DRDO-2008

SECTION-A (TECHNICAL)

1. The threshold voltage V_t is negative for
(a) an n-channel enhancement MOSFET
(b) an n-channel depletion MOSFET
(c) a p-channel depletion MOSFET
(d) a p-channel JFET

2. At a given temperature a semiconductor with intrinsic carrier concentration $n_i = 10^{16}/m^3$ is doped with a donor dopant of concentration $N_D = 10^{26}/m^3$. Temperature remaining the same the hole concentration in the doped semiconductor is
(a) $10^{26}/m^3$ (b) $10^{16}/m^3$
(c) $10^{14}/m^3$ (d) $10^{6}/m^3$

3. At room temperature the diffusion and drift constants for holes in a P-type semiconductor were measured to be $D_p = 10\ cm^2/s$ and $\mu_p = 1200\ cm^2/V\text{-}s$, respectively. If the diffusion constant of electrons in an N-type semiconductor at the same temperature is $D_n = 20\ cm^2/s$, the drift constant for electrons in it is
(a) $\mu_n = 2400\ cm^2/V\text{-}s$
(b) $\mu_n = 1200\ cm^2/V\text{-}s$
(c) $\mu_n = 1000\ cm^2/V\text{-}s$
(d) $\mu_n = 600\ cm^2/V\text{-}s$

4. A common LED is made up of
(a) intrinsic semiconductor
(b) direct semiconductor
(c) degenerate semiconductor
(d) indirect semiconductor

5. When operating as a voltage regulator the breakdown in a Zener diode occurs due to the
(a) tunneling effect
(b) avalanche breakdown
(c) impact ionization
(d) excess heating of the junction

6. If the common base DC current gain of a BJT is 0.98, its common emitter DC current gain is
(a) 51 (b) 49
(c) 1 (d) 0.02

7. Negative resistance characteristics is exhibited by a
(a) Zener diode (b) Schottky diode
(c) Photo diode (d) Tunnel diode

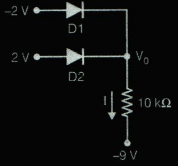
8. Let E_{Fn} and E_{Fp}, respectively, represent the effective Fermi levels for electrons and holes during current conduction in a semiconductor. For lasing to occur in a P-N junction of band-gap energy 1.2 eV, $(E_{Fn} - E_{Fp})$ should be
(a) greater than 1.2 eV
(b) less than 1.2 eV
(c) equal to 1.1 eV
(d) equal to 0.7 eV

9. In a P-well fabrication process, the substrate is

(a) N-type semiconductor is used to build P-channel MOSFET
(b) P-type semiconductor is used to build P-channel MOSFET
(c) N-type semiconductor and is used to build N-channel MOSFET
(d) P-type semiconductor and is used to build N-channel MOSFET

10. In a MOS capacitor with n-type silicon substrate, the Fermi potential $\phi_F = -0.41$ V and the flat-band voltage $V_{FB} = 0$ V. The value of the threshold voltage V_T is
(a) –0.82 V (b) –0.41 V
(c) 0.41 V (d) 0.82 V

Refer Figure for Q.11 and Q.12. Assume D1 and D2 to be ideal diodes.



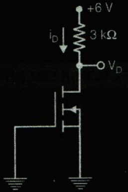
11. Which one of the following statements is true?
(a) Both D1 and D2 are ON
(b) Both D1 and D2 are OFF
(c) D1 is ON and D2 is OFF
(d) D2 is ON and D1 is OFF

12. Values of V_0 and I, respectively, are
(a) 2 V and 1.1 mA
(b) 0 V and 0 mA
(c) –2 V and 0.7 mA
(d) 4 V and 1.3 mA

13. In a BJT CASCODE pair, a
(a) common emitter follows a common base
(b) common base follows a common collector
(c) common collector follows a common base
(d) common base follows a common emitter

14. Inside a 741 op-amp the last functional block is a
(a) differential amplifier
(b) level shifter
(c) class-A power amplifier
(d) class-AB power amplifier

15. For the MOSFET in the circuit in figure, the threshold voltage $V_T = 0.5$ V, the process parameter $K_p = 150\ \mu A/V^2$ and W/L = 10. The values of V_D and I_D, respectively, are



(a) $V_D = 4.5$ V and $I_D = 1$ mA
(b) $V_D = 4.5$ V and $I_D = 0.5$ mA
(c) $V_D = 4.8$ V and $I_D = 0.4$ mA
(d) $V_D = 6$ V and $I_D = 0$ mA

16. A negative feedback is applied to an amplifier with the feedback voltage proportional to the output current. This feedback increase the
(a) input impedance of the amplifier
(b) output impedance of the amplifier
(c) distortion in the amplifier
(d) gain of the amplifier

17. The early effect in a BJT is modeled by the small signal parameter
(a) r_0 (b) r_π
(c) g_m (d) β

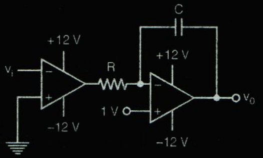
18. For a given filter order, which one of the following type of filters has the least amount of ripple both in pass-band and stop-band?
(a) Chebyshev type-I
(b) Bessel
(c) Chebyshev type-II
(d) Elliptic

19. For a practical feedback circuit to have sustained oscillation, the most appropriate value of the loop gain T is

(a) 1 (b) −1

(c) −1.02 (d) 1.02

20. Assume the op-amps in figure to be ideal. If the input signal v_i is a sinusoid of 2 V peak-to-peak and with zero DC component, the output signal v_0 is a



(a) sine wave (b) square wave

(c) pulse train (d) triangular wave

21. In a common source amplifier, the mid-band voltage gain is 40 dB and the upper cut-off frequency is 150 kHz. Assuming single pole approximation for the amplifier, the unity gain frequency f_T is

