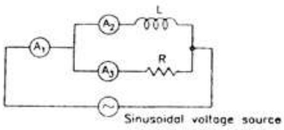
GATE - 1996

Electronics and Communication Engineering

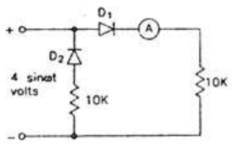
1. **For each of the following questions (1.1—1.20), four alternatives *a, b, c* and *d* are given.** **(20 × 1 = 20)**

1.1 In the given figure, A_1, A_2 and A_3 are ideal ammeters. If A_2 and A_3 read 3 A and 4 A respectvely, then A_1 should read



(*a*) 1 A (*b*) 5 A
(*c*) 7 A (*d*) None of these

1.2 In the circuit of the given figure, assume that the diodes are ideal and the meter is an average indicating ammeter. The ammeter will read



(*a*) $0.4\sqrt{2}$ A (*b*) 0.4 A
(*c*) $\frac{0.8}{\pi}$ A (*d*) $\frac{0.4}{\pi}$

1.3 The number of independent loops for a network with n nodes and b branches is
(*a*) $n - 1$
(*b*) $b - n$
(*c*) $b - n + 1$
(*d*) independent of the number of nodes

1.4 A lossless transmission line having 50Ω charateristic impedance and lengh $\lambda/4$ is short circuited at one end and connected to an ideal voltage source of 1 V at the other end. The current drawn from the voltage source is
(*a*) 0 (*b*) 0.02 A
(*c*) ∞ (*d*) none of these

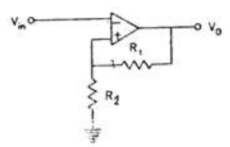
1.5 The *p*-type substrate in a conventional *pn*-junction isolated integrated circuit should be connected to
(*a*) nowhere, i.e. left floating
(*b*) a *dc* ground potential
(*c*) the most positive potential available in the circuit
(*d*) the most negative potential available in the circuit

1.6 If a transistor is operating with both of its junctions forward biased, but with the collector base forward bais greater than the emitter - base forward bias, then it is operating in the
(*a*) forward active mode
(*b*) reverse saturation mode
(*c*) reverse active mode
(*d*) forward saturation mode

1.7 The common-emitter short-circuit current gain β of a transistor
(*a*) is a monotonically increasing function of the collector current I_C
(*b*) is a monotonically decreasing function of I_C
(*c*) increases with I_C, for low I_C, reaches a maximum and then decreases with further increase in I_C
(*d*) is not a function of I_C

1.8 A n-channel silicon (E_g = 1.1 eV) MOSFET was fabricated using n + poly-silicon gate and the threshold voltage was found to be 1 V. Now, if the gate is changed to p^+ poly-silicon, other things remaining the same, the new threshold voltage should be
(*a*) − 0.1 V (*b*) 0 V
(*c*) 1.0 V (*d*) 2.1 V

1.9 The circuit shown in the figure is that of



(*a*) a non-inverting amplifier
(*b*) an inverting amplifier
(*c*) an oscillator
(*d*) a Schmitt trigger

1.10 Schottky clamping is resorted in TTL gates
(*a*) to reduce propagation delay
(*b*) to increase noise margins
(*c*) to increase packing density
(*d*) to increase fan-out

1.11 A pulse train can be delayed by a finite number of clock periods using

(*a*) a serial-in serial-out shift register
(*b*) a serial-in parallel-out shift register
(*c*) a parallel-in serial-out shift register
(*d*) a paralel-in parallel-out shift register

1.12 A 12-bit ADC is operating with a 1 μ sec clock period and the total conversion time is seen to be 14 μ secs. The ADC must be of the

(*a*) flash type
(*b*) counting type
(*c*) intergrating type
(*d*) successive approximation type

1.13 The total number of memory accesses involved (inclusive of the op-code fetch) when an 8085 processor executes the instruction LDA 2003 is

