ESE 2024

UPSC ENGINEERING SERVICES EXAMINATION

Preliminary Examination

ELECTRICAL ENGINEERING

Objective Solved Papers

Volume-II

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MADE EASY
PUBLICATIONS

ESE-2024 : Preliminary Examination
Electrical Engineering : Volume-2
Topicwise Objective Solved Questions : (2001-2023)

Director's Message

B. Singh (Ex. IES)

Engineering is one of the most chosen graduating field. Taking engineering is usually a matter of interest but this eventually develops into "purpose of being an engineer" when you choose engineering services as a career option.

Train goes in tunnel we don't panic but sit still and trust the engineer, even we don't doubt on signalling system, we don't think twice crossing over a bridge reducing our travel time; every engineer has a purpose in his department which when coupled with his unique talent provides service to mankind.

I believe *"the educator must realize in the potential power of his pupil and he must employ all his art, in seeking to bring his pupil to experience this power".* To support dreams of every engineer and to make efficient use of capabilities of aspirant, MADE EASY team has put sincere efforts in compiling all the previous years' ESE-Pre questions with accurate and detailed explanation. The objective of this book is to facilitate every aspirant in ESE preparation and so, questions are segregated chapterwise and topicwise to enable the student to do topicwise preparation and strengthen the concept as and when they are read.

I would like to acknowledge efforts of entire MADE EASY team who worked hard to solve previous years' papers with accuracy and I hope this book will stand up to the expectations of aspirants and my desire to serve student fraternity by providing best study material and quality guidance will get accomplished.

B. Singh (Ex. IES)
CMD, MADE EASY Group

Volume-II

ELECTRICAL ENGINEERING

Objective Solved Questions
of UPSC Engineering Services Examination

Contents

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Analog Electronics

Syllabus

Operational amplifiers – characteristics and applications, multi-vibrators, sample and hold circuits, basics of filter circuits and applications, simple active filters; basics of linear integrated circuits.

Contents

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1

1.1 Active load is used in the collector of the differential amplifier of an op-amp to
   (a) increase the output resistance
   (b) increase the differential gain A_d
   (c) increase maximum peak to peak output voltage
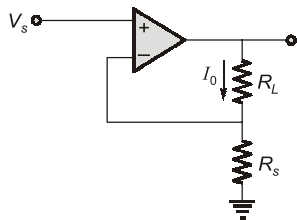   (d) eliminate load resistance from the circuit

   [ESE-2001]

1.2 The slew rate of an op-amp is 0.5 V/μsec. The maximum frequency of a sinusoidal input of $2\,V_{rms}$ with unity gain that can be handled without excessive distortion is
   (a) 3 kHz   (b) 30 kHz
   (c) 200 kHz   (d) 2 MHz
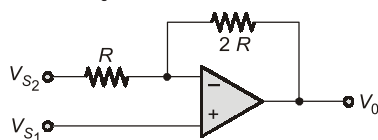
   [ESE-2001]

1.3 An op-amp is used in the circuit as shown in the below figure. Current I_0 is

   (a) $V_S \times \dfrac{R_L}{R_S(R_L + R_S)}$ (b) $\dfrac{V_S}{R_S}$

   (c) $\dfrac{V_S}{R_L}$ (d) $V_s\left(\dfrac{1}{R_S} + \dfrac{1}{R_L}\right)$

   [ESE-2001]

1.4 A circuit with op-amp is shown in the below figure. The voltage V_0 is

   (a) $3\,V_{s_1} - 6\,V_{s_2}$ (b) $2\,V_{s_1} - 3\,V_{s_2}$
   (c) $2\,V_{s_1} - 2\,V_{s_2}$ (d) $3\,V_{s_1} - 2\,V_{s2}$

   [ESE-2001]

1.5 The Schmitt trigger circuit is shown in the below figure. If $V_{sat} = \pm10$ V, the tripping point for the increasing input voltage will be
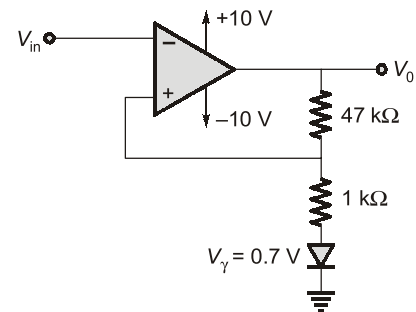
   (a) 1 V   (b) 0.893 V
   (c) 0.477 V   (d) 0.416 V   **[ESE-2001]**

1.6 In the op-amp circuit shown below, $V_i > 0$ and $i = I_0\, e^{V/V_T}$. The output V_0 will be proportional to
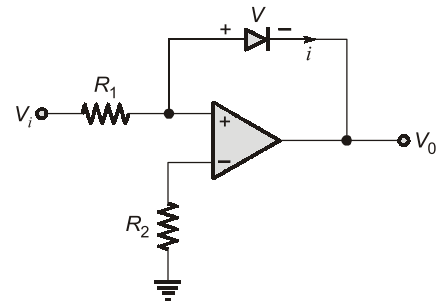
   (a) $\sqrt{V_i}$ (b) V_i
   (c) e^{kV_i} (d) $In(kV_i)$ **[ESE-2002]**

