1. What is value of output voltage when switch is closed? It is assumed that system is in steady state position?

\[ V_0 = \frac{5V}{2K\Omega} = -\frac{5}{2} = -2.5 \]

(a) +5  (b) −5  (c) −2.5  (d) +2.5

2. The OP-AMP in inverting amplifier show in figure has an equivalent input offset voltage of 5mV. The total offset voltage is:

\[ V_{out} = V_{in} + V_{offset} \]

\[ V_{total} = 5mV + 5mV = 10mV \]

(a) 5mV  (b) −280mV  (c) −285mV  (d) 560mV

3. Feedback factor (β) of circuit is

\[ \beta = \frac{-1}{R_2} \]

\[ \beta = \frac{-1}{0.002K} = -500 \]

(a) 0.33  (b) 0.67  (c) data is insufficient  (d) 0.03

4. In case of circuit shown in figure, \( V_{in} = 10mV \) D.C. the maximum possible offset voltage \( V_{offset} \), caused by input voltage \( V_{in} \), w.r.t. GND is

\[ V_{offset} = \frac{5K\Omega}{1K\Omega} \times 10mV = 50mV \]

(a) 60 volt D.C  (b) 60 mV D.C  (c) 110 volt D.C  (d) 50 mV D.C
5. What is CMRR of given Op-Amp circuit?

\[ R_1 \quad R_3 \]
\[ \begin{array}{c}
3V \\
R_3
\end{array} \quad V_0 \]

(a) 0  
(b) 1  
(c) \infty  
(d) 3

6. For the above question, what is the value of output?

(a) 0  
(b) 1  
(c) 3  
(d) \text{interns of } R_1, R_2 \text{ & } R_3

7. For given ideal OP-AMP if \( V_i = \sin t \) what is the value of \( V_0 \)?

\[ \begin{array}{c}
10K \\
R=1\Omega \\
1F
\end{array} \quad \begin{array}{c}
V_i \\
V_0
\end{array} \]

(a) \( \sqrt{2} \sin (t + 45^\circ) \)  
(b) \( \sqrt{2} \sin (t - 45^\circ) \)  
(c) \( 1/\sqrt{2} \sin (t + 45^\circ) \)  
(d) \( 1/\sqrt{2} \sin (t - 45^\circ) \)

8. For the circuit shown in figure, with an ideal OP-AMP, what is the maximum phase shift of output with reference to input?

\[ \begin{array}{c}
R_1 \\
V_i \\
V_0
\end{array} \]

(a) 0°  
(b) 90°  
(c) -95°  
(d) ±180°

9. The inverting OP-AMP, shown in figure has an open loop gain of 50, what is value of closed loop gain?

\[ \begin{array}{c}
1V \\
10K \\
100K
\end{array} \quad \begin{array}{c}
V_i \\
V_0
\end{array} \]

(a) -8  
(b) -9  
(c) -10  
(d) +11

10. What is the value of gain of given circuit?

\[ \begin{array}{c}
\pm V_i \\
\begin{array}{c}
R \\
R \\
R \\
R
\end{array}
\end{array} \quad \begin{array}{c}
V_0
\end{array} \]

(a) -4  
(b) -7  
(c) -9  
(d) -8
11. In the OP-AMP circuit shown, assume that diode current follows the equation \( I = I_0 \exp(V/V_T) \). For \( V_i = 2V, V_0 = V_{o1} \) and for \( V_i = 4V, V_0 = V_{o2} \), relationship between \( V_{o1} \) & \( V_{o2} \) is:

(a) \( V_{o2} = \sqrt{2}V_{o1} \)  
(b) \( V_{o2} = e^{3}V_{o1} \)  
(c) \( V_{o2} = V_{o1} \ln 2 \)  
(d) \( V_{o1} - V_{o2} = V_T \ln 2 \)

12. In circuit shown in figure, function of diode \( D_2 \) is:

(a) to provide negative feedback when input in negative. 
(b) to avoid saturation of operational amplifier. 
(c) to reduced reverse breakdown voltage of diode \( D_1 \). 
(d) in significant and can be removed.

