Solutions to Quiz-1 Paper (Group-B) IEC103

(Q1) Find the input resistance of between the terminals B and G in the circuit shown in Fig. Q1.

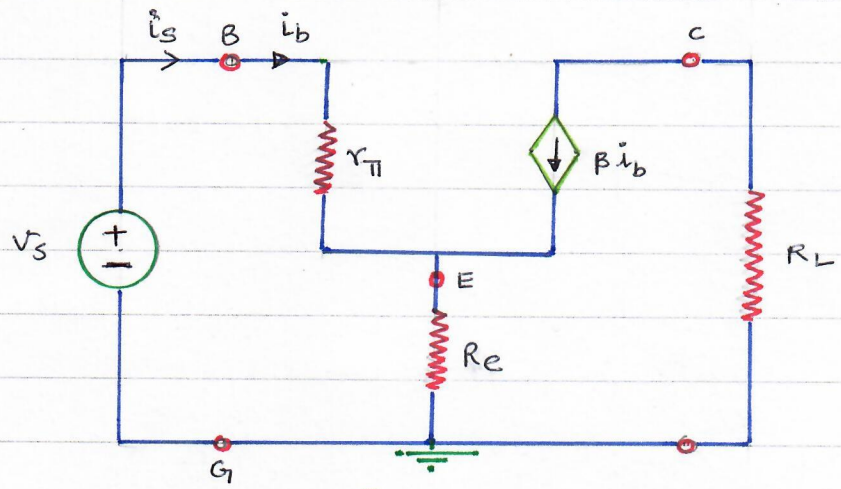
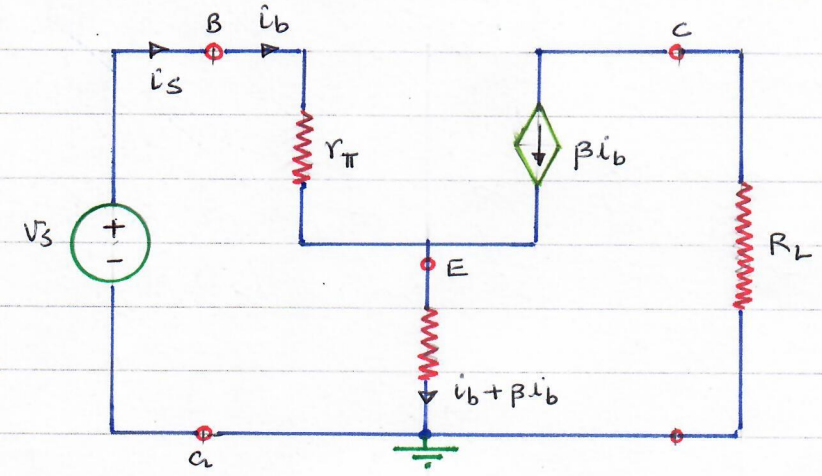


Fig. Q1

Sol.



Input resistance between terminals B and G is the resistance seen by the source v_s.

$$R_{in} = \frac{v_s}{i_s}$$

$$v_s = v_{BG} = r_\pi i_b + (\beta+1) i_b \times R_e$$

$$= [r_\pi + (\beta+1) R_e] i_b$$

$$i_s = i_b$$

$$\therefore v_s = [r_\pi + (\beta+1) R_e] i_s$$

$$\Rightarrow R_{in} = v_s / i_s = r_\pi + (\beta+1) R_e$$

(Q2) Assuming op-amp to be ideal, find the current gain i_L/i_I, in the circuit shown in Fig. Q. Find the value of R required for having a current gain (i_L/i_I) equal to 20 A/A.