1.7 In the inverting op-amp circuit shown below, the resistance R_g is chosen as $R_1 \| R_2$ in order to

(a) increase gain

(b) reduce offset voltage

(c) reduce offset current

(d) increase CMRR   **[ESE-2002]**

1.8 An op-amp has a differential gain of 10^3 and a CMRR of 100. The output voltage of the op-amp with inputs of 120 µV and 80 µV will be

(a) 26 mV   (b) 41 mV

(c) 100 mV   (d) 200 mV

                       [ESE-2003]

1.9 Consider the following statements with reference to an ideal voltage follower circuit as shown below:

1. Unity gain and no phase shift
2. Infinite gain and 180° phase shift
3. Very high input impedance and very low output impedance
4. It is a buffer amplifier

Which of these statements are correct?

(a) 1 and 3   (b) 2 and 4

(c) 1, 3 and 4   (d) 1, 2, 3 and 4

                       [ESE-2003]

1.10 In the op-amp circuit as shown below, the current i_L is

(a) $\dfrac{V_i}{Z_L}$ (b) $\dfrac{V_i}{Z_L \| R_1}$

(c) $\dfrac{V_i}{R_1}$ (d) $V_i(R_1 + Z_L)$

                       [ESE-2003]

1.11 Which one of the following is the correct expression for the current I_0?
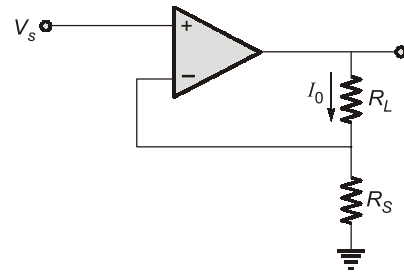
(a) $\dfrac{V_S \cdot R_L}{R_S(R_L + R_S)}$ (b) $\dfrac{V_S}{R_S}$

(c) $\dfrac{V_S}{R_L}$ (d) $V_S\left(\dfrac{1}{R_L} + \dfrac{1}{R_S}\right)$
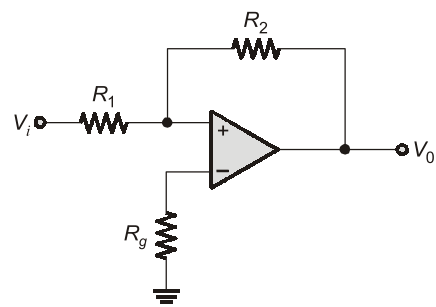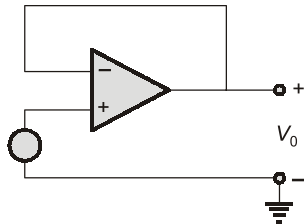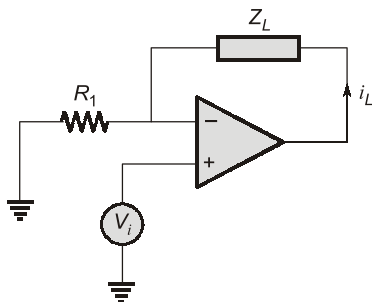
                       [ESE-2004]

1.12 Consider the following circuit:
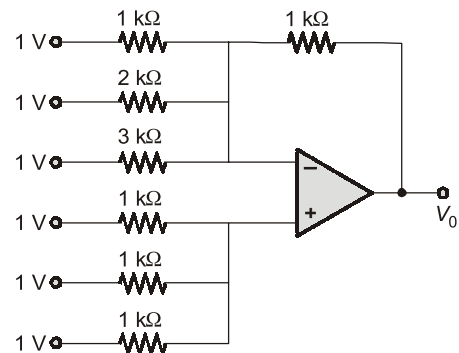
What is the output voltage V_0 in the above circuit?

(a) 9.5 V   (b) 3 V

(c) 32.2 V   (d) 1 V

                       [ESE-2004]

1.13 For the operational amplifier circuit shown in the figure below, what is the maximum possible value of R_1, if the voltage gain required is between –10 and –25? (The upper limit on R_F is 1 MΩ)
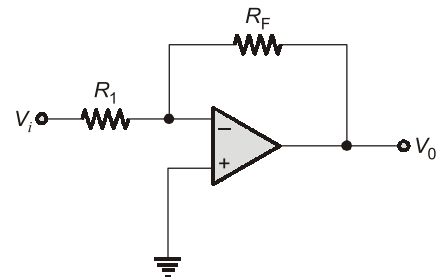
(a) Infinity   (b) 1 MΩ

(c) 100 kΩ   (d) 40 kΩ   **[ESE-2007]**

1.14 What is the output voltage V_0 of the given circuit?
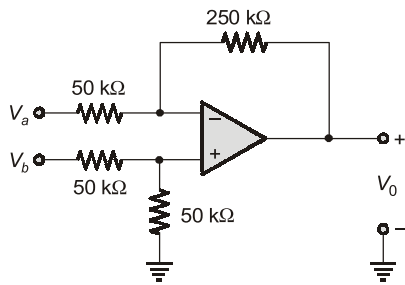
(a) $-5\ V_a + 2.5\ V_b$ (b) $-5\ V_a + 3V_b$
(c) $-2.5\ V_a + 2.5\ V_b$ (d) $-2.5\ V_a + 3V_b$