13. If the input to the circuit of figure is 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

14. The input to a lock-in amplifier has the form \( V_i(t) = V_r \sin(\omega t + \theta) \) where \( V_r, \omega, \theta \) are the amplitude frequency and phase of the input signal respectively. This signal is multiplied by a reference signal of the same frequency \( \omega \), amplitude \( V_r \) and phase \( \theta_r \). If the multiplied signal is fed to a low pass filter of cut-off frequency \( \omega \), then the final output signal is:

(a) \( \frac{1}{2}V_r \cos(\theta - \theta_r) \)  
(b) \( V_r \left[ \cos(\theta - \theta_r) - \cos\left(\frac{1}{2}\omega t + \theta + \theta_r\right)\right] \)  
(c) \( V_r \sin(\theta - \theta_r) \)  
(d) \( V_r \left[ \cos(\theta - \theta_r) + \cos\left(\frac{1}{2}\omega t + \theta + \theta_r\right)\right] \)

15. The circuit given below works as:

(a) differentiator 
(b) integrator 
(c) both as integrator and differentiator 
(d) none of above
16. If the given circuit (figure) if the voltage inputs \( V_- \) and \( V_+ \) are to be amplified by the same amplification factor the value of \( R \) should be:

![Circuit Diagram](image)

(a) 66 \( K \)  
(b) 99 \( K \)  
(c) 33 \( K \)  
(d) 11 \( K \)

17. Negative feedback in voltage series configuration:
   (a) increases input impedance  
   (b) decreases input impedance  
   (c) increases closed loop gain  
   (d) leads to oscillation

18. Assume that the OP-AMP of figure is ideal, if \( V_i \) is a triangular wave, then \( V_o \) will be

![Circuit Diagram](image)

(a) square wave  
(b) triangular wave  
(c) parabolic wave  
(d) sine wave

19. The circuit of figure represents a

![Circuit Diagram](image)

(a) low pass filter  
(b) high pass filter  
(c) band pass filter  
(d) band reject filter

20. In figure assume the OP-Amps to be ideal. The output \( V_o \) of the circuit is

![Circuit Diagram](image)

(a) \( 100 \cos(100t) \)  
(b) \( 10 \int_0^t \cos(100\tau)d\tau \)  
(c) \( 10^{-1} \int_0^t \cos(100\tau)d\tau \)  
(d) \( 10^{-4} \frac{d}{dt} \cos(100t) \)

21. 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.
22. The circuit in figure is a

(a) low-pass filter  (b) high-pass filter  (c) band-pass filter  (d) band-reject filter

23. A differential amplifier has a differential gain of 20,000. CMRR = 80 dB. The common mode gain is given by

(a) 2  (b) 1  (c) 0.5  (d) 0

24. Which of the following pairs is /are correctly matched?

<table>
<thead>
<tr>
<th>Waveform</th>
<th>Circuitry and input signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. triangular wave</td>
<td>integrating circuit and square wave</td>
</tr>
<tr>
<td>2. impulsive wave</td>
<td>differentiating circuit and step signal</td>
</tr>
<tr>
<td>3. saw-tooth wave</td>
<td>differentiating circuit and triangular wave</td>
</tr>
</tbody>
</table>

Select the correct answer using the codes given below

(a) 2 and 3  (b) 1 and 2  (c) 1 alone  (d) 1 and 3

25. An ideal OP-AMP has

(a) infinite input and output impedance.
(b) very low input and output impedance.
(c) low input impedance and infinite output impedance.
(d) infinite input impedance and zero output impedance.

26. A different amplifier is invariably used in the input stage of all OP-AMPs. This is done basically to provide the OP-AMPs with a very high

(a) CMRR  (b) Bandwidth  (c) Slew rate  (d) open-loop gain

27. The output $V_0$ of the ideal OP-AMP circuit shown in the figure is

(a) $-7V$  (b) $-5V$  (c) $5V$  (d) $7V$

28. The low-pass active filter shown in the figure has a cut-off frequency of 2kHz and a pass band gain of 1.5, the values of the resistors are:

(a) $R_1 = 10k\Omega; R_2 = 1.3 \Omega$  (b) $R_1 = 30k\Omega; R_2 = 1.3 \Omega$
(c) $R_1 = 10k\Omega; R_2 = 1.7 \Omega$  (d) $R_1 = 30k\Omega; R_2 = 1.7 \Omega$
29. In the following circuit, for the output voltage to \( V_o = (-V_1 + V_2 / 2) \) the ratio \( R_1 / R_2 \) is

\[
\begin{align*}
(a) & \quad \frac{1}{2} \\
(b) & \quad 1 \\
(c) & \quad 2 \\
(d) & \quad 3
\end{align*}
\]

30. A power amplifier gives 150 \( W \) output for an input of 1.5 \( W \). The gain in \( dB \), is

\[
\begin{align*}
(a) & \quad 10 \\
(b) & \quad 20 \\
(c) & \quad 54 \\
(d) & \quad 100
\end{align*}
\]

