GATE - 1995

Electronics and Communication Engineering

1. For each of the following question (1.1 - 1.47), 4 alternatives, a,b, c and d are given.

1.1 A DC voltage source is connected across a series R-L-C circuit. Under steady-state conditions, the applied DC voltage drops entirely across the

(*a*) R only (*b*) L only
(*c*) C only (*d*) R and L combination

1.2 Consider a DC voltage source connected to a series R-C circuit. When the steady-state reaches, the ratio of the energy stored in the capacitor to the total energy supplied by the voltage source, is equal to

(*a*) 0.362 (*b*) 0.500
(*b*) 0.632 (*d*) 1,000

1.3 Two 2 H inductance coils are connected in series and are also magnetically coupled to each other the coefficient of coupling being 0.1. The total inductance of the combination can be

(*a*) 0.4 H (*b*) 3.2 H
(*c*) 4.0 H (*d*) 3.3 H

1.4 The RMS value of a rectangular wave of period T, having a value of + V for a duration, T_1 (< T) and -V for the duration, $T - T_1 = T_2$, equals

(*a*) V (*b*) $\frac{T_1 - T_2}{T} V$

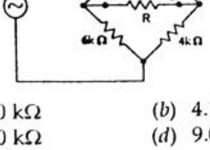
(*c*) $\frac{V}{\sqrt{2}}$ (*d*) $\frac{T_1}{T_2} V$

1.5 If $L[f(t)] = \frac{2(s+1)}{s^2+2s+5}$ then $f(0+)$ and $f(\infty)$ are given by

(*a*) 0, 2 respectively (*b*) 2, 0 respectively
(*c*) 0,1 respectively (*d*) 2/5, 0 respectively

[**Note :** 'L' stands for 'Laplace Transform of']

1.6 The value of the resistance, R, connected across the terminals, A and B, which will absorb the maximum power, is



(*a*) 4.00 kΩ (*b*) 4.11 kΩ
(*c*) 8.00 kΩ (*d*) 9.00 kΩ

1.7 The current, $i(t)$, through a 10 Ω resistor in series with an inductance, is given by

$i(t) = 3 + 4\sin(100t + 45°) + 4\sin(300t + 60°)$ Amperes

The RMS value of the current and the power dissipated in the circuit are :

(*a*) $\sqrt{41}$ A, 410 W, respectively
(*b*) $\sqrt{35}$ A, 350 W, respectively
(*c*) 5 A, 250 W, respectively
(*d*) 11 A, 1210 W, respectively

1.8 Signal flow graph is used to find

(*a*) stability of the system
(*b*) controllability of the system
(*c*) transfer function of the system
(*d*) poles of the system

1.9 The step error coefficient of a system $G(s) = \frac{1}{(s+6)(s+1)}$ with unity feedback is

(*a*) 1/6 (*b*) ∞
(*c*) 0 (*d*) 1

1.10 The final value theorem is used to find the

(*a*) steady state value of the system output
(*b*) initial value of the system output
(*c*) transient behaviour of the system output
(*d*) none of these

1.11 For a second order system , damping ratio, (ξ) is $0 < \xi < 1$, then the roots of the characteristic polynomial are

(*a*) real but not equal
(*b*) real and equal
(*c*) complex conjugates
(*d*) imaginary

1.12 The transfer function of a linear system is the

(*a*) ratio of the output, $v_0(t)$, and input, $v_i(t)$
(*b*) ratio of the derivatives of the output and the input
(*c*) ratio of the Laplace transform of the output and that of the input with all initial conditions zeros
(*d*) none of these

1.13 e^{At} can be expanded as

(*a*) $\sum_{k=0}^{\infty} \frac{A^k t^k}{(k+1)!}$ (*b*) $\sum_{k=0}^{\infty} \frac{A^k t^k}{k!}$

(*c*) $\sum_{k=0}^{\infty} \frac{A^k t^{k+1}}{(k+1)!}$ (*d*) $\sum_{k=0}^{\infty} \frac{A^k t^{k+1}}{k!}$

