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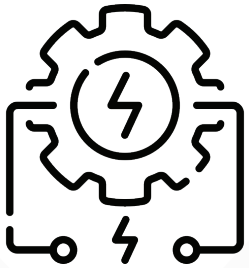
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ANALOG AND DIGITAL ELECTRONICS

SECTION 1

SYLLABUS

Operational amplifiers – characteristics and applications, combinational and sequential logic circuits, multiplexers, multi-vibrators, sample and hold circuits, A/D and D/A converters, basics of filter circuits and applications, simple active filters;Microprocessor basics- interfaces and applications, basics of linear integrated circuits; Analog communication basics, Modulation and de-modulation, noise and bandwidth, transmitters and receivers, signal to noise ratio, digital communication basics, sampling, quantizing, coding, frequency and time domain multiplexing, power line carrier communication systems.



NUMBER OF QUESTIONS ASKED IN ESE ELECTRICAL ENGINEERING VOLUME-II (2001 TO 2025)

Analog and Digital Electronics		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1.1	Operational Amplifiers	5	3	3	3	-	-	1	1	-	1	3	2	4	1	2	4	-	1	4	7	1	5	2	1	10
1.2	Digital Electronics																									
1.2.1	Number System	-	2	2	1	1	-	-	-	-	-	-	1	-	-	-	-	2	-	-	1	-	-	-	-	-
1.2.2	Boolean Algebra	1	-	2	-	2	-	1	3	-	1	1	-	1	1	1	-	1	1	-	1	-	-	-	-	1
1.2.3	Logic Gates	1	3	-	-	-	-	-	2	1	2	1	1	1	1	1	3	-	-	-	-	-	-	-	-	-
1.2.4	Combinational Circuit	-	2	-	-	-	-	1	-	-	1	-	-	1	-	-	-	1	1	1	-	-	-	-	1	-
1.2.5	Sequential Circuits	-	-	4	1	1	1	2	3	1	5	-	4	3	2	5	3	-	-	1	-	-	-	-	1	-
1.2.6	Logic Gates Families	1	-	2	-	-	-	1	1	1	-	-	3	3	1	-	1	-	-	-	-	-	-	-	-	-
1.2.7	AD & DA Conversion	-	1	1	-	-	-	-	-	-	-	-	-	1	-	-	-	1	3	1	-	1	-	1	3	1
1.2.8	Semiconductor Memories	-	-	-	-	-	-	-	-	-	-	-	3	1	2	-	-	-	-	-	-	-	-	-	-	-
1.3	Microprocessors																									
1.3.1	Architecture of 8085	-	-	2	1	-	1	1	3	3	-	4	2	2	2	1	-	-	-	-	-	-	-	-	1	2
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1.3.5	Programming with 8085	1	1	3	3	3	1	5	1	1	2	-	-	3	1	2	-	-	-	-	-	-	-	-	-	-
1.3.6	Microprocessor 8086	1	-	1	-	4	-	-	-	-	-	-	1	1	3	1	5	-	-	-	-	1	-	-	-	-
1.4	Communication System																									
1.4.1	Amplitude Modulation	4	-	5	2	6	2	3	7	-	-	-	3	5	4	-	2	-	1	2	1	3	1	2	1	2
1.4.2	Angle Modulation	1	4	3	2	1	2	2	2	6	6	3	2	2	3	1	6	-	-	-	-	-	-	1	-	2
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CHAPTER-1 ANALOG AND DIGITAL ELECTRONICS

Unit 1.1: Operational Amplifiers

Previous Year Exam Questions

[ESE-2001]

1. Active load is used in the collector of the differential amplifier of op-amp to

(a) Increase the output resistance
(b) Increases the differential gain A_d
(c) Increase maximum peak to peak output voltage
(d) Eliminate load resistance from the circuit

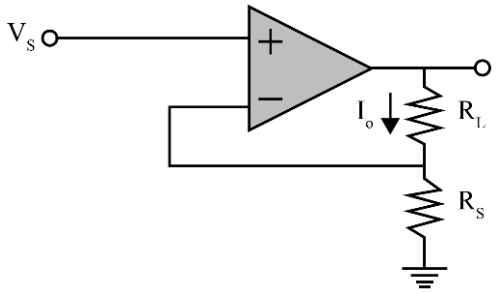
[ESE-2001]

2. The slew rate of an op-amp is 0.5 V/micro sec. The maximum frequency of a sinusoidal input of 2 V rms that can be handled without excessive distortion is

(a) 3 kHz (b) 30 kHz
(c) 200 kHz (d) 2 MHz

[ESE-2001]

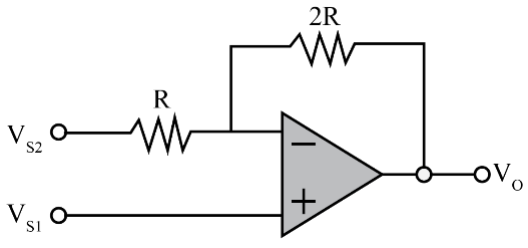
3. An op-amp is used in the circuit as shown in the above figure. Current I_o is



(a) $V_S \times \frac{R_L}{R_S(R_L+R_S)}$ (b) $\frac{V_S}{R_s}$
(c) $\frac{V_S}{R_L}$ (d) $V_S\left(\frac{1}{R_S}+\frac{1}{R_L}\right)$

[ESE-2001]

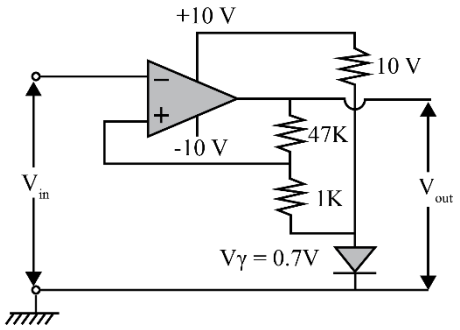
4. A circuit with op-amp is shown in the below figure. The voltage V_0 is



(a) $3V_{s1} - 6V_{s2}$
(b) $2V_{s1} - 3V_{s2}$
(c) $2V_{s1} - 2V_{s2}$
(d) $3V_{s1} - 2V_{s2}$

[ESE-2001]

5.

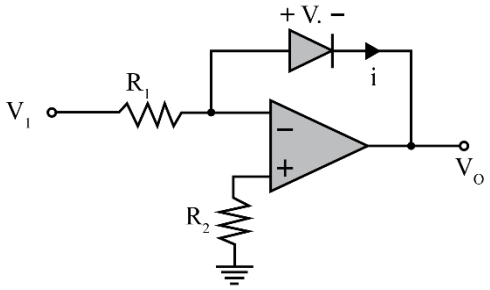


The Schmitt trigger circuit is shown in the above figure. If $V_{sat} = \pm 10$ V, the tripping point for the increasing input voltage will be

(a) 1 V (b) 0.893 V
(c) 0.477 V (d) 0.416 V

[ESE-2002]

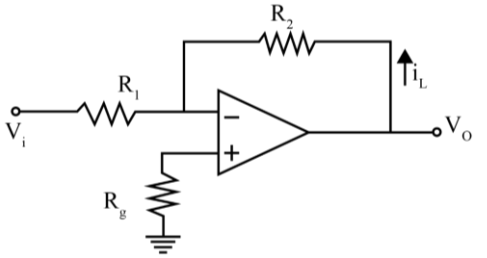
6. In the op-amp circuit shown below, $v_i > 0$ and $i = I_0 \cdot a^{\alpha v}$ The output V_0 will be proportional to



(a) $\sqrt{v_i}$ (b) v_i
(c) e^{kv_i} (d) $\ln(kv_i)$

[ESE-2002]

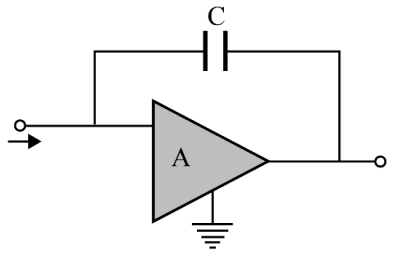
7. In the inverting op-amp circuit shown below, the resistance R_g is chosen as $R_1 \| R_2$ in order to



(a) increase gain
(b) reduce offset voltage
(c) reduce offset current
(d) increase CMRR

[ESE-2002]

8. An amplifier of gain A is bridged by a capacitance C as shown below.



The effective input capacitance is

(a) C/A (b) $C(1-A)$

(c) $C(1+A)$ (d) CA

[ESE-2003]

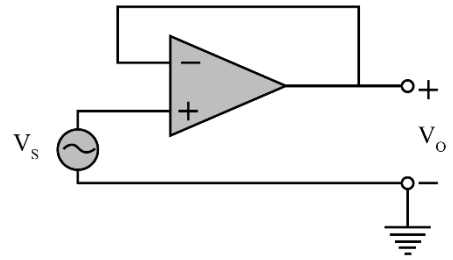
9. An op-amp has a differential gain of 10^3 and a CMRR of 100. The output voltage of the opamp with inputs of $120\ \mu V$ and $80\ \mu V$ will be

(a) 26 mV (b) 41 mV

(c) 100 mV (d) 200 mV

[ESE-2003]

10.



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

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

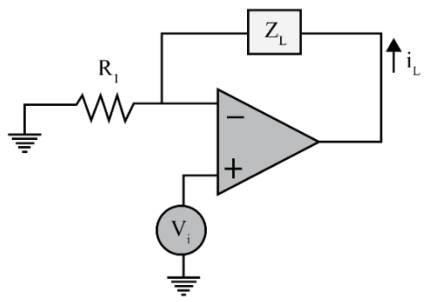
Which of these statements are correct?

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

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

[ESE-2003]

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



(a) $\frac{V_i}{Z_L}$ (b) $\frac{V_i}{Z_L+R_1}$

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

[ESE-2004]

12. Match List I (Circuit) with List II (Application) and select the correct answer using the codes given below the lists:

List I (Circuit)	List II (Application)
A. Monostable multivibrator	1. Comparator
B. Bistable multivibrator	2. D.C. level translator
C. Clamping circuit	3. Delay
D. Schmitt trigger	4. Voltage controlled oscillator
	5. Counter

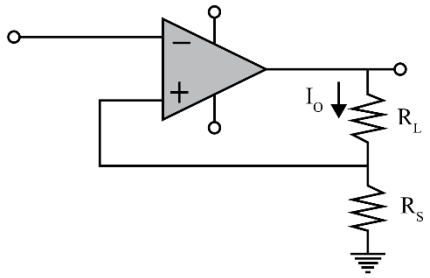
Codes:

	A	B	C	D
(a)	4	3	1	2
(b)	3	5	2	1
(c)	4	5	2	1
(d)	5	4	1	2

[ESE-2004]

13. Consider the following circuit:

Which one of the following is the correct expression for the current I_0 ?



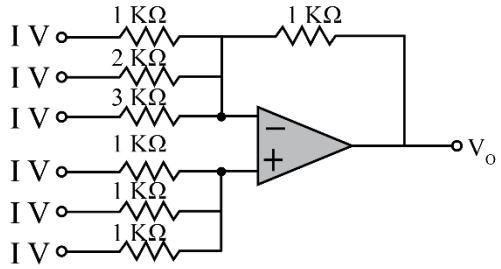
(a) $\frac{V_S \cdot R_L}{R_S(R_L+R_S)}$ (b) $\frac{V_S}{R_S}$

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

[ESE-2004]

14. Consider the following circuit:

What is the output voltage V_0 in the below circuit?

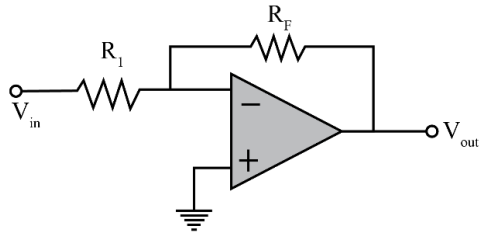


(a) 9.5 V (b) 3 V

(c) 32.2 V (d) 1 V

[ESE-2007]

15.



