ASSIUT UNIVERSITY
FACULTY OF ENGINEERING
DEPT. OF ELECTRICAL ENG.

E222 CIRCUIT THEORY

First Term Examination, 2014/2015

2nd Year Elect.

Model Answer

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 Ω, ΔR = 1 Ω, R_f = 1.2 KΩ, and V_{ref} = 8 V; find the value V_{out}. (4 Points)

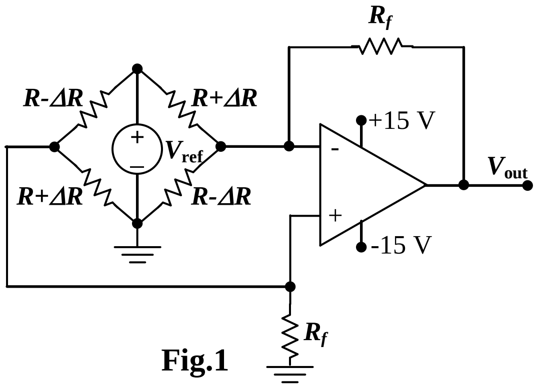


Fig.1

Expression for V_{out}:

$$V_{out} = \frac{2R_f\Delta R}{R^2} \cdot V_{ref}$$

Value of V_{out}:

V_{out} = 0.75 V

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)

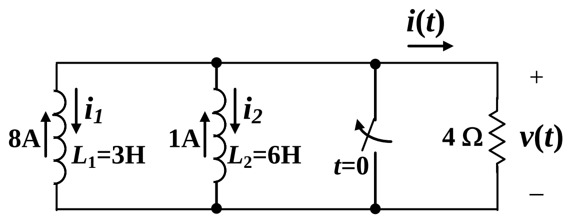


Fig.2

$i(0^+) = 9$ A	$i(\infty) = 0$	$\tau = 0.5$ S

$i(t) = 9\,e^{-2t}$ A

$v(t) = 36\,e^{-2t}$ V

$i_1(t) = -2 - 6\,e^{-2t}$ A

$i_2(t) = 2 - 3\,e^{-2t}$ A

Energy stored in the inductors as $t \to \infty$ = 18 J

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 $t \geq 0$.

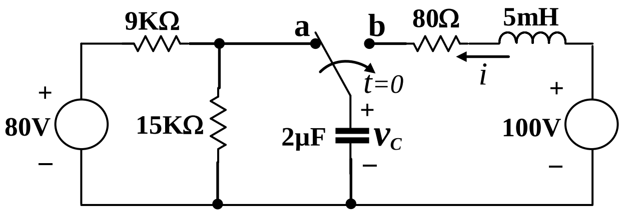


Fig. 3

$i(0^+) = 0$	$v_C(0^+) = 50$ V
$di(0^+)/dt = 10^4$ A/S	
$s_1 = -8000 + j\,6000$	$s_2 = -8000 - j\,6000$

$i(t) = 1.6736\, e^{-8000t} \sin(6000t)$ A

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 =	$4\angle 0°$ A
The Line current $\overline{I_A}$ =	$6.08\angle 25.3°$ A
The Line current $\overline{I_C}$ =	$7.94\angle 79.1°$ A
The reading of W_1 =	1.32 KW
The reading of W_2 =	1.8 KW
The total power dissipated in the load =	3.12 KW

<u>Question #5</u>: (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)

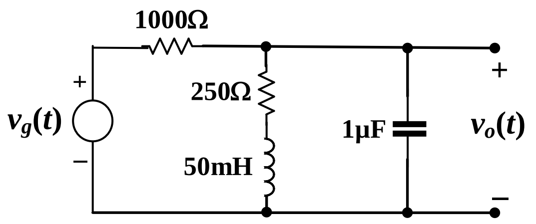


Fig.5

$H_v(s)$ =	$\frac{1000(s+5000)}{s^2+6000s+25\times10^6}$
Poles:	**- 3000 + *j*4000, - 3000 - *j*4000**
Zeros:	**- 5000, ∞**
$V_{out}(t)$ =	$[10 + 11.18\, e^{-3000t} \cos(4000t - 153.4°)]u(t)$ V