[ESE-2008]

1.15 **Assertion (A):** It is not possible to design a current source using operational amplifier.
Reason (R): Operational amplifier is a voltage-controlled voltage source.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

[ESE-2008]

1.16 For the below circuit what will be the output for the sinusoidal input shown at the input terminal?
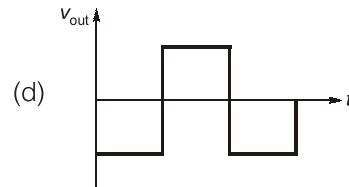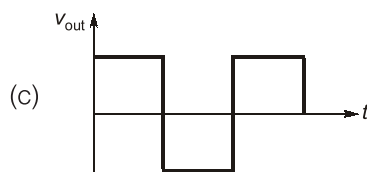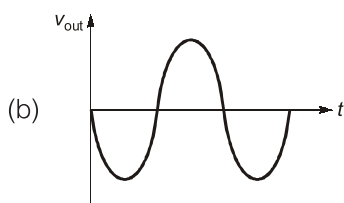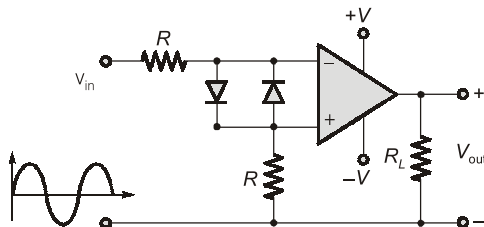
1.17 For the given sinusoidal input to the circuit as shown in the figure below, the voltage waveform at point P of the clamper circuit is
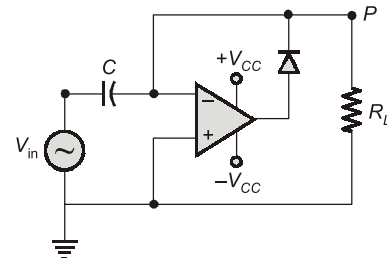

[ESE-2010]

1.18 **Assertion (A) :** In normal operation, the non-inverting and inverting input terminals of an operational amplifier are at almost same potential.
Reason (R) : The two terminals are connected together.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true   [ESE-2010]

1.19 The circuit shown is
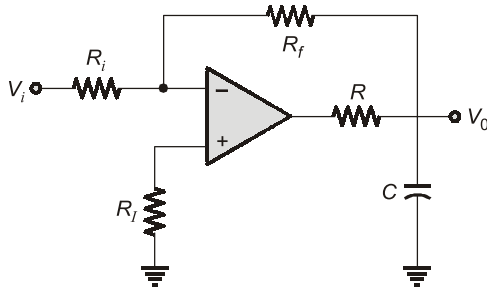
(a) A low pass filter
(b) A clamper
(c) A lag compensated inverting amplifier
(d) A narrow band video amplifier

[ESE-2011]

1.20 The circuit shown is
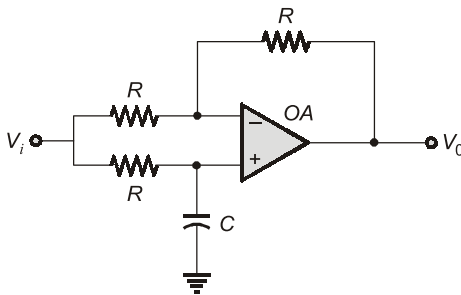
(a) A low-pass filter   (b) A high-pass filter
(c) A comparator   (d) An all-pass filter

[ESE-2011]

1.21 In the given circuit, the magnitude of the output voltage.
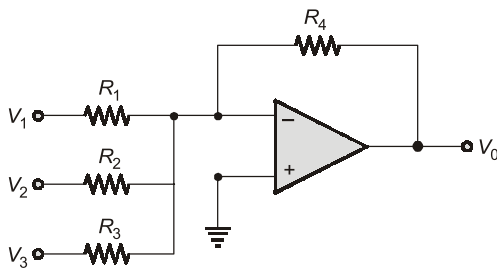
$|V_0| = 3V_1 + 2V_2 + 7V_3$, then the values of R_1, R_2, R_3 and R_4 are:

(a) 3 kΩ, 2 kΩ, 7 kΩ and 1 kΩ

(b) $\dfrac{1}{4}$ kΩ, $\dfrac{1}{6}$ kΩ, $\dfrac{7}{12}$ kΩ and 12 kΩ

(c) 4 kΩ, 6 kΩ, $\dfrac{12}{7}$ kΩ and 12 kΩ

(d) $\dfrac{1}{3}$ kΩ, $\dfrac{1}{2}$ kΩ, $\dfrac{1}{7}$ kΩ and 12 kΩ
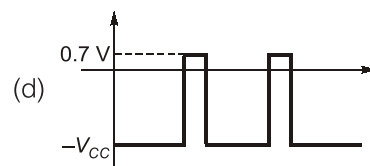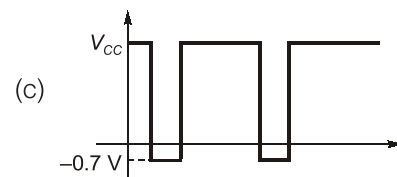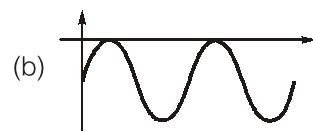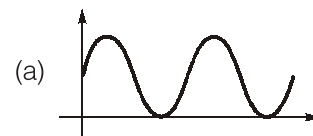
[ESE-2011]