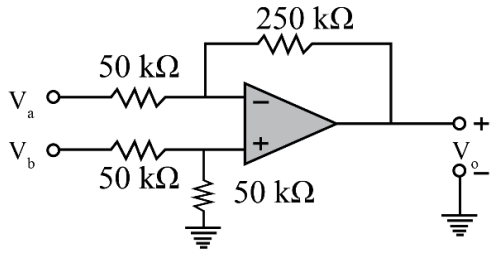
For the operational amplifier circuit shown in the figure above, what is the maximum possible value of R_1, if the voltage gain required is between - 10 and -25 ? (The upper limit on R_F is)

(a) Infinity (b) 1 Mega ohm

(c) 100 k ohm (d) 40 k ohm

[ESE-2008]

16. What is the output voltage V_0 of the given circuit?

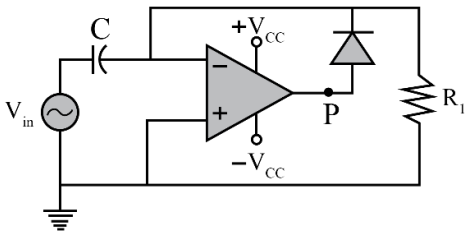


(a) $-5\ V_a + 2.5\ V_b$ (b) $-5\ V_a + 3\ V_b$

(c) $-2.5\ V_a + 2.5\ V_b$ (d) $-2.5\ V_a + 3\ V_b$

[ESE-2010]

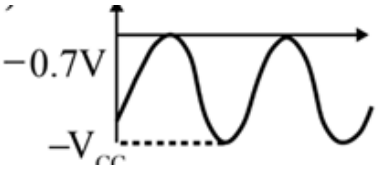
17. For the given sinusoidal input to the circuit as shown below, the voltage waveform at point 'P' of the clamper circuit is



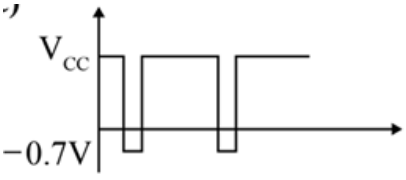
(a)



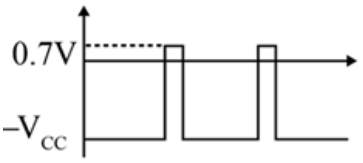
(b)



(c)

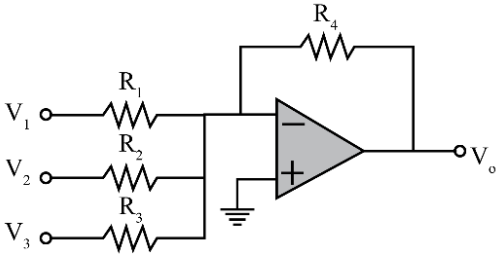


(d)



[ESE-2011]

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



(a) 3 kΩ, 2 kΩ, 7 kΩ and 12 kΩ

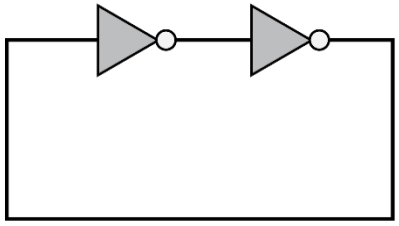
(b) $\frac{1}{4}\Omega, \frac{1}{6}\Omega, \frac{7}{12}$ kΩ and 12kΩ

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

(d) $\frac{1}{3}$ kΩ, $\frac{1}{2}$ 6kΩ, $\frac{1}{7}$ kΩ, 12 kΩ

[ESE-2011]

19. The circuit shown is:



(a) A low pass filter

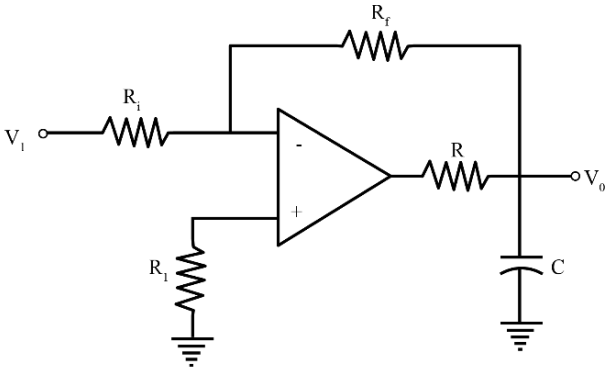
(b) A high pass filter

(c) A comparator

(d) An all-pass filter

[ESE-2011]

20. The Circuits shown is:



(a) A low pass filter

(b) A clamper

(c) A lag compensated inverting amplifier

(d) A narrow band video amplifier

[ESE-2012]

21. A comparator circuit is used to
(a) Mark the instant when an arbitrary wave form 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]

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-2013]

23. A signal $V_m \sin(\omega t + \phi)$ is applied to an amplifier whose gain A is independent of frequency. The amplifier will preserve the form of the input signal (though with a delay) if the phase shift ϕ is
(a) Constant
(b) Inversely proportional to frequency
(c) Proportional to frequency
(d) Proportional to the square the frequency

[ESE-2013]

24. An operational amplifier is connected in voltage follower configuration. Input given to this circuit 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) $15\pi \times 10^{-3}$ V/μsec (d) $\pi \times 10^{-3}$ V/μsec

[ESE-2013]

25. An OPAMP has slew rate of $5V/\mu s$. The largest sine wave output voltage possible at a frequency of 1 MHz is
(a) 10π V (b) 5 V
(c) $\frac{5}{\pi}$ V (d) $\frac{5}{2\pi}$ V

[ESE-2013]

26. In any function where microphone amplifier and speakers are used often one would hear a hamming sound, which increases in volume gradually. This is due to
(a) Positive feedback between micro-phone and speaker
(b) Negative feedback between microphone and speaker
(c) Inadequate frequency response of amplifier
(d) Noise pickup (50Hz) from power supply

[ESE-2014]

27. Active load is primarily used in the collector of the differential amplifier of an OPAMP
(a) To increase the output resistance
(b) To increase the differential gain A
(c) To handle large signals
(d) To provide symmetry

[ESE-2015]

28. Statement (I): An ideal op-amp should have infinite band-width.
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]

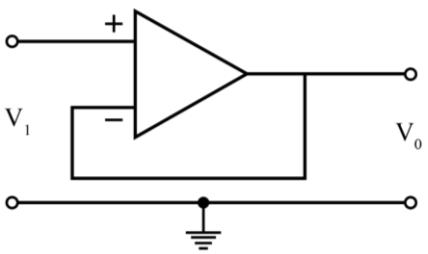
29. In order to generate a square wave from a sinusoidal input signal, one can use
1. Schmitt trigger circuit
2. Clippers and amplifiers
3. Monostable multivibrator
Which of the above statements are correct?
(a) 1, 2 and 3 (b) 1 and 2 only
(c) 1 and 3 only (d) 2 and 3 only

[ESE-2016]

30. In an amplifier with a gain of 1000 without feedback and cut-off frequencies at 2 kHz and 20 kHz. negative feed-back of 1% is employed. The cut-off frequencies with feed back would be
(a) 220 Hz and 22 kHz (b) 182 Hz and 220 kHz
(c) 220 kHz and 220 kHz (d) 182 Hz and 22 kHz

[ESE-2016]

31.



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]

32. An operational amplifier has a slew rate of $\mathbf{V/\mu sec}$. 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]

33. 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-2018]

34. An ideal operational amplifier is connected as shown in figure. What is the output voltage V_2?
(a) $3\ V_1$ (b) $2\ V_1$
(c) $1\ V_1$ (d) $\frac{V_1}{3}$

[ESE-2019]

35. The dB gain of cascaded systems is simply
(a) The square of the dB gains of each stage
(b) The sum of the dB gains of each stage
(c)The multiplication of the dB gains of each stage
(d) The division of the dB gains of each stage

[ESE-2019]

36. The miller effect input capacitance C_{M_1} is
(a) $(1-A_{V^2})C_f$ (b) $(1-A_V)C_f$
(c) $(1-C_f)A_V$ (d) $(1-C_{f^2})A_V$
Where C_f = feedback capacitance $A_{V=\frac{v_0}{v_i}}$

[ESE-2019]

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

[ESE-2019]

38. A negative feedback amplifier where an input current an output voltage is called
(a) Current amplifier
(b) Transconductance amplifier
(c) Transresistance amplifier
(d) Voltage amplifier

[ESE-2020]

39. Which one of the following is not a distortion type that exists either separately or simultaneously in amplifiers?
(a) Linear distortion
(b) Non-linear distortion
(c) Frequency distortion
(d) Delay distortion

[ESE-2020]

40. Transistor noise caused by the recombination and generation of carriers on the surface of the crystal is called
(a) Thermal noise (b) Excess noise
(c) White noise (d) Shot noise

[ESE-2020]

41. During a low frequency response of an amplifier which is invariably of RC-coupled type, there is a range of frequency characteristics over which the amplification is constant and delay is also constant, called
(a) Low band frequency
(b) Mid band frequency
(c) High band frequency
(d) Hyper band frequency

[ESE-2020]

42. In a crystal oscillator, especially when piezoelectric crystal like quartz is applied, then the inductor L, capacitor C and resistor R are the analogs of the mechanical system as
(a) Mass, compliance, viscous-damping factor
(b) Mass, spring constant, viscous-damping
(c) Mass, momentum, viscous-damping
(d) Mass, displacement, viscous-damping

[ESE-2020]

43. In a phase shift oscillator using an FET, at a certain frequency if the phase shift introduced by the RC network in 180°, then the total phase shift from gate around the circuit and back to the gate will be
(a) 0 (b) 90°
(c) 180° (d) 270°

[ESE-2020]

44. Multivibrator circuit that remains in stable state until a triggering signal causes a transition to quasi stable state and returns to stable state after certain time is called
(a) Astable multivibrator
(b) Monostable multivibrator factor
(c) Bistable multivibrator
(d) Unstable multivibrator

[ESE-2020]

45. In a paraphase amplifier, where two amplifiers are connected in castade, the output from second stage
(a) Equals signal input without change of sign
(b) Equals signal input with change of sign

(c) Does not equal to signal input and has no sign change
(d) Does not equal to signal input but has sign change

[ESE-2021]

46. 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-2022]

47. What is the power gain of a transistor amplifier, if its current gain is 40 and voltage gain is 25?
(a) 100 (b) 1200
(c) 1000 (d) 950

[ESE-2022]

48. Which one of the following statements is not correct regarding common-base amplifier?
(a) The output is in the same phase as the input alternating signal.
(b) It cannot operate at higher frequency as compared to CE amplifier.
(c) The current gain is less than unity.
(d) Impedance matching is needed when cascading because there is very large difference in the input and output impedances, the input. impedance is low and the output high.

[ESE-2022]

49. When the quiescent point of an amplifier is biased just at the cut-off axis, so that only the positive half of the signal input is amplified and the negative half of the signal is cut off, it is referred to as
(a) class AB amplification
(b) class A amplification
(c) class B amplification
(d) class C amplification

[ESE-2022]

50. Which one of the following is a disadvantage of CE amplifier?
(a) It provides good current as well as voltage gain
(b) It provides the maximum power gain of the three configurations
(c) It has medium both input and output impedances
(d) Its frequency response bandwidth is lower than the amplifiers of the other two configurations

[ESE-2022]

51. 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 purposes 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-2023]

52. An amplifier has a bandwidth of 500 kHz and voltage gain of 100. What is the amount of negative feedback if the bandwidth is extended to 5 MHz?
(a) 9.0 (b) 0.9
(c) 0.09 (d) 0.009

[ESE-2023]

53. An amplifier has an open loop voltage gain of 1000. If 10% negative voltage series feedback is used, what is the closed loop voltage gain?
(a) $0 \cdot 19$ (b) $1 \cdot 9$
(c) $9 \cdot 9$ (d) $0 \cdot 99$

[ESE-2024]

54. What are the key properties of an op-amp which plays an important role in designing op-amp operated active filters?
(a) High output impedance, low input impedance and the possibility of having signal amplification to the desired level
(b) High input impedance, low output impedance and the possibility of having signal amplification to the desired level
(c) High output impedance, low input impedance and the possibility of having signal amplification to the higher level only
(d) High input impedance, low output impedance and the possibility of having signal amplification to the lower level only

[ESE-2025]

55. The rise time of certain amplifier is $35n_4$. What is the approximate bandwidth of the amplifier?
(a) 10 MHz
(b) 35 MHz
(c) 28.5 MHz
(d) 1 MHz

[ESE-2025]

56. For JFET, $I_{DSS} = 6\ mA, V_P = -4.5\ V$ and $V_{GS} = -2\ V$. The value of I_D will be nearly
(a) 0.9 mA (b) 1.9 mA
(c) 2.7 mA (d) 3.7 mA

[ESE-2025]

57. If the feedback network is purely resistive, then negative feedback is introduced as feedback voltage V_f and output voltage V_o are in phase, and such amplifier is called
(a) summing amplifier
(b) inverting amplifier
(c) non-inverting amplifier
(d) integrator amplifier

[ESE-2025]

58. Which one of the following amplifiers transmits the input to the output terminals and is used as a buffer amplifier?
(a) Common-emitter amplifier
(b) Common-base amplifier
(c) Common-collector amplifier
(d) Common-source amplifier

[ESE-2025]

59. In the low-frequency range, the gain is influenced by the coupling capacitor C_c. The amplifier behaves like an (a) R-C high-pass filter (b) R-C low-pass filter
(c) R-C all-pass filter (d) R-C notch filter

[ESE-2025]

60. An amplifier has an open-loop gain of 1000. This gain varies by ± 100, and feedback is introduced to ensure that the voltage gain varies by not more than $\pm 0.1\%$. The gain with feedback A_F will be
(a) 5 (b) 10
(c) 15 (d) 20

[ESE-2025]

61. In $L-C$ oscillators, radio frequency choke (RFC) is used
(a) to produce high frequency
(b) to provide stability to oscillator
(c) to prevent high-frequency current flowing through the power supply
(d) to provide positive feedback