(a) 6 MHz (b) 15 MHz

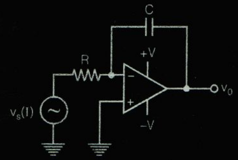
(c) 150 MHz (d) 1.5 GHz

22. An op-amp is ideal except for finite-gain and CMRR. Given, the open loop differential gain A_d = 2000, CMRR = 1000, the input to the non inverting terminal is 5.001 V and the input to the inverting terminal is 4.999 V, the output voltage of the op-amp is

(a) 14 V (b) 24 V

(c) −6 V (d) −8 V

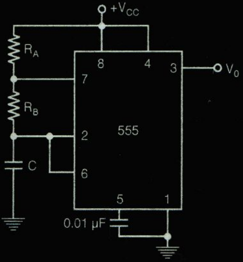
23. The op-amp in the circuit in figure has a non-zero DC-offset. The steady state value of the output voltage v_0 is



(a) $-RC\frac{dV_s(t)}{dt}$ (b) $-\frac{1}{RC}\int_0^t v_s(\tau)\,d\tau$

(c) −V (d) +V

24. For the circuit in figure, if the value of the capacitor C is doubled, the duty-cycle of the output waveform v_0



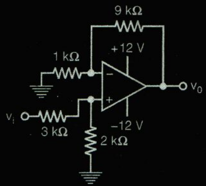
(a) increases by a factor of 2

(b) increases by a factor of 1.44

(c) remains constant

(d) decreases by a factor of 1.44

25. Assume the op-amp in the circuit of figure to be ideal. The value of the output voltage v_0 is



(a) $3.2\ v_i$ (b) $4\ v_i$

(c) $9\ v_i$ (d) $10\ v_i$

26. The complement of the Boolean expression

$F = (X+\bar{Y}+Z)(\bar{X}+\bar{Z})(X+Y)$

(a) $XYZ+X\bar{Z}+\bar{Y}Z$ (b) $\bar{X}Y\bar{Z}+XZ+\bar{X}\bar{Y}$

(c) $\bar{X}Y\bar{Z}+XZ+\bar{Y}\bar{Z}$ (d) $XYZ+\bar{X}\bar{Y}$

27. The Boolean function F(A, B, C, D) $= \Sigma(0, 6, 8, 13, 14)$ with don't care conditions d(A, B, C, D) $= \Sigma(2, 4, 10)$ can be simplified to

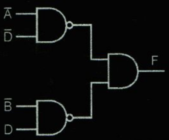
(a) $F = \bar{B}\bar{D} + C\bar{D} + AB\bar{C}$

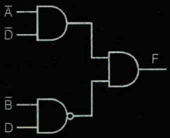
(b) $F = \bar{B}\bar{D} + C\bar{D} + AB\bar{C}D$

(c) $F = A\bar{B}\bar{D} + C\bar{D} + AB\bar{C}$

(d) $F = \bar{B}\bar{D} + C\bar{D} + ABCD$

28. The Boolean function $F = \bar{A}\bar{D} + \bar{B}D$ can be realized by

(a)


(b)


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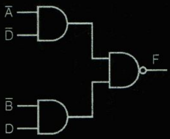

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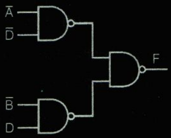
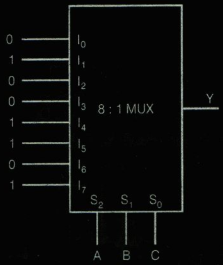


29. For the multiplexer shown in figure, the Boolean expression for the output Y is



(a) $\bar{A}\bar{B} + \bar{B}\bar{C} + AC$ (b) $A\bar{B} + \bar{B}\bar{C} + A\bar{C}$

(c) $A\bar{B} + \bar{B}C + AC$ (d) $\bar{A}\bar{B} + \bar{B}C + \bar{A}\bar{C}$

30. Which one of the following is TRUE?
(a) Both latch and flip-flop are edge triggered
(b) A latch is level triggered and a flip-flop is edge triggered
(c) A latch is edge triggered and a flip-flop is level triggered
(d) Both latch and flip-flop are level triggered.

31. In a Schottky TTL gate, the Schottky diode
(a) increases the propagation delay
(b) increases the power consumption
(c) prevents saturation of the output transistor
(d) keeps the transistor in cut-off region

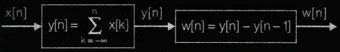
32. For which one of the following ultraviolet light is used to erase the stored contents?
(a) PROM (b) EPROM
(c) EEPROM (d) PLA

33. Which one of the following is NOT a synchronous counter?
(a) Johnson counter
(b) Ring counter
(c) Ripple counter
(d) Up-down counter

34. In 8085 microprocessor, the accumulator is a
(a) 4 bit register (b) 8 bit register
(c) 16 bit register (d) 32 bit register

35. In the register indirect addressing mode of 8085 microprocessor, data is stored
(a) at the address contained in the register pair
(b) in the register pair
(c) in the accumulator
(d) in a fixed location of the memory

36. The output w[n] of the system shown in figure is

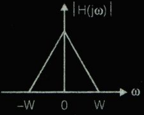


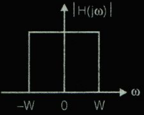
(a) $x[n]$ (b) $x[n-1]$
(c) $x[n]-x[n-1]$ (d) $\frac{1}{2}(x[n-1]+x[n])$

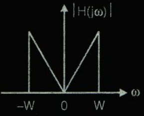
37. Which one of the following is a periodic signal?
(a) $x_1(t) = 2e^{j\left(t+\frac{\pi}{4}\right)}u(t)$
(b) $x_2[n] = u[n] + u[-n]$
(c) $x_3[n] = \sum_{k=-\infty}^{\infty} \{\delta[n-4k]-\delta[n-1-4k]\}$
(d) $x_4(t) = e^{(-1+j)t}$