31. In one of the following circuits, negative feedback does not operate for a negative input. Which one is it? The op-amps are running from

\[
\begin{align*}
(a) \quad & \quad \text{ } \\
(b) \quad & \quad \begin{array}{c}
5.1 \text{ V} \\
\end{array} \\
(c) \quad & \quad \text{ } \\
(d) \quad & \quad \text{ }
\end{align*}
\]

Statement for linked answer Q.32 and Q.33
The following circuit contains three operational amplifiers and resistors

32. The output voltage at the end of second operational amplifier \( V_{02} \) is

\[
\begin{align*}
(a) & \quad V_{01} = 3(V_a + V_b + V_c) \\
(b) & \quad V_{01} = -\frac{1}{3}(V_a + V_b + V_c) \\
(c) & \quad V_{02} = \frac{1}{3}(V_a + V_b + V_c) \\
(d) & \quad V_{01} = 4(V_a + V_b + V_c)
\end{align*}
\]

33. The output \( V_{02} \) (at the end of third OP-AMP) of the above circuit is:

\[
\begin{align*}
(a) & \quad V_{02} = 2(V_a + V_b + V_c) \\
(b) & \quad V_{02} = 3(V_a + V_b + V_c) \\
(c) & \quad V_{02} = \frac{1}{2}(V_a + V_b + V_c) \\
(d) & \quad \text{zero}
\end{align*}
\]

34. The circuit for which the input and output waveforms are shown below is

\[
\begin{align*}
(a) \quad & \quad \text{clipping circuit} \\
(b) \quad & \quad \text{integrator} \\
(c) \quad & \quad \text{differentiation} \\
(d) \quad & \quad \text{Schmitt trigger}
\end{align*}
\]
35. An operational amplifier
   (a) has a very high gain  (b) has a high input resistance
   (c) is a negative feedback amplifier (d) has a very small input current

36. The output of the circuit on the right will be

   ![Circuit Diagram](image)

   (a) 1V (b) 11V (c) -10V (d) 0 V

37. A bistable multivibrator with a saturation voltage ±5V is shown in the diagram. The positive and negative threshold at the inverting terminal for which the multivibrator will switch to the other state are

   ![Multivibrator Diagram](image)

   (a) ±5/11V (b) ±10/11V (c) ±5V (d) ±11V

38. The inverting input terminal of an operational amplifier (OP-AMP) is shorted with the output terminal apart from being grounded. A voltage signal $v_i$ is applied to the non-inverting input terminal of the op-amp. Under this configuration, the op-amp functions as

   (a) an open loop inverter (b) a voltage to current converter
   (c) a voltage follower (d) an oscillator

39. Consider the following operational amplifier circuit with an input signal of frequency 10 kHz.

   ![Operational Amplifier Circuit](image)

   Which of the following represents the output waveform $V_o$?

   ![Output Waveform](image)

40. In an OP-AMP, when the input drives the output at a rate of voltage change greater than the slew rate then the resulting signal.

   (a) is enhanced (b) is clipped
   (c) is unaffected (d) remains the same but with 90° phase difference

41. For the OP-AMP circuit shown in the figure below, which is the correct output wavelength?

   ![Figure](image)

42. Consider the following circuit

   ![Circuit Diagram](image)

   Which of the following represents the output $V_{out}$ corresponding to the input $V_{in}$?

   ![Output Representation](image)
43. A time varying signal $V_{in}$ is fed to an op-amp circuit with output signal $V_0$ as shown in the figure below. The circuit implements a

(a) high pass filter with cut-off frequency 16 Hz  (b) high pass filter with cut-off frequency 100 Hz
(c) low pass filter with cut-off frequency 16 Hz  (d) low pass filter with cut-off frequency 100Hz

44. Consider the following circuit

If the waveform given below is fed in at

Then the waveform at the output $V_{out}$ will be

45. In the operational amplifier circuit below the voltage at point $A$ is

(a) 1.0 V  (b) 0.5 V  (c) 0 V  (d) −5.0 V
46. The classic three op-amp instrumentation amplifier configuration is shown below:

![Instrumentation Amplifier Diagram]

The value of \( \frac{V_0}{V_1 - V_2} \) is:
(a) 3 \hspace{1cm} (b) 4 \hspace{1cm} (c) 5 \hspace{1cm} (d) 6

47. A triangular waveform is applied to the input of a differentiator. The output is:
(a) a dc signal \hspace{1cm} (b) a square waveform \hspace{1cm} (c) an inverted triangular waveform \hspace{1cm} (d) the first harmonic of the triangular waveform

48. The circuit shown below implements a 4-bit DAC. Which of the switches S1……S4 should be closed to get an output voltage \( V_0 \) as close as 2.6 V as possible?

