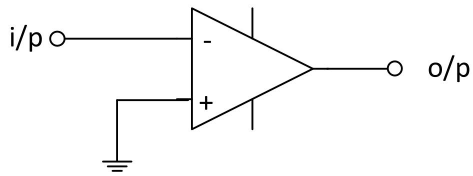
OPERATIONAL AMPLIFIERS

1. If the input to the circuit of figure is a sine wave the output will be



a. A half wave rectified sine wave

b. A full-wave rectified sine wave

c. A triangular wave

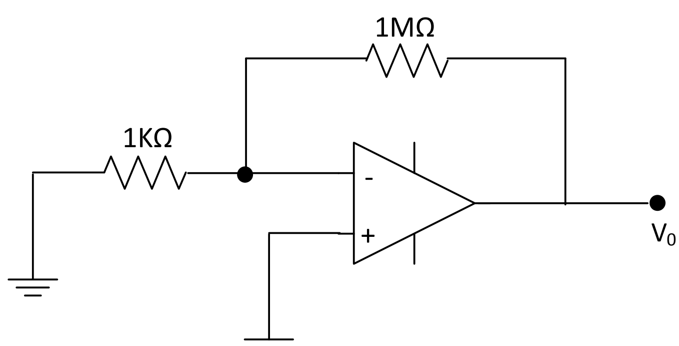
d. A square wave

[GATE-1990: 2 Marks]

Ans. (d)

Explanation: - The op-amp is in open-loop so it will work as comparator. The circuit shown here is a zero crossing detector a special case of comparator. When the input is above ground level, the output is saturated at its negative maximum and when the input is below ground, the output is at its positive maximum.

2. An Op – Amp has offset voltage of 1mV and is ideal in all other respects. If this Op – Amp is used in the circuit shown in figure. The output voltage will be (Select the nearest value)



a. 1 mV

b. 1 V

c. ± 1V

d. 0 V

[GATE-1992: 2 Marks]

Ans. (c)

Explanation: -

$$Gain = \frac{-R_f}{R_1} = -\frac{10^6}{10^3} = -10^3$$

$V_{is} = V_{offset} = 1\ mV$

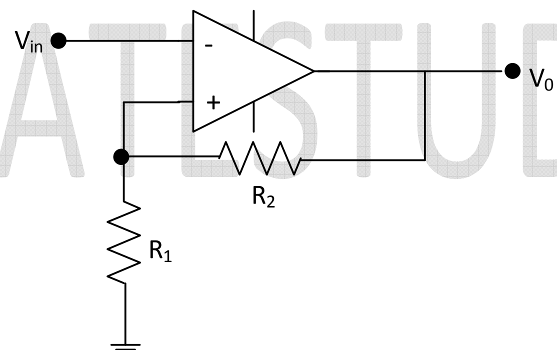
$V_0 = V_{is} . Gain$

$= -1 . 10^{-3} . 10^3$

$= - 1\ V$

It may be ± 1V (since the polarity of offset voltage is not know)

3. The circuit shown in the figure is that of



a. a non-inverting Amplifiers

b. an inverting Amplifiers

c. an oscillator

d. a Schmitt trigger

[GATE-1996: 1 Mark]

Ans. (d)

Explanation: - The circuit has a positive feedback and in positive feedback, op-amp operates in its saturation region. It is a fast operating voltage level detector. The circuit switches between negative and positive output voltage levels (- V_{sat} to V_{sat}). It is Schmitt trigger circuit.

