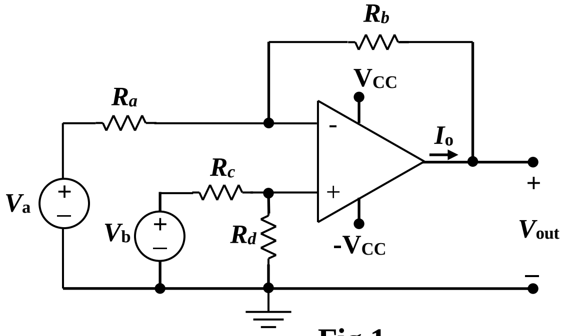


**Fig.1**

a) $R_a$ = 22 KΩ | $R_b$ = 88 KΩ | $R_c$ = 200 KΩ | $R_d$ = 300 KΩ

b) $I_o$ = 0.052 mA

## Question #2: (20 Points)

The switch in the circuit of Fig.2 have been in position (a) for a long time. At $t$ = 0, the switch moves to position (b). The switch remains in position (b) a time equals $t_1$ until the voltage $v$ becomes 5 V, then it moves again to position (a).

a) Find $v(t)$ for $0 \le t \le t_1$. (8 Points)

b) Find the time $t_1$. (4 Points)

c) Find the current $i(t)$ for $t_1 \le t \le \infty$. (8 Points)

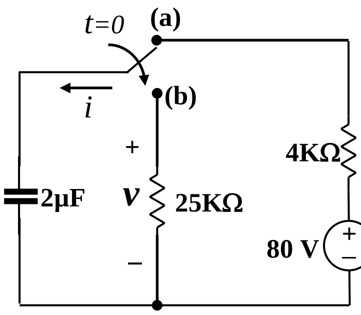


**Fig. 2**

a) $v(0^+)$ = 80 V | $v(\infty)$ = 0 | $\tau_1$ = 50 mS

$v(t) = 80\ e^{-t/50}$ , (t in mSec)

b) $t_1$ = 138.6 mS

c) $i(t_1)$ = 18.75 mA | $i(\infty)$ = 0 | $\tau_2$ = 8 mS

$i(t) = 18.75\ e^{-(t-138.6)/8}$

**<u>Question #3</u>: (14 Points)**

The two switches in the circuit of Fig.3 operate synchronously. Switch (1) has been in position (a) and switch (2) is closed for a long time, at $t = 0$, switch (1) moves instantaneously to position (b) and switch (2) is open. Find $v_c(0^+)$, $v_c(\infty)$, $i_L(0^+)$, $[dv_c/dt]_{0+}$, the roots of the characteristic equation $s_1$, $s_2$ and $v_c(t)$ for $t \geq 0$.

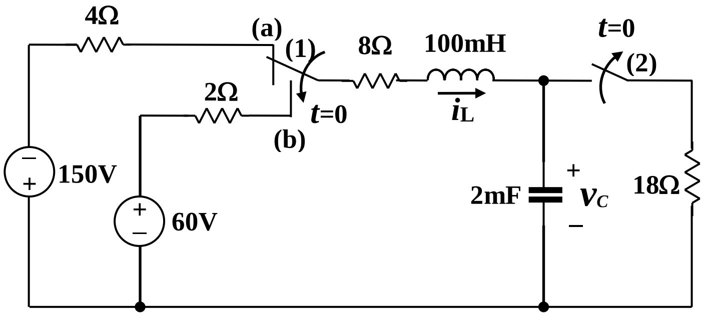


**Fig. 3**

| | |
|---|---|
| $v_C(0^+) = -90$ V | $v_C(\infty) = 60$ V |
| $i_L(0^+) = -5$ A | $[dv_c/dt]_{0+} = -2500$ V/Sec |
| $s_1 = -50 + j50$ | $s_2 = -50 - j50$ |

$v_C(t) = 60 - e^{-50t}$ (150 cos 50t + 200 sin 50t) volts

**<u>Question #4</u>: (12 Points)**

3. A balanced Δ-connected load has an impedance of 180 + j75 Ω/φ. The load is fed through lines having an impedance of 1 + j1 Ω/line. The phase voltage at the terminals of the load is 1950V. Calculate:
   a) The magnitude of the phase current at the load.
   b) The magnitude of the line current.
   c) The magnitude of the line voltage at the sending end.
   d) The total power dissipated in the load.

The magnitude of the phase current at the load .................. **10 A**

The magnitude of the line current.................................. **17.3 A**

The magnitude of the line voltage at the sending end .......... **1989.3 V**

The total power dissipated in the load............................. **54 KW**

**Question #5: (12 Points)**
The two switches in the circuit shown in Fig.5 operate simultaneously. There is no energy stored in the circuit at the instant the switches close. Find the s-domain Thevenin equivalent of the circuit to the left of the terminals (a), (b), then find $I(s)$ and $i(t)$ for $t \geq 0$.