[ESE-2025]

62. A sinusoidal oscillator is an amplifier with
(a) negative feedback and does not require any input
(b) negative feedback and does not require any active device
(c) positive feedback and does not require any input
(d) positive feedback and does not require any active device

[ESE-2025]

63. The output signal of an op-amp with a slew rate of $2\ V/\mu s$ has a maximum value of 10 V. The maximum frequency for undistorted output voltage will be nearly
(a) 32 kHz (b) 36 kHz
(c) 42 kHz (d) 46 kHz

[ESE-2025]

64. Non-inverting amplifier with feedback exhibits the characteristics of the perfect
(a) current amplifier
(b) voltage amplifier
(c) current-to-voltage converter
(d) voltage-to-current converter

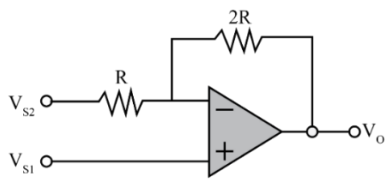
ANSWER KEY									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
(d)	(b)	(b)	(d)	(b)	(d)	(c)	(b)	(b)	(c)
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
(c)	(b)	(b)	(d)	(c)	(b)	(d)	(c)	(d)	(c)
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
(a)	(b)	(c)	(b)	(d)	(a)	(b)	(b)	(c)	(b)
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
(b)	(b)	(c)	(a)	(b)	(b)	(b)	(c)	(a)	(b)
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
(b)	(b)	(a)	(b)	(a)	(a)	(c)	(b)	(c)	(d)
51	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
(b)	(c)	(c)	(b)	(a)	(b)	(c)	(c)	(a)	(b)
61	**62**	**63**	**64**						
(c)	(c)	(a)	(b)						

EXPLANATIONS

1. Explanation: (d)
An active load replaces the passive load resistor in the collector of a differential amplifier

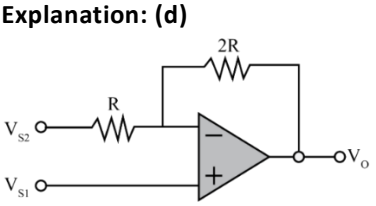
2. Explanation: (b)
$V_i = V_m \sin \omega t$
$\frac{dv_i}{dt} = V_m . \omega . \cos \omega t$
$\left|\frac{dv_i}{dt}\right| = V_m . \omega .$
$\Rightarrow \frac{0.5}{10^{-6}} = V_m . 2\pi f_{max}$
$f_{max} = \frac{0.5}{10^{-6} \times 2\pi \times 2\sqrt{2}}$
$= 30 kHz$

3. Explanation: (b)



From basic rule
$V_+ = V- = V_s$
$: R_i = \alpha (I_f = 0)$
$: I_L = I_0 = \frac{V_s}{R_s}$

4. Explanation: (d)



Using superposition Theorem

$$V_0 = -V_{s2}\left(\frac{2R}{R}\right) + V_{sl}\left(1 + \frac{2R}{R}\right)$$

$$V_0 = 3V_{sl} - 2V_{s2}$$

5. Explanation: (b)

Tripping point at non inverting terminal

$$= \left[\frac{10 - 0.7}{47\text{k} + 1\text{k}}\right](1\text{k}) + 0.7$$

$$= 0.893\ \text{V}$$

6. Explanation: (d)

It is a logarithmic amplifier

: $V_0 = \ln(kv_i)$

7. Explanation: (c)

The Resistance R_g is chosen as $R_1 \| R_2$ increases, input resistance and then reduces offset current

8. Explanation: (b)

It acts as Miller circuit

Input capacitance $C_{in} = C(1 - A)$

Output capacitance $C_0 = \frac{C(A-1)}{A}$

9. Explanation: (b)

Given data

$A_d = 10^3 =$ differential gain

CMRR $= 100$

$V_o = ?$

$V_{i1} = 120\mu\ V;\ V_{i2} = 80\mu\ V$

$V_0 = A_d\ V_d + A_c\ V_c$

$$V_0 = A_d\ V_d\left[1 + \frac{1}{\text{CMRR}} \times \frac{V_C}{V_d}\right]$$

$V_0 = 41\text{mV}$

10. Explanation: (c)

Voltage follower circuit

1. Unity gain
2. Output voltage follows input voltage
3. No phase shift (0° phase shift)
4. High input impedance and low output impedance
5. Impedance matching (buffer)

11. Explanation: (c)

$$\frac{V_i - 0}{R_1} - i_L = 0$$

$$i_L = \frac{V_i}{R_1}$$

12. Explanation: (b)

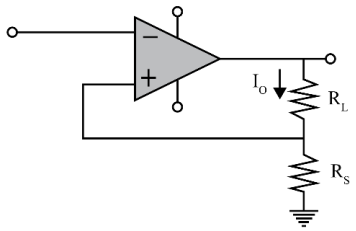
Bistable multivibrator: counter

Mono stable multivibrator: delay

Clamping circuit: dc level translator

Schimitt Trigger: comparator

13. Explanation: (b)



$$V_+ = V_- = V_s$$

$$I_0 = \frac{V_s}{R_s}$$

14. Explanation: (d)

Step (1) Assuming non-inverting input is zero

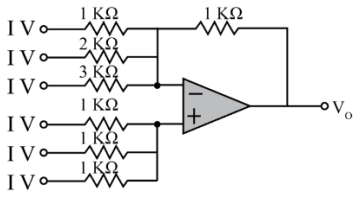
Output voltage due to the inverting input, can be estimated as

$$V_{01} = -1K\left[\frac{1}{3k} + \frac{1}{2k} + \frac{1}{1k}\right]$$

$$= \frac{-11}{6}V \ldots\ldots\ldots (1)$$

Step (2):

Assuming Inverting input is zero. The equivalent circuit.



$$V_1 = \frac{\frac{1V}{1K} + \frac{1V}{1K} + \frac{1V}{1K}}{\frac{1}{1K} + \frac{1}{1K} + \frac{1}{1K}} = 1V$$

Output due to non inverting input is

$$V_{02} = V_1\left[1 + \frac{R_f}{R_i}\right]$$

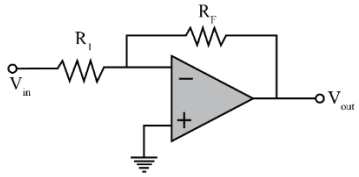
$$= 1\ \text{V}\left[1 + \frac{1\ \text{K}}{6/11\ \text{K}}\right]$$

$$= \frac{17}{6}\ \text{V}$$

Step (3): $V_0 = V_{01} + V_{02}$

$$\frac{17\ \text{V} - 11\ \text{V}}{6} = 1\ \text{V}$$

15. Explanation: (c)



Given data

Voltage Gain between -10 & 25

$R_F = 1\text{M}\Omega$

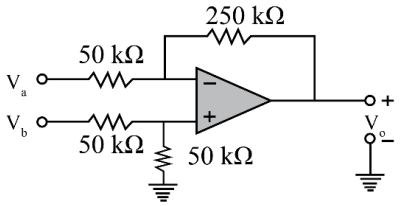
$$A_v = \frac{V_0}{V_{in}} = \frac{-R_f}{R_1} = \frac{-1\text{M}}{100\text{k}} = -10$$

$$|A_v| = \left|\frac{R_f}{R_i}\right| \Rightarrow R_1 = \frac{R_f}{|A_v|}$$

Since $R_1 \propto \frac{1}{A_v}$, for less value A_v, R_1 will be maximum

$$R_{1max} = \frac{1\text{M}\Omega}{10} = 100\text{k}\Omega$$

16. Explanation: (b)



Method (i):

$$V_+ = V_- = \frac{V_b}{2}$$

KCL at inverting Terminal

$$\frac{V_a - V}{50} = \frac{V_- - V_0}{250}$$

$$V_- = \frac{5V_a + V_0}{6}$$

$$\frac{V_b}{2} = \frac{5V_a + V_0}{6}$$

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

Method (ii):

$$V_0 = -\left(\frac{R_f}{R_1}\right)V_i + \left(1 + \frac{R_f}{R_1}\right)V_e$$

Where $V_c = \frac{V_b \times 50}{50 + 50} = \frac{V_b}{2}$

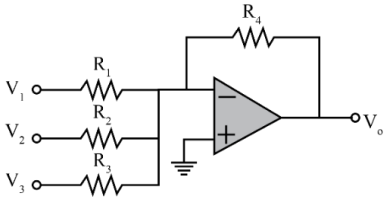
$$\therefore V_0 = \frac{250}{50} \times V_a + \left[1 + \frac{250}{50}\right] \times \frac{V_b}{2}$$

$$\therefore V_0 = 3\ V_b - 5\ V_a$$

17. Explanation: (d)

During positive half cycle of the input, the voltage at point 'P' becomes negative due to inverting amplifier. Therefore diode becomes off and the voltage at point ' P ' is $-V_{CC}$. During negative half cycle of the input. The voltage at point 'P' is positive, the diode will conduct only if voltage at point ' P ' is > 0.7 V. During this time capacitor charges to the polarity as shown. So, for a little duration voltage at point ' P ' is 0.7 V. Once capacitor voltage increases beyond 0.7 V. The voltage across diode becomes negative and diode becomes off & voltage at point ' P ' is $-V_\infty$

18. Explanation: (c)



Apply KCL at inverting terminal

We get

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

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

$\frac{R_4}{R_1} = 3$,

Given $R_4 = 12$ k (in the option)

Then $R_1 = \frac{12}{3} = 4k\Omega$

$$\frac{R_4}{R_2} = 2; \quad R_2 = \frac{12}{2} = 6k\Omega$$

$$\frac{R_4}{R_3} = 7; \quad R_3 = \frac{12}{7}k\Omega$$

19. Explanation: (d)

$$V_+ = \frac{V_1}{SCR + 1}$$

The virtual ground property of operational amplifier indicates that inverting and non-inverting terminals are at the same potential.

$\therefore V_+ = V_-$

$\frac{V_- - V_1}{R} + \frac{V_- - V_0}{R} = 0$

$2V_- - V_1 = V_0 (\therefore V_- = V_+)$

$\frac{V_0}{V_1} = \frac{1-SCR}{1+SCR}$

$\therefore$ It is a all - pass filter

20. Explanation: (c)

$$V_0 = -\left[\frac{R_f}{R_i}\right] \times V_{in}$$

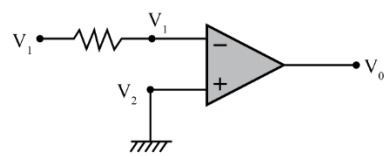
$$I_0 = -\left[\frac{R_f}{R_i}\right] \times V_{in} \times SC$$

$\therefore$ It is a lag compensated inverting amplifier.

21. Explanation: (a)

A comparator circuit is used to mark the instant when an arbitrary wave form attains some reference level

22. Explanation: (b)



Since op-amp does not draw any current the voltage V_2 and voltage V_1 are at same potential

24. Explanation: (b)

$$S.R = 2\pi f_{max} V_{0max}$$

$$= \frac{2\pi \times 10^3}{2} \cdot 3$$

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

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

25. Explanation: (d)

$$SR = 2\pi f_{max} V_{0_{max}} = \frac{5 \text{ V}}{10^{-6} \text{ s}}$$

$$2\pi \times 10^6 \cdot V_{0_{max}} = \frac{5 \text{ V}}{10^{-6} \text{ s}}$$

$$V_{0_{max}} = \frac{5}{2\pi} \text{ V}$$

26. Explanation: (a)

During events where microphones, amplifiers, and loudspeakers are used together, a continuous humming or howling sound may gradually build up. This occurs because of positive feedback, where the microphone repeatedly picks up sound from the speakers and re-amplifies it

27. Explanation: (b)

An active load (using BJT, FET, or MOSFET) behaves like a very high resistance compared to a passive resistor. Since the differential gain of a differential amplifier is directly proportional to the load resistance, using an active load significantly increases the overall differential gain.

28. Explanation: (b)

Ideal OP-amp characteristics:

i) Infinite Bandwidth

ii) Infinite input resistance

iii) Zero output resistance

So both statements are corrected but not related to each other.

29. Explanation: (c)

"A Schmitt Trigger acts as a sine-to-square wave converter. A Monostable Multivibrator, when triggered, produces a single pulse, whereas a continuous square wave is obtained from an Astable Multivibrator.