4. One input terminal of high gain comparator circuit is connected to ground and a sinusoidal voltage is applied to the other input. The output of comparator will be

a. a sinusoid

b. a full rectified sinusoid

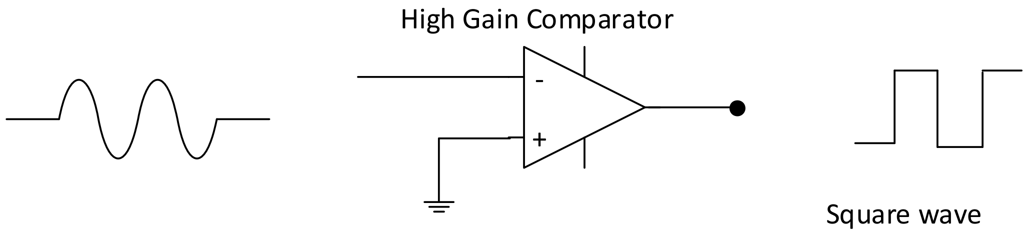
c. a half rectified sinusoid

d. a square wave

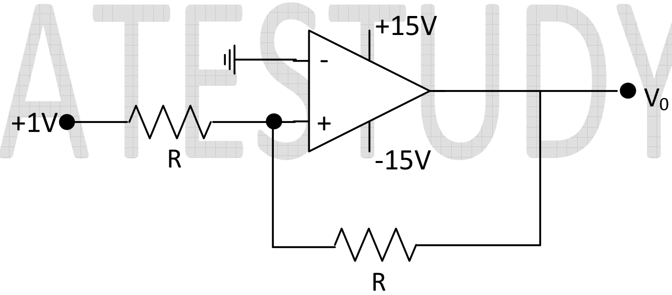
[GATE-1998: 1 Mark]

Ans. (d)

Explanation: - When positive cycle of input is applied to inverting terminal output is saturated to its negative maximum. When negative cycle is applied output goes to the positive maximum value. So output is square wave.



5. In the circuit of the figure, V_0 is



a. -1V

b. 2b

c. +1V

d. +15V

[GATE-2000: 1 Mark]

Ans. (d)

Explanation: - In positive feedback op-amp operates in its saturation region ± V_{sat} Here, applied voltage is positive 1 volt and is at noninverting terminal.

$$V_0 = + V_{sat} = + 15\ V$$

6. The most commonly used amplifier in sample and hold circuit is

a. a unity gain inverting amplifier

b. a unity gain non inverting amplifier

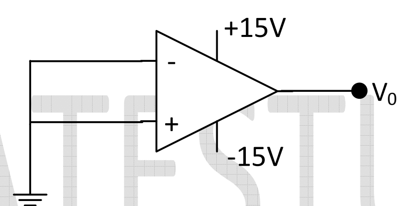
c. an inverting amplifier with a gain of 10

d. an inverting amplifier with a gain of 100 **[GATE-2000: 1 Mark]**

Ans. (b)

Explanation: - The most commonly used amplifier in sample and hold circuit is a unity gain non inverting amplifier. Since the polarity and amplitude of the samples have to remains same.

7. If the Op – Amp in the figure has an input offset voltage of 5 mV and an open-loop voltage gain of 10,000 then V_0 will be



a. 0 V

b. 5 mV

c. + 15 V or -15 V

d. +50 V or -50 V

[GATE-2000: 2 Marks]

Ans. (c)

Explanation: - Output V_0 = $V_{io} \times Gain = 5mV \times 10,000 = 50V$

But V_0 (output voltage) in open loop can never be greater than ± V_{sat}

So, ± 15 V

8. The ideal Op – Amp has the following characteristics.

a. $R_i = \infty$, $A = \infty$, $R_0 = 0$

b. $R_i = 0$, $A = \infty$, $R_0 = 0$

c. $R_i = \infty$, $A = \infty$, $R_0 = \infty$

d. $R_i = 0$, $A = \infty$, $R_0 = \infty$ **[GATE-2000: 1 Mark]**

Ans. (a)

Explanation: - An ideal op-amp has infinite voltage gain, infinite input resistance and zero output resistance.

