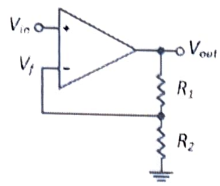
1.

The dual-supply op-amp below is connected in a negative feedback configuration as a non-inverting amplifier. Assume Vin = 1V, the op-amp open-loop DC gain A_OLo = 1000, R1 = 5 kΩ and R2 = 1 kΩ.

The first stage of the op-amp is a differential amplifier.

The differential input voltage of the differential amplifier is equal to ____ mV.

Hint: Do NOT assume LG >> 1.



$$V_{id} = \frac{V_{out}}{A_{OL}} = \frac{V_{in} A_{CL}}{A_{OL}}$$

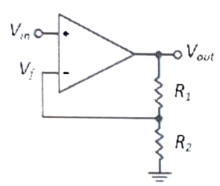
$$\therefore A_{CL} = \frac{A_{OL}}{1+\beta A_{OL}} = \frac{1000}{1+\frac{1}{6} * 1000} = 5{,}96$$

$$\therefore V_{id} = \frac{5{,}96}{1000} = 5{,}96\ mV$$

2.

The op-amp below is connected in a negative feedback configuration as a non-inverting amplifier. Assume Vin = 1 V, the op-amp open-loop DC gain A_OLo = 1000, R1 = 2 kΩ and R2 = 1 kΩ.

The static gain error (in percent) is equal to ____ %.



$$e_s = \frac{|A_{CL\,actual} - A_{CL.\,ideal}|}{A_{CL.\,ideal}} \times 100$$

$$\therefore A_{CL\,ideal} = \frac{1}{B} = \frac{1}{3}, \quad A_{CL\,actual} = \frac{1000}{1+\frac{1000}{3}} = 2{,}991$$

$$\therefore e_s = 0{,}299\ \%$$

3.

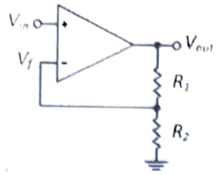
For a feedback system, the unity-gain frequency of the ____ depends on the feedback factor (β).

LG

4.

The op-amp below is connected in a negative feedback configuration as a non inverting amplifier. Assume Vin = 1V, the op-amp open-loop DC gain A OLo = 1000, the op-amp open-loop bandwidth BW OL = 100 Hz, R1 = 4 kΩ and R2 = 1 kΩ.

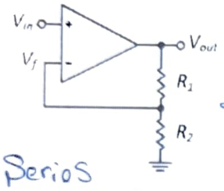
The closed loop bandwidth of the amplifier is equal to kHz.



$$BW_{CL} = BW_{OL} \cdot (1 + \beta A_{OL})$$
$$= 100 \times \left(1 + \frac{1000}{5}\right)$$
$$= 20.1\,kHz$$

5.

The feedback type in the amplifier below is



Shunt Sensing

Serios mixing

series mixing - shunt sensing

6.

The following systems always have a large phase margin (select all correct answers):

1st order

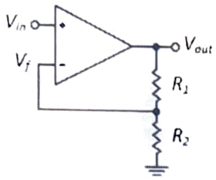
7.

The dual-supply op-amp below is connected in a negative feedback configuration as a non-inverting amplifier. Assume Vin = 1V, the op-amp open-loop DC gain A_OLo = 1000, R1 = 4 kΩ and R2 = 1 kΩ.

The exact voltage at the (-) terminal of the op-amp is equal to ....

Hint: Do NOT assume LG >> 1 when you calculate the exact voltage.

Note: Write the answer with 3 decimal places (three digits after the decimal point), e.g., 1.211.



$$V_f = V_{out} \times B = V_{in} A_{CL} \times B$$
$$= 1 \cdot \frac{1000}{1+\frac{1000}{5}} \times \frac{1}{5} = 0.995$$

8.

For an OTA connected as negative feedback amplifier, if the input signal experiences large transient steps, the optimum ratio between the non-dominant pole and the UGF is ......

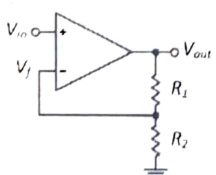
4

9.

The op-amp below is connected in a negative feedback configuration as a non-inverting amplifier. Assume Vin = 1 V, the op-amp open-loop DC gain A_OLo = 1000, R1 = 3 kΩ and R2 = 1 kΩ.

The first stage of the op-amp is a differential amplifier.

The CM input voltage of the differential amplifier is approximately equal to ...... V.



$$\therefore V_f = V_{out} \times B = 1 \cdot \frac{1000}{1+\frac{1000}{4}} \cdot \frac{1}{4} = 0.996\,V$$

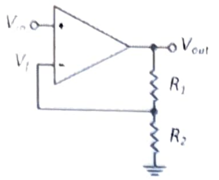
$$\therefore V_{CM} = \frac{V_+ + V_-}{2} = 0.998\,V$$

10.

The op-amp below is connected in a negative feedback configuration as a non inverting amplifier. Assume Vin - 1V, the op-amp open loop DC gain A OLo - 1000, R1 - 4 kΩ and R2 - 1 kΩ.

The closed loop time constant of the amplifier is required to be 100 us

The op-amp should be designed such that the open-loop bandwidth is equal to   Hz



$$BW_{CL} = \frac{1}{2\pi \tau_{CL}} = \frac{1}{2\pi \cdot 100\mu} = 1{,}591\,kHz$$

$$BW_{OL} = \frac{BW_{CL}}{1+\beta A_{OL}} = 7{,}918\ Hz$$