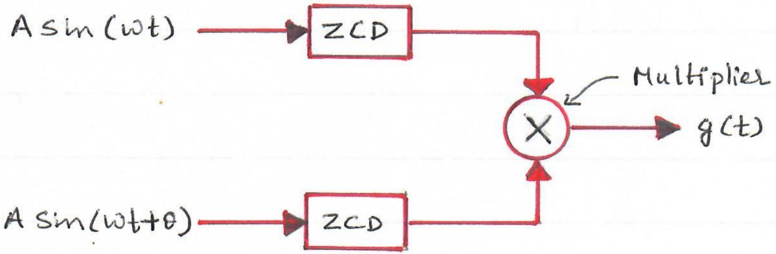
Tutorial sheet-2 IEC103

(Q1) A device called zero crossing detector (ZCD) has the following property.

$$\text{output Amplitude} = \begin{cases} 1, & \text{for input amplitude} > 0 \\ 0, & \text{for input amplitude} < 0 \end{cases}$$

The waveforms $A\sin(\omega t)$ and $B\sin(\omega t+\theta)$ are passed through a system shown below : Find the amplitude and RMS value of $g(t)$



Q2 In the circuit shown in Fig. Q, $R_1 = 1.5\,K\Omega$; $R_2 = 2.0\,K\Omega$, and $C = 0.5\,\mu F$.

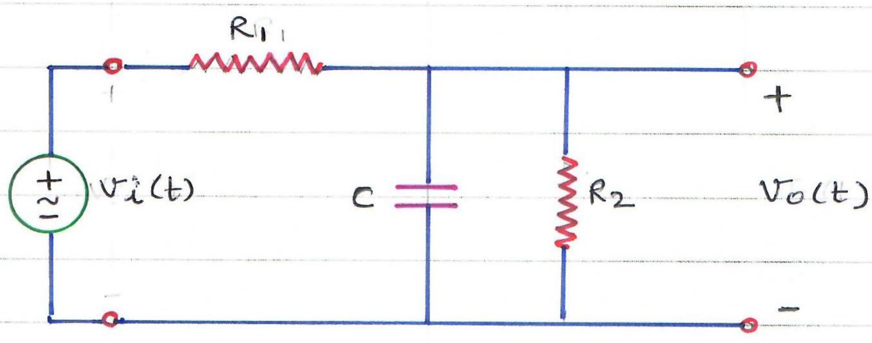


Fig. Q2

Determine

a) The voltage transfer function $H_V(\omega) = \dfrac{V_o(\omega)}{V_i(\omega)}$

b) How the voltage transfer function $H_V(\omega)$ behaves at extremely high and low frequencies.

c) Show that the transfer function can be manipulated into the form $H_V(\omega) = \dfrac{H_o}{1 + jf(\omega)}$

Find H_o and $f(\omega)$.

d) Find the frequency at which $f(\omega) = 1$ and the value of $H_V(\omega)$ in decibels.

Q3 One application of narrowband filters is seen in rejecting interference due to AC line power. Any undesired 50 Hz signal originating in the AC line power can cause serious interference in sensitive instruments. In medical instruments such as the electrocardiograph, 50 Hz notch filters are often provided to reduce the effect of this interference on cardiac measurements. Fig. Q3 depicts a circuit in which the effect of 50 Hz noise is represented by way of 50 Hz sinusoidal generator connected in series with a signal source (V_S), representing the desired signal. In this example we design a 50 Hz narrowband (or notch) filter to remove the unwanted 50 Hz noise.

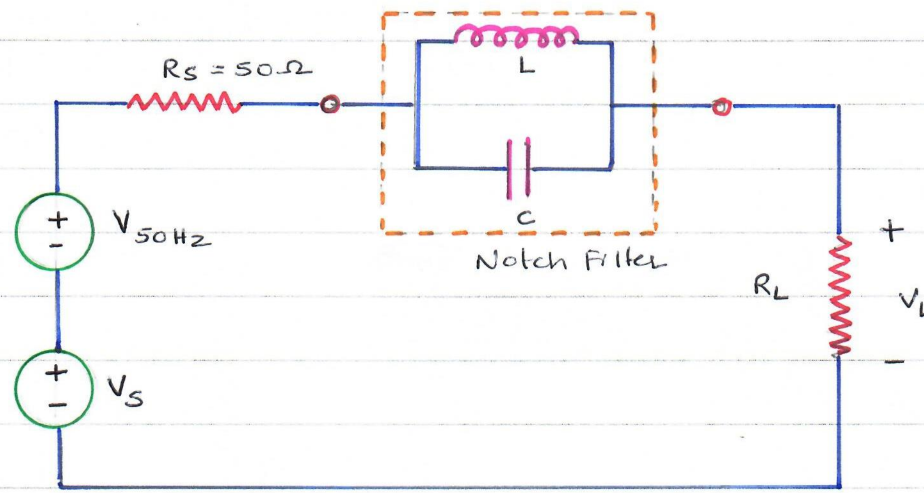


Fig. Q3 50 Hz Notch Filter

Find the appropriate value of L and C for the notch filter.

(Q7) A source with output a source resistance of 10K puts out a signal of 10 mV amplitude. It is intended to amplify the signal to feed into a load of 1K. An amplifier is available with open-loop voltage gain of 10 and output resistance 1K and input resistance of 10K.

i) What would be the output amplitude if the available amplifier is used.

ii) If N such amplifiers are connected in cascade and used between source and load, what is the signal amplitude at the output?

Q5) Derive the exact formula for the overall gain of an inverting op-amp circuit (v_o/v_s) shown in Fig. Q5.

a) If $R_1 = 1K\Omega$, $R_f = 10K\Omega$, $R_i = 100K\Omega$, $R_o = 100\Omega$, and open-loop gain $A_{OL} = 10^5$, evaluate the gain of this inverting amplifier.

b) Compare the result in part a) with ideal op-amp approximation

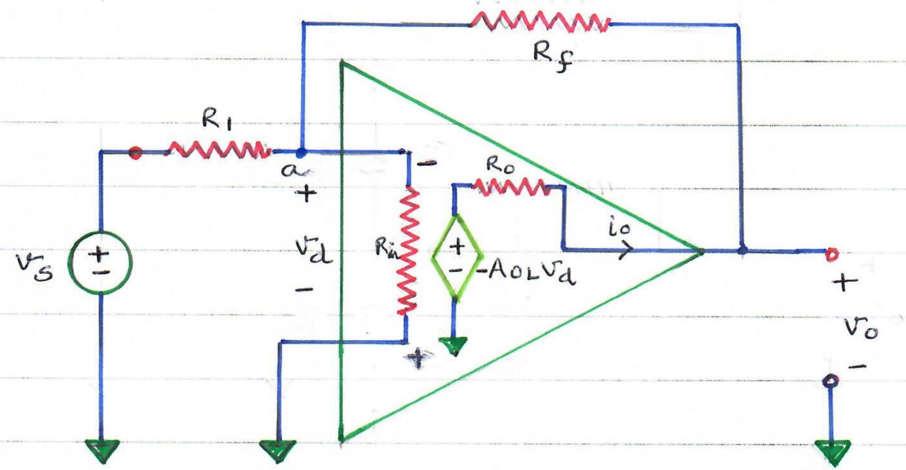


Fig. Q5