1.22 Virtual ground property of operational amplifier indicates that
(a) inverting and non-inverting terminals are connected to ground.
(b) inverting and non-inverting terminals are at the same potential.
(c) system is at rest.
(d) any one terminal is connected to ground.

[ESE-2012]

1.23 A comparator circuit is used to
(a) mark the instant when an arbitrary waveform attains some reference level.
(b) switch off a circuit when output becomes zero.
(c) switch on and off a circuit alternately at a particular rate.
(d) mark the instant when the input voltage becomes constant.

[ESE-2012]

1.24 A signal may have frequency components which lie in the range of 0.001 Hz to 10 Hz. Which one of the following types of couplings should be chosen in a multistage amplifier designed to amplify the signal?
(a) RC coupling
(b) Direct coupling
(c) Transformer coupling
(d) Double tuned transformer   [ESE-2013]

1.25 An operational amplifier is connected in voltage follower configuration. Input given to this is $3\sin 10^3 \pi t$. Compute the slew rate of operational amplifier.
(a) $6\pi \times 10^{-3}$ V/μsec   (b) $3\pi \times 10^{-3}$ V/μsec
(c) $1.5\pi \times 10^{-3}$ V/μsec (d) $\pi \times 10^{-3}$ V/μsec

[ESE-2013]

1.26 An OP-AMP has a common mode gain of 0.01 and a differential mode gain of 10^5. Its common mode rejection ratio would be
(a) 10^{-7} (b) 10^{-3}
(c) 10^3 (d) 10^7

[ESE-2013]

1.27 An OP-AMP has a slew rate of 5 V/μs. The largest sine wave output voltage possible at a frequency of 1 MHz is

(a) $10\pi V$ (b) $5 V$

(c) $\dfrac{5}{\pi} V$ (d) $\dfrac{5}{2\pi} V$ **[ESE-2013]**

1.28 The gain and distortion of an amplifier are respectively 150 and 5%. When used with a 10% negative feedback the % distortion would be

(a) $\dfrac{5}{16}$ (b) $\dfrac{9}{16}$

(c) 6   (d) 8   **[ESE-2014]**

1.29 A two stage amplifier with negative feedback
  (a) can become unstable for larger values of β.
  (b) becomes unstable at high and very low frequencies if A is very large.
  (c) becomes unstable when the pole frequencies become complex.
 (d) is always stable.   **[ESE-2014]**

1.30 **Statement (I)** : An ideal op-amp should have infinite bandwidth.
  Statement (II) : An ideal op amp should have infinite input resistance and zero output resistance.
  (a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I).
  (b) Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I).
  (c) Statement (I) is true but Statement (II) is false.
  (d) Statement (I) is false but Statement (II) is true.   **[ESE-2015]**

1.31 Three identical amplifiers each having a voltage gain of 50 are cascaded. The open loop voltage gain of the combined amplifier is
  (a) 71 dB   (b) 82 dB
  (c) 91 dB   (d) 102 dB   **[ESE-2016]**

1.32 The operational amplifier circuit shown in figure having a voltage gain of unity has
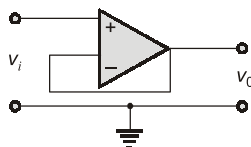
  (a) high input impedance and high output impedance.
  (b) high input impedance and low output impedance.

  (c) low input impedance and low output impedance.
  (d) low input impedance and high output impedance.
       [ESE-2016]

1.33 An operational amplifier has a slew rate of $2 V/\mu$ sec. If the peak output is 12 V, what will be the power bandwidth?
  (a) 36.5 kHz   (b) 26.5 kHz
  (c) 22.5 kHz   (d) 12.5 kHz
       [ESE-2016]

1.34 A voltage follower is used as
  1.   An isolation amplifier
  2.   A buffer amplifier
  Which of the above statements is/are correct?
  (a) 1 only   (b) 2 only
  (c) Both 1 and 2   (d) Neither 1 nor 2
       [ESE-2016]

1.35 How fast can the output of an Op-amp change by 10 V, if its slew rate is 1 $V/\mu s$?
  (a) $5 \mu s$ (b) $10 \mu s$
  (c) $15 \mu s$ (d) $20 \mu s$
       [ESE-2017]

