QUIZ 1

Question 1

- A series resonant circuit consisting of R-L-C elements is driven by a voltage source given by $v = V \sin wt$. Do the following
- (a) Write down the expression for resonant frequency (Hz) in terms of L and C
- (b) Write down the expression for the instantaneous current $i(t)$ at resonance
- (c) Obtain the complex expression for current at a frequency which is $1.5\ w_0$ in terms of current at resonance and Q

Solution to Question 1

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

$$At \;\; resonance$$

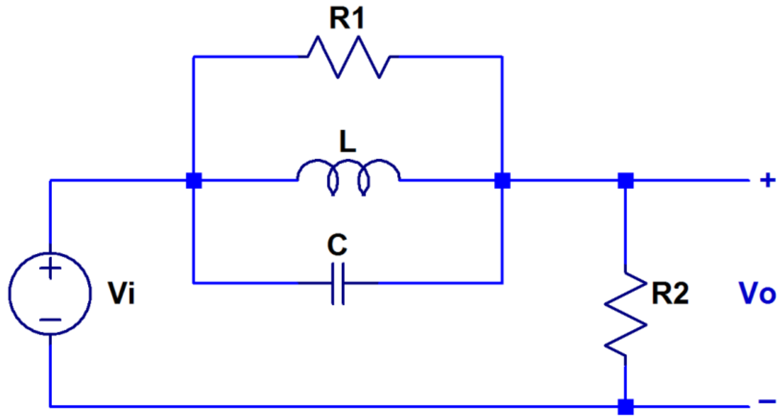
$$i(t) = \frac{V}{R}\sin\omega t$$

$$At \;\; \omega = 1.5\,\omega_0$$

$$I = \frac{V}{R\left(1 + jQ\left[\frac{\omega}{\omega_0} - \frac{\omega_0}{\omega}\right]\right)} = \frac{I_0}{\left(1 + jQ\left[1.5 - \frac{1}{1.5}\right]\right)}$$

$$= \frac{I_0}{\left(1 + jQ[0.833]\right)}$$

Question 2

- For the circuit shown below find the voltage gain (With brief explanation) at
- (1) Zero frequency
- (2) Infinite frequency
- (3) Resonant frequency
- (4) Discuss the nature of filter if R1 >> R2
- 

Solution to Question 2

(1) Gain = 1 since inductor is short circuit for DC

(2) Gain = 1 since capacitor is short circuit at infinite frequency

(3) $$Gain = \frac{R_2}{R_1 + R_2}$$

$$Since\ L-C\ circuit\ is\ open\ at\ resonance$$

(4) Works like a band reject filter since gain is small at resonant frequency

Question 3

- Consider a *5* stage synchronously tuned amplifier and derive the expression for the overall bandwidth in terms of bandwidth of individual stages starting with the complex gain for an individual stage as a function of frequency