9. If the differential voltage gain and the common mode voltage gain of a differential amplifier are 48 dB and 2 dB respectively, then its common mode rejection ratio is

a. 23 dB

b. 25 dB

c. 46 dB

d. 50 dB

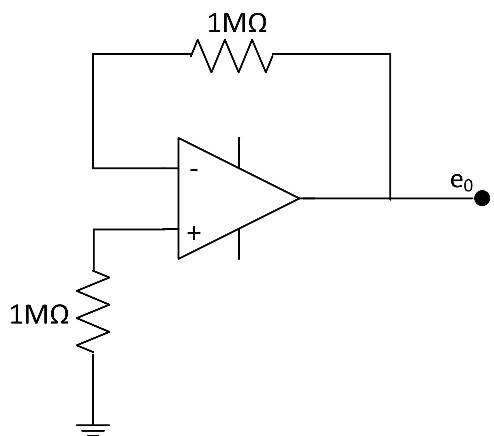
[GATE-2003: 1 Mark]

Ans. (c)

Explanation: - $CMRR = \frac{A_d}{A_c} = 20\log\left|\frac{A_d}{A_c}\right|\ dB$

CMRR = 48 – 2 = 46 dB

10. The voltage e_0 indicated in the figure has been measured by an ideal voltmeter, which of the following can be calculated?



a. Bias current of the inverting input only

b. Bias current of the inverting and non-inverting inputs only

c. Input offset current only

d. Both the bias current and the input offset current

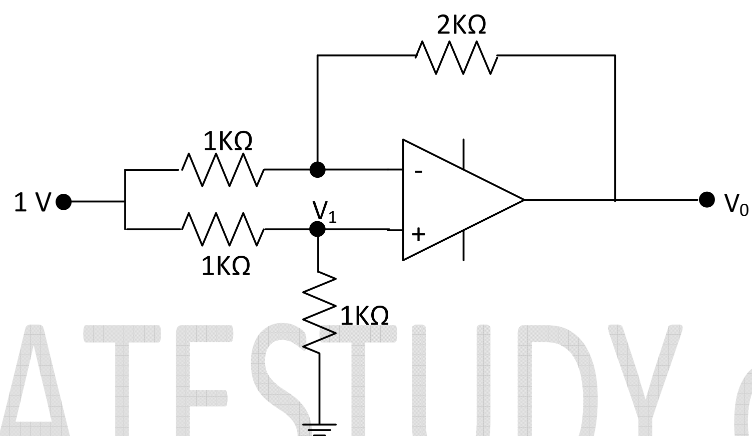
[GATE-2005: 2 Marks]

Ans. (c)

Explanation: - Input offset current is the algebraic difference between the current into the inverting and noninverting terminals. The output voltage

e_0 = (offset current). 1MΩ

11. For the Op-Amp circuit shown in the figure. V_0 is



a. -2 V
b. -1 V
c. -0.5 V
d. 0.5 V

[GATE-2007: 2 Marks]

Ans. (c)

Explanation: - The output due to inverting input $= V_i \times \left(-\frac{R_f}{R}\right) = 1 \times \left(\frac{2K\Omega}{1K\Omega}\right)$

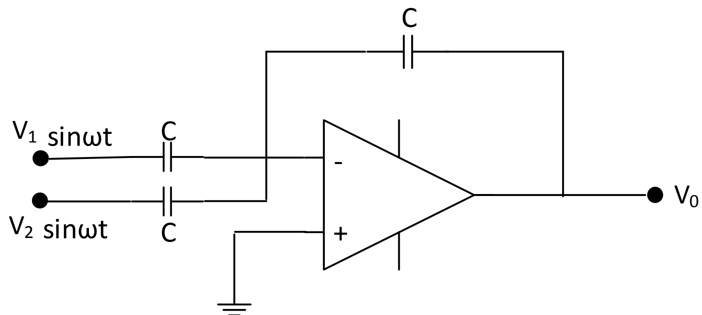
$$V_1 = \frac{1K \times 1}{1K + 1K} = \frac{1}{2}$$