1.36 An ideal operational amplifier is connected as shown in figure. What is the output voltage V_2?
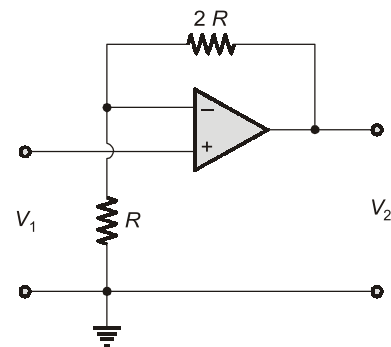
  (a) $3V_1$ (b) $2V_1$

  (c) $1V_1$ (d) $\dfrac{V_1}{3}$
       [ESE-2018]

1.37 For an op-amp having a slew rate of 2 $V/\mu s$, if the input signal varies by 0.5 V in 10 μs, the maximum closed-loop voltage gain will be
  (a) 50   (b) 40
  (c) 22   (d) 20   **[ESE-2019]**

1.38 In order to balance the offset voltage of an operational amplifier, a small DC voltage is applied to input terminals where the connection is
(a) Series with both inverting as well as non–inverting input
(b) Series with non–inverting input
(c) Shunt with inverting input
(d) Shunt with non–inverting input
[ESE-2020]

1.39 Multi-vibrator circuit that remains in stable state until a triggering signal causes transition to quasistable state and returns to stable state after certain time is called
(a) Astable multivibrator
(b) Monostable multivibrator
(c) Bistable multivibrator
(d) Unstable multivibrator   **[ESE-2020]**

1.40 What is the output voltage for an integrator when input is a step voltage for $0 \le t \le 2$, $R_1 C_F = 3$ sec and $V_{in} = 6$ V?
(a) −4 V   (b) −6 V
(c) −8 V   (d) −10 V   **[ESE-2021]**

1.41 Which one of the following statements is correct for the active filter using op-amps?
(a) High frequency response is limited by the gain bandwidth product and slew-rate of the op-amp.
(b) Op-amps are not providing any gain.
(c) Due to the low input impedance of the op-amp, large value resistors can be used.
(d) High frequency active filters are not more expensive than passive filters.
[ESE-2021]

1.42 Which one of the following consists of op-amp in inverting mode and network of R-C components, and the op-amp being in inverting mode it serves two purpose of amplifying and at its output 180° shifted phase is obtained?
(a) Wien's bridge oscillator
(b) R-C phase-shift oscillator
(c) Triangular wave generator
(d) Charging capacitor
[ESE-2022]

■■■■

Answers	**Operational Amplifier Characteristics and Application**

1.1	(b)	**1.2**	(b)	**1.3**	(b)	**1.4**	(d)	**1.5**	(b)	**1.6**	(d)	**1.7**	(c)	**1.8**	(b)	**1.9**	(c)
1.10	(c)	**1.11**	(b)	**1.12**	(d)	**1.13**	(c)	**1.14**	(b)	**1.15**	(d)	**1.16**	(d)	**1.17**	(a)	**1.18**	(c)
1.19	(a)	**1.20**	(d)	**1.21**	(c)	**1.22**	(b)	**1.23**	(a)	**1.24**	(b)	**1.25**	(b)	**1.26**	(d)	**1.27**	(d)
1.28	(a)	**1.29**	(d)	**1.30**	(b)	**1.31**	(d)	**1.32**	(b)	**1.33**	(b)	**1.34**	(c)	**1.35**	(b)	**1.36**	(a)
1.37	(b)	**1.38**	(b)	**1.39**	(b)	**1.40**	(a)	**1.41**	(a)	**1.42**	(b)						

Explanations	**Operational Amplifier Characteristics and Application**

1.1   **(b)**
Active load is used to increase differential gain A_d.

1.2   **(b)**
For a sinusoidal signal of general form $v_o = k \sin(2\pi ft)$ the maximum voltage rate of change can be shown to be

$$\Rightarrow \quad \left(\frac{dv_o}{dt}\right)_{maximum} = 2\pi fk \, (\text{V/s})$$

To prevent distortion at the output the rate of change must also be less than the slew rate, that is,
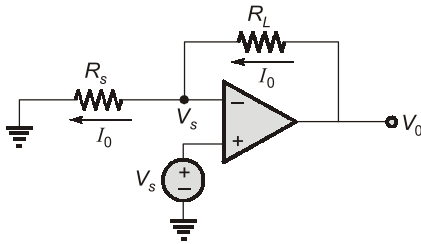
$$2\pi fk \le SR$$

$$\therefore \quad f \le \frac{SR}{2\pi k} \, \text{Hz}$$

voltage gain = 1
For $k = 2\sqrt{2}$ V and $SR = 0.5$ V/μs

$$\therefore \quad \text{Input } f_{max} = \frac{0.5}{10^{-6} \times 2 \times \pi \times 2 \times \sqrt{2}}$$
$$= 28.13 \text{ kHz} \simeq 30 \text{ kHz}$$

1.3 (b)

According to virtual short theory,

$$V^+ = V^-$$

$$I_0 = \frac{V_s}{R_s} \quad \text{[Non-inverting amplifier]}$$

1.4 (d)

Using superposition

For $V_{S1}, \; V_{01} = \left(1 + \dfrac{2R}{R}\right) V_{S1}$

For $V_{S2}, \; V_{02} = -\dfrac{2R}{R} V_{S2}$

∴ $V_0, \; V_{01} + V_{02} = 3V_{S1} - 2V_{S2}$

1.5 (b)