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

1.14 The trigonometric Fourier series of an even function of time does not have the

(*a*) *dc* term (*b*) cosine terms
(*c*) sine terms (*d*) odd harmonic terms

1.15 The Fourier transform of a real valued time signal has

(*a*) odd symmetry
(*b*) even symmetry
(*c*) conjugate symmetry
(*d*) no symmetry

1.16 A rectangular pulse of duration T is applied to a filter matched to this input. The out put of the filter is a

(*a*) rectangular pulse of duration T
(*b*) rectangular pulse of duration 2T
(*c*) triangular pulse
(*d*) sine function

1.17 The image channel rejection in a superheterodyne receiver comes from

(*a*) IF stages only
(*b*) RF stages only
(*c*) detector and RF stages only
(*d*) detector RF, and IF stages

1.18 The capacitance per unit length and the characteristic impedance of a lossless transmission line are C and Zo respectively. The velocity of a travelling wave on the transmission line is

(*a*) $Z_o C$ (*b*) $\frac{1}{Z_o C}$

(*c*) $\frac{Z_o}{C}$ (*d*) $\frac{C}{Z_o}$

1.19 A transverse electromagnetic wave with circular polarisation is received by a dipole antenna. Due to polarisation mismatch, the power transfer efficiency from the wave to the antenna is reduced to about

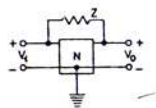
(*a*) 50% (*b*) 35.3%
(*c*) 25% (*d*) 0%

1.20 A metal sphere with 1 m radius and a surface charge density of 10 Coulombs/m^2 is enclosed in a cube of 10 m side. The total outward electric displacement normal to the surface of the cube is

(*a*) 40π Coulombs (*b*) 10π Coulombs
(*c*) 5π Couloms (*d*) None of these

2. For each of the following questions (2.1—2.20) four alternatives *a, b, c* and d are given
(20 × 2 = 40)

2.1 In the circuit shown in the given figure N is a finite gain amplifier with a gain of *k*, a very large input impedance, and a very low output impedance. The input impedance of the feedback amplifier with the feedback impedance Z connected as shown will be



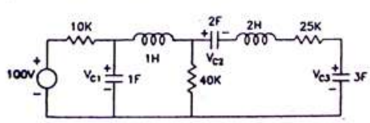
(*a*) $Z\left(1-\frac{1}{k}\right)$ (*b*) $Z(1-k)$

(*c*) $\frac{Z}{(k-1)}$ (*d*) $\frac{Z}{(1-k)}$

2.2 The inverse Laplace transform of the function $\frac{s+5}{(s+1)(s+3)}$ is

(*a*) $2e^{-t} - e^{-3t}$ (*b*) $2e^{-t} + e^{-3t}$
(*c*) $e^{-t} - 2e^{-3t}$ (*d*) $e^{-t} + e^{-3t}$

2.3 The voltages V_{C1}, V_{C2}, and V_{C3} across the capacitors in the circuit in the given figure, under steady state, are respectively.



(*a*) 80V, 32V, 48V (*b*) 80V, 48V, 32V
(*c*) 20V, 8V, 12V (*d*) 20V, 12V, 8V

2.4 A uniform plane wave in air is normally incident on infinitely thick slab. If the refractive index of the glass slab is 1.5, then the percentage of incident power that is reflected from the air-glass interface is

(*a*) 0% (*b*) 4%
(*c*) 20% (*d*) 100%

2.5 In a bipolar transistor at room temperature, if the emitter current is doubled the voltage across its base-emitter junction

(*a*) doubles
(*b*) halves
(*c*) increases by about 20 mV
(*d*) decreases by about 20 mV

2.6 An npn transistor has a beta cut-off frequency $f\beta$ of 1 MHz, and common emitter short circuit low-frequency current gain βo of 200. It unity gain frequency fT and the alpha cut-off frequency $f\alpha$ respenctively are

(*a*) 200 MHz, 201 MHz
(*b*) 200 MHz, 199 MHz
(*c*) 199 MHz, 200 MHz
(*d*) 201 MHz, 200 MHz

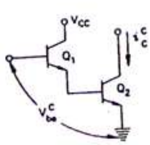
2.7 A silicon *n* MOSFET has a threshold voltage of 1 V and oxide thickness of AO.

