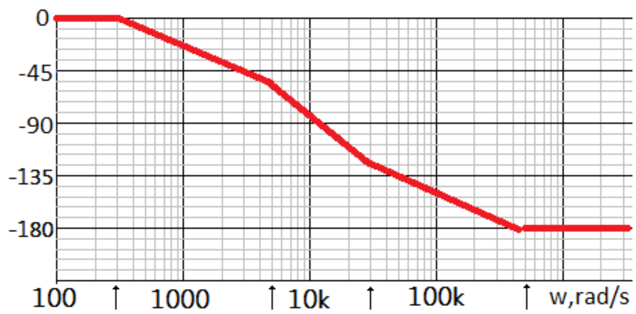
*Higher Technological Institute 10^{th} of Ramadan City
Department of Electrical & Computers Engineering
Mid Term Examination

Subject: Shaping Circuits /(EEC 242)(G2)
Examiner : Dr. Mustafa M. Shiple

Term: Sep - Jan 2015/16
Exam Time:60 min

ANSWER THE FOLLOWING QUESTIONS:

1. Design a filter having the phase asymptotic plot shown in the next Figure. [10 marks] [A_a, C_p]
   (a) Drive the transfer function.
   (b) Find the circuit and give the schematic and element values.
   (c) Redesign the circuit to raise its DC gain to be 2.



Solution: From the Figure, there are vertex at 300 rad/sec, 5000 rad/sec, 30k rad/sec, and 500K rad/sec
Q1.(a)

$$\therefore \omega_1 = 3Krad/sec, \text{ and } \omega_2 = 50Krad/sec$$

$$|T(S)| = \frac{1}{(\frac{s}{3K}+1)(\frac{s}{500K}+1)}$$

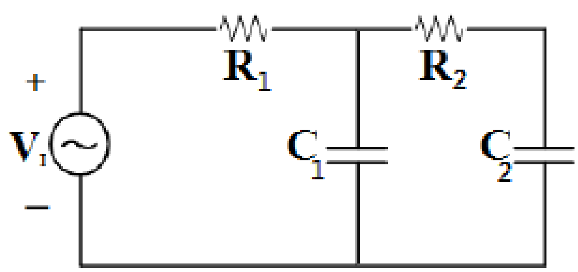
(b) Since the gain is not specified.

$$\omega = \frac{1}{RC} \Rightarrow R = \frac{1}{\omega C}$$

$$R_1 = \frac{1}{10n \times 3k} = 33.3k\Omega.$$

$$R_2 = \frac{1}{100p \times 500k} = 20K\Omega.$$

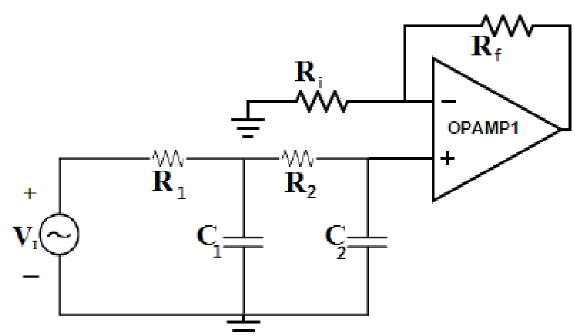
Since the gain is not specified.



(c)

$$K = 1 + \frac{R_f}{R_i}$$

$$\therefore R_f = R_i$$



[Total Marks is 30]

Signature of:
Examiner:

Good Luck

2. For 6^{th} order Butterworth. [5 marks] $[B_a, A_d, A_q]$

(a) State the main features of Butterworth filter.

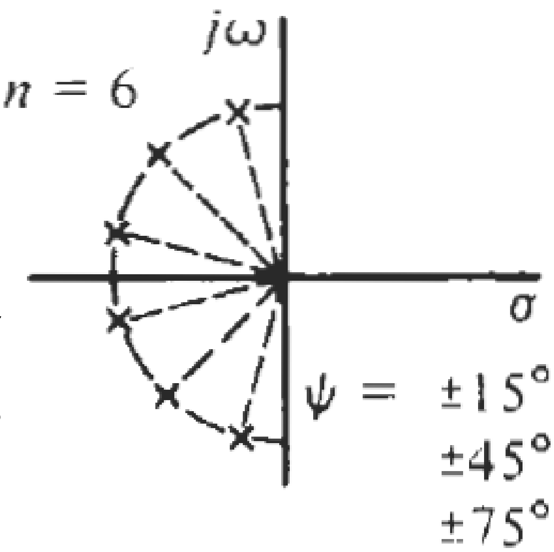
(b) Find the pole locations.

Solution: (a)

- The Butterworth filter is all pole filter.
- $|T(j0)| = 1$.
- $|T(j1)| = 0.707 = \frac{1}{\sqrt{2}}$ for $\forall n$.
- The attenuation increases by 20n dB/decade.