1.14 Non-minimum phase transfer function is defined as the transfer function.

(*a*) which has zeros in the right-half *S*-plane
(*b*) which has zeros only in the left-half *S*-plane
(*c*) which has poles in the right-half *S*-plane
(*d*) which has poles in the left-half *S*-plane

1.15 The solution of $\dot{X} = A(t)\,X(t)$, is

(*a*) $e^{At} \cdot X_0$ (*b*) $e^{\int_{t_0}^{t} A(\tau)d\tau} \cdot X_0$

(*c*) $\left[I + \int_{t_0}^{t} A(\tau)\, d\tau\right] X_0$ (*d*) none of these

1.16 Let h(t) be the impulse response of a linear time invariant system. Then the response of the system for any input u(t) is

(*a*) $\int_0^t h(\tau)\, u(t-\tau) d\tau$ (*b*) $\frac{d}{dt}\int_0^t h(\tau)\, u(t-\tau) d\tau$

(*c*) $\left[\int_0^t h(\tau)\, u(t-\tau) d\tau\right]$ (*d*) $\int_0^t h^2(\tau)\, u(t-\tau) d\tau$

1.17 The probability that an electron in a metal occupies the Fermi-level at any temperature (> 0 K)

(*a*) 0 (*b*) 1
(*c*) 0.5 (*d*) 1.0

1.18 The drift velocity of electrons, in silicon

(*a*) is proportional to the electric field for all values of electric field
(*b*) is independent of the electric field
(*c*) increases at low values of electric field and decreases at high values of electric field exhibiting negative differential resistance
(*d*) increases linearly with electric field at low values of electric field and gradually saturates at higher values of electric field.

1.19 The diffusion potential across a P-N junction

(*a*) decreases with increasing doping concentration
(*b*) increases with decreasing band gap
(*c*) does not depend on doping concentration
(*d*) increases with increase in doping concentrations

1.20 The break down voltage of a transistor with its base open is BV_{CEO} and that with emitter open is BV_{CBO}, then

(*a*) $BV_{CEO} = BV_{CBO}$
(*b*) $BV_{CEO} > BV_{CBO}$
(*c*) $BV_{CEO} < BV_{CBO}$
(*d*) BV_{CEO} is not related to BV_{CBO}

1.21 In a P type silicon sample, the hole concentration is $2.25 \times 10^{15}/cm^3$. If the intrinsic carrier concentration is $1.5 \times 10^{10}/cm^3$, the electron concentration is

(*a*) zero (*b*) $10^{10}/cm^3$
(*c*) $10^5/cm^3$ (*d*) $1.5 \times 10^{25}/cm^3$.

1.22 A zener diode works on the principle of

(*a*) tunneling of charge carriers across the junction
(*b*) thermionic emission
(*c*) diffusion of charge carriers across the junction
(*d*) hopping of charge carriers across the junction

1.23 A BJT is said to be operating in the saturation region if

(*a*) both the junctions are reverse biased
(*b*) base-emitter junction is reverse biased and base-collector junction is forward biased
(*c*) base-emitter junction is forward biased and base-collector junction reverse-biased
(*d*) both the junctions are forward biased

1.24 The depletion capacitance, C_J, of an abrupt P-N junction with constant doping on either side varies with reverse bias, V_R, as

(*a*) $C_J \propto V_R$ (*b*) $C_J \propto V_R^{-1}$
(*c*) $C_J \propto V_R^{-1/2}$ (*d*) $C_J \propto V_R^{-1/3}$

1.25 A change in the value of the emitter resistance, R_e, in a difference amplifier

(*a*) affects the difference mode gain A_d
(*b*) affects the common mode gain A_c
(*c*) affects both A_d and A_c
(*d*) does not affect either A_d and A_c

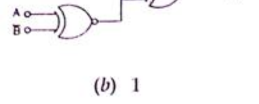
1.26 The Ebers-Moll model is applicable to