$[\varepsilon_r\ (siO_2) = 3.9,\ \varepsilon_o = 8.854 \times 10^{-14}\ F/cm,$ $q = 1.6 \times 10^{-19}\ C]$.

The region under the gate is ion implanted for threshold voltage tailoring. The dose and type of the implant (assumed to be a sheet charge at the interface) required to shift the threshold voltage to - 1V are

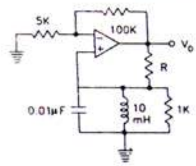
(*a*) $1.08 \times 10^{12}/cm^2$, *p*-type
(*b*) $1.08 \times 10^{12}/cm^2$, *n*-type
(*c*) $5.4 \times 10^{11}/cm^2$, *p*-type
(*d*) $5.4 \times 10^{11}/cm^2$, *n*-type

2.8 A Darlington stage is shown in the figure is. If the transconductance of Q_1 is g_{m1} and Q_2 is g_{m2}, then the overall transconductance $g_{mc}\left[\triangleq \frac{i_c^c}{v_{be}^c}\right]$ is given by



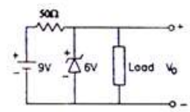
(*a*) g_{m1} (*b*) $0.5\,g_{m1}$
(*c*) g_{m2} (*d*) $0.5\,g_{m2}$

2.9 Value of R in the oscillator circuit shown in the given figure, so chosen that it just oscillates at an angular frequency of ω. The value of ω and the required value of R will respectively be



(*a*) 10^5 rad/sec, $2 \times 10^4\ \Omega$
(*b*) 2×10^4 rad/sec, $2 \times 10^4\ \Omega$
(*c*) 2×10^4 rad/sec, $10^5\ \Omega$
(*d*) 10^5 rad/sec, $10^5\ \Omega$

2.10 A zener diode in the circuit shown in the figure is has a knee current of 5 mA, and a maximum allowed power dissipation of 300 mW. What are the minimum and maximum load currents that can be drawn safely from the circuit, keeping the output voltage V_o constant at 6 V ?



(*a*) 0 mA, 180 mA (*b*) 5 mA, 110 mA
(*c*) 10 mA, 55 mA (*d*) 60 mA, 180 mA

2.11 A dynamic RAM cell which hold 5 V has to be refreshed every 20 m secs, so that the stored voltage does not fall by more than 0.5 V. If the cell has a constant discharge current of 0.1 pA, the storage capacitance of the cell is

(*a*) 4×10^{-6} F (*b*) 4×10^{-9} F
(*c*) 4×10^{-12} F (*d*) 4×10^{-15} F

2.12 A 10 - bit ADC with a full scale output voltage of 10. 24 V is designed to have a ± LSB/2 accuracy. If the ADC is calibrated at 25°C and the operating temperature ranges from 0°C to 50°C , then the maximum net temperature coefficient of the ADC should not exceed

(*a*) ± 200 μ V/°C (*b*) ± 400 μ V/°C
(*c*) ± 600 μ V/°C (*d*) ± 800 μ V/°C

2.13 A memory system of size 26 K bytes is required to be designed using memory chips which have 12 address lines and 4 data lines each. The number of such chips required to design the memory system is

(*a*) 2 (*b*) 4
(*c*) 8 (*d*) 16

2.14 The following sequence of instructions are executed by an 8085 microprocessor :

1000	LXI	SP,	27 FF
1000	CALL		1006
1006	POP H		

The contents of the stack pointer (SP) and the HL, register pair on completion of execution of these instructions are