30. Explanation: (b)

$A = 100, f_L = 2 \text{ kHz}, f_H = 20 \text{ kHz}, \beta = 1\%$

$$A_f = \frac{A}{1+\beta A}$$

$$1 + \beta A = 1 + \frac{1}{100} \times 1000 = 11$$

$$F_{Lf} = \frac{f_L}{1+\beta A} = \frac{2K}{11} = 181.8 \text{ Hz}$$

$$F_{Hf} = f_H(1 + \beta A)$$

$$= 20 \times 10^3 (11)$$

$$= 220 \text{ kHz}$$

31. Explanation: (b)

Voltage follower circuit has

Gain ≈ 1

High input impedance

Low output impedance

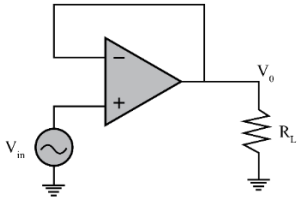
32. Explanation: (b)

$SR = 2 \text{ V}/\mu\text{sec}, V_m = 12 \text{ V}$

$SR = 2\pi f V_m$

$\Rightarrow f = \frac{SR}{2\pi V_m} = 26.52 \text{ kHz}$

33. Explanation: (c) Voltage Follower: The lowest gain that can be obtained from a non-inverting amplifier with feedback is 1. When the non-inverting amplifier gives unity gain, it is called voltage follower because the output voltage is equal to the input voltage and in phase with the input voltage. In other words the output voltage follows the input voltage.



$V_{out} = AV_d = A(V_1 - V_2)$

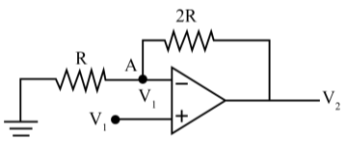
$V_1 = V_{in}$ & $V_2 = V_{out}$

$V_1 = V_2$ if $A \gg$

1(Virtual ground concept)

$\therefore V_{out} = V_{in}$.

34. Explanation: (a)



Applying virtual short circuit concept the potential at point A= V_1

Applying nodal analysis at A

$$\frac{V_1}{R}+\frac{V_1-V_2}{2R}=0$$

$$V_2=3V_1$$

35. Explanation: (b)

36. Explanation: (b)

The Miller effect describes how a feedback capacitance (C_f) appears magnified at the input terminal of an amplifier.

The Miller effect input capacitance (C_{M1}) is given by:

$$C_{M1}=(1-A_V)C_f$$

where A_V is the voltage gain of the amplifier stage.

37. Explanation: (b) Given:

Slew rate $= 2\ V/\mu s$

Input signal variation $= 0.5\ V$

Time for input signal variation $= 10\ \mu s$

Maximum allowable output voltage change

$\Delta V_{o(max)}$ = Slew Rate × Time

$= 2\ V/\mu s \times 10\ \mu s = 20\ V$

Maximum closed-loop voltage gain

The maximum allowable gain A_v without distortion (limited by slew rate) is given by:

$$A_v=\frac{\text{Max. Output Voltage Change}}{\text{Input Voltage Change}}$$

$$=\frac{20\ V}{0.5\ V}=40$$

38. Explanation: (c) A negative feedback amplifier that takes an **input current** and produces an **output voltage** is called a **transresistance amplifier** (also known as a current-to-voltage converter). Its gain is expressed in ohms (volts per ampere).

39. Explanation: (a) Linear distortion is not a separate distortion type in amplifiers, as linear systems do not cause distortion if they stay within their limits. The other options—non-linear, frequency, and delay distortion—are common types of distortion in amplifiers.

40. Explanation: (b)

This noise in transistors is caused by the recombination and generation of carriers on the surface of the crystal, which is specific to the material properties of the semiconductor.

41. Explanation: (b)

In an RC-coupled amplifier, the mid band frequency is the range where amplification and delay remain constant, and the amplifier operates efficiently.

42. Explanation: (b)

In a crystal oscillator, the inductor (L), capacitor (C), and resistor (R) correspond to the mechanical system's mass, spring constant, and viscous damping factor, respectively.

43. Explanation: (a)

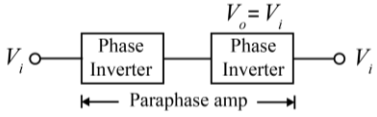
The correct answer is (a) 0∘ because:

1. The RC network provides 180∘ phase shift.
2. The FET amplifier adds another 180∘ shift (total 360∘≡0∘).
3. This 0∘ net shift meets the oscillation requirement (Barkhausen criterion).

44. Explanation: (b)

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

45. Explanation: (a)



46. Explanation: (a)

In an active filter using op-amps, the high-frequency response is limited by the op-amp's gain-bandwidth product and slew rate. These factors determine the maximum frequency at which the filter can operate effectively.

47. Explanation: (c)

$A_V = 25$

$A_I = 40$

$P_{gain} = A_V.A_I = 40 \times 25 = 1000$

48. Explanation: (b)

This statement b is **incorrect**. In fact, a common-base (CB) amplifier can operate at **higher frequencies** compared to a common-emitter (CE) amplifier. The CB amplifier has a low input impedance, reduced Miller effect, and better high-frequency response, making it suitable for high-frequency applications.

All other given statements (a, c, d) about the CB amplifier are correct.

49. Explanation: (c)

In class B amplification, the quiescent point (bias point) is set at the cut-off point of the transistor. This means that only the positive half of the input signal is amplified, while the negative half is cut off. This results in high efficiency but introduces distortion, as only half of the input signal is amplified.

50. Explanation: (d)

The Common-Emitter (CE) amplifier provides high voltage, current, and power gain but has reduced bandwidth due to the Miller effect, limiting high-frequency response. Thus, it has lower bandwidth compared to CB and CC amplifiers.

51. Explanation: (b)

An R-C phase-shift oscillator uses an operational amplifier in the inverting configuration along with a network of resistors and capacitors (R-C components). The R-C network provides a total phase shift of 180°, and the op-amp inverting amplifier adds another 180°, achieving a total of 360°, required for sustained oscillations.

52. Explanation: (c)

GBW = Gain × Bandwidth

Given:

Initial bandwidth (BW_1) = 500 kHz

Initial voltage gain (A_1) = 100

New bandwidth (BW_2) = 5 MHz = 5000 kHz

First, calculate the initial gain-bandwidth product:

$GBW = A_1 \times BW_1$

$= 100 \times 500 \text{ kHz} = 50{,}000 \text{ kHz}$

With negative feedback, the new gain (A_2) can be found using the new bandwidth:

$$A_2 = \frac{GBW}{BW_2} = \frac{50{,}000 \text{ kHz}}{5000 \text{ kHz}} = 10$$

The amount of negative feedback (β) is related to the change in gain. The feedback factor is given by:

$$A_2 = \frac{A_1}{1 + A_1\beta}$$

Rearranging to solve for β:

$$10 = \frac{100}{1 + 100\beta}$$

$$1 + 100\beta = 10$$

$$100\beta = 9$$

$$\beta = \frac{9}{100} = 0.09$$

53. Explanation: (c) To determine the closed-loop voltage gain of an amplifier with negative feedback, we use the following formula:

$$A_{closed} = \frac{A_{open}}{1 + A_{open}\beta}$$

where:

A_{open} is the open-loop voltage gain.

β is the feedback factor (fraction of the output voltage fed back to the input).

Given:

Open-loop voltage gain (A_{open}) = 1000

Negative feedback (β) = 10% = 0.10

Plugging in the values:

$$A_{closed} = \frac{1000}{1 + 1000 \times 0.10}$$

$$A_{closed} = \frac{1000}{1 + 100}$$

$$A_{closed} = \frac{1000}{101}$$

$$A_{closed} \approx 9.9$$

54. Explanation: (b) The key properties of an operational amplifier (op-amp) that are crucial for designing op-amp-operated active filters include:

1. **High Input Impedance:** This ensures that the op-amp draws minimal current from the input signal, which is important for maintaining signal integrity.
2. **Low Output Impedance:** This allows the op-amp to drive loads without significant signal loss, ensuring that the output signal is strong and stable.
3. **High Gain:** Op-amps typically have very high open-loop gain, which is essential for achieving the desired filter characteristics and ensuring accurate signal processing.
4. **Bandwidth:** The frequency range over which the op-amp can operate effectively is important for determining the filter's performance, especially in high-frequency applications.

55. Explanation: (a)

$$t_r = \frac{0.35}{\text{Band Width}}$$

$$\text{Band Width} = \frac{0.35}{t_r} = \frac{0.35}{35\text{ns}}$$

$$= 10 \text{ MHz}$$

56. Explanation: (b)

$$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$$

$$= 6 \text{ mA}\left(1 - \frac{(-2)}{-4.5}\right) = 1.9 \text{ mA}$$

57. Explanation: (c)

Non-inverting amplifier

58. Explanation: (c)

Common-Collector Amplifier (Emitter Follower):

Function: Acts as a buffer due to its:

High input impedance (minimal loading of the input source).

Low output impedance (can drive heavy loads).

Gain: Voltage gain≈1 (output follows input, hence "follower").

Phase: Output is in-phase with input.

59. Explanation: (a)

Coupling Capacitor (C_c):

At low frequencies, C_c introduces reactance ($X_c = \frac{1}{2\pi f C_c}$), which blocks DC and attenuates low-frequency signals.The amplifier's gain rolls off at low frequencies due to this high-pass effect.

Behavior:-The input coupling network (resistor + capacitor) forms an R-C high-pass filter, allowing higher frequencies to pass while attenuating lower frequencies.

Cutoff frequency (f_c):$f_c = \frac{1}{2\pi RC_c}$.

60. Explanation: (b) A = 1000

∂A = 10% of A

$\partial A_F = 0.1\%$ of A_F

$$\frac{\left(\frac{\partial A}{A}\right)}{\frac{\partial A_F}{A_F}} = \frac{10}{0.1} = 100$$

$$A_F = \frac{A}{1 + A\beta} = \frac{1000}{100} = 10$$

61. Explanation: (c)

In L-C oscillators, the radio frequency choke (RFC) is used to block the flow of high-frequency signals from the oscillator into the power supply. This helps to isolate the oscillator from the power supply and prevents interference with the oscillator's operation.

62. Explanation: (c) Positive feedback and does not require any input

63. Explanation: (a)

$V_o = A_F V_m \sin \omega t$

$S.R. = \frac{dv_o}{dt} = A_F V_m \cos \omega t \omega_n$

SRI $I_{max} = A_F V_m \omega_{max}$

$$f_{max} = \frac{SR}{2\pi A_F V_m} = \frac{SR}{2\pi V_{o,max}}$$

$$= \frac{2 \text{ V}}{10^{-6} \times 2 \times 3.14 \times 10}$$

$$= 32\text{kHz}$$

64. Explanation: (b) A non-inverting amplifier with feedback amplifies the input voltage without inverting it. It maintains the input signal's polarity while providing a high gain for voltage, making it characteristic of a **voltage amplifier**.

Unit 1.2 Digital Electronics

1.2.1 Number System

Previous Year Exam Questions

[ESE-2002]

1. The decimal equivalent of hexadecimal number 2 A 0 F is

(a) 17670 (b) 17607
(c) 17067 (d) 10767

[ESE-2002]

2. The binary equivalent of hexadecimal number 4 F 2 D is

(a) 0101 1111 0010 1100
(b) 0100 1111 0010 1100
(c) 0100 1110 0010 1101
(d) 0100 1111 0010 1101

[ESE-2003]

3. Which one of the following statement is not correct? Conversion of EXCESS-3 code to BCD can be achieved by using

(a) Discrete gates
(b) 4 : 16 de-multiplexer.
(c) A 4-bit full adder
(d) A 4-bit half adder

[ESE-2003]

4. The binary representation 100110 is numerically equivalent to the

(1) Decimal representation 46
(2) Octal representation 46
(3) Hexadecimal representation 26
(4) Excess-3 representation 13

Select the correct answer using the codes given below:

Codes:

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

[ESE-2004]

5. What are the values respectively, of $\mathbf{R_1}$ and $\mathbf{R_2}$ in the expression $(235)_{R_1} = (565)_{10} = (1065)_{R_2}$?

a) 8,16 (b) 16,8
(c) 6,16 (d) 12,8

[ESE-2005]

6. Which of the following notations have two representations of zero?

(1) 1 's complement with radix of number being 2
(2) 7 's complement with radix of number being 8
(3) 9 's complement with radix of number being 10
(4) 10 's complement with radix of number being 10

Select the correct answer using the code given below.

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

[ESE-2012]

7. Statement (I): 2's complement arithmetic is preferred in digital computers.

Statement (II): The hardware required to obtain the 2's complement of a number, is simple

(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-2017]

8. What is the octal equivalent of $(5621 \cdot 125)_{10}$?

(a) $11774 \cdot 010$ (b) $12765 \cdot 100$
(c) $16572 \cdot 100$ (d) $17652 \cdot 010$

[ESE-2017]

9. What is the hexadecimal representation of $(657)_8$?

(a) 1 AF (b) D 78
(c) D 71 (d) 32 F

[ESE-2020]

10. The hexadecimal of the binary number $(11010011)_2$ is

(a) $D3_{16}$ (b) $D4_{16}$
(c) $C3_{16}$ (d) $C4_{16}$

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
(d)	(d)	(b)	(b)	(b)	(d)	(c)	(b)	(a)	(a)

EXPLANATIONS

1. Explanation: (d)

Given 2 A 0 $F_{16} = x_{10}$
$= 2 \times 16^3 + 10 \times 16^2 + 0 \times 16^1 + 15 \times 16^0$
$= 8192 + 2560 + 0 + 15$
$= (10767)_{10}$

2. Explanation: (d)

4 F $2D_{16} = x_2$
$= 0100\ 1111\ 0010\ 1101_2$

3. Explanation: (b)

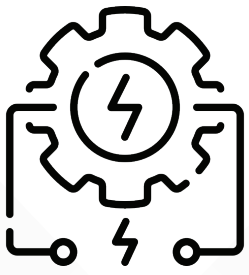
We can't construct Excess-3 code to BCD code converter using 4 : 16 de-multiplexer.