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

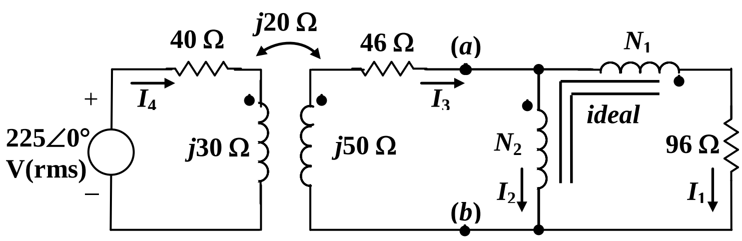


Fig.6

$$Z_R = \left(\frac{a}{1+a}\right)^2 R_L = 54\Omega$$

$I_1 = 0.584\angle 30.1°$ A	$I_2 = 0.195\angle 30.1°$ A
$I_3 = 0.779\angle 30.1°$ A	$I_4 = 4.35\angle -33.3°$ A

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)

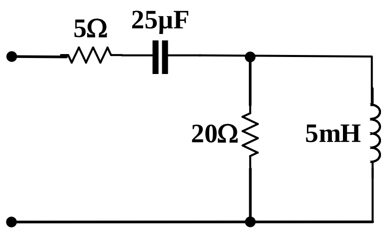
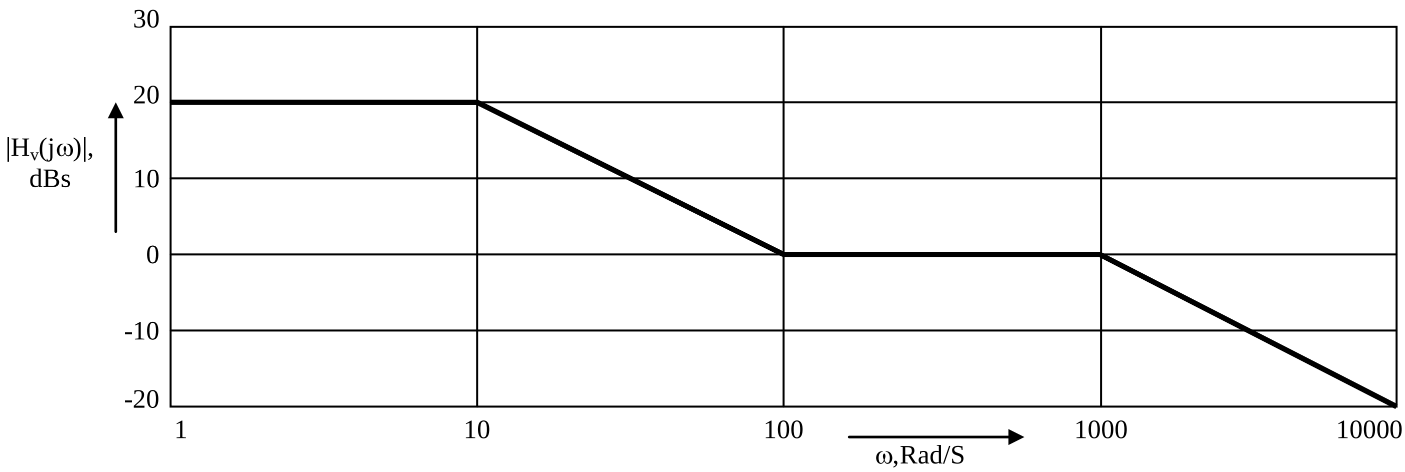


Fig.7

Z(2Krad) = 9 – j12 Ω	**ω_r = 4 Krad/S**	**$Z(\omega_r)$ = 15 Ω**

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 $\boldsymbol{V_1}$, $\boldsymbol{V_2}$, $\boldsymbol{I_1}$, and $\boldsymbol{I_2}$.

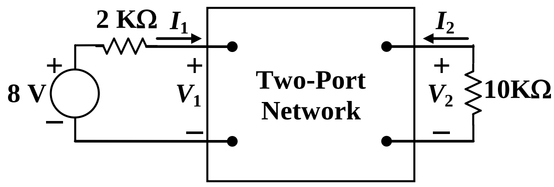


Fig.9

V_1 = - 1.6 V	**V_2 = - 40 V**
I_1 = 4.8 mA	**I_2 = 4 mA**