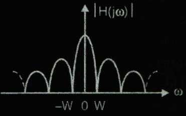
38. If the input-output relation of a system is
$$y(t) = \int_{-\infty}^{2t} x(\tau)d\tau,$$ then the system is
(a) linear, time invariant and unstable
(b) linear, non-causal and unstable
(c) linear, causal and time invariant
(d) non-causal, time invariant and unstable

39. Which one of the following can be the magnitude of the transfer function $|H(j\omega)|$ of a causal system?

(a)


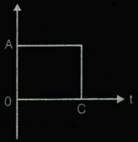
(b)


(c)


(d)


40. Consider the function $H(j\omega) = H_1(\omega) + jH_2(\omega)$, where $H_1(\omega)$ is an odd function and $H_2(\omega)$ is an even function. The inverse Fourier transform of $H(j\omega)$, is
(a) a real and odd function
(b) a complex function
(c) a purely imaginary function
(d) a purely imaginary and odd function

41. The Laplace transform of the signal given in figure is



(a) $-A\left(\frac{1-e^{cs}}{s}\right)$ (b) $A\left(\frac{1-e^{cs}}{s}\right)$
(c) $A\left(\frac{1-e^{-cs}}{s}\right)$ (d) $-A\left(\frac{1-e^{-cs}}{s}\right)$

42. If X(z) is the z-transform of $x[n] = \left(\frac{1}{2}\right)^{|n|}$ the ROC of X(z) is

(a) $|z| > 2$ (b) $|z| < 2$

(c) $\frac{1}{2} < |z| < 2$ (d) the entire z-plane

43. In a linear phase system, τ_g the group delay and τ_p the phase delay are

(a) constant and equal to each other

(b) τ_g is a constant and $\tau_p \propto \omega$

(c) a constant and $\tau_g \propto \omega$

(d) $\tau_g \propto \omega$ and $\tau_p \propto \omega$

44. A signal m(t), band-limited to a maximum frequency of 20 kHz is sampled at a frequency f_s kHz to generate s(t). An ideal low pass filter having cut-off frequency 37 kHz is used to reconstruct m(t) from s(t). The minimum of f_s required to reconstruct m(t) without distortion is

(a) 20 kHz (b) 40 kHz

(c) 57 kHz (d) 77 kHz

45. If the signal x(t) shown in figure (a) is fed to an LTI system having impulse response h(t) as shown in figure (b), the value of the DC component present in the output y(t) is

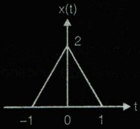


Figure (a)

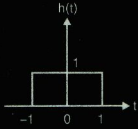


Figure (b)

(a) 1 (b) 2

(c) 3 (d) 4

46. The characteristic equation of an LTI system is given as $s^3 + Ks^2 + 5s + 10 = 0$. When the system is marginally stable, the value of K and the sustained oscillation frequency ω, respectively are

(a) 2 and 5 (b) 0.5 and $\sqrt{5}$

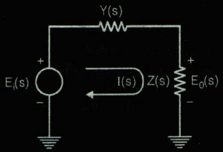
(c) 0.5 and 5 (d) 2 and $\sqrt{5}$

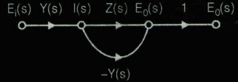
47. The time required for the response of a linear time-invariant system to reach half the final value for the first time is

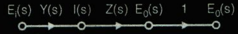
(a) delay time (b) peak time

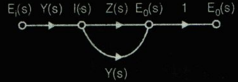
(c) rise time (d) decay time

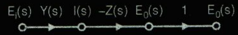
48. The signal flow graph of the network in figure is



(a)


(b)


(c)


(d)


49. Let c(t) be the unit step response of a system with transfer function $\frac{K(s+a)}{(s+K)}$. If $c(0^+) = 2$ and $c(\infty) = 10$, then the values of a and K, respectively, are

(a) 2 and 10 (b) –2 and 10

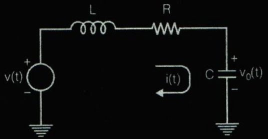
(c) 10 and 2 (d) 2 and –10

50. The loop transfer function of an LTI system is $G(s)H(s) = \frac{K(s+1)(s+5)}{s(s+2)(s+3)}$. For K > 0, the point on the real axis that DOES NOT belong to the root locus of the system is

(a) –0.5 (b) –2.5

(c) –3.5 (d) –5.5

51. The state-space equation of the circuit shown in figure, for $x_1 = v_0$, $x_2 = i$ is



(a) $\begin{pmatrix} \dot{x}_1 \\ \dot{x}_2 \end{pmatrix} = \begin{pmatrix} 0 & \frac{1}{C} \\ \frac{1}{L} & \frac{-R}{L} \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} + \begin{pmatrix} 0 \\ \frac{1}{L} \end{pmatrix} v$

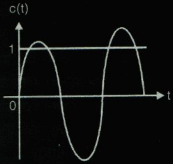
(b) $\begin{pmatrix} \dot{x}_1 \\ \dot{x}_2 \end{pmatrix} = \begin{pmatrix} 0 & \frac{1}{C} \\ \frac{1}{L} & \frac{R}{L} \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} + \begin{pmatrix} 1 \\ \frac{1}{L} \end{pmatrix} v$

(c) $\begin{pmatrix} \dot{x}_1 \\ \dot{x}_2 \end{pmatrix} = \begin{pmatrix} 0 & \frac{1}{C} \\ \frac{-1}{L} & \frac{-R}{L} \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} + \begin{pmatrix} 0 \\ \frac{1}{L} \end{pmatrix} v$