POWER SYSTEMS

SECTION 5

SYLLABUS

Basic power generation concepts, steam, gas and water turbines, transmission line models and performance, cable performance,insulation, corona and radio interference, power factor correction, symmetrical components, fault analysis, principles of protection systems, basics of solid state relays & digital protection; Circuit breakers, Radial &ring-main distribution systems, Matrix representation of power systems, load flow analysis, voltage control and economic operation, System stability concepts, Swing curves and equal area criterion. HVDC transmission and FACTS concepts, Concepts of power system dynamics, distributed generation, solar and wind power, smart grid concepts, environmental implications, fundamentals of power economics.



NUMBER OF QUESTIONS ASKED IN ESE ELECTRICAL ENGINEERING VOLUME-II (2001 TO 2025)

Power Systems		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
5.1	Power Generation	2	-	3	3	4	4	7	1	6	4	6	4	2	4	2	1	1	-	2	3	3	1	1	2	3
5.2	Performance of Transmission Line Parameters & Cable and Insulators	7	13	3	5	4	5	3	3	2	3	-	-	-	-	-	4	5	9	3	3	5	4	5	6	4
5.3	Fundamentals of Power Economics	3	-	1	-	-	2	2	2	1	-	1	-	2	1	2	2	2	-	-	-	-	-	-	-	1
5.4	Load Frequency Control	1	1	2	1	-	-	1	-	-	1	3	-	-	-	1	-	-	-	-	-	-	-	-	-	-
5.5	Load Flow Studies	1	2	2	4	3	4	-	-	-	1	-	1	-	-	-	-	-	1	-	-	-	-	2	1	2
5.6	Fault Analysis	6	6	4	4	3	1	2	2	-	4	2	3	1	-	1	3	-	3	2	1	3	2	1	-	1
5.7	Power System Stability	2	3	-	-	-	3	2	1	1	2	2	1	3	4	-	7	1	2	1	-	-	1	1	1	-
5.8	Circuit Breakers & Protection	3	2	-	1	2	4	2	3	3	3	1	1	1	2	1	2	-	2	-	-	-	3	2	2	1
5.9	FACT & HVDC	1	-	2	1	-	2	1	1	1	4	1	1	2	1	2	1	1	1	2	1	1	-	1	1	-

CHAPTER-5 POWER SYSTEMS

Unit: 5.1 Power Generation

Previous Year Exam Questions

[ESE-2001]

1. In pumped storage hydro power plant, the electrical machine is made to work alternately as genera and motor. The efficiency of the generator work at the same electrical power level is

(a) greater than that as motor
(b) equal to that as motor
(c) less then that as motor
(d) greater or less than that as motor depending on the type of the machine

[ESE-2001]

2. In a thermal nuclear reactor

1. The purpose of moderator is to slow down fast neutrons produced due to fission
2. The moderator material must have molecular weight
3. Ordinary water can be used as moderator with π = natural uranium as fuel
4. The multiplication factor is kept slightly great than unity during its normal functioning Of these statements

(a) 1 and 3 are correct (b) 3 and 4 are
(c) 1,2 and 3 are correct (d) 1,2 and 4 are

[ESE-2003]

3. When a 'pumped storage' power plant is open in conjunction with a steam power plant

(a) The operating cost of the steam plant be optimum
(b) Load factor of the steam plant is increase
(c) Chances of the tripping of the system der because of the use of two heterogeneous of plants
(d) Operation of the storage plant in the pumping mode during the low-load period improves the steam-plant stability.

[ESE-2003]

4. Assertion (A): Hydroelectric plants with large storage can be best used as base load plants having high load factor.
Reason (R): For a plant to be used as base plant, the unit cost of energy generated by the plant should be low.

(a) Both A and R are individually true and R is the correct Explanation: of A
(b) Both A and R are individually 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-2003/2012]

5. Match List-I (Components) with List-II (Materials) and select the correct answer using the codes given below the lists:

List I (components)	List-II (Materials)
A. Moderator	1. Boron
B. Control Rod	2. Concrete
c. Coolant	3. Graphite
D. Shield	4. Sodium

Codes:

	A	B	C	D
(a)	3	1	4	2
(b)	1	3	2	4
(c)	3	1	2	4
(d)	1	3	4	2

[ESE-2004]

6. Consider the following statements regarding pumped storage plants:

1. A pumped storage plant is a base load plant
2. The starting time of a pumped storage plant is very short
3. Reversible turbines and pumps are highly suitable for pumped storage plants

Which of the statements given above are correct?

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

[ESE-2004/2005]

7. Match List-I (Name of Power Plant) with List-II (Plant Features) and select the correct answer using the codes given below

List-I	List-II
A. Thermal	1. High operating cost
B. Nuclear	2. High capital cost
C. Hydro	3. High plant life
D. Diesel	4. High fuel transportation cost

Codes:

	A	B	C	D
(a)	3	1	4	2
(b)	4	2	3	1

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

[ESE-2004/2005]

8. Match List-I (classification based on Head) with List-II (Type of Turbine) and select the correct answer using the codes given below:

List-I	List-II
A. Low head $2-15$ m	1. Pelton
B. Medium head $16-70$ m	2. Francis or Pelton
C. High head $71-500$ m	3. Kaplan or Francis
D. Very high head >500 m	4. Propeller or Kaplan

Codes:

	A	B	C	D
(a)	4	3	2	1
(b)	3	4	1	2
(c)	4	3	1	2
(d)	3	4	2	1

[ESE-2005]

9. On which one of the following cycles does a modern steam power plant work?
(a) Carnot cycle (b) Rankine cycle
(c) Otto cycle (d) Bell-Coleman cycle

[ESE-2005]

10. Assertion (A): A pumped storage plant is very suitable for supplying peak loads. During off peak period, water is pumped back from tail race pond to head water pond.
Reason (R): The starting time of pumped storage plant is very short.
(a) Both A and R are individually true and R is the correct Explanation: of A
(b) Both A and R are individually 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-2006]

11. Which one of the following is employed as a moderator by CANDU type of slow thermal nuclear reactors?
(a) Water (b) Heavy water
(c) Graphite (d) Beryllium

[ESE-2006]

12. Match List-I (Power Station) with List-II (Component) and select the correct answer using the code given below the lists:

List - I	List - II
A. Hydroelectric power station	1. Grate and stokers
B. Nuclear power station	2. Forebay
C. Steam power station	3. Pressurized water reactor
D. Pressure gasification combined cycle power plant	4. Fluidized bed gasifier

Codes:

	A	B	C	D
(a)	1	4	2	3
(b)	2	3	1	4
(c)	1	3	2	4
(d)	2	4	1	3

[ESE-2006]

13. In hydro power stations, what is an enlarged body of water just above the intake and used as a regulating reservoir, called?
(a) Spillways (b) Forebay
(c) Reservoir (d) Penstock

[ESE-2006]

14. For variable heads of near about but less than 30 meters, which type of turbines is used in hydro power stations?
(a) Pelton (b) Kaplan
(c) Francis (d) None of these

[ESE-2007]

15. What is the total power installed capacity (approximate) in India?
(a) 1,25,000MW (b) 1,75,000MW
(c) 2,00,000MW (d) 50,000MW

[ESE-2007]

16. What is the approximate efficiency of a norm thermal power station?
(a) $30-40\%$ (b) $45-55\%$
(c) $20-25\%$ (d) $60-70\%$

[ESE-2007]

17. In coal-fired thermal power-stations, what are the electrostatic precipitators used for?
(a) To remove dust particles settling on bus conductors in the station switch yard
(b) To condense steam by electrostatic means
(c) To keep the air heaters clean
(d) To collect the dust particles from the flue

[ESE-2007]

18. Which one of the following fuels is used by the thermal nuclear reactors for power generation?
(a) U^{235} (b) U^{238}
(c) Th^{232} (d) Pu^{239}

[ESE-2007]

19. Which of the following statements is/are correct In pumped storage power plants,

(a) water is recalculated through water turbines

(b) reversible turbines are used which operate the turbines for power generation during peak hours and as pumps for pumping water dumping peak-off hours

(c) plain Francis turbines are used

(d) both (a) and (c) above are employed

[ESE-2007]

20. Maximum efficiency of modern coal-fired stream raising thermal power plants is restricted to about 0.35 (a low value), mainly because of

(a) low alternator efficiency

(b) high energy loss in boilers

(c) low steam turbine mechanical efficiency

(d) high energy loss from turbine exhans condenser

[ESE-2008]

21. Taking the density of water to be $0\ \mathrm{kg/m^3}$, how much power would be developed by a hydroelectric generator unit, assuming 100% efficiency, with 1.0 m head and $1.0\ \mathrm{m^3/s}$ discharge?

(a) 2.90 Kw (b) 4.45 kW

(c) 9.80 kW (d) 19.60 kW

[ESE-2007]

22. Consider the following statements regarding the nuclear power plants:

1. A thermal reactors needs a moderator material
2. In a nuclear reactor, multiplication factor is kept almost equal to one
3. Nuclear power plants are used as peak load plants only

Which of the statements given above are correct?

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

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

[ESE-2009]

23. Where is the draft tube of a hydropower station that is an airtight pipe located?

(a) Near the surge tank

(b) In between the penstock and the runner

(c) In between the runner exhaust and the tailrace

(d) At the beginning of penstock

[ESE-2009]

24. Consider the following statements concerning steam power plants:

1. Maintenance and operating costs are low
2. Water is required in huge quantity
3. Requires long time for installation
4. Handling of coal and disposal of ash can be done easily.

Which of the above statements is/are correct?

(a) 1 only (b) 2 and 3

(c) 3 only (d) 3 and 4

[ESE-2009]

25. What is the nominal pH value of water that is to be maintained in a steam raising thermal power station?

(a) 0.0 (b) 7.0

(c) 8.5 (d) 14.3

[ESE-2009]

26. Complete combustion of pulverized coal in a steam raising thermal power plant is ensured by what type of an analysis of flue gas going out by the chimney?

(a) O_2 content for given air intake

(b) CO_2 content for given fuel rate feed

(c) CO content

(d) All of these

[ESE-2009]

27. Consider the following statements regarding the pumped storage plants:

1. A pumped storage plant is a peak load plant.
2. The starting time of a pumped storage plant is very long.
3. Reversible turbines and pumps are very suitable for pumped storage plants.
4. Pumped storage plants can be used for load frequency control.

Which of the above statements is/are correct?

(a) 1 only (b) 1 and 2 only

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

[ESE-2009]

28. In what form the initial energy will be released for the 200 MeV per fission by a neutron in a slow thermal nuclear reactor?

(a) Heat energy

(b) Electromagnetic radiation

(c) Kinetic energy of particles and Electromagnetic radiation

(d) Kinetic and sound energy

[ESE-2010]

29. For a 3-element feed water control in a coal fired thermal power station, measurements of level of water in the boiler drums is made so that the water level does not

(a) Exceed a specified upper limit

(b) Fall below a specified lower limit

(c) Violate specified upper and lower limits

(d) Restrict to a specified limit

[ESE-2010]

30. Consider the following statements: Pumped storage plants when operated in interconnected power systems serve to

1. Increase load factor of steam plant
2. Provide added capacity to meet peak loads.
3. Decrease load factor of steam plant.
4. Provide added capacity to meet base loads.

Which of the above statements are correct?

(a) 1,2,3 and 4 (b) 1 and 3 only
(c) 1 and 2 only (d) 3 and 4 only

[ESE-2010]

31. Consider the following statements:

1. Nuclear fission occurs whenever Uranium reacts with a neutron.
2. Nuclear fission is accompanied by the release of neutrons and gamma rays.
3. About 200 MeV of energy is released in the fission of a U^{235} nucleus.
4. Energy from the fission of U^{235} nucleus is released mainly as kinetic energy of the neutrons and the energy of gamma radiations.

Which of the above statements are correct?

