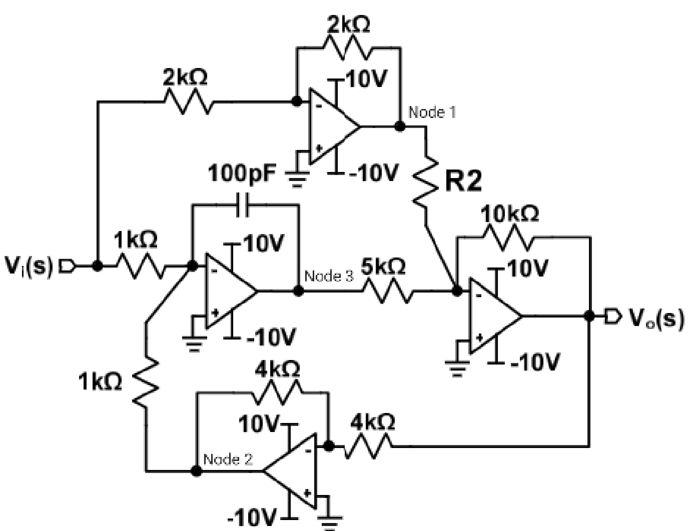
GATE - BM 41

EE23BTECH11215 - Penmetsa Srikar Varma

Question

Q41) A filter designed using op-amps, resistors and capacitors as shown in figure. op-amps are ideal with infinite gain and infinite bandwidth. If $\frac{V_0(s)}{V_i(s)}$ is an all-pass transfer function, the value of resistor R2 (in kΩ) is



(A) 1
(B) 10
(C) 5
(D) 2 (GATE BM 2022)

Solution

variables	conditions
voltage at node 1	$-V_i(s)$
voltage at node 2	$V_0(s)$
voltage at node 3	V_x
voltage at remaining nodes	0 V
C	capacitor of 100pF
$\frac{1}{sC}$	laplace domain of capacitor
$H(s)=\frac{V_0(S)}{V_i(S)}$	transfer function
s_1	root of transfer function
s_2	pole of transfer function
R_2	unknown

Table of Parameters

for op-amp at $V_0(s)$, (we assume R_2 in kΩ)

$$V_x = \frac{5V_i(s)}{R_2} - \frac{V_0(s)}{2} \tag{1}$$

for op-amp at $V_i(s)$,

$$V_x = sC\left(\frac{V_0(s) - V_i(s)}{1000}\right) \tag{2}$$

from (1) and (2) transfer function is given by,

$$H(s) = 2\left(\frac{5000+sCR_2}{1000+2sC}\right) \tag{3}$$

we can observe that for transfer function,

$$s_1 = -\frac{5000}{CR_2},\ s_2 = -\frac{1000}{2C} \tag{4}$$

since, for all-pass transfer function s_1=s_2,

$$R_2 = 10\ \text{k}\Omega \tag{5}$$

so, option B is correct