(*a*) bipolar junction transistors
(*b*) NMOS transistors
(*c*) unipolar junction transistors
(*d*) junction field-effect transistors

1.27 To obtain very high input and output impedances in a feedback amplifier, the topolomostly used is

(*a*) voltage-series (*b*) current-series
(*c*) voltage-shunt (*d*) current-shunt

1.28 The output of the circuit in the figure is equal to



(*a*) 0 (*b*) 1

(*c*) $\bar{A}B + A\bar{B}$ (*d*) $\overline{(A * B)} * \overline{(A * B)}$

1.29 The minimum number of NAND gates required to implement the Boolean function $A + A\overline{B} + A\overline{B}C$, is equal to
(*a*) zero (*b*) 1
(*c*) 4 (*d*) 7

1.30 A switch-tail ring counter is made by using a single D flip-flop. The resulting circuit is a
(*a*) SR flip-flop (*b*) JK flip-flop
(*c*) D flip-flop (*d*) T flip-flop

1.31 When a CPU is interrupted, it
(*a*) stops execution of instructions
(*b*) acknowledges interrupt and branches of subroutine
(*c*) acknowledges interrupt and continues
(*d*) acknowledges interrupt and waits for the next instruction from the interrupting device

1.32 The minimum number of MOS transistors required to make a dynamic RAM cell is
(*a*) 1 (*b*) 2
(*c*) 3 (*d*) 4

1.33 An R-S latch is a
(*a*) combinatorial circuit
(*b*) synchronous sequental circuit
(*c*) one bit memory element
(*d*) one clock delay element

1.34 A 'DMA' transfer implies
(*a*) direct transfer of data between memory and accumulator
(*b*) direct transfer of data between memory and I/O devices without the use of μp
(*c*) transfer of data exclusively within μP registers
(*d*) A fast transfer of data between μP and *I/O* devices

1.35 An 'Assembler' for a microprocessor is used for
(*a*) assembly of processors in a production line
(*b*) creation of new programmes using differnet modules
(*c*) translation of a programm from assembly language to machine language
(*d*) translation of a higher level language into English text

1.36 The image (second) channel selectivity of a super beterodync communication receiver is determined by
(*a*) antenna and preselector
(*b*) the preselector and RF amplifier
(*c*) the preselector and IF amplifier
(*d*) the RF and IF amplifier

1.37 For a narrow band noise with Gaussian Gradrature components, the probability density function of its envelope will be
(*a*) uniform (*b*) Gaussian
(*c*) exponential (*d*) Rayleigh

1.38 If the number of bits per sample in a PCM system is increased from improvement in signal-to-quantisation noise ratio will be
(*a*) 3*d*B (*b*) 6*d*B
(*c*) 2*n* *d*B (*d*) 0 *d*B

1.39 A PLL can be used to demodulate
(*a*) PAM signals (*b*) PCM signals
(*c*) FM signals (*d*) DSB-SC signals

1.40 A PAM signal can be detected by using
(*a*) an ADC (*b*) an integrator
(*c*) a band pass filter (*d*) a high pass filter

1.41 A 1.0 kHz signal is flat-top sampled at the rate of 1800 samples sec and the samples are applied to an ideal rectangular LPF with cat-off frequency of 1100 Hz, then the output of the filter contains.
(*a*) only 800 Hz component
(*b*) 800 Hz and 900 Hz components
(*c*) 800 Hz and 1000 Hz components
(*d*) 800 Hz, 900 and 1000 Hz components

1.42 The signal to quantisation noise ratio in an n-bit PCM system
(*a*) depends upon the sampling frequency employed
(*b*) is independent of the value of '*n*'
(*c*) increases with increasing value of '*n*'
(*d*) decreases with the increasing value of '*n*'

1.43 The electric field strength at a distance point, P, due to a point charge, $+q$. located on the origin, is $100\ \mu$ V/m. If the point charge is now enclosed by a perfectly conducting metal sheet sphere whose centre is at the origin, then the electric field strength at the point. P. outside the sphere, becomes.
(*a*) zero (*b*) $100\ \mu$ V/m
(*c*) $-100\ \mu$ V/m (*d*) $50\ \mu$ V/m