For the increasing input voltage; ($V_0 = +10$ V)

∴ Triggering voltage using superposition theorem

$$= \frac{47}{48} \times 0.7 + \frac{1}{48} \times 10 = 0.893 \text{ V}$$

1.6 (d)

We know that,

$$V_1 = V_2$$
∵ $V_2 = 0$
∴ $V_1 = 0$

So, net voltage across diode D

$$V = V_1 - V_0$$
$$= 0 - V_0 = -V_0$$

So, current i through diode D (when $V_i > 0$)

$$i = I_0 \left[e^{V/\eta V_T} - 1 \right] \qquad \ldots(i)$$

Where I_0 = reverse saturation current.
V_T = Voltage equivalent of temperature
Now current,

$$i_1 = \frac{V_i - V_1}{R} = \frac{V_i}{R}$$

∵ Current inside the op-amp is zero

$$(\because R_i \to \infty)$$

∴ $i = i_1$

i.e. $I_0 [e^{V/\eta V_T} - 1] = \dfrac{V_i}{R}$

$$e^{V/\eta V_T} - 1 = \frac{V_i}{I_0 R}$$

$$e^{V/\eta V_T} = 1 + \frac{V_i}{I_0 R}$$

$$V = \eta V_T \, In\left(1 + \frac{V_i}{I_0 R}\right)$$

∵ $I_o << 0$

So, $\dfrac{V_i}{I_0 R} >> 1$

So, we can write,

$$V = \eta V_T \, In\left(\frac{V_i}{I_0 R}\right)$$

$$-V_0 = \eta V_T \, In \frac{V_i}{I_0 R}$$

$$V_0 = -\eta V_T \, In \frac{V_i}{I_0 R}$$

$V_0 = -\eta V_T \, In \, kV_i$ where $k = (I_0 R)^{-1}$
$V_0 \propto In \, kV_i$

1.7 (c)

R_g is chosen such that it is equal to impedance seen from the –ve terminal by replacing all the sources by their internal impedances and this is done for reducing the effect of offset current.

1.8 (b)

$$V_o = A_d V_d + A_c V_c \quad \text{and} \quad \text{CMRR} = \frac{A_d}{A_c}$$

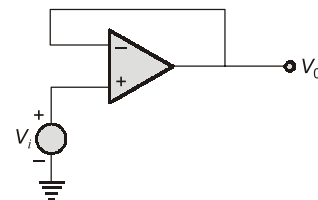$$V_o = A_d V_d \left(1 + \frac{1}{\text{CMRR}} \frac{V_C}{V_d}\right)$$

$$V_C = \frac{1}{2}(120 + 80) = 100 \times 10^{-6} \text{ V}$$

$$V_d = 120 - 80 = 40 \times 10^{-6} \text{ V}$$

∴ $V_o = 10^3 \times 40 \times 10^{-6} \times \left(1 + \dfrac{1}{100} \times \dfrac{10^{-4}}{40 \times 10^{-6}}\right)$

∴ $V_o = 41$ mV

1.9 (c)

This is non-inverting amplifier with $R_f = R_2 = 0$, $R_1 \to \infty$.

We know that gain,
$$A_V = (1 + R_2/R_1)$$
$$A_V = 1$$
$$\because \qquad R_2 = 0, R_1 \to \infty.$$

Now this is a voltage series feedback configuration so, input impedance further increases as compare to open loop configuration and output impedance decreases (due to shunt connection at output) compare to open loop configuration.

$\therefore$ In open loop configuration input impedance is high and output impedance is low so in this configuration it becomes very high and very low respectively.

$\therefore$ It passes the input as it is ($\because A_V = 1$) and with some delay so it act as buffer.

1.10 (c)
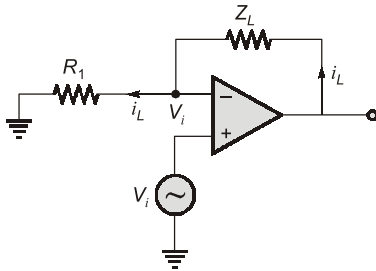
According to virtual short theory,
$$V^+ = V^-$$
$$i_L = \frac{V_i}{R_1}$$

1.11 (b)

$$I_0 = \frac{V_S}{R_S}$$

1.12 (d)

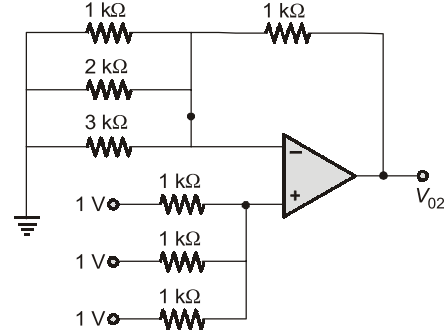$V_{01} \to$ output voltage due to voltages at inverting terminal assuming voltages at non-inverting terminals = 0.

$$\frac{1}{3k} + \frac{1}{2k} + \frac{1}{1k} = \frac{0 - V_{01}}{1k}$$
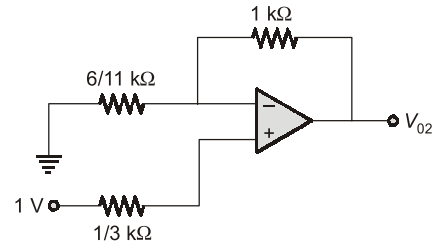$$V_{01} = -\frac{1}{6}[2 + 3 + 6]$$
$$V_{01} = -\frac{11}{6} V$$

$V_{02} \to$ output voltage due to voltages at non-inverting terminals keeping voltages at inverting terminals zero.