(a) 1, 2, 3 and 4 (b) 3 and 4 only
(c) 2,3 and 4 only (d) 1,2 and 4 only

[ESE-2010]

32. Which of the following power stations is mainly used to cover peak load on the system?

(a) Coal based thermal power plant
(b) Nuclear power plant
(c) Gas based thermal power plant
(d) Pumped storage hydro power plant

[ESE-2011]

33. For harnessing low variable water heads, the suitable hydraulic turbine with reaction and adjustable vanes runners is:

(a) Francis (b) Impeller
(c) Kaplan (d) Pelton

[ESE-2011]

34. One million cubic meters of water is stored in a reservoir feeding a water turbine. The density of water is kg/m^3. If the centre of mass of water is 50 meters above the turbine and the losses are negligible, the energy produced by that volume of water is:

(a) 135.3 MWhr (b) 130 MWhr
(c) 120 MWhr (d) 140 MWhr

[ESE-2011]

35. With reference to hydropower station, the graphical representation of the discharge as a function of time is known as:

(a) Monograph (b) Hectograph
(c) Load duration curve (d) Hydrograph

[ESE-2011]

36. In a thermal power station, a typical heat balance sheet, for a large turbine and surface condenser taken together, is the percentage distribution of heat energy in:

1. Work done or thermal efficiency
2. Friction and windage loss
3. Heat to circulating water
4. Heat in condensate to be retained to the boiler

The percentage amount of heat in the heads above, in the descending order is:

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

[ESE-2011]

37. The radiation shield for a nuclear power for biological safety is provided by having the reactor:

(a) Immersed in water pool
(b) Encased by thick metal walls
(c) Encased by thick concrete wall
(d) Isolated from outside world with strong magnetic fields

[ESE-2011]

38. A 'Pumped storage hydro-electric plant' constant of:

(a) A synchronous machine and a multistag centrifugal pump in one shaft
(b) A synchronous machine, a reaction turbine, and a multistage centrifugal pump all in one shaft.
(c) An induction generator, a synchronous machine and a reaction turbine, all in one shaft.
(d) An induction generator, a synchronous machine,and a multistage centrifugal pump, all in one shaft.

[ESE-2012]

39. A Pelton wheel turbine having a rated speed of 300 rpm is connected to an alternator to produce power at 50 Hz . The number of poles required in the alternator is

(a) 4 (b) 8
(c) 10 (d) 20

[ESE-2012]

40. In an interconnected power system, the most suitable power plant to meet the peak load conditions is

(a) Hydel
(b) Nuclear
(c) Steam
(d) Pumped storage

[ESE-2012]

41. The utilizable water from a catchment is 60×10^6cum annually and the hydro-station has head of 40 m. Assuming ideal generator and turbine, the power that can be theoretically generated is

(a) 250 kW (b) 300 kW
(c) 500 kW (d) 750 kW

[ESE-2013]

42. The advantage of hydro-electric power station over thermal power station is

(a) The initial cost of hydro-electric power station is low
(b) The operating cost of hydro-electric power station is low
(c) Hydro-electric power station can supply the power throughout the year
(d) Hydro-electric power station can be constructed at the place where the energy is required

[ESE-2013]

43. A microprocessor based safety control system installed in a nuclear power plant must be stress tested under which of the following conditions?

1. Ageing due to radiation
2. Thermal stresses
3. Seismic vibration
4. Inadequate nuclear reactor coolant

(a) 1 and 2 only (b) 2 and 4 only
(c) 1,2 and 3 only (d) 1,2,3 and 4

[ESE-2014]

44. The thermal and electrical efficiencies of a 100 MW steam station are respectively 30% and 92%. The coal used has a calorific value of 6400kcal/kg. For the supply of full load rated capacity the coal consumption in kg/ hour would be approximately

(a) 24340 (b) 32450
(c) 48690 (d) 64910

[ESE-2014]

45. Compared to turbines in conventional coal-fired thermal stations, nuclear power plant turbines use steam at

(a) Lower pressure and temperature
(b) Higher pressure and temperature
(c) Lower pressure and higher temperature
(d) Higher pressure and lower temperature

[ESE-2014]

46. The term 'Surge Tank' is associated with which type of power plant?

(a) High head hydro (b) Low head hydro
(c) Medium head hydro (d) Thermal

[ESE-2014]

47. Statement (I): In high head hydel stations, the action of governor due to sudden change in load, changes the water admitted to turbine blades leading to water hammering effect on pen-stocks

Statement (II): A surge tank in high head hydel stations is used to absorb the flow variations

(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]

48. Compared to turbines in the conventional coalfired thermal stations, nuclear power plant turbines use steam at

(a) higher pressure and higher temperature
(b) lower pressure and lower temperature
(c) higher pressure and lower temperature
(d) lower pressure and higher temperature

[ESE-2015]

49. The power output from a hydro-electric power plant depends on

(a) head, type of dam and discharge
(b) head, discharge and efficiency of the system
(c) type of draft tube, type of turbine and efficiency of the system
(d) type of dam, discharge and type of catchment area

[ESE-2016]

50. Air pollution due to smoke around a thermal power station can be reduced by installing

(a) Induced draft fan
(b) Super heater
(c) Economizer
(d) Electrostatic precipitator

[ESE-2017]

51. Statement (I): The power available from wind is directly proportional to V^3, where V is the velocity.

Statement (II): Drag type wind turbines have lower speeds and high torque capabilities.

(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 - 2019]

52. Statement (I): Reaction turbines are generally used for sites with high head and low flow.
Statement (II): Kaplan and Francis turbines are reaction turbines
(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 - 2019]

53. Consider the following statements for a large national interconnected grid:
1. Better load frequency control
2. Same total installed capacity can meet lower demands
3. Better hydro / thermal nuclear / renewable co-ordination and energy conservation.
Which of the above statements are correct?
(a) 1 and 3 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and

[ESE - 2020]

54. Which of the following are the main parts of a power system?
1. Generating stations
2. Transmission systems
3. Distribution networks
(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

[ESE - 2020]

55. In a power system, due to interconnection or grid formation and transmission line redundancy, the ability to serve all power demands without failure over long periods of time, is due to
(a)Power system quality
(b) Power system reliability
(c) Computers and microprocessors
(d) Reserve generating capacity

[ESE - 2020]

56. In wind power, the speed which is considered as the single most important parameter is
(a) Wind speed
(b) Peripheral speed
(c) Tip speed
(d) Blade speed

[ESE - 2021]

57. The fill factor of a photovoltaic module is $0-8$ A single cell in a module has an open circuit voltage of 0.6 V and short circuit current of 8 A . The module has 48 cells connected in series. If the voltage at maximum power is 0.9 times open circuit voltage, the current at maximum power is
(a) 8.21 A (b) $7 \cdot 11$ A
(c) 6.32 A (d) $5 \cdot 45$ A

[ESE - 2021]

58. The equivalent circuit of a photovoltaic module is presented below : The requirements for more power production are
(a) I_L should be maximum, R_g should be large, R_{sh} should be small
(b) I_L should be minimum, R_s should be small, R_{sh} should be large
(c) I_L should be maximum, R_s should be small, R_{eh} should be large
(d) I_L should be minimum, R_s should be large, R_{sh} should be small

[ESE - 2021]

59. Which one of the following power plants is the least reliable?
(a) Tidal (b) Solar
(c) Wind (d) Geothermal

[ESE - 2022]

60. Which one of the following is not an example of renewable energy?
(a) Solar (b) Wind
(c) Geothermal (d) Nuclear

[ESE - 2023]

61. Which type of hydro turbine is totally embedded in the fluid and powered from the pressure drop across the device?
(a) Impulse turbine only
(b) Reaction turbine only
(c) Squirrel cage turbine only
(d) Both impulse turbine and reaction turbine

[ESE - 2024]

62. A large hydropower station has a head of 324 m and an average flow of $1370\ m^3/s$. The reservoir of water behind the dams and dikes is composed of series of lakes covering an area of $6400\ km^2$. What is the available hydraulic power?
(a) 4350 Kw (b) 4350 MW
(c) 435 MW (d) 435 kW

[ESE - 2024]

63. Which one of the following statements is correct regarding super heaters in steam power plants?

(a) In modern utility high-pressure boilers, more than 40% of the total heat absorbed in the generation. of steam takes place in the super heaters.
(b) In modern utility high-pressure boilers, less than 40% of the total heat absorbed in the generation of steam takes place in the super heaters.
(c) In modern utility high-pressure boilers, less than 20% of the total heat absorbed in the generation of steam takes place in the super heaters.
(d) In modern utility high-pressure boilers, less than 30% of the total heat absorbed in the generation of steam takes place in the super heaters.

[ESE - 2025]

64. Which one of the following power plants is suitable for supplying peak loads?
(a) Nuclear power plant
(b) Steam power plant
(c) Hydropower plant
(d) Gas turbine power plant

[ESE - 2025]

65. The specific rotational speed (N_s) for a water turbine is
(a) $\frac{N\sqrt{P_t}}{H^{2.25}}$ (b) $\frac{P_t\sqrt{N}}{H^{1.25}}$
(c) $\frac{N\sqrt{P_t}}{H^{1.25}}$ (d) $\frac{P_t\sqrt{N}}{H^{2\cdot25}}$
where, P_t is output in metric hp N is actual rotational speed of the turbine H is effective head in metres

[ESE - 2025]

66. The advantages of supercritical steam power plants are
1. low grade fossil fuels can be used
2. NO_2 emissions are completely eliminated
3. SO_2 emissions are reduced and complete burning of coal occurs
Which of the above advantages are correct?
(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

ANSWER KEY									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
(c)	(d)	(b)	(d)	(a)	(c)	(b)	(a)	(b)	(b)
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
(b)	(b)	(b)	(b)	(a)	(a)	(d)	(a)	(b)	(d)
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
(c)	(b)	(c)	(b)	(c)	(d)	(c)	(c)	(c)	(c)
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
(a)	(d)	(c)	(a)	(d)	(c)	(b)	(b)	(d)	(d)
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
(d)	(b)	(c)	(c)	(a)	(a)	(a)	(b)	(b)	(d)
51	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
(b)	(d)	(a)	(d)	(b)	(c)	(b)	(c)	(c)	(d)
61	**62**	**63**	**64**	**65**	**66**				
(b)	(b)	(a)	(c)	(c)	(b)				

EXPLANATIONS

1. Explanation: (b)
In a pumped storage hydro plant, the same machine works as motor (pumping) and generator (generating). At equal power levels, the motor operates with slightly higher efficiency. Thus, the generator efficiency is less than motor efficiency .

2. Explanation: (d)
In a thermal nuclear reactor, the moderator slows down fast neutrons to sustain fission. The moderator must have low molecular weight, and the multiplication factor is kept slightly above unity for steady operation. Ordinary water cannot be used with natural uranium, so statements 1, 2, and 4 are correct.

3. Explanation: (b)
When a pumped storage plant operates with a steam plant, it absorbs excess power during off-peak hours (by pumping) and generates during peak hours. This allows the steam plant to run at a steady high load continuously, increasing its load factor

4. Explanation: (d)
Assertion (A): False Hydroelectric plants with large storage are **peak load plants**, not base load plants, because they can start/stop quickly to meet demand variations. Base load plants are typically nuclear/coal with high capital cost but low running cost, meant for continuous operation.
Reason (R): True For a base load plant, the unit cost of energy should be low, which generally comes from high load factor operation of low-fuel-cost plants.
Since A is false and R is true, the correct choice is **(d)**.

5. Explanation: (a)
Moderator → Graphite (3) (slows down fast neutrons)
Control Rod → Boron (1) (absorbs neutrons to control chain reaction)
Coolant → Sodium (4) (transfers heat from core)
Shield → Concrete (2) (protects against radiation leakage)
Correct option: A–3, B–1, C–4, D–2

6. Explanation: (c)
1. A pumped storage plant is a base load plant False It is a peak load

plant, used during high demand; it stores energy during low demand.

2. The starting time of a pumped storage plant is very short True It can start quickly (minutes) to respond to peak demand.
3. Reversible turbines and pumps are highly suitable for pumped storage plants True Reversible pump-turbines are commonly used.

7. Explanation: (b)

A. Thermal → High fuel transportation cost (4)
B. Nuclear → High capital cost (2)
C. Hydro → High plant life (3)
D. Diesel → High operating cost (1)
Correct option : A-4, B-2, C-3, D-1

8. Explanation: (a)

Matching Turbines to Head Range:
A. Low head (2–15 m) → Propeller or Kaplan (4)
B. Medium head (16–70 m) → Francis or Kaplan (3)
C. High head (71–500 m) → Francis or Pelton (2)
D. Very high head (>500 m) → Pelton (1)
Correct option: A-4, B-3, C-2, D-1

9. Explanation: (b)

A modern steam power plant operates on the Rankine cycle, which uses phase change of water (liquid to steam and back) for efficient power generation.

10. Explanation: (b)

Assertion (A): True. Pumped storage plants supply peak loads and pump water back during off-peak for energy storage.
Reason (R): True. They have very short start times

11. Explanation: (b)

The CANDU (CANada Deuterium Uranium) reactor uses heavy water (D_2O) as both the moderator and coolant, allowing it to use natural uranium fuel without enrichment.