The output due to noninverting input is $= V_1 \left(1 + \frac{R_f}{R}\right)$

$$= V_1 \left(1 + \frac{2}{1}\right) = V_1 \times 3 = 0.5 \times 3 = 1.5$$

$$the\ total\ output\ V_0 = -2 + 1.5 = -0.5$$

12. If the op-amp in the figure, is ideal then V_0 is



a. Zero

b. $(V_1 - V_2)\sin\omega t$

c. $-(V_1 + V_2)\sin\omega t$

d. $(V_1 + V_2)\sin\omega t$

[GATE-2000: 1 Mark]

Ans. (c)

Explanation: - The op-amp in the figure is ideal then

$$V_0 = \frac{-R_f}{R_1} vin$$

$$R_f = \frac{1}{\omega C}, R_1 = \frac{1}{\omega C}$$

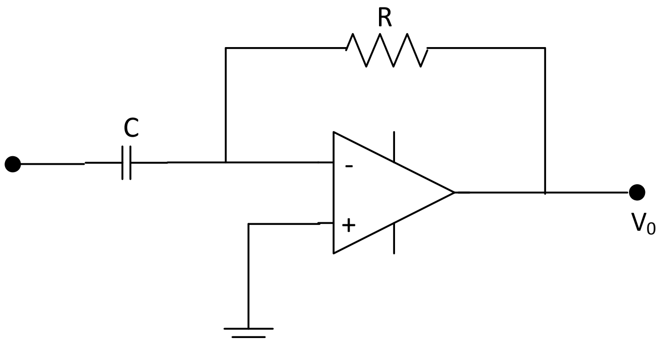
$$V_0 = -V_1\left(\frac{\omega C}{\omega C}\right) sin\omega t - V_2\left(\frac{\omega C}{\omega C}\right) sin\omega t$$

$$so\ V_0 = -V_1\ sin\omega t - V_2\ sin\omega t$$

$$= -(V_1 + V_2)\ sin\omega t$$

Point to note: An inverting amplifier can have more than one input because with virtual ground point, each input is isolated from the other. Each input sees its own input resistance and nothing else.

13. Assume that the op-amp of the figure is ideal. If V_i is a triangular wave, then V_0 will be



a. square wave
b. triangular wave
c. parabolic wave
d. sine wave

[GATE-2000: 1 Mark]

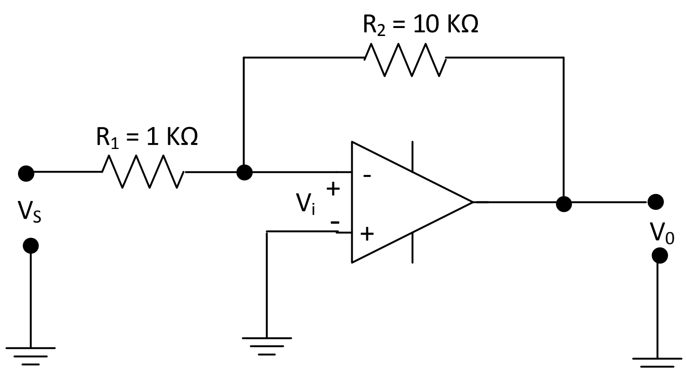
Ans. (a)

Explanation: - The circuit shown here is a differentiator which provides an output voltage proportional to the rate of change of the input voltage

$$V_0 = -RC\frac{dV_i}{dt}$$

All the input is a triangular wave, the output will be a square wave.