So,

Equivalent circuit will be

So output,
$$V_{02} = 1V \times \left[1 + \frac{R_2}{R_1}\right] = 1V \times \left[1 + \frac{1}{6/11}\right] = \frac{17}{6} V$$

$\therefore$ Net output according to superposition theorem
$$V_0 = V_{01} + V_{02}$$
$$= -\frac{11}{6} + \frac{17}{6} = \frac{6}{6} = 1 V$$

1.13 (c)

Gain, $\qquad A_V = -\frac{R_f}{R_1}$

$\therefore \qquad R_1 = -\frac{R_f}{A_V}$

So, R_1 will be $\propto \dfrac{1}{A_V}$

So lesser the gain higher will be R_1
So for $A_V = -10$
$\to R_1$ will be maximum

$\therefore \qquad R_1 = \dfrac{-R_f}{-10} = \dfrac{R_f}{10} = \dfrac{1 \times 10^6}{10} = 10^5 \Omega$

$\qquad R_1 = 100$ kΩ

1.14 (b)

Output due to voltage at inverting terminal keeping voltage at non-inverting terminal zero is

$$V_{01} = V_a \times \left(-\frac{R_f}{R}\right) = V_a\left(-\frac{250}{50}\right)$$

$$V_{OC} = -5\,V_a$$

Output voltage due voltage at non-inverting terminal keeping voltage at inverting terminal zero,

$$V_{02} = V_b \times \frac{50}{(50+50)} \times \left(1+\frac{R_f}{R}\right)$$

$$= V_b \times \frac{1}{2}\left(1+\frac{250}{50}\right)$$
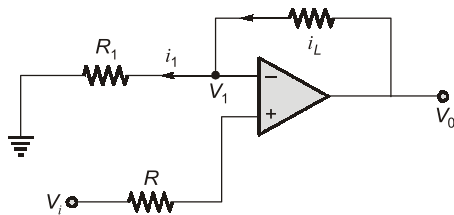
$$V_{02} = 3V_b$$

So according to superposition theorem, net output voltage,

$$V_0 = V_{01} + V_{02}$$

$$V_0 = -5V_a + 3V_b$$

1.15 (d)

Here, $V_1 = V_i$

due to virtual ground concept

$$\therefore \qquad i_1 = \frac{V_1}{R_1} = \frac{V_i}{R_1}$$

∵ current inside the op-amp = 0 ($R_i = \infty$)
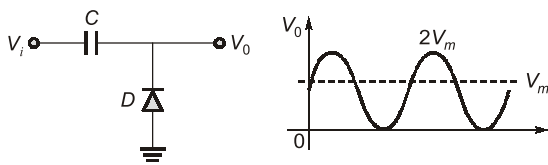
$$\therefore \qquad i_L = i_1 = \frac{V_i}{R}$$

Independent of load so work as current source. Statement (A) is incorrect.

1.16 (d)

Output will be at its saturated values and it is having a phase difference of (–180°)

1.17 (a)

It is a clamper circuit,

1.18 (c)

Correct reason is virtual grounding.

1.19 (a)

For low frequency $Z_C = \dfrac{1}{j\omega C} \Rightarrow \infty$

So, output $\qquad V_0 = -\dfrac{R_f}{R_1}\,V_i$

we will get the output for high frequency

$$Z_C = \frac{1}{j\omega C} \Rightarrow 0$$

$\therefore \qquad$ Output $V_0 \cong 0$

So cut the high frequency.

So it is a low pass filter.

1.20 (d)

It is all pass filter,

$$\text{Transfer function} = \frac{1 - j2\pi fRC}{1 + j2\pi fRC}$$

1.21 (c)

$$V_0 = -\frac{R_4}{R_1}V_1 + \left(-\frac{R_4}{R_2}\right)V_2 + \left(-\frac{R_4}{R_3}\right)V_3$$

$$= -\left[\frac{R_4}{R_1}V_1 + \frac{R_4}{R_2}V_2 + \frac{R_4}{R_3}V_3\right]$$

$$|V_0| = \frac{R_4}{R_1}V_1 + \frac{R_4}{R_2}V_2 + \frac{R_4}{R_3}V_3$$

Given,

$$|V_0| = 3V_1 + 2V_2 + 7V_3$$

$$\therefore \quad \frac{R_4}{R_1} = 3, \ \frac{R_4}{R_2} = 2, \frac{R_4}{R_3} = 7$$

$$\therefore \qquad R_1 : R_2 : R_3 : R_4$$

$$\frac{1}{3} : \frac{1}{2} : \frac{1}{7} : 1$$

Multiplying by 12 we get,

$$\frac{12}{3} : \frac{12}{2} : \frac{12}{7} : 12$$

$$4\,k\Omega : 6\,k\Omega : \frac{12}{7}\,k\Omega : 12\,k\Omega$$

1.22 (b)

In virtual ground property the potential of inverting and non-inverting end are same.