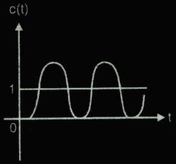
(d) $\begin{pmatrix} \dot{x}_1 \\ \dot{x}_2 \end{pmatrix} = \begin{pmatrix} 0 & \frac{1}{C} \\ \frac{-1}{L} & \frac{-R}{L} \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} + \begin{pmatrix} 1 \\ \frac{1}{L} \end{pmatrix} v$

52. The open-loop gain of a unity feedback system is $G(s) = \frac{\omega_n^2}{s(s+2\omega_n)}$. The unit step response c(t) of the system is

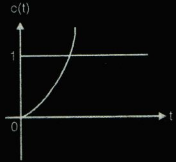
(a)



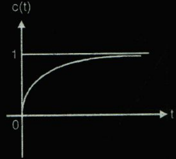
(b)



(c)



(d)



53. If $A = \begin{pmatrix} 2 & 0 \\ 0 & 2 \end{pmatrix}$, then e^{At} is given by

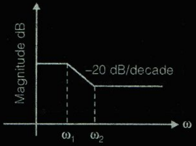
(a) $\begin{pmatrix} e^{2t} & 0 \\ 0 & e^{2t} \end{pmatrix}$ (b) $\begin{pmatrix} e^{-2t} & 0 \\ 0 & e^{-2t} \end{pmatrix}$

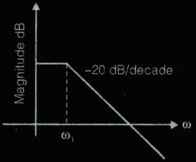
(c) $\begin{pmatrix} e^{t/2} & 0 \\ 0 & e^{t/2} \end{pmatrix}$ (d) $\begin{pmatrix} e^{-t/2} & 0 \\ 0 & e^{-t/2} \end{pmatrix}$

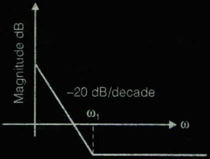
54. The angles of the asymptotes of the root loci of the equation $s^3 + 5s^2 + (K + 2)s + K = 0$, for $0 \le K < \infty$, are

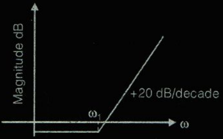
(a) 0° and 270° (b) 0° and 180°
(c) 90° and 270° (d) 90° and 180°

55. The Bode plot corresponding to a proportional derivative controller is the one shown in

(a) 

(b) 

(c) 

(d) 

56. In frequency modulation, the instantaneous
(a) amplitude of the carrier signal is varied with the instantaneous amplitude of the message signal
(b) amplitude of the carrier signal is varied with the instantaneous frequency of the message signal
(c) frequency of the carrier signal is varied with the instantaneous amplitude of the message signal
(d) frequency of the carrier signal is varied with the instantaneous frequency of the message signal

57. If X is a zero mean Gaussian random variable, then $P\{X \leq 0\}$ is
(a) 0 (b) 0.25
(c) 0.5 (d) 1

58. If a single-tone amplitude modulated signal at a modulation depth of 100% transmits a total power of 15 W, the power in the carrier component is
(a) 5 W (b) 10 W
(c) 12 W (d) 15 W

59. In a superheterodyne receiver, rejection of the image signal can be achieved by using a
(a) higher local oscillator frequency
(b) crystal oscillator
(c) narrow band IF filter
(d) narrow band filter at RF stage

60. The number of bits per sample of a PCM system depends upon the
(a) sampler type
(b) quantizer type
(c) number of levels of the quantizer
(d) sampling rate

61. Which one of the following is used for the detection of AM-DSB-SC signal?
(a) Ratio detector
(b) Foster-Seeley discriminator
(c) Product demodulator
(d) Balanced-slope detector

62. Which one of the following signal pairs can represent a BPSK signal?
(a) $A \cos 2\pi f_c t$, $A \sin 2\pi f_c t$
(b) $A \cos 2\pi f_c t$, $-A \sin 2\pi f_c t$
(c) $-A \cos 2\pi f_c t$, $A \cos 2\pi f_c t$
(d) $A \sin 2\pi f_c t$, $A \cos 2\pi f_c t$

63. Which one of the following can be used for the detection of the noncoherent BFSK signal?
(a) Matched filter
(b) Phase-locked loop
(c) Envelope detector
(d) Product demodulator

64. Bits of duration T_b are to be transmitted using a BPSK modulation with a carrier of frequency f_c Hz. The power spectral density of the transmitted signal has the first null at the normalized frequency
(a) $|f - f_c| T_b = 0$ (b) $|f - f_c| T_b = 1$
(c) $|f - f_c| T_b = 2$ (d) $|f - f_c| T_b = 4$

65. The probability of bit error of a BFSK modulation scheme, with transmitted signal energy per bit E_b, in an additive white Gaussian noise channel having one-sided power spectral density N_0, is

(a) $\frac{1}{2}\text{erfc}\left(\frac{E_b}{2N_0}\right)$ (b) $\frac{1}{2}\text{erfc}\left(\sqrt{\frac{E_b}{2N_0}}\right)$

(c) $\frac{1}{2}\text{erfc}\left(\frac{E_b}{N_0}\right)$ (d) $\frac{1}{2}\text{erfc}\left(\sqrt{\frac{E_b}{N_0}}\right)$

66. For a given transmitted pulse p(t), $0 \le t \le T$, the impulse response of a filter matched to the received signal is

(a) $-p(t-T),\ 0 \le t \le T$
(b) $-p(T-t),\ 0 \le t \le T$
(c) $p(t-T),\ 0 \le t \le T$
(d) $p(T-t),\ 0 \le t \le T$

67. The multiple access communication scheme in which each user is allocated the full available channel spectrum for a specified duration of time is known as

(a) CDMA (b) FDMA
(c) TDMA (d) MC-CDMA

68. GSM system uses TDMA with

(a) 32 users per channel
(b) 16 users per channel
(c) 8 users per channel
(d) 4 users per channel

69. If $R_X(\tau)$ is the auto correlation function of a zero-mean wide sense stationary random process X, then which one of the following is NOT true?