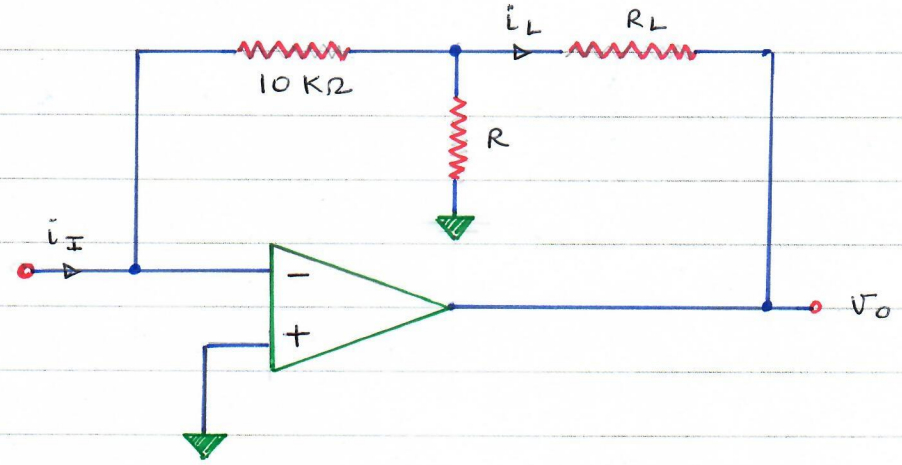
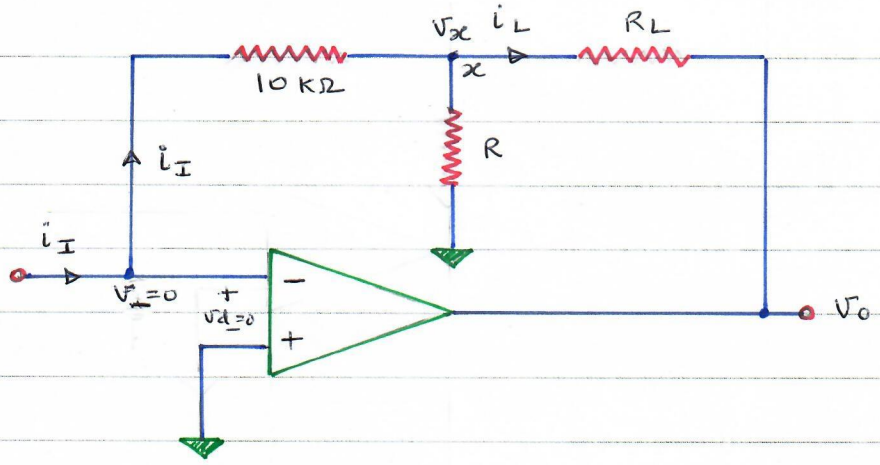


Fig. Q2

Sol. Since the op-amp is ideal the differential voltage at the input terminals $v_d = v_+ - v_-$ is zero, and the currents entering the terminals (input) is zero.



Applying KCL at node x

$$\frac{v_x - 0}{10K} + \frac{v_x}{R} + \frac{v_x - v_o}{R_L} \quad \cdots (A)$$

$$\Rightarrow -i_I + \frac{v_x}{R} + i_L = 0 \quad \cdots (B)$$

but $v_x = -10K\, i_I$

$$\therefore -i_I - \frac{10K\, i_I}{R} + i_L = 0$$

$$-i_I - \frac{10K\, i_I}{R} + i_L = 0$$

$$\Rightarrow i_I\left(1 + \frac{10K}{R}\right) = i_L$$

$$\Rightarrow \text{current gain} = \frac{i_L}{i_I} = 1 + \frac{10K}{R}$$

If current again = 20 $\qquad 1 + \frac{10K}{R} = 20$

$$\Rightarrow \frac{10K}{R} = 19$$

$$\Rightarrow R = \frac{10}{19} K \simeq 526\,\Omega$$

(Q3) Find the voltage gain V_o/V_i of the circuit shown below in Fig. Q3

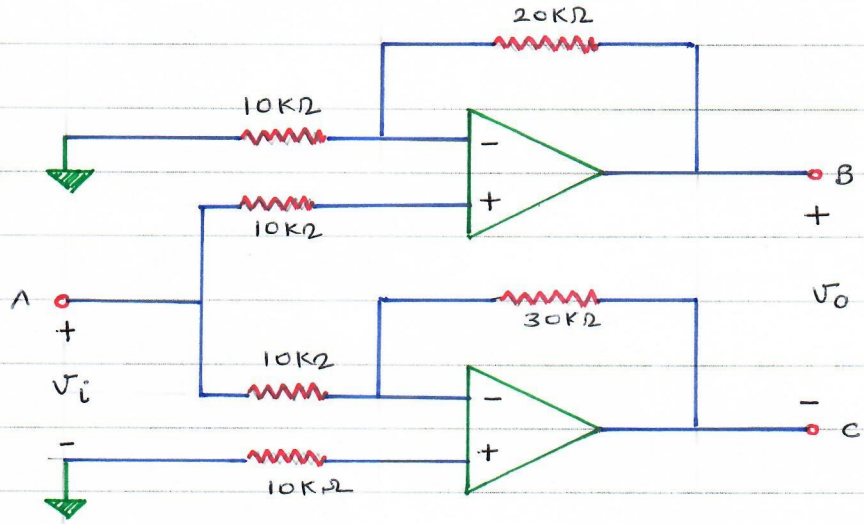


Fig. Q3

Sol.

The top circuit is an non-inverting amplifier and the lower one is a inverting amplifier.

The output of non-inverting amplifier is V_B and that of the inverting amplifier is V_C.

$$V_B = \left(1 + \frac{20K}{10K}\right) V_i = 3V_i$$

$$V_C = -\frac{30K}{10K} V_i = -3V_i$$

$$V_o = V_{BC} = V_B - V_C = 3V_i - (-3V_i) = 6V_i$$

$$\text{voltage gain} = A_V = \frac{V_o}{V_i} = 6$$