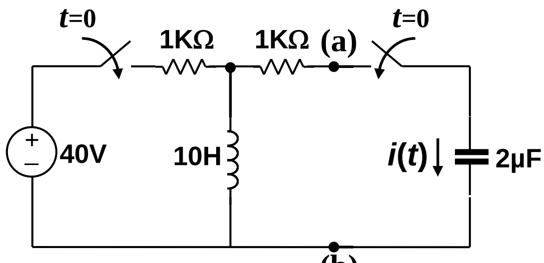

Fig.5

$V_{Th}(s) = \frac{40}{s+100}$ V.Sec

$Z_{Th}(s) = 2000\frac{s+50}{s+100}$ Ω

$I(s) = \frac{s/50}{s^2+300s+25\times10^3}$

$i(t) = 0.0632e^{-150t}\cos(50t + 71.6°)$A

**Question #6: (12 Points)**
Find the current $I_1$, $I_2$ and the voltage $V_o$ in the circuit of Fig.6

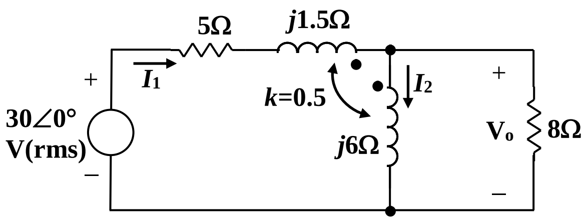

Fig.6

*The first loop equation*

$5 I_1 + j4.5 I_2 = 30$

*The second loop equation*

$-(8 + j1.5)I_1 + (8 + j6)I_2 = 0$

$I_1 = 4.06 \angle -26.39°$ A $= 3.64 - j1.8$ A

$I_2 = 3.3 \angle -52.64°$ A $= 2 - j0.82$ A

$V_o = 14.66 \angle 26.6°$ V $= 13.12 + j6.56$ V

**Question #7: (14 Points)**

The Fourier series of the half-wave rectified sinusoidal voltage:

$$v(t) = V_M \sin(\omega_o t), \quad 0 \le t \le \frac{T}{2};$$

$$v(t) = 0, \quad \frac{T}{2} \le t \le T$$

is given by:

$$v(t) = \frac{V_M}{\pi} + \frac{V_M}{2}\sin(\omega_o t) - \frac{2V_M}{\pi}\sum_{n=1}^{\infty}\frac{\cos(2n\omega_o t)}{4n^2-1}.$$

A half-wave rectified sinusoidal voltage having $V_M$ = 100 V and $\omega_o$ = 800 rad/s is applied to the circuit of Fig.7. Find:

a) The magnitude of the first three non-zero terms of the output voltage. (6 Points)

b) The RMS value of the input voltage. (4 Points)

c) The RMS value of the output voltage. (4 Points)

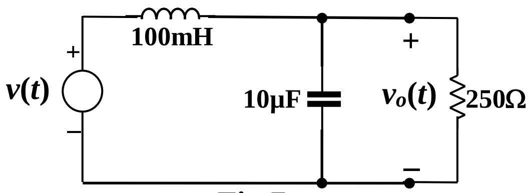


Fig.7

| | | |
|---|---|---|
| $V_{o(dc)}$ = 100/π V | $V_{o(1)}$ = 103.8 V | $V_{o(2)}$ = 12.6 V |

| | |
|---|---|
| $V_{in(RMS)}$ = 50 V | $V_{o(RMS)}$ = 80.5 V |

**Question #8: (8 Points)**

The following dc measurements were made on the resistive network shown in Fig.8

Measurement 1:

$V_1$ = 4V, $I_1$ = 44 mA, $V_2$ =0, $I_2$ = -200 mA

Measurement 2:

$V_1$ = 20 V, $I_1$ = 20 mA, $V_2$ = 4 V, $I_2$ = 0

a) Find the transmission (*a*) parameters of the circuit. (4 Points)

b) Find $V_1$, $V_2$, $I_1$, and $I_2$. (4 Points)

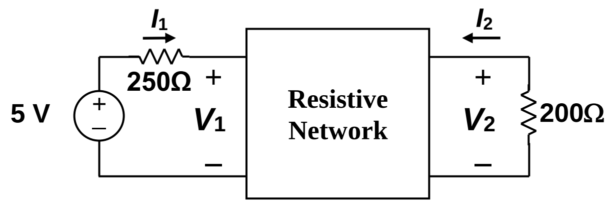


Fig.8

| | | | |
|---|---|---|---|
| $a_{11}$ = 5 | $a_{12}$ = 20 Ω | $a_{21}$ = 5 mS | $a_{22}$ = 0.22 |
| $V_1$= 3.85 V | $V_2$= 0.754 V | $I_1$= 4.6 mA | $I_2$= -3.77 mA |

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