(a) $R_X(\tau) = R_X(-\tau)$ (b) $R_X(\tau) = -R_X(-\tau)$

(c) $\sigma_X^2 = R_X(0)$ (d) $|R_X(\tau)| \le R_X(0)$

70. If E denotes the expectation operator, then $E[X - EX]^3$ of a random variable X is

(a) $EX^3 - E^3X$
(b) $EX^3 + 2E^3X - 3EX\,EX^2$
(c) $3EX^3 - E^3X$
(d) $2EX^3 + E^3X - 3EX\,EX^2$

71. A discrete memoryless source produces symbols m_1, m_2, m_3 and m_4 with probabilities $\frac{1}{2}, \frac{1}{4}, \frac{1}{8}$ and $\frac{1}{8}$, respectively. The entropy of the source is

(a) $\frac{1}{4}$ (b) 1

(c) $\frac{7}{4}$ (d) 2

72. A channel has a signal-to-noise ratio of 63 and bandwidth of 1200 Hz. The maximum data rate that can be sent through the channel with arbitrary low probability of error is

(a) 600 bps (b) 1200 bps
(c) 4800 bps (d) 7200 bps

73. For the vectors $\bar{A} = x\hat{a}_x + y\hat{a}_x$ and $\bar{B} = z\hat{a}_z$, $\nabla \cdot (\bar{A} \times \bar{B})$ is

(a) 0 (b) 1
(c) xz (d) yz

74. Which one of the following relations represent Stoke's theorem (symbols have their usual meaning)?

(a) $\int_S \nabla \times \vec{A} \cdot \vec{ds} = 0$

(b) $\oint_L \vec{A} \cdot \vec{dl} = \int_S \nabla \times \vec{A} \cdot \vec{ds}$

(c) $\int_S \vec{A} \times \vec{dS} = -\int_V (\nabla \times \vec{A})\, dv$

(d) $\int_V \nabla \cdot \vec{A}\, dv = \oint_S \vec{A} \cdot \vec{ds}$

75. Which one of the following is NOT correct (symbols have their usual meaning)?

(a) $\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$ (b) $\nabla \times \bar{H} = \vec{J} + \frac{\partial \vec{E}}{\partial t}$

(c) $\nabla \cdot \vec{D} = \rho_v$ (d) $\nabla \cdot \vec{B} = 0$

76. The electric field component of a uniform plane wave propagating in a lossless magnetic dielectric medium is given by

$\vec{E}(t, z) = \hat{a}_x\, 5\cos\left(10^9 t - \frac{20}{3} z\right)$ V/m. If η_0 represents the intrinsic impedance of the free space, the corresponding magnetic field component is given by

(a) $\vec{H}(t, z) = \hat{a}_y \frac{5}{2\eta_0} \cos\left(10^9 t - \frac{20}{3} z\right)$ A/m

(b) $\vec{H}(t, z) = \hat{a}_y \frac{10}{\eta_0} \cos\left(10^9 t - \frac{20}{3} z\right)$ A/m

(c) $\vec{H}(t, z) = \hat{a}_z \frac{10}{2\eta_0} \cos\left(10^9 t - \frac{20}{3} z\right)$ A/m

(d) $\vec{H}(t, z) = \hat{a}_z \frac{10}{\eta_0} \cos\left(10^9 t - \frac{20}{3} z\right)$ A/m

77. The skin depth of a non-magnetic conducting material at 100 MHz is 0.15 mm. The distance which a plane wave of frequency 10 GHz travels in this material before its amplitude reduces by a factor of e^{-1} is

(a) 0.0015 mm (b) 0.015 mm
(c) 0.15 mm (d) 1.5 mm

78. A lossless transmission line has a characteristic impedance of 100 Ω an inductance per unit length of 1 μH/m. If the line is operated at 1 GHz, the propagation constant β is

(a) 2π rad/m (b) $\frac{20\pi}{3}$ rad/m
(c) 20π rad/m (d) $2\pi \times 10^5$ rad/m

79. When a load resistance R_L is connected to a lossless transmission line of characteristic impedance 75 Ω, it results in a VSWR of 2. The load resistance is

(a) 100 Ω (b) $75\sqrt{2}$ Ω
(c) 120 Ω (d) 150 Ω

80. A two-port characterized by the S-parameter matrix,

$$[s] = \begin{bmatrix} 0.3\angle 0^\circ & 0.9\angle 90^\circ \\ 0.9\angle 90^\circ & 0.2\angle 0^\circ \end{bmatrix} \text{ is}$$

(a) both reciprocal and lossless
(b) reciprocal, but not lossless
(c) lossless, but not reciprocal
(d) neither reciprocal nor lossless

81. A lossless air filled rectangular waveguide has internal dimensions of a cm × b cm. If a = 2b and the cut-off frequency of the TE_{02} mode is 12 GHz, the cut-off frequency of the dominant mode is

(a) 1 GHz (b) 3 GHz
(c) 6 GHz (d) 9 GHz

82. A Hertzian dipole antenna is placed at the origin of a coordinate system and it is oriented along z-axis. In which one of the following planes the radiation pattern of the antenna has a circular shape?