(*a*) SP = 27 FF, HL = 1003
(*b*) SP = 27 FD, HL = 1003
(*c*) SP = 27 FF, HL = 1006
(*d*) SP = 27 FD, HL = 1006

2.15 The number of bits in a binary PCM system is increased from n to $n + 1$. As a result, the signal to quantization noise ratio will improve by a factor

(*a*) $\frac{n+1}{n}$
(*b*) $2^{(n+1)/n}$
(*c*) $2^{2(n+1)/n}$
(*d*) which is independent of n

2.16 The autocorrelation function of an energy signal has

(*a*) no symmetery (*b*) conjugate symmetry
(*c*) odd symmetry (*d*) even symmetry

2.17 An FM signal with a modulation index 9 is applied to a frequency tripler. The modulation index in the output signal will be

(*a*) 0 (*b*) 3
(*c*) 9 (*d*) 27

2.18 The critical frequency of an ionospheric layer is 10 MHz. What is the maximum launching angle from the horizon for which 20 MHz wave will be reflected by the layer ?

(*a*) 0° (*b*) 30°
(*c*) 45° (*d*) 90°

2.19 A 1 km long microwave link uses two antennas each having 30 *d*B gain. If the power transmitted by one antenna is 1 W at 3 GHz, the power received by the other antenna is approximately

(*a*) 98.6 μW (*b*) 76.8 μW
(*c*) 63.4 μW (*d*) 55.2 μW

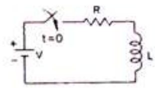
2.20 Some unknown material has a conductivity of 10^6 mho/m and a permeability of $4\pi \times 10^{-7}$ H/m. The skin depth for the material at 1 GHz is

(*a*) 15.9 μm (*b*) 20.9 μm
(*c*) 25.9 μm (*d*) 30.9 μm

3. In the following questions (3.1 – 3.5), match each of the items *A*, *B* and *C* with an appropriate item on the right. (5 × 3 = 15)

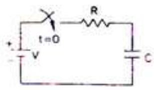
3.1. In the circuit shown in the figure is (*a*) - (*c*), assuming initial voltage and capacitors and currents through the inductors to be zero at the time of switching (t = 0), then at anytime t > 0.

(*a*)



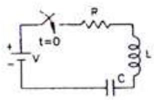
(1) Current increases monotonically with time

(*b*)



(2) Current decreases monotonically with time

(*c*)



(3) Current remains constant at V/R
(4) Current first increases then decreases
(5) No current can ever flow

3.2 (*a*) Cascade amplifier
(*b*) Differential amplifier
(*c*) Darlington pair common-emitter amplifier

(1) does not provide current gain
(2) is a wideband amplifier
(3) has very low input impedance and very high current gain
(4) has very high input impedance and very high current gain
(5) provides high common mode voltage rejection

3.3 (*a*) A shift register can be used
(*b*) A multiplexer can be used
(*c*) A decoder can be used

(1) for code conversion
(2) to generate memory chip select
(3) for parallel-to-serial conversion
(4) as a many-to-one switch
(5) for analog-to-digital conversion

3.4 (*a*) Capture effect is a characteristics of
(*b*) Granular noise occurs in
(*c*) Guard band is required in

(1) an AM system
(2) an FM system
(3) a DM system
(4) a FDM system
(5) a PCM system
(6) a TDM system

3.5 (*a*) SSB Modulation (1) Transmission line
(*b*) $\nabla \cdot \overline{B} = 0$ (2) Hilbert transform
(*c*) Model dispersion (3) Faraday's law
(4) Absence of magnetic monopoles
(5) Waveguides
(6) Phase-locked loop