1.23 (a)

A comparator mark the instant when an arbitrary waveform attains some reference level.

1.24 (b)

For the application where the signal frequency is below 10 Hz, the coupling and bypass capacitors can no longer be treated as short circuits because they offered extremely high impedance besides this if these capacitor are to serve their purpose their value must be very large which generate the problem like high cost and size therefore at low frequency direct coupling is used.

1.25 (b)

$$V = 3 \sin 10^3 \pi t$$

$$\text{S.R.} = \left. \frac{dV}{dt} \right|_{max.}$$

$$= \left| 3 \times 10^3 \pi \times \cos 10^3 \pi t \right|_{max.}$$

$$= 3\pi \times 10^3 \text{ V/sec}$$

$$= 3\pi \times 10^{-3} \text{ V/}\mu\text{sec}$$

1.26 (d)

$$\text{CMRR} = \frac{A_d}{A_c} = \frac{10^5}{0.01} = 10^7$$

1.27 (d)

$$V_{max} = \frac{\text{S.R.}}{\omega} = \frac{5 \times 10^6}{2\pi 10^6} = \frac{5}{2\pi} \text{ V}$$

1.28 (a)

$$AB = 150 \times \frac{10}{100}$$

$$= 15$$

$$\% \text{ D.F.} = \frac{\%D}{1+AB} = \frac{5}{1+15} = \frac{5}{16}$$

1.30 (b)

Both the statements are correct and statement-II is not reason of statement-I.

1.31 (d)

$$20 \log_{10} A_1 A_2 A_3 = 20 \log 50 \times 50 \times 50$$

$$= 102 \text{ dB}$$

1.33 (b)

$$f_m = \frac{S.R}{2\pi \times V_m} = \frac{2 \times 10^6}{2 \times \pi \times 12}$$
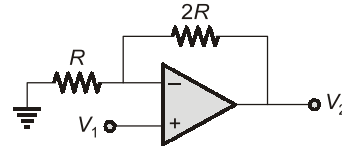
$$= 26.5 \text{ kHz}$$

1.35 (b)

Slew rate = 1 V/μs

$$V_{0\,max} = 10 \text{ V}$$

$$\omega_{max} = \frac{\text{S.R.}}{V_{0max}}$$

$$= \frac{\dfrac{1}{10^{-6}}}{10} = \frac{1}{10^{-5}}$$

$$= 10^5 \text{ rad/sec}$$

$$t = \frac{1}{\omega_{max}} = \frac{1}{10^5} = 10 \text{ }\mu\text{s}$$
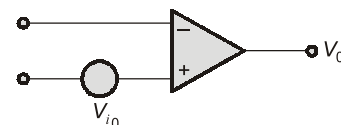
1.36 (a)

It is non inverting amplifier,

$$V_2 = V_1 \left(1 + \frac{2R}{R} \right) = 3V_1$$

1.37 (b)

$$\text{S.R.} = A_{CL} \cdot \frac{\Delta V_i}{\Delta t}$$

$$= A_{CL} \cdot \frac{0.5}{10 \times 10^{-6}}$$

$$A_{CL} = 40$$

1.38 (b)

In order to balance the offset voltage of op-amp where external DC voltage applied most be same in magnitude and opposite in polarity of input offset voltage.

(Polarity depends on input offset voltage polarity)

1.39 (b)

Mono stable multivibrator remains in stable state until a triggering signal causes a transition to quasi-stable state and return to stable state.

1.40 (a)
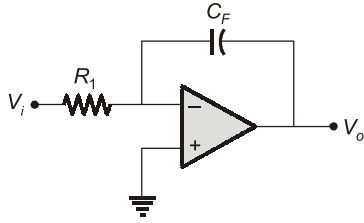
$$V_o(s) = \dfrac{-\dfrac{1}{C_F s}}{R_1} \times V_i(s)$$

$$V_o(s) = -\dfrac{1}{R_1 C_F s} \times V_i(s)$$

$$V_o(t) = -\dfrac{1}{R_1 C_F}\int_0^t V_i(t)$$

$$V_o = -\dfrac{1}{RC}\int V_i dt = \dfrac{-1}{3\ \text{sec}}\int_0^2 6 dt$$

$$= -\dfrac{6}{3}[t]_0^2 = -\dfrac{6}{3}\times 2 = -\dfrac{12}{3} = -4 = -4\text{ V}$$

1.41 (a)

- Op-amp provides very high gain in active filters.
- The input impedance of op-amp is very high, practically in Mega-ohms.
- Due to presence of active elements, these filters are expensive than passive filters.

1.42 (b)

Opamp in inverting mode and network of RC components.

■■■■