(a) x = 0 (b) y = 0
(c) z = 0 (d) $\phi = 45^\circ$

83. Which of the following statements is NOT true?

(a) Antenna losses are taken into account in calculating its power gain
(b) For an antenna which does not dissipate any power, the directive gain and the power gain are equal
(c) Directivity of an antenna is the maximum value of its directive gain
(d) The directive gain of a Hertzian dipole is same in all directions

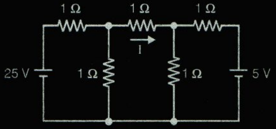
84. The directivity of a half wave dipole antenna is

(a) 1.0 (b) 1.5
(c) 1.64 (d) 2

85. Which one of the following statements is NOT true for a step index optical fibre?

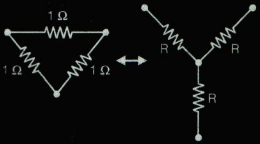
(a) It can support multiple modes
(b) HE_{11} mode is its lowest order mode
(c) The refractive index of the cladding is higher that of the core
(d) At a given wavelength, single mode operation is possible by proper choice of core diameter, core and cladding refractive indices

86. The current I in the network in figure is



(a) 1 A (b) 3 A
(c) 5 A (d) 7 A

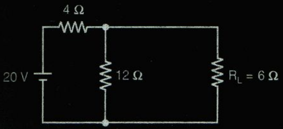
87. For the Delta-Wye transformation in figure, the value of the resistance R is



(a) $\frac{1}{3}\,\Omega$ (b) $\frac{2}{3}\,\Omega$

(c) $\frac{3}{2}\,\Omega$ (d) $3\,\Omega$

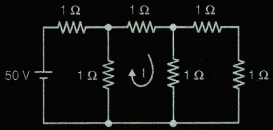
88. In the network in figure, the Thevenin's equivalent as seen by the load resistance R_L is



(a) $V_{Th} = 10$ V, $R_{Th} = 2\,\Omega$
(b) $V_{Th} = 10$ V, $R_{Th} = 3\,\Omega$
(c) $V_{Th} = 15$ V, $R_{Th} = 2\,\Omega$
(d) $V_{Th} = 15$ V, $R_{Th} = 3\,\Omega$

89. The current i in a series R-L circuit with R = 10 Ω and L = 20 mH is given by i = 2sin 500t A. If v is the voltage across the R-L combination, then i
(a) lags v by 45° (b) is in-phase with v
(c) leads v by 45° (d) lags v by 90°

90. In the network in figure, the mesh current I and the input impedance seen by the 50 V source, respectively, are



(a) $\frac{125}{13}$ A and $\frac{11}{8}\,\Omega$

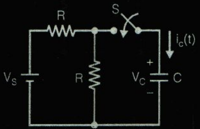
(b) $\frac{150}{13}$ A and $\frac{13}{8}\,\Omega$

(c) $\frac{150}{13}$ A and $\frac{11}{8}\,\Omega$

(d) $\frac{125}{13}$ A and $\frac{13}{8}\,\Omega$

91. A voltage source having a source impedance $Z_S = R_S + jX_S$ can deliver maximum average power to a load impedance Z_L, when
(a) $Z_L = R_S + jX_s$ (b) $Z_L = R_S$
(c) $Z_L = jX_S$ (d) $Z_L = R_S - jX_S$

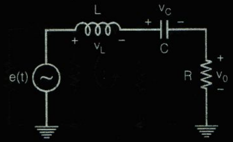
92. In the circuit in figure, the switch S is closed at t = 0. Assuming that there is no initial charge in the capacitor, the current $i_c(t)$ for t > 0 is



(a) $\frac{V_S}{R}e^{-\frac{2t}{RC}}$A (b) $\frac{V_S}{R}e^{-\frac{t}{RC}}$A

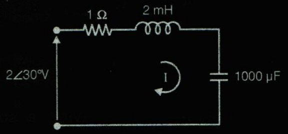
(c) $\frac{V_S}{2R}e^{-\frac{2t}{RC}}$A (d) $\frac{V_S}{2R}e^{-\frac{t}{RC}}$A

93. For the circuit in figure, if e(t) is a unit ramp signal, the steady state value of the output voltage $v_0(t)$ is



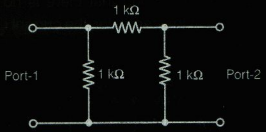
(a) 0 (b) LC
(c) R/L (d) RC

94. For the series RLC circuit in figure, if ω = 1000 rad/sec, then the current I (in Ampere) is



(a) $2\angle -15°$ (b) $2\angle 15°$
(c) $\sqrt{2}\angle -15°$ (d) $\sqrt{2}\angle 15°$

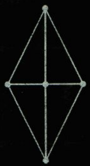
95. The Y-parameter matrix (mA/V) of the two-port network in figure is



(a) $\begin{pmatrix} 2 & -1 \\ -1 & 2 \end{pmatrix}$ (b) $\begin{pmatrix} 2 & 1 \\ -1 & 2 \end{pmatrix}$

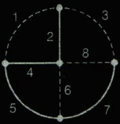
(c) $\begin{pmatrix} 1 & -2 \\ -2 & 1 \end{pmatrix}$ (d) $\begin{pmatrix} 2 & 1 \\ 1 & 2 \end{pmatrix}$

96. The maximum number of trees of the graph in figure is



(a) 16 (b) 25
(c) 100 (d) 125

97. Figure shows a graph and one of its trees (darker lines). Corresponding to the tree, the group of branches that CAN NOT constitute a fundamental cutset is



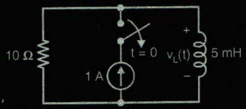
(a) 1, 2, 3 (b) 1, 4, 6, 8, 3
(c) 5, 6, 8, 3 (d) 4, 6, 7, 3

98. The Y-parameter matrix of a network is given by $Y = \begin{pmatrix} 1 & 1 \\ -1 & 1 \end{pmatrix}$ A/V. The Z_{11} parameter of the same network is

(a) $\frac{1}{2}\,\Omega$ (b) $\frac{1}{\sqrt{2}}\,\Omega$

(c) 1 Ω (d) 2 Ω

99. For the circuit in figure, the switch was kept closed for a long time before opening it at time t = 0. The voltage $v_L(0+)$ is