ANSWERS

1. 1 (*b*)	**1. 2** (*d*)	**1. 3** (*c*)	**1. 4** (*a*)	**1. 5** (*d*)	**1. 6** (*c*)	**1. 7** (*c*)	**1. 8** (*c*)	**1. 9** (*d*)	**1. 10** (*a*)
1. 11 (*b*)	**1. 12** (*d*)	**1. 13** (*b*)	**1. 14** (*c*)	**1.15** (*c*)	**1. 16** (*c*)	**1. 17** (*c*)	**1. 18** (*b*)	**1. 19** (*d*)	**1. 20** (*d*)
2. 1 (*d*)	**2. 2** (*a*)	**2. 3** (*b*)	**2. 4** (*b*)	**2. 5** (*b*)	**2. 6** (*a*)	**2. 7** (*a*)	**2. 8** (*a*)	**2. 9** (*a*)	**2. 10** (*c*)
2. 11 (*d*)	**2. 12** (*b*)	**2. 13** (*c*)	**2. 14** (*d*)	**2. 15** (*c*)	**2. 16** (*d*)	**2. 17** (*d*)	**2. 18** (*b*)	**2. 19** (*c*)	**2. 20** (*a*)

EXPLANATIONS

1.1 $A_1 = \sqrt{A_2^2 + A_3^2} = \sqrt{3^2 + 4^2} = 5\text{ A}$

1.2 The meter will read during positive half for half-wave rectifier.

$$V_{av} = \frac{V_m}{\pi R} = \frac{4}{\pi 10\text{ K}} = \frac{0.4}{\pi}\text{ mA.}$$

Hence none of the answer is correct as current is given in A and not in *m*A.

1.4 A short circuited line of length $\lambda/4$ shows infinite impedance at the other end, hence the current is zero.

1.6 $V_{CE} = V_{BE} + V_{CB}$.

As V_{CB} is increased, V_{CE} is pushed to the negative region, I_C start even from the negative region and transistor operates in the reverse active mode.

1.7 $\beta_{forced} = \beta_F$ in the active region.
In the saturation region β_{forced} is less then β_F.

1.11 Since delay has to be of finite number of clock pulses.

1.12 Flash type $1\,\tau$, where τ is clock period.
Counter type $(2^n - 1)\,\tau = 4095\ \mu$ sec.
Integrating type > 4095 μ secs.
Successive Apporximation type $n\,\tau = 12\ \mu$ secs.

1.17 Response cut-off resonance, $A_R = \dfrac{1}{\sqrt{1 + y^2 Q^2}}$

where $y = \dfrac{\omega}{\omega_R} - \dfrac{\omega_R}{\omega}$

ω = image frequency.
So the first detector gives some image rejection which may be sufficient at low tuned frequencies. As this may be insufficient at high frequencies, RF stages may be added.

1.18 $\omega = \dfrac{1}{\sqrt{LC}}$,

Now $Z_o = \sqrt{\dfrac{L}{C}}$

$\Rightarrow \sqrt{L} = Z_o \sqrt{C}$

$\therefore \omega = \dfrac{1}{Z_o \sqrt{C}\sqrt{C}} = \dfrac{1}{Z_o C}$

1.19 Polarisation mismatch means that if the wave is left circularly polarised, the antenna is right circularily polarised and power transfer is 0.

1.20 Charge enclosed by the cube,

$Q = 4\,\pi \times 1^2 \times 10 = 40\,\pi$

$$D = \frac{Q}{\text{Area of one face}} = \frac{40\pi}{100} = 0.4\,\pi\text{ C/m}^2$$

2.

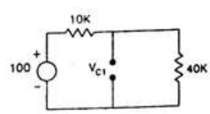
2.2

$$F(s) = \frac{s+5}{(s+1)(s+3)} = \frac{A}{s+1} + \frac{B}{s+3}$$

$$A = \left.\frac{s+5}{s+3}\right|_{s=-1} = 2,\quad B = \left.\frac{s+5}{s+1}\right|_{s=-3} = \frac{2}{-2} = -1$$

$\therefore L^{-1} F(s) = 2e^{-t} - e^{-3t}$

2.3 In steady state, capacitors are open and inductances are short.



For V_{C1}

$$V_{C1} = 100 \times \frac{40}{50} = 80\text{ V}$$