(b)

$$\psi = \frac{180}{6} = 30°$$
$$B = (S^2 + 2\cos 15 S + 1)$$
$$(S^2 + 2\cos 45 S + 1)$$
$$(S^2 + 2\cos 75 S + 1)$$



$$P_{1,2} = \cos 15 \pm \sin 15 = -0.26 \pm j0.97$$
$$P_{3,4} = \cos 45 \pm \sin 45 = -0.71 \pm j0.71$$
$$P_{5,6} = \cos 75 \pm \sin 75 = -0.97 \pm j0.26$$

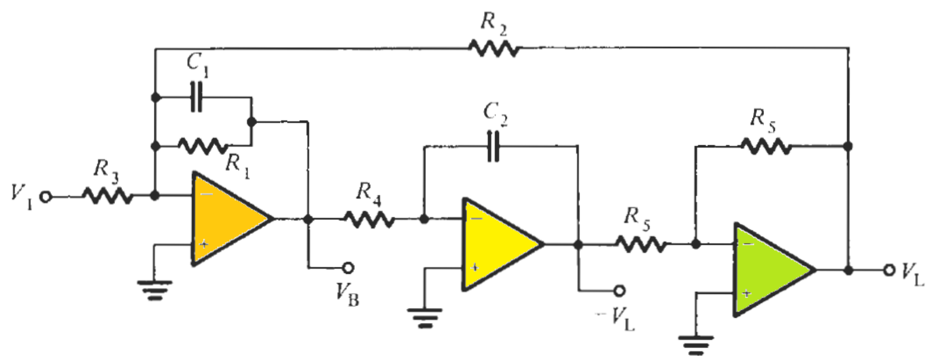
3. Draw the wiring diagram of Tow-Thomas. [15 marks] $[B_a, A_d, A_q]$

(a) Drive an expression for transfer function of bandpass Tow-Thomas.

(b) Draw bode plot for phase and magnitude of the bandpass Tow-Thomas.

(c) Find the Tow-Thomas circuit that will realize a bandpass filter with center frequency $f_o = 38Hz$ and -3 dB passband should be located between 34.8 kHz and 41.1 kHz. Calculate quality factor, and Find the proper values of the circuit components. Midband gain must be H=2

Solution:



(a)

$$V_B = -\frac{Z_F}{R_3}V_1 - \frac{Z_F}{R_2}V_L$$

$$Z_F = (Z_{C_1} \| Z_{R_1}) = \frac{R_1}{1 + SC_1R_1}$$

$$(1 + SC_1R_1)V_B = -\frac{R_1}{R_3}V_1 - \frac{R_1}{R_2}V_L$$

$$\because V_L = \frac{1}{SC_2R_4}V_B$$

$$(1+SC_1R_1 + \frac{R_1}{SC_2R_2R_4})V_B = -\frac{R_1}{R_3}V_1$$

$$\frac{V_B}{V_1} = \frac{-\frac{R_1}{R_3}SC_2R_2R_4}{SC_2R_2R_4 + S^2C_1C_2R_1R_2R_4 + R_1} \qquad \div C_1C_2R_1R_2R_4$$

$$\frac{V_B}{V_1} = \frac{\left(-\frac{R_1}{R_3}\right) S\frac{1}{C_1R_1}}{S^2 + S\frac{1}{C_1R_1} + \frac{1}{C_1C_2R_2R_4}}$$

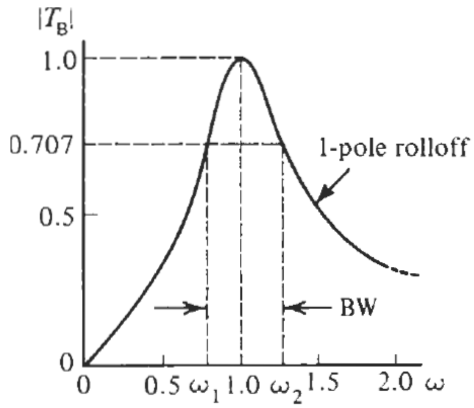
$$\therefore \omega_o = \frac{1}{\sqrt{C_1C_2R_2R_4}} \text{ and } Q = \frac{R_1}{\sqrt{R_2R_4}}\sqrt{\frac{C_1}{C_2}}$$

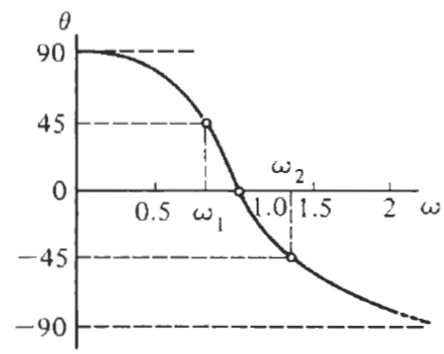
(b)

$$T_B(S) = \frac{H(\omega_o/Q)S}{S^2 + (\omega_o/Q)S + \omega_o^2}$$

$$|T_B(j\omega)| = \frac{H(\omega/Q)}{\sqrt{(1-\omega^2)^2 + (\omega/Q)^2}}$$

$$\theta = 90^\circ - \tan^{-1}\left(\frac{\omega/Q}{1-\omega^2}\right)$$





(c)

$$\beta = \frac{\omega_o}{Q} \Rightarrow Q = \frac{\omega_o}{\beta} = \frac{38}{41.1 - 34.8} \approx 6$$

$$\text{let } C_1 = C_2 = C = 0.01\mu F$$

$$\therefore \omega_o = \frac{1}{C\sqrt{R_2 R_4}}, \quad H = -\frac{R_1}{R_3} \text{ and } Q = \frac{R_1}{\sqrt{R_2 R_4}}$$

$$\text{let } R_2 = R_4 = R$$

$$\therefore \omega_o = \frac{1}{CR}, \quad H = -\frac{R_1}{R_3} \text{ and } Q = \frac{R_1}{R}$$

$$\therefore R = \frac{1}{\omega_o C} = 419\Omega$$

$$R_1 = QR = 2.51k\Omega$$

$$R_3 = \frac{R_1}{H} = 1.26k\Omega$$