(a) –10 V (b) –1 V
(c) 0 V (d) 10 V

100. The input impedance of a series RLC circuit operating at frequency $\omega = \sqrt{2}\omega_0$, ω_0 being the resonant frequency, is

(a) $\left(R - j\frac{\omega_0 L}{\sqrt{2}}\right)\Omega$ (b) $\left(R + j\frac{\omega_0 L}{\sqrt{2}}\right)\Omega$

(c) $(R - j\sqrt{2}\omega_0 L)\Omega$ (d) $(R + j\sqrt{2}\omega_0 L)\Omega$

SECTION-B (NON-TECHNICAL)

101. Sarnath is situated in the state of
(a) Madhya Pradesh
(b) Bihar
(c) Punjab
(d) Uttar Pradesh

102. Green house effect is due to the increase of atmospheric
(a) CO_2 level (b) SO_2 level
(c) CO level (d) N_2 level

103. In the month of July, it is winter in
(a) New York (b) Beijing
(c) Sydney (d) London

104. The Chairman of the Planning Commission of India is
(a) The Prime Minister
(b) The Vice President
(c) The Union Finance Minister
(d) The Union Commerce Minister

105. The satellite launch vehicle that placed a number of satellites into orbit in May 2008 is
(a) PSLV-C7 (b) PSLV-C8
(c) PSLV-C9 (d) PSLV-C10

106. DRDO was formed in
(a) 1947 (b) 1950
(c) 1954 (d) 1958

107. SAMYUKTA is developed for the use of
(a) Navy (b) Army
(c) Air force (d) RAC

108. DARL 202 is a variety of
(a) pea (b) garlic
(c) capsicum (d) tomato

109. TRISHUL is
(a) a surface to surface battle field missile
(b) a quick reaction surface to air missile
(c) an intermediate range ballistic missile
(d) a supersonic cruise missile

110. HUMSA is a
(a) sonar
(b) tank
(c) mine
(d) night vision device

111. The value of $\frac{1+2i}{3-4i} + \frac{2-i}{5i}$, where $i^2 = -1$, is

(a) $-\frac{5}{2}$ (b) $\frac{5}{2}$

(c) $\frac{2}{5}$ (d) $-\frac{2}{5}$

112. The particular solution of the differential equation $\frac{d^2y}{dx^2} + 2\frac{dy}{dx} + 5y = 0$ satisfying the conditions $y(0) = 0$ and $y'(0) = 1$ is

(a) $y = \frac{1}{2}e^{-x}\cos 2x$

(b) $y = \frac{1}{2}e^{-x}\sin 4x$

(c) $y = \frac{1}{2}e^{-x}\sin 2x$

(d) $y = \frac{1}{2}e^{-x}\cos 4x$

113. For the vectors $\vec{A} = 3\hat{i} - 2\hat{j} + \hat{k}$ and $\vec{B} = 2\hat{i} - \hat{k}$, the value of $(\vec{A} \times \vec{B}) \cdot \vec{A}$ is
(a) 0 (b) 1
(c) 2 (d) 3

114. The orthogonal trajectory of the family of curves $x^2 - y^2 = \alpha$ (where α is a constant) and passing through the point (1, 1) is

(a) $y = -\frac{1}{x}$ (b) $y = \frac{1}{x}$

(c) $y = -x$ (d) $y = x$

115. The value of the line integral $\int y^2dx + 2xy\,dy$ over the curve $x = a\cos t$, $y = a\sin t$ is

(a) 0 (b) 1
(c) 2 (d) 4

116. The n-th partial sum of the infinite series

$$\frac{1}{1\times2}+\frac{1}{2\times3}+\frac{1}{3\times4}+\cdots+\frac{1}{n\times(n+1)}+\cdots \text{ is}$$

(a) $\frac{1}{n+1}$ (b) $\frac{n+2}{n+1}$
(c) $\frac{n}{n+1}$ (d) $\frac{n-1}{n+1}$

117. The complex-valued function $f(z) = e^z$ is analytic for

(a) no z (b) all z
(c) real z only (d) imaginary z only

118. The inverse of the matrix $\begin{pmatrix}\cos\theta & \sin\theta\\ -\sin\theta & \cos\theta\end{pmatrix}$ is

(a) $\begin{pmatrix}-\cos\theta & \sin\theta\\ \sin\theta & \cos\theta\end{pmatrix}$

(b) $\begin{pmatrix}\cos\theta & \sin\theta\\ \sin\theta & -\cos\theta\end{pmatrix}$

(c) $\begin{pmatrix}\cos\theta & -\sin\theta\\ -\sin\theta & \cos\theta\end{pmatrix}$

(d) $\begin{pmatrix}\cos\theta & -\sin\theta\\ \sin\theta & \cos\theta\end{pmatrix}$

119. Consider the function f(x) defined as

$$f(x)=\begin{cases}3x-1, & x<0\\ 0, & x=0\\ 2x+5, & x>0\end{cases}$$

In the following table List-I shows four expressions for limits of f(x) and List-II indicates the values of the limit

List-I	List-II
A. $\lim_{x\to2} f(x)$	1. −1
B. $\lim_{x\to0^+} f(x)$	2. 9
C. $\lim_{x\to0^-} f(x)$	3. −10
D. $\lim_{x\to-3} f(x)$	4. 5

The CORRECT matches for items in List-I and List-II are:

Codes:

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

120. Two events A and B with probability 0.5 and 0.7, respectively, have joint probability of 0.4. The probability that neither A nor B happens is

(a) 0.2 (b) 0.4
(c) 0.6 (d) 0.8

121. Consider the differential equation

$$x^2\frac{d^2y}{dx^2}+x\frac{dy}{dx}+(x^2-4)y=0$$

The statements which is NOT TRUE for this differential equation is:

(a) It is a linear second order ordinary differential equation
(b) It cannot be reduced to a differential equation with constant coefficients
(c) x = 0 is a regular singular point
(d) It is a non-homogeneous second order ordinary differential equation

122. The sum of two numbers is 16 and the sum of their squares is a minimum. The two numbers are

(a) 10, 6 (b) 9, 7
(c) 8, 8 (d) 5, 11

123. The value of the definite $\int_0^{\left(\frac{\pi}{2}\right)^{1/3}} x^2\sin(x^3)dx$ is

(a) $-\frac{1}{3}$ (b) 0

(c) 1 (d) $\frac{1}{3}$

124. A circle C_2 is concentric with the circle $C_1: x^2 + y^2 - 4x + 6y - 12 = 0$, and has a radius twice that of C_1. The equation of the circle C_2 is
(a) $x^2 + y^2 - 4x + 6y - 13 = 0$
(b) $x^2 + y^2 - 4x + 6y - 87 = 0$
(c) $x^2 + y^2 - 4x + 6y - 100 = 0$
(d) $x^2 + y^2 - 4x + 6y - 88 = 0$

125. Consider the quadratic equation $x^2 + px + q = 0$. If p and q are roots of the equation, the values of p and q are
(a) $p = 0, q = 0$ only
(b) $p = 1, q = -2$ only
(c) $p = 0, q = 0$ and $p = 1, q = -2$
(d) $p = 0, q = 0$ and $p = -2, q = 1$

126. Consider the list of words: etiquette, accomodate, forty, exaggerate, continous, independant, reciept.
The number of misspelt words in the list is
(a) 1 (b) 2
(c) 3 (d) 4

127. Consider the following sentences:
Sentence 1: A few friends he has are all very rich.
Sentence 2: Do not insult the weak.
Sentence 3: The later of the two persons was more interesting.
Sentence 4: All the informations were correct.
(a) Sentence 1 (b) Sentence 2
(c) Sentence 3 (d) Sentence 4

128. The appropriate auxiliary verb to fill in the blank of the sentence "Gandhi knew that he ____ soon be jailed." is
(a) would (b) will
(c) shall (d) may

129. The number of missing punctuation marks in the sentence "Rajesh along with Amit went to the market." is
(a) 0 (b) 1
(c) 2 (d) 3

130. The meaning of word PLAGIARISM is
(a) theft of public money
(b) theft of idea
(c) belief in one god
(d) belief in many gods

131. The antonym of the word TRANSIENT is
(a) certain (b) close
(c) fire (d) water

132. ACROPHOBIA is the abnormal fear of
(a) open space (b) height
(c) fire (d) water

133. The appropriate pair of prepositions to fill in the blanks in the sentence "He was angry ____ me, because my remarks were aimed ____ him." is
(a) at, to (b) with, at
(c) with, to (d) at, for

134. The appropriate word(s) to fill up the blank in the sentence "I remember ____ voices in the middle of the night." is (are)
(a) hear (b) to hear
(c) hearing (d) heard

135. The passive voice form of the sentence "I have known him for a long time." is
(a) He is known to me for a long time
(b) He is known by me for a long time
(c) He has been known to me for a long time
(d) He has been known by me for a long time

136. If kennel is to a dog, then ____ is to a hen.
(a) nest (b) coop
(c) hole (d) stable

137. If NATION is to 523675 then NOTION is to
(a) 573675 (b) 563765
(c) 576375 (d) 557365

138. The next two number of the series 3, 5, 11, 21 are
(a) 34 and 52 (b) 34 and 53
(c) 35 and 52 (d) 35 and 53

139. A, B and C are three places in India with longitude 80°E, 85° E and 90° E respectively. Which one of the following statements about the local times of the places is true?
(a) Local time of C is ahead of that of B
(b) Local time of B is ahead of that of C
(c) Local time of A is ahead of that of C
(d) A, B and C all have the same local time

140. In this question, notations +, ÷ and × are used as follows
A + B means A is the husband of B;
A ÷ S means A is the sister of B;
A × B means A is the son of B.
With these relations, the relationship denoted by P ÷ Q × R is
(a) P is son of R (b) P is daughter of R
(c) P is uncle of R (d) P is father of R

141. If DELHI written as EDHIL, then PARIS written as
(a) APRIS (b) SARIP
(c) SAPIR (d) APISR

142. The number of prime numbers between 10 and 50 is
(a) 10 (b) 11
(c) 12 (d) 13

143. The odd one in the list: LAN, TCP/IP, HACKER and KILLER is
(a) LAN (b) TCP/IP
(c) KILLER (d) HACKER

144. SAW is to carpenter as SCALPEL is to
(a) surgeon (b) mason
(c) plumber (d) tailor

145. The first three pictures in a sequence are given below:

The next figure in the sequence is

(a) 

(b) 

(c) 

(d) 

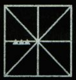
146. The first three pictures in a sequence are given below:

The next picture in the sequence is

(a) 

(b) 

(c) 

(d) 

147. The first three pictures in a sequence are given below:

The next picture in the sequence is

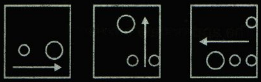
(a) 

(b) 

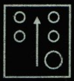
(c) 

(d) 

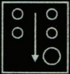
148. The first three pictures in a sequence are given below:

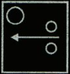


The next picture in the sequence

(a) 

(b) 

(c) 

(d) 

149. Consider figure X given below

Figure x

When figure X is rotated clockwise 90° and held before a plane mirror, the image obtained is

(a) 

(b) 

(c) 

(d) 

150. The relationship between Figure (I) and Figure (II) is similar to that between Figure (III) and the missing Figure (IV) below:

Figure (I)

Figure (II)

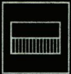


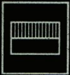
Figure (III)

Figure (IV)

The figure (IV) is

(a) 

(b) 

(c) 

(d)