14. The inverting op-amp shown in the figure has an open-loop gain of 100. The closed-loop gain V_0 / V_S is



a. – 8
b. – 9
c. – 10
d. – 11

[GATE-2001: 2 Marks]

Ans. (b)

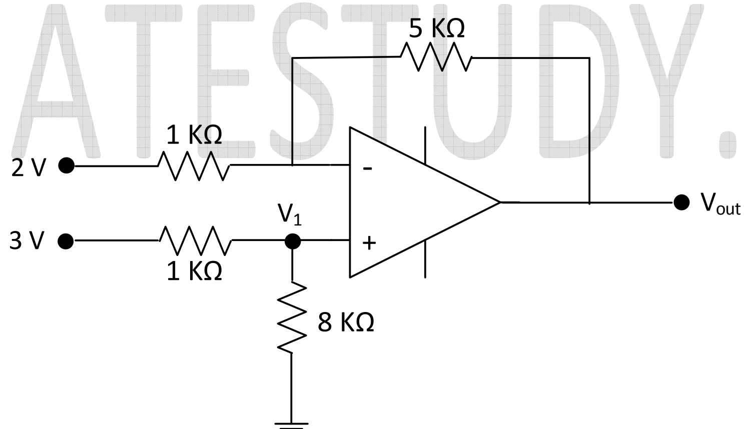
Explanation: - The open loop gain of the op-amp is 100. Then the gain with negative feedback is negative since input is at inverting terminal and is given by

$$A_f = \frac{-A}{1+A\beta} \qquad where\ \beta = \frac{1}{10}\ and\ A = 100$$

$$so\ A_f = \frac{-100}{1+100\times\frac{1}{10}} \quad = \frac{-100}{11} = -9$$

Point to note: Relations of gain are derived for op-amps assume the open loop gain as infinite. Since the open loop gain is low i.e. 100, the gain with feedback is to be derived.

15. If the op-amp in the figure is ideal, the output voltage V_{out} will be equal to



a. 1 V

b. 6 V

c. 14 V

d. 17

[GATE-2003: 2 Marks]

Ans. (b)

Explanation: - The op-amp in the figure is ideal

The output due to inverting input

$$= 2 \times \left(\frac{-5}{1}\right) = -10$$

$$V_1 = \frac{3}{9} \times 8 = \frac{8}{3}$$

The output due to noninverting input

$$V_1\left(1 + \frac{R_f}{R}\right) = \frac{8}{3}\left(1 + \frac{5K}{1K}\right) = \frac{8}{3} \times 6$$

$$so\ V_0 = 16 - 10 = 6$$

16. An ideal op-amp is an ideal

a. voltage controlled current source

b. voltage controlled voltage source

c. current controlled current source

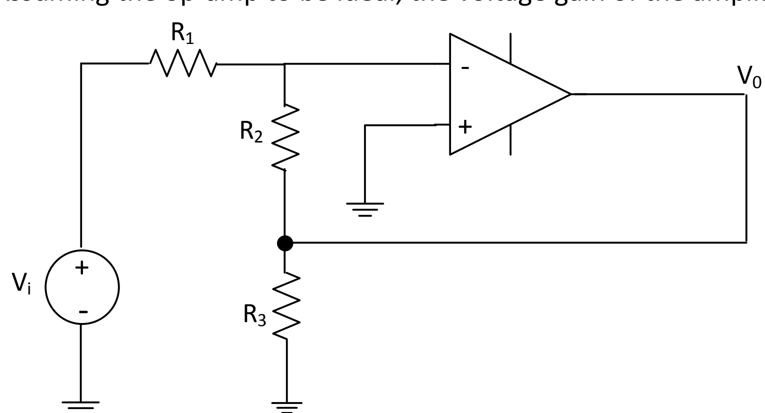
d. current controlled voltage source

[GATE-2004: 1 Mark]

Ans. (b)

