E2.2 Design a voltage amplifier with a gain of -10 and an input resistance of 10kΩ by using an operational amplifer.

S2.2 Having learned the inverting amplifier configuration, we can easily solve this question. Consider the circuit given in Figure-1 below,
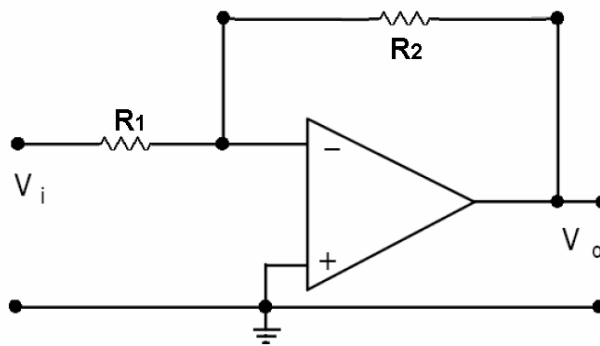

Figure-1

We know that the gain of this circuit is equal to

$$A_V = \frac{V_o}{V_i} = -\frac{R_2}{R_1} \quad (1)$$

In order to obtain the gain of -10, we need the condition of

$$-\frac{R_2}{R_1} = -10 \Rightarrow R_2 = 10R_1 \quad (2)$$

Now, we should provide the second design condition, that is, the input resistance. The input resistance is equal to the ratio of the input voltage to the input current (Vi/Ii). Since the opamp is used in the closed-loop configuration with a negative feedback the inputs are equal to each other. Thus, as seen from the figure, the inverting input is virtually grounded. Therefore, the input voltage Vi is appeared completely across the resistor R_1. So, the input current is obtained as Ii=Vi/R_1, that is, the input resistance of the circuit is R_1. In order to obtain an input resistance of 10kΩ, R_1 should be made 10kΩ. Then, from Equation-2, R_2 is obtained as 100kΩ.

R_1=10kΩ
R_2=100kΩ