1.44 In the infinite plance, $y = 6$ m, there exists a uniform surface charge density of $(1600\ \pi)$ $\mu\ C/m^2$. The associated electric field strength is
(*a*) $30\ i$ V/m (*b*) $30\ j$ V/m
(*c*) $30\ k$ V/m (*d*) $60\ i$ V/m

1.45 The intrinsic impedance of a lossy dielectric medium is given by
(*a*) $\frac{j\omega\mu}{\sigma}$ (*b*) $\frac{j\omega\varepsilon}{\mu}$
(*c*) $\sqrt{\frac{j\omega\mu}{\sigma + j\omega\varepsilon}}$ (*d*) $\sqrt{\frac{\mu}{\varepsilon}}$

1.46 An antenna, when radiating, has a highly directional radiation pattern. When the antenna is receiving, its radiation pattern
(*a*) is more directive
(*b*) is less directive
(*c*) is the same
(*d*) exhibits no directivity at all

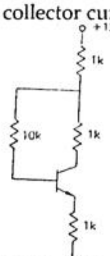
1.47 Copper behaves as a
(*a*) conductor always
(*b*) conductor or dielectric depending on the applied electric field strength
(*c*) conductor or dielectric depending on the frequency
(*d*) conductor or dielectric depending on the electric current density

2. **In each of the following questions, (2.1-2.10), fill in the blanks appropriately. (10 × 1 = 10)**

2.1 A series R–L–C circuit has a Q of 100 and an impedance of (100 + j0) Ω at its resonant angular frequency of 10^7 radian/sec. The values of R and L are :

R = ________ ohms, L = _________ ohms.

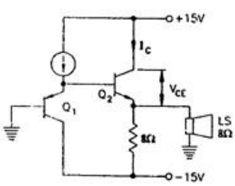
2.2 A transistor having $\alpha = 0.99$ and $V_{BE} = 0.7$ V, is used in the circuit shown the figure is. The value of the collector current will be



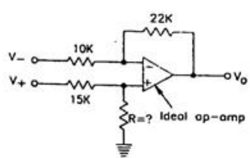
2.3 The circuit shown the given figure, supplies power to an 8 Ω speaker, LS. The values of I_C and V_{CE} for this circuit will be :

I_C = ____________

and V_{CE} = ____________



2.4 In the given circuit the given figure, if the voltage inputs V− and V+ are to be amplified by the same amplification factor, the value of R should be



2.5 An npn transistor under forward-active mode of operation is biased at $I_C = 1$ mA, and has a total emitter-base capacitance C_K of 12 pF, and the base transit time τ_F of 260 psec. Under this condition, the depetion capacitance of the emitter-base junction is ____________. [use $V_T = 26$ m V]

2.6 An RC-coupled amplifier is assumed to have a single-pole low frequency transfer function. The maximum lower cut-off frequency allowed for the amplifier to pass 50 Hz square wave with no more than 10% tilt is ________.

2.7 An OP-AMP is used as a zero-crossing detector. If the maximum output available from the OP-AMP is ± 12 V *p-p*, and the slew rate of the OP-AMP is 12 V/μsec, then the maximum frequency of the input signal that can be applied without causing a reduction in the *p-p* output is __________.

2.8 A power amplifiers delivers 50 W output at 50% efficiency. The ambient temperature is 25°C. If the maximum allowable junction temperature is 150°C, then the maximum thermal resistance ϕ_{jc} that can be tolerated is ________.

2.9 An amplifier has an open-loop gain of 100, and its lower-and upper-cut-off frequency of 100 Hz and 100 kHz, respectively. A feedback network with a feedback fact or of 0.99 is connected to the amplifier. The new lower and upper-cut-off frequencies are at __________ and __________.