Explanation: - An ideal op-amp is an ideal voltage controlled voltage source

17. Assuming the op-amp to be ideal, the voltage gain of the amplifier shown below is



a. $-\frac{R_2}{R_1}$

b. $-\frac{R_3}{R_1}$

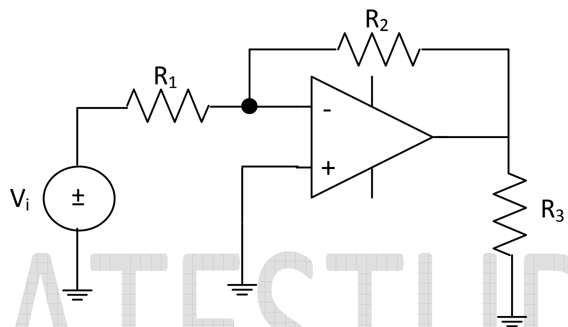
c. $-\left(\frac{R_2 \| R_3}{R_1}\right)$

d. $-\left(\frac{R_2+R_3}{R_1}\right)$

[GATE-2010: 1 Mark]

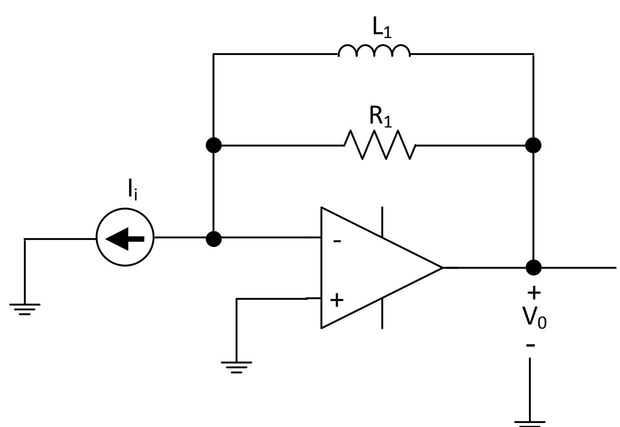
Ans. (a)

Explanation: - The circuit can be redrawn as



The voltage gain $A_u = -\frac{R_2}{R_1}$

18. The circuit below implement a filter between the input current i_i and output voltage the op-amp is ideal. The filter implemented is a



a. low pass filter

b. band pass filter

c. band stop filter

d. high pass filter

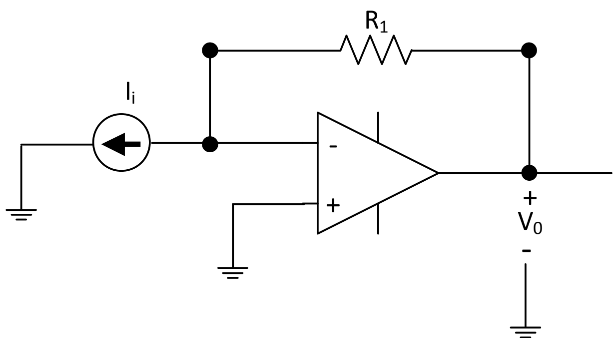
[GATE-2011: 1 Mark]

Ans. (d)

Explanation: - At high frequency $\omega = \infty$, $\omega L = \infty$

At $\omega = 0$, $X_L = \omega L = 0$

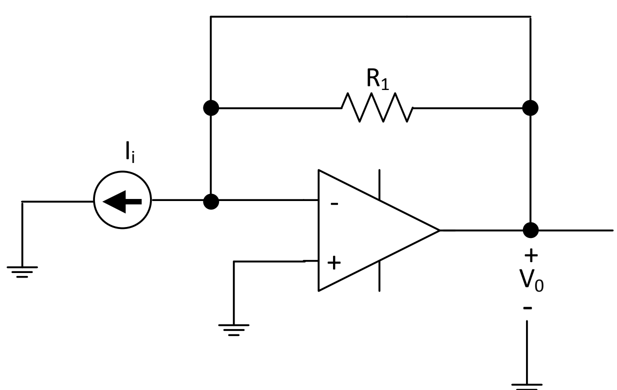
So the branch containing L will be shorted, the circuit can be redrawn as following



The output $V_0 = 0$

At high frequency $\omega = \infty$, $X_L = \omega L$ (very large)

The circuit is redrawn as shown



$$V_0 = R_1 \cdot I_i$$

The given circuit is a high pass filter