![4-bit DAC Circuit Diagram]

(a) S1 and S4 \hspace{1cm} (b) S2 and S3 \hspace{1cm} (c) S3 and S4 \hspace{1cm} (d) S2 and S4

49. A sinusoidal signal \( V(t) = V_p \sin(\omega t) \) is applied to the input of an op-amp with slew rate \( S_R \). The op-amp maximum frequency \( \omega_{\text{max}} \) that the op-amp can sustain without output distortion is:
(a) \( \sqrt{2\pi S_R} / V_p \) \hspace{1cm} (b) \( S_R / 2V_p \) \hspace{1cm} (c) \( 2S_R / V_p \) \hspace{1cm} (d) \( S_R / V \)

50. In the given operational amplifier circuit what is the correct expression for the output voltage

(a) \( V_0 = -RC \frac{dV_{in}}{dt} \) \hspace{1cm} (b) \( V_0 = -\frac{1}{RC} \frac{dV_{in}}{dt} \)
(c) \( V_0 = -RC \int_{t=0}^{1} V_{in} dt \) \hspace{1cm} (d) \( V_0 = -\frac{1}{RC} \int_{t=0}^{1} V_{in} dt \)

51. For a step input, the output of an integrator is a
(a) pulse \hspace{1cm} (b) ramp \hspace{1cm} (c) triangular wave from \hspace{1cm} (d) spike

52. A certain inverting amplifier has a closed-loop gain of 25. The OP-amp has an open-loop gain of 100000. If another OP-AMP with an open-loop gain of 300, 000 is substituted in the configuration, the closed-loop gain.
(a) drops to 12.5 \hspace{1cm} (b) doubles \hspace{1cm} (c) remains at 25 \hspace{1cm} (d) become \( 25 \left(1 - \frac{25}{200000}\right) \)

53. A signal of frequency 10 kHz is being digitized by an A/D converter. Which of the following is an appropriate value for the sampling time?
(a) 400 \( \mu \)s \hspace{1cm} (b) 40 \( \mu \)s \hspace{1cm} (c) 100 \( \mu \)s \hspace{1cm} (d) 200 \( \mu \)s
54. Consider the following OP-AMP circuit

Which one of the following correctly represents the output $V_{out}$ corresponding to the input $V_{in}$?

(a) ![Graph A](image)

(b) ![Graph B](image)

(c) ![Graph C](image)

(d) ![Graph D](image)

55. An input of 1.0 V DC is given to the ideal op-amp circuit depicted below. What will be the output voltage?

(a) 10.0 V  
(b) −9.0 V  
(c) 1.0 V  
(d) 0 V

56. In the op-amp circuit shown in the figure, $V_i$ is a sinusoidal input signal frequency 10 Hz and $V_0$ is the output signal.

The magnitude of the gain and the phase shift, respectively are close to the values

(a) $5\sqrt{2}$ and $\frac{\pi}{2}$  
(b) $5\sqrt{2}$ and $\frac{-\pi}{2}$  
(c) 10 and zero  
(d) 10 and $\pi$
57. Band-pass and band-reject filters can be implemented by combining a low pass and a high pass filter in series and in parallel, respectively. If the cut-off frequencies of the low pass and high pass filters are \( \omega_{0LP} \) and \( \omega_{0HP} \), respectively, the condition required to implement the band-pass and band-reject filters are respectively.

(a) \( \omega_{0HP} < \omega_{0LP} \) and \( \omega_{0HP} < \omega_{0LP} \)  
(b) \( \omega_{0HP} < \omega_{0LP} \) and \( \omega_{0HP} > \omega_{0LP} \)  
(c) \( \omega_{0HP} > \omega_{0LP} \) and \( \omega_{0HP} < \omega_{0LP} \)  
(d) \( \omega_{0HP} > \omega_{0LP} \) and \( \omega_{0HP} > \omega_{0LP} \)

**Statement for linked Q. 58 and Q.59**

Shown in the figure is a circuit to measure light intensity and convert it to a digital signal. The photodiode P has a responsivity of 0.1 A per watt of incident light intensity. The Op-amp converts the induced photocurrent to a voltage which is digitized by the 10-bit A/D converter with a reference voltage of 4V.