2.10 An n-channel JFET has $I_{DSS} = 1$ mA and $V_P = -5$ V.
Its maximum transconductance is ________.

3. **In each of the following questions, (3.1 - 3.9), match each of the items, A,B and C with an appropriate item from 1, 2, 3, 4 and 5.**

3.1

(*A*) Fourier transform of a Gaussian function	(1) Gaussian function
(*B*) Convolution of a rectangular pulse with itself	(2) Rectangular pulse
(C) Current through an inductor for a step input voltage	(3) Triangular pulse
	(4) Ramp function
	(5) Zero

3.2 In a bipolar junction transistor if

(*A*) the current gain increases	(1) the base doping is increased and the base width is reduced
(*B*) the collector break-down voltage increases	(2) the base doping is reduced and the base width is increased

(C) the cut-off frequency increases | (3) the base doping and the base width are reduced
(4) the emitter area is increased and the collector area is reduced
(5) the base doping and the base width are increased

3.3 In a JFET if

(A) the pinch-off voltage decreases | (1) the channel doping is reduced
(B) the transconductance increases | (2) the channel length is increased
(C) the transit time of the carriers in the channel is reduced | (3) the conductivity of the channel increased
(4) the channel length is reduced
(5) the Gate area is reduced

3.4 In an extriansic semiconductor if

(A) the resistivity decreases | (1) the doping concentration is low
(B) the temperature coefficient of resistivity is negative | (2) the length of the semiconductor is reduced
(C) the photo conductivity is low | (3) the band gap is high
(4) the area of cross-section of the semiconductor is increased
(5) the doping concentration is increased

3.5 For a TTL gate, match the following

(A) V_{OH} (min) | (1) 2.4 volts
(B) V_{IH} (min) | (2) 1.5 volts
(C) V_{OL} (max) | (3) 0.4 volts
(4) 2.0 volts
(5) 0.8 volts

3.6 For an ADC, match the following

(A) Flash converter | (1) requires a conversion time of the order of a few seconds
(B) Dual slope converter | (2) requires a digital-to-analog converter
(C) Successive approximation converter | (3) minimizes the effect of power supply interference
(4) requires a very complex hardware
(5) is a tracking A/D convertes.

3.7 (A) Common-collector amplifier | (1) Provides voltage gain but no current gain
(B) Common-emitter amplifier | (2) Provides current gain but no voltage gain
(C) Common-base amplifier | (3) Provides neither voltage nor power gain
(4) Provides neither current nor power gain
(5) Provides both voltage and current gain

3.8 (A) AM system | (1) Coherent detection
(B) DSB-SC system | (2) Envelope detection
(C) PAM system | (3) Correlation detection
(4) PLL
(5) LPF

3.9 (A) AM system | (1) 2B (Band width of the modulating signal)
(B) SSB system | (2) 2B
(C) PCM (n bit) system | (3) Between B and 2B
(4) 2nB
(5) nB

$$V_0(s) = \frac{A}{s^2+1}\coth(\alpha s)$$

where α is a constant. Determine the value of α

■■

ANSWERS

1. 1 (c)	1. 2 (b)	1. 3 (d)	1. 4 (a)	1. 5 (b)	1. 6 (a)	1. 7 (c)	1. 8 (c)	1. 9 (a)	1. 10 (a)
1. 11 (c)	1. 12 (c)	1. 13 (b)	1. 14 (a,c)	1.15 (b)	1. 16 (a)	1. 17 (b)	1. 18 (d)	1. 19 (d)	1. 20 (c)
1. 21 (c)	1. 22 (a)	1. 23 (d)	1. 24 (c)	1. 25 (b)	1. 26 (a)	1. 27 (c)	1. 28 (a)	1. 29 (a)	1. 30 (d)
1. 31 (b)	1. 32 (d)	1. 33 (c)	1. 34 (b)	1. 35 (c)	1. 36 (b)	1. 37 (d)	1. 38 (b)	1. 39 (c)	1. 40 (b)
1. 41 (b)	1. 42 (c)	1. 43 (b)	1. 44 (*)	1. 45 (c)	1. 46 (c)	1. 47 (a)			