12. Explanation: (b)

A. Hydroelectric power station → Forebay (2)
B. Nuclear power station → Pressurized water reactor (3)
C. Steam power station → Grate and stokers (1)
D. Pressure gasification combined cycle power plant → Fluidized bed gasifier (4)
Correct option: A-2, B-3, C-1, D-4

13. Explanation: (b)

The enlarged body of water located just above the intake in a hydro power station, which acts as a regulating reservoir, is called a Forebay.
Spillway → Used to discharge excess water safely.
Reservoir → Large storage of water behind the dam.
Penstock → Pressure conduit carrying water to the turbine.
Forebay → Small regulating basin before the penstock/intake

14. Explanation: (b)

Kaplan turbine → specifically designed for low heads (<30 m) and variable discharge, with adjustable runner blades.

16. Explanation: (a)

The typical efficiency of a conventional thermal power plant ranges from 30% to 40% due to heat losses in the condenser, boiler, and other components.

17. Explanation: (d)

Electrostatic precipitators in coal-fired thermal power stations are used to collect dust particles from the flue gas before it is released into the atmosphere, reducing air pollution.

18. Explanation: (a)

Thermal nuclear reactors primarily use Uranium-235 (U^{235}) as the fissile fuel for power generation, as it can sustain a chain reaction with slow neutrons.

19. Explanation: (b)

In pumped storage power plants, reversible turbines (pump-turbines) are used.
They act as turbines during peak load for power generation and as pumps during off-peak hours to return water to the upper reservoir.

20. Explanation: (d)

The maximum efficiency of modern coal-fired thermal power plants is limited to about 35% mainly due to high energy loss in the turbine exhaust condenser, where a large amount of heat is rejected to the environment.

21. Explanation: (c)

Given:
Density of water, $\rho = 1000\ \text{kg/m}^3$
Head, $h = 1.0\ \text{m}$
Discharge, $Q = 1.0\ \text{m}^3/\text{s}$
Efficiency, $\eta = 100\% = 1$
Formula for hydraulic power:
$P = \rho g Q h \eta$
$P = 1000 \times 9.81 \times 1.0 \times 1.0 \times 1$
$P = 9810\ \text{W},\ P = 9.81\ \text{kW}$

22. Explanation: (b)

1. In nuclear reactors, a moderator is used to reduce the speed of fast neutrons, making them more effective in sustaining fission.
2. The multiplication factor (k) is kept close to or slightly above unity to ensure the chain reaction continues steadily.
3. Nuclear power plants are generally operated as base-load stations, since they are most efficient at delivering constant output.

23. Explanation: (c)

In Hydro power station, the draft tube is located between the runner exhaust and the tail race.

24. Explanation: (b)

High Costs – Both maintenance and operating expenses are greater compared to other types of power plants.

Water Requirement – Needs a very large and continuous supply of water for operation and cooling.
Time-Consuming Installation Construction and commissioning take longer than most other plants.

25. Explanation: (c)
The nominal pH value of water is equal to 8.5 which is to be maintained in steam raising thermal power station.

26. Explanation: (d)
Complete combustion is monitored by low CO (incomplete combustion indicator), adequate O_2 (ensuring excess air is sufficient), and appropriate CO_2 (peaks near optimal air–fuel ratio). Using all three ensures combustion is complete and efficient.

27. Explanation: (c)
1. Peak load plant: True used to meet peak demand by generating from stored water.
2. Very long starting time: False start-up is relatively fast (minutes).
3. Reversible turbines/pumps: True widely used (pump in off-peak, generate in peak).
4. Load frequency control: True rapid response enables frequency regulation.

28. Explanation: (c)
The initial energy will be released in form of kinetic energy of particles and electromagnetic radiation for the 200 MeV per fission by a neutron in slow thermal nuclear reactor.

29. Explanation: (c)
Violate specified upper and lower limit

30. Explanation: (c)
Pumped storage plants when operated interconnected power systems serve to provide added capacity to meet peak load and increased load factor of steam plant.

31. Explanation: (a)
- When a neutron strikes U-235, it is absorbed to form an unstable compound nucleus U-236.
- U-236 splits (fissions) into two lighter nuclei, releasing fast neutrons, gamma rays, and large energy.
- About 85% of the energy appears as kinetic energy of fission fragments, which is converted into heat when they collide with surrounding atoms.
- The remaining energy comes from emitted neutrons and gamma radiation.

32. Explanation: (d)
pumped storage plants are employed at the place where the quantity of water available is inadequate During low load periods water is pumped back the head reservoir and this water can be used age for generating power during peak load periods.

33. Explanation: (c)
For low variable water heads (i.e., less than $30\text{m} =$ the suitable hydraulic turbine is Kaplan.

34. Explanation: (a)
Weight of water = volume of water stored × density
$= (10 \times 10^5)993\ \text{kg}$
$= (10 \times 10^5)993 \times 9.81\ \text{N}$
$= 9741.33 \times 10^6\ \text{N}$
Energy produced by volume of water
$= \text{W} \times \text{H} \times \eta_{\text{overall}}$
$= 9741.33 \times 10^6 \times 50 \times 1.00$ watt-sec
(Losses are neglected, overall efficiency is 100%)
$= \dfrac{9741 \times 10^6 \times 50}{3600}$ watt-hr
$= 135.3\text{MWhr}$

35. Explanation: (d)
The graphical representation of the discharge as a function of time is known as Hydrograph.

36. Explanation: (c)
- **Purpose** – To reduce radiation exposure to personnel and the public near the reactor.
- **Material Used** – **Concrete** is the most common shielding material due to its low cost, strength, and high absorption capacity for both neutrons and gamma rays.

37. Explanation: (b)
The reactor is encased by thick metal walls (reactor pressure vessel) for radiation shielding.
Metal provides effective gamma radiation attenuation as part of primary shielding.
Concrete is also used, but the question's correct option refers to metal encasement.

38. Explanation: (b)
In pumped storage plants a synchronous machine a reaction turbine and a multistage centrifugal pump all are connected in one shaft.

39. Explanation: (d)
$\text{N}_\text{s} = 300\text{rpm}$
$\text{f} = 50\ \text{Hz}$
$$\text{N}_\text{s} = \frac{120\text{f}}{\text{P}}$$
$$\Rightarrow \text{P} = \frac{120\text{f}}{\text{N}_\text{s}} = \frac{120 \times 50}{300} = 20$$
$$\text{P} = 20$$

40. Explanation: (d)
Best suited to meet peak load demand.
- During off-peak hours, surplus energy is used to pump water back to the upper reservoir.
- During peak hours, stored water is released to generate electricity.

41. Explanation: (d)
Water used $= 60 \times 10^6$ cubic meter/year
$$\text{Q} = \frac{60 \times 10^6}{365 \times 24 \times 3600}$$
$$= 1.9\ \text{m}^3/\text{sec}$$
$\text{Head} = 40\ \text{m}$

$$P = \frac{735.5}{75} QH\eta \text{ W}$$
$$= \frac{735.5}{75} \times 1.9 \times 40 \times 1$$
$$= 745.3 \text{ kW}$$
$$\approx 750 \text{ kW}$$

42. Explanation: (b)
The advantage of hydroelectric plant over thermal power station is that operating cost of hydroelectric power station is low because of minimal fuel cost.

44. Explanation: (c)
Overall efficiency of the power station is
$\eta_{overall} = \eta_{thermal} \times \eta_{elect}$
$= 0.30 \times 0.92$
$= 0.276$
Units generated / hour $= (100 \times 10^3) \times 1$
$= 10^5 \text{kWh}$
Heat produced / hour,
$$H = \frac{\text{Electrical output in heat units}}{\eta_{overall}}$$
$$\frac{10^5 \times 860}{0.276} = 311.6 \times 10^6 \text{kcal}$$
$(\therefore 1\text{kWh} = 860\text{kcal})$
$\therefore$ Coal consumption/hour
$$= \frac{H}{\text{Calorific value}}$$
$$= \frac{311.6 \times 10^6}{6400} = 4868 \text{ kg}$$

45. Explanation: (a)
In Nuclear plant, there is no super heater so pressure and temperatures are low compared to thermal plant.

46. Explanation: (a)
A surge tank is a protective device used in hydroelectric power plants to absorb pressure fluctuations (water hammer) in long penstocks. It is mainly required in high head hydro plants, where steep and long penstocks create large pressure surges during sudden load changes.

47. Explanation: (a)
Both statements are correct, and the surge tank in high-head hydro stations is specifically used to absorb flow variations caused by governor action and prevent water hammer.

48. Explanation: (b)
Nuclear turbines use steam at lower pressure and lower temperature than coal-fired plants.

49. Explanation: (b)
Power formula: $P=\rho gQH\eta$
Where Q = discharge, H = head, η = efficiency.
So, output depends on head, discharge, and efficiency.

50. Explanation: (d)
Smoke/ash pollution in thermal plants is reduced by an electrostatic precipitator.

51. Explanation: (b)
Statement (I): True wind power $P \propto V^3$.
Statement (II): True drag-type turbines (e.g., Savonius) have low speed, high torque.
Not causal; the V3V^3 dependence comes from fluid dynamics (energy flux in wind), not from the drag-type turbine characteristics.

52. Explanation: (d)
Statement (I) is false because reaction turbines, like Francis and Kaplan turbines, are used for moderate to low head and high flow, not high-head, low-flow conditions.
Statement (II) is true, as Kaplan and Francis turbines are indeed reaction turbines.

53. Explanation: (a)
Hunting in synchronous machines causes harmful rotor oscillations, leading to mechanical stress, fatigue damage, and potential loss of synchronism.

54. Explanation: (d)
Generating stations
Transmission systems
Distribution networks

55. Explanation: (b)
It refers to the ability of the system to meet power demands without failure, even under fault conditions. Redundancy through grid formation and interconnections enhances long-term reliability.

56. Explanation: (c)
In wind power systems, wind speed is the most critical parameter because:
Power Output: The kinetic energy of wind is proportional to the cube of wind speed ($P \propto v^3$), making it the dominant factor in power generation.

57. Explanation: (b)
Given:
FF of module = 0.8
$V_{OC} = 0.6 \text{ V}, I_{SC} = 8 \text{ A}$
For 48 cells in series:
$V_{OC} = 48 \times 0.6$
$I_{SC} = 8$ A (Remains the same)
Voltage at maximum power:
$V_m = 0.9 \times V_{OC} = 0.9 \times 48 \times 0.6$
To find I_m, use the fill factor equation:
$$FF = \frac{I_m V_m}{I_{SC} V_{OC}}$$
Substitute the values:
$$0.8 = \frac{I_m \times (0.9 \times 48 \times 0.6)}{8 \times 48 \times 0.6}$$
Solve for I_m:
$$I_m = \frac{48 \times 0.6 \times 8 \times 0.8}{0.9 \times 48 \times 0.6} = 7.11 \text{ A}$$

58. Explanation: (c)
As $I_L \longrightarrow \text{High}, R_s \longrightarrow \text{High}$

59. Explanation: (c)
Solar power plants are generally considered the least reliable among the options listed because they depend on sunlight, which is intermittent and varies with weather, time of day, and seasonal changes. This makes solar power less predictable and reliable compared to other energy sources.

60. Explanation: (d)
Nuclear power plant is not an example of renewable energy

61. Explanation: (b)
A reaction turbine is fully immersed in the fluid, and it

generates power from the pressure drop across the device. On the other hand, an impulse turbine uses the kinetic energy of the fluid to rotate the turbine blades and is not entirely submerged.

62. Explanation: (b)

$P_{avg} = 9.81 \times 10^{-3} \times \eta \times W \times Q \times H$

$\eta = 100\% = 1.0$

$P_{avg} = 9.81 \times 10^{-3} \times 1 \times 1000 \times 1370 \times 324$

$= 4354.6 \cong 4350 MW$

63. Explanation: (a)

In modern utility high-pressure boilers, more than 40% of the total heat absorbed in the generation of steam takes place in the super heaters.

64. Explanation: (c)

Hydropower plants are best suited for supplying peak loads due to their ability to quickly adjust power output to meet sudden demand changes.

65. Explanation: (c)

The specific rotational speed (N_s) for a water turbine is given by the formula:

$$N_s = \frac{N\sqrt{P_t}}{H^{1.25}}$$

This formula helps to characterize the performance of a turbine in relation to its rotational speed, output power, and head.

66. Explanation: (b)

Supercritical steam power plants allow the use of low-grade fossil fuels and reduce SO_2 emissions by ensuring complete coal combustion. However, they do not eliminate NO_2 emissions completely. Therefore, only advantages 1 and 3 are correct.