Solution to Question 3

$$|A| = \frac{A_0^5}{\left(\sqrt{1+x^2}\right)^5}$$

$$At\ \ x = x_c$$

$$|A| = \frac{A_0^5}{\sqrt{2}} : \left(\sqrt{1+x_c^2}\right)^5 = \sqrt{2}$$

$$\left(\sqrt{1+x_c^2}\right) = \left(\sqrt{2}\right)^{1/5}$$

$$1 + x_c^2 = 2^{1/5}$$

$$x_c = \sqrt{2^{1/5} - 1} = 0.386$$

Question 4

- Consider the oscillator circuit shown below.
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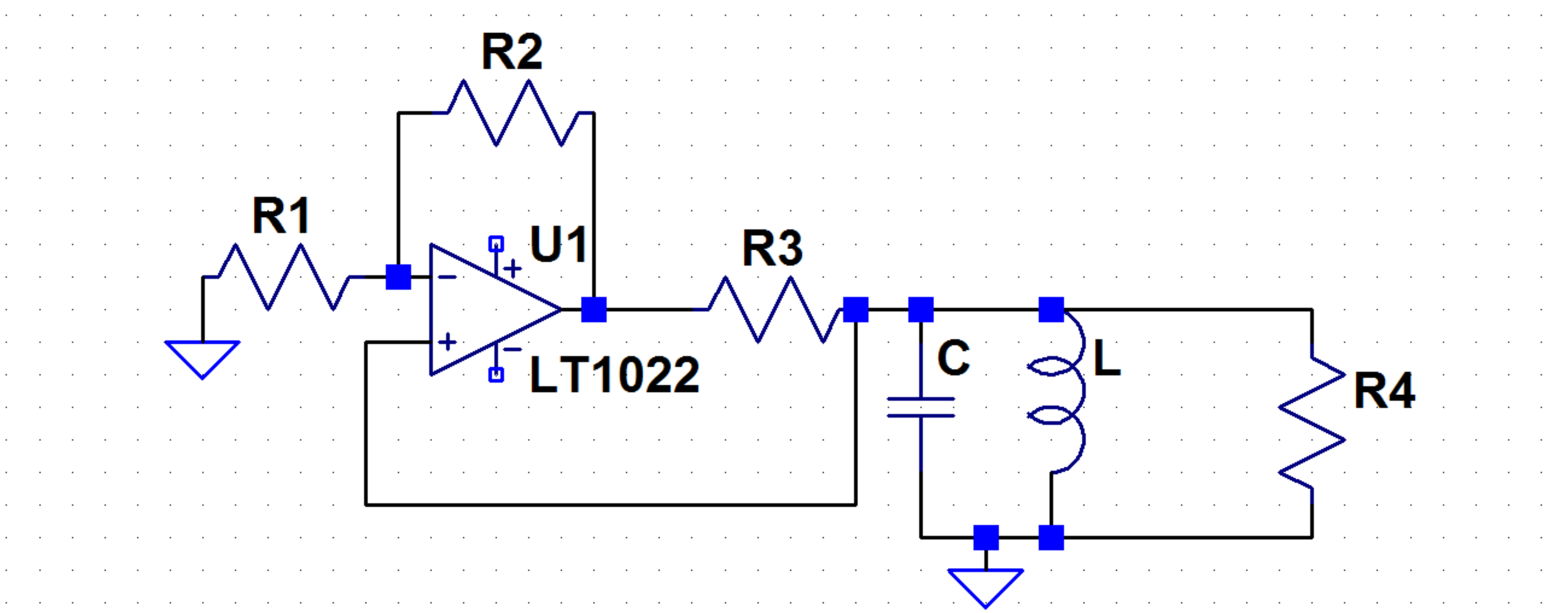
- Suppose R4 = 2 R3
- (a) Find the ratio of R2 and R1 to satisfy Barkhausen criterion
- (b) Let the output of the Op-Amp be V1 .
- Now consider a nonlinearity in either R4 or R3 and because of that the ratio R4/R3 decreases with V1 linearly . One point on this line is R4/R3 = 3 and V1 = 1 volts .The other point on this line is given as V1 = 4 and R4/R3 = 1 . Initially the ratio of R4/R3 is kept greater than 2 so the oscillations grow.
- Find the stabilized amplitude (V1).

Question 4 continued



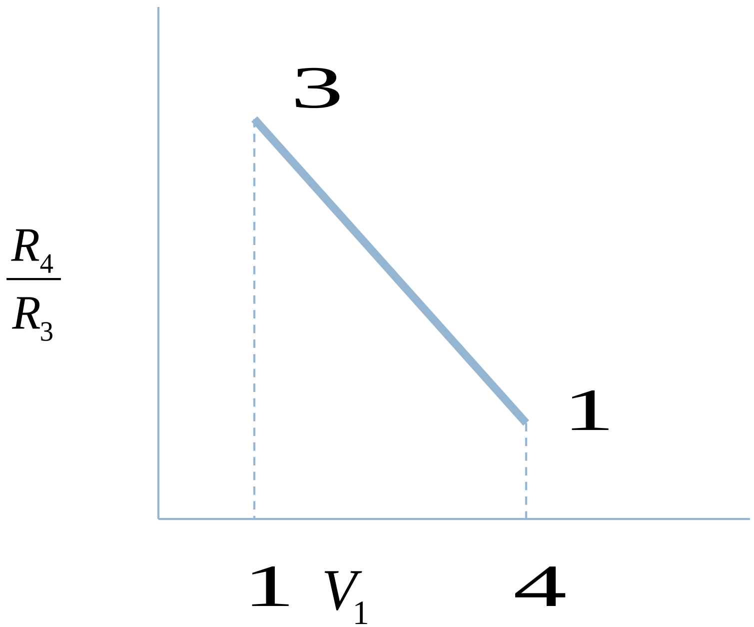
Solution to Question 4

$$\beta = \frac{R_4}{R_3 + R_4} = \frac{2R_3}{R_3 + 2R_3} = \frac{2}{3}$$

$$A_{\min} = \frac{1}{\beta} = \frac{3}{2}$$

$$1 + \frac{R_2}{R_1} = 1.5 \therefore \frac{R_2}{R_1} = 0.5$$

Solution to 4 continued



$$\frac{R_4}{R_3} = -\frac{2}{3}v_1 + C$$

$$3 = -\frac{2}{3} + C \quad : C = \frac{11}{3}$$

$$\frac{R_4}{R_3} = -\frac{2}{3}v_1 + \frac{11}{3}$$

$$At\ \frac{R_4}{R_3} = 2\ the\ amplitude\ stabilizes$$

$$2 = -\frac{2}{3}v_1 + \frac{11}{3}$$

$$v_1 = 2.5$$

Question 5

- A 100 KHz sinusoidal signal is connected to the cascade of following blocks
- (1) Two frequency doublers in cascade
- (2) An up converter with local oscillator frequency of 150 KHz
- (3) A frequency tripler
- Find the frequency of the output signal

Solution to Question 5

Output of first block

f1 = 100X4 = 400 KHz

Output of second block

f2 = 400+150 = 550 KHz

Output of third block

f3 = 550X3 = 1650 KHz

Question 6

Consider the antenna tank circuit and the oscillator circuit in a radio receiver. Now instead of using a gang capacitor suppose you use discrete capacitors to tune to three stations . You will require a mechanical multipole multiway switch . How many poles and how many ways you need? Draw the circuit.What will be the advantage of this arrangement over using identical gang capacitor ? What will be the disadvantage ?

Solution to Question 6