58. For a light intensity of 25\( \mu \)W incident on the photodiode, the voltage output of the OP-amp is

(a) 0.25 V  
(b) 1.0 V  
(c) 4.0 V  
(d) 2.5 V

59. The range of light intensity which can be measured by this set up is

(a) 100 nW to 100\( \mu \)W  
(b) 100 nW to 100\( \mu \)W  
(c) 40 nW to 40\( \mu \)W  
(d) 40 nW to 40\( \mu \)W

60. In the op-amp circuit shown in the figure below, the input voltage \( V_i \) is 1V. The value of the output \( V_o \) is:

(a) −0.33 V  
(b) −0.50 V  
(c) −1.00 V  
(d) −0.25 V

61. If the analog input to an 8-bit successive approximation ADC is increased from 1.0 V to 2.0 V, then the conversion time will

(a) remain unchanged  
(b) double  
(c) decreased to half  
(d) increase four times

**Statement for linked answer Q.62 and Q.63**

Consider the following circuit
62. For this circuit the frequency above which the gain will decreases by 20dB per decade is
(a) 15.9 kHz  (b) 1.2 kHz  (c) 5.6 kHz  (d) 22.5 kHz

63. At 1.2 kHz the closed loop gain is
(a) 1  (b) 1.5  (c) 3  (d) 0.5

64. Consider the op-amp circuit shown in the figure

If the input is a sinusoidal wave \( V_i = 5\sin(1000\pi t) \), then the amplitude of the output \( V_o \) is
(a) \( \frac{5}{2} \)  (b) 5  (c) \( \frac{5\sqrt{2}}{2} \)  (d) \( 5\sqrt{2} \)

65. In the following circuit, the resistance \( R_2 \) is doubled

It follows that the current through \( R_2 \)
(a) remains the same  (b) is halved  (c) is doubled  (d) is quadrupled

66. An op-amp based voltage follower
(a) is useful for converting a low impedance source into a high impedance source.
(b) is useful for converting a high impedance source into a low impedance source.
(c) has infinitely high closed loop output impedance.
(d) has infinitely high closed loop gain.

67. The inner shield of a triaxial conductor is driven by an (ideal) op-amp follower circuit as shown. The effective capacitance between the signal-carrying conductor and ground is
(a) unaffected  (b) doubled  (c) halved  (d) made zero

68. The input given to be an ideal op-amp integrator circuit is

The correct output of the integrator circuit is
69. Consider the amplifier circuit comprising of the two op-amps $A_1$ and $A_2$ as shown in the figure. If the input ac signal source has an impedance of $50k\Omega$, which of the following statements is true?

(a) $A_1$ is required in the circuit because the source impedance is much greater than $r$.
(b) $A_1$ is required in the circuit because the source impedance is much less than $R$.
(c) $A_1$ can be eliminated from the circuit without affecting the overall gain.
(d) $A_1$ is required in the circuit if the output has to follow the phase of the input signal.

70. In the circuit shown below, the op-amp is powered by a bipolar supply of $\pm 10V$.

Which one of the following graphs represents $V_{out}$ correctly?

(a) $V_{out}$
(b) $V_{out}$
(c) $V_{out}$
(d) $V_{out}$
71. What is the voltage at the output of the following operational amplifier circuit?

\[ \text{10MΩ} \quad 1\text{nA} \quad 1\text{kΩ} \quad 9\text{kΩ} \quad R_L \quad V_{\text{out}} \]

(a) 1V  
(b) 1mV  
(c) 1μV  
(d) 1nV

72. In the given circuit, if the open loop gain \( A = 10^5 \), the feedback configuration and the closed loop gain \( A_f \) are

\[ V_1 \quad 1\text{kΩ} \quad 9\text{kΩ} \quad R_L \quad V_0 \]

(a) series-shunt, \( A_f = 9 \)  
(b) series-series, \( A_f = 10 \)  
(c) series-shunt, \( A_f = 10 \)  
(d) shunt-shunt, \( A_f = 10 \)

73. Consider the circuit shown in the figure, where \( RC = 1 \). For an input signal \( V_i \) shown below, choose the correct \( V_0 \) from the options:

\[ V_i \quad V_0 \]

(a)  
(b)  
(c)  
(d) 

\[ V_0 \]

(a)  
(b)  
(c)  
(d)
74. For the circuit and the input sinusoidal waveform shown in the figures below, which is the correct wave forms at the output?

(The time scales in all the plots are the same)

75. In the circuit given below, the thermistor has a resistance 3kΩ °C upon heating. The output voltage of the circuit at 30° C is

**ANSWER KEY**

<table>
<thead>
<tr>
<th></th>
<th>1.(a)</th>
<th>2.(c)</th>
<th>3.(a)</th>
<th>4.(b)</th>
<th>5.(c)</th>
<th>6.(a)</th>
<th>7.(b)</th>
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