Unit: 5.2 Performance of Transmission Line Parameters & Cable and Insulators

Previous Year Exam Questions

[ESE-2001]

1. The surge impedance of a 3-phase, transmission line is 400Ω. The surge ding (SIL) is

(a) 400 MW (b) 100 MW
(c) 1600 MW (d) 200 MW

[ESE-2001]

2. a traveling-wave traveling along a loss-free lower head line does not result in any reflection after has reached the far end, then the far end of the time is

(a) open circuited
(b) short circuited
(c) terminated into a resistance equal to surge impedance of the line
(d) terminated into a capacitor

[ESE-2001]

3. The active and the reactive power delivered at receiving end of a short transmission line of impedance $Z\angle\psi$ are respectively given by

$B_a = \frac{V_s V_R}{Z}\cos(\psi - \delta) - \frac{V_R^2}{Z}\cos\psi$ and

$= \frac{V_s V_R}{Z}\sin(\psi - \delta) - \frac{V_R^2}{Z}\sin\psi$ with

V_s and V_R being the magnitude of voltages at the ending and receiving ends, δ the power-angle. At the power-limit condition i.e. for maximum P_R

(a) leading VARs (Q_R) goes to the load for any values of V_S and V_R
(b) leading VARs(Q_R) goes to the load ONLY for $V_s = V_R$
(c) lagging VARs (Q_R) goes to the load for any values of V_S and V_R
(d) lagging VARs (Q_R) goes to the load ONLY for $V_s = V_R$

[ESE-2001]

4. A traveling wave 400/1/50 means crest value of

(a) 400 V with rise time of $1/50$ s
(b) 400 kV with rise time 1 s and fall time 50 s
(c) 400 kV with rise time 1μ s and fall time 50μ s
(d) 400 MV with rise time 1μ s and fall time 50μ s

[ESE-2001]

5. Bundled conductors are used for EHV transmission lines primarily for reducing the

(a) corona loss
(b) surge impedance of the line
(c) voltage drop across the line
(d) I^2R losses

[ESE-2001]

6. The good effect of corona on overhead lines is to

(a) increase the line carrying capacity due to conducting ionized air envelop around the conductor
(b) increase the power factor due to corona loss
(c) reduce the radio interference from the conductor
(d) reduce the steepness of surge fronts

[ESE-2001]

7. In a three unit insulator string, voltage across the lowest unit is 17.5 kV and string efficiency is 84.28%. The total voltage across the string will be equal to

(a) 8.825 kV (b) 44.25 kV
(c) 88.25 kV (d) 442.5 kV

[ESE-2002]

8. Match List-I (Design parameters) with List-II [Factor(s) on which they depend] and select the correct answer using the codes given below the lists:

List-I (Design parameters)	List-II (Factor (s) on which they depend)
A. Number of suspension insulator discs	1. Voltage and Tower footing resistance
B. Permissible sag of transmission Line conductor for a given tower	2. Voltage
C. Corona discharge	3. Voltage and conductor configuration
D. Inductance of transmission Line conductor	4. Conductor configuration and Tower configuration

Codes:

	A	B	C	D
(a)	1	2	3	4
(b)	4	3	2	1
(c)	1	3	2	4
(d)	4	2	3	1

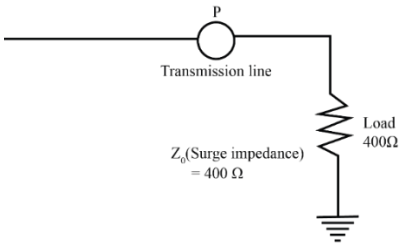
[ESE-2002]

9. For transmission line which one of the following relations is true?

(a) $AD - BC = 1$ (b) $-AD - BC = 1$
(c) $AD - BC = -1$ (d) $AD - BC = 0$

[ESE-2002]

10. The reflection coefficient for the transmission line shown in figure at point P is



(a) +1 (b) 0.05
(c) 0 (d) -1

[ESE-2002]

11. A 3-phase transmission line has its conductors at the corners of an equilateral triangle with side 3 m. The diameter of each conductor is 1.63 cm. The inductance of the line per phase per km is

(a) 1.232 mH (b) 1.182 mH
(c) 1.093 mH (d) 1.043 mH

[ESE-2002]

12. A cable has inductance of 0.22 mH per km and capacitance of $0.202\mu F$ per km . The surge impedance of the cable is

(a) 28Ω (b) 33Ω
(c) 42Ω (d) 50Ω

[ESE-2002]

13. For some transmission line the expression for voltage regulation is given as $\frac{|V_s|-|V_R|}{|V_R|} \times 100\%$ Hence,

(a) this must be a 'short line'
(b) this may either be a 'medium line' or 'short line
(c) this expression is true for any line
(d) this may either be a 'medium line' or 'long line'

[ESE-2002]

14. The capacitance of an overhead transmission line increases with

1. increases in mutual geometrical mean distance.
2. increase height of conductors above ground

Select the correct answer from the following:

(a) Both 1 and 2 are true
(b) Both 1 and 2 are false
(c) Only 1 is true
(d) Only 2 is true

[ESE-2002]

15. Consider the following statements:

Addition of lumped capacitances in parallel to a loss-free transmission line increases

1. characteristic impedance
2. propagation constant
3. system stability
4. charging current

Which of these statements are correct?

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

[ESE-2002]

16. A surge of 100 kV travels along an overheal line towards its junction with a cable. The sure impedances for the overhead line and cable are 4 I ohms and 50 ohms respectively. The magnitude the surge transmitted through the cable is

(a) 11.11 kV (b) 22.22 kV
(c) 12.50 kV (d) 88.89 kV

[ESE-2002]

17. A surge voltage rising at $100\text{kV}/\mu s$ travels along loss-less open-circuited transmission line. It tals 10μ s to reach the open end. The reflected watch from the open end, will be rising at

(a) $100\text{kV}/\mu s$ (b) $200\text{kV}/\mu s$
(c) $1000\text{kV}/\mu s$ (d) $2000\text{kV}/\mu s$

[ESE-2002]

18. Assertion (A): The maximum operatize temperature of overhead line conductors made 1 aluminum or copper is restricted to 75°C

Reason (R): Conductor temperature beyond 752 may shatter porcelain insulators.

(a) Both A and R are individually true and R is the correct Explanation: of A
(b) Both A and R are individually 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-2002]

19. Assertion (A): In the modeling of medium and lime transmission lines the nominal- π and T circuits and not equivalent to each other.

Reason (R): A star delta transformation can $=$ used to derive the one circuit from the other.

(a) Both A and R are individually true and R is the correct Explanation: of A
(b) Both A and R are individually 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-2002]

20. The component inductance due to the internal fix linkage of a non-magnetic straight solid citculs conductor per meter length, has a constant and is independent of the conductor-dia because

(a) All the internal flux due to current concentrated on the peripheral region of $z =$ conductor
(b) The internal magnetic flux density along 하 radial distance from the centre of the condine increases proportionately to the enclosed
(c) The entire current is assumed to flow along the conductor-axis and the internal flux is distributed uniformly and concentrically
(d) The current in the conductor is assumed to be uniformly distributed throughout the conductor cross-section

[ESE-2003]

21. Which one of the following statements is NOT correct for the use of bundled conductors in ransmission lines?

(a) Control of voltage gradient
(b) Reduction in corona loss
(c) Reduction in radio interference
(d) Increase in interference with communication line

[ESE-2003]

22. A 100 km long transmission line if loaded at 110 kV. If the loss of line is 15 MW and the load is 150 MVA, the resistance of the line is

(a) 8.06 ohms per phase
(b) 0.806 ohms per phase
(c) 0.0806 ohms per phase
(d) 80.6 ohms per phase

[ESE-2003]

23. Two insulator discs of identical capacitance value C make up a string for a $22\text{kV}, 50\text{ Hz}$ single-phase overhead line insulation system. If the pin to earth capacitance is also C, then the string efficiency is

(a) 50% (b) 75%
(c) 90% (d) 86%

[ESE-2004]

24. Which one of the following equations is correct?

(a) $-\text{AB} + \text{CD} = -1$ (b) $\text{AD} + \text{CB} = 1$
(c) $\text{AB} - \text{CD} = -1$ (d) $-\text{AD} + \text{BC} = -1$

[ESE-2004]

25. The combined effect of series and shunt compensation on transmission lines in terms of degree of series compensation ($\mathbf{K_{se}}$), degree of shunt compensation ($\mathbf{K_{sh}}$), and surge impedance of uncompensated line ($\mathbf{Z_0}$) is given by which one of the following equations?

(a) $Z_0' = Z_0\sqrt{1 - K_{\text{se}}}\sqrt{1 - K_{\text{sh}}}$
(b) $Z_0' = \sqrt{1 - K_{se}}\sqrt{1 - K_{sh}}/Z_0$
(c) $Z_0' = Z_0\sqrt{(1 - K_{\text{se}})/(1 - K_{\text{sh}})}$
(d) $\text{Z}_0' = \text{Z}_0\sqrt{(1 - \text{K}_{\text{sh}})/(1 - \text{K}_{\text{se}})}$

[ESE-2004]

26. $\mathbf{D_s}$ is the GMR of each sub conductor of a four sub conductor bundle conductor and d is the bundle spacing. What is the GMR of the equivalent single conductor?

(a) $1.09\sqrt{\text{D}_\text{s} \times \text{d}^3}$ (b) $1.09\sqrt{\text{D}_\text{s}^3 \times \text{d}^3}$
(c) $1.09\sqrt[4]{\text{D}_\text{s}^3 \times \text{d}^3}$ (d) $1.09\sqrt[4]{\text{D}_\text{s} \times \text{d}^3}$

[ESE-2004]

27. Corona loss increases with

(a) decrease in conductor size and increase in supply frequency
(b) increase in both conductor size and supply frequency
(c) decrease in both conductor size and supply frequency
(d) increase in conductor size and decrease in supply frequency

[ESE-2004]

28. For a fixed receiving end and sending end voltage in a transmission system, what is the locus of the constant power?

(a) A straight line (b) An ellipse
(c) A parabola (d) A circle

[ESE-2005]

29. On what basis is the insulation level of a 400 kV , EHV overhead transmission line decided?

(a) Lightning over voltage
(b) Corona inception voltage
(c) Switching over voltage
(d) Radio and TV interference

[ESE-2005]

30. The charging reactance of 50 km length of the line is 1500Ω. What is the charging reactance for 100 km length of the line?

(a) 1500Ω (b) 3000Ω
(c) 750Ω (d) 600Ω

[ESE-2005]

31. Equivalent π model is quite suitable for analyzing the performance of transmission line of

(a) 50 km length (b) 150 km length
(c) 250 km length (d) All of the above

[ESE-2005]

32. The corona loss on a particular system at 50 Hz is $1\ \mathrm{kW/km}$ per phase. What is the corona loss at 60 Hz in $\mathrm{kW/km}$ per phase?

(a) 0.83 (b) 1.0
(c) 1.13 (d) 1.2

[ESE-2006]

33. If X is the inductive reactance/phase and R is the resistance/phase of a short transmission line, what is the power factor angle of the load for maximum voltage regulation?

(a) $\cos^{-1} X/R$ (b) $\tan^{-1} X/R$
(c) $\cos^{-1}$ R/X (d) $\tan^{-1}$ R/X

[ESE-2006]

34. For a loss-free long transmission line, the conventional line equations become,

$\mathbf{V_s} = (\cos \boldsymbol{\beta\ell})\mathbf{V_R} + (\mathbf{j}\sin \boldsymbol{\beta\ell})\mathbf{I_R Z_C}$ **and**

$$I_S = \left(\frac{j\sin \beta\ell}{Z_C}\right) V_R + (\cos \beta\ell) I_R$$

Which one of the following statements is correct?
If the line is terminated at the receiving end by its natural load impedance Z_C, then

(a) the voltage is constant in magnitude at all points along the line and, V_S and V_R always remain in phase
(b) the voltage is constant in magnitude at all points along the line but V_S advance in phase relative to V_R by an angle β radians per km .
(c) the magnitude of the voltage along the line changes in proportion to the line-length, and the V_S and V_R always remain in phase
(d) the magnitude of the voltage along the line changes in proportion to the line-length, V_s advances in phase relative to V_R by β radians per km.

[ESE-2006]

35. What is the approximate value of the surge impedance loading of a $400\mathrm{kV}, 3-$ phase 50 Hz overhead single circuit transmission line?

(a) 230 MW (b) 400 MW
(c) 1000 MW (d) 1600 MW

[ESE-2006]

36. A traveling wave due to lightning with an incide voltage V travels through the overhead line of surg: impedance of 400Ω and enters a cable of sure impedance of 40Ω What is the voltage entering the cable at the junction?

(a) $\mathrm{V}/11$ (b) $4\ \mathrm{V}/11$
(c) $2\ \mathrm{V}/11$ (d) V

[ESE-2006]

37. In a $7/30$ ACSR conductor why is grease between steel and aluminum conductors?

(a) to reduce corrosion by electrolytic acti between zinc (galvanizing agent on steel) aluminum
(b) to reduce friction between the strands
(c) to reduce leakage of current from aluminar strands to steel strands
(d) to eliminate air pockets

[ESE-2007]

38. What is the approximate breakdown strength atmospheric air at N.T.P.?

(a) $0.3\mathrm{kV/cm}$ (b) $1.0\mathrm{kV/cm}$
(c) $3\mathrm{kV/cm}$ (d) $30\mathrm{kV/cm}$

[ESE-2007]

39. Consider the following statements:

1. Equivalent-T circuit of a long line is prefem to equivalent- π circuit
2. The nature of reactive power compens is different for peak load and off peak conditions.
3. Ferranti effect is significant only on medire and long lines

Which of the statements given above are correct.

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