GATE Electronics and Communication Engineering

Sample Paper – 2

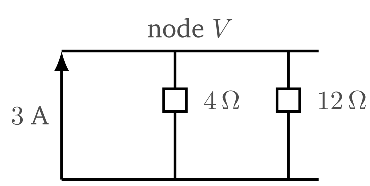
Duration: 128 Minutes **Maximum Marks: 72**

Instructions

- This paper contains **46 questions** covering the core **Electronics and Communication Engineering** subject of the GATE paper conducted by the IITs and IISc (General Aptitude and Engineering Mathematics are provided as separate papers).
- **Q1–Q20 carry 1 mark each** and **Q21–Q46 carry 2 marks each**, for a total of **72 marks**.
- Each question carries **negative marking of one-third of its allotted marks**: a wrong 1-mark question costs **0.33** and a wrong 2-mark question costs **0.67**. Unattempted questions carry no penalty.
- Every question here is a single-correct **MCQ**. The real GATE paper also has Multiple Select (MSQ) and Numerical Answer Type (NAT) questions, and **those carry no negative marking**.
- Attempt this paper in one timed sitting of about **128 minutes**, the share this core subject earns at GATE's overall pace of 180 minutes for 65 questions. Unless stated otherwise take $n_i = 1.5 \times 10^{10}$ cm^{-3} for silicon, thermal voltage $V_T = 25$ mV at room temperature, $\varepsilon_0 = 8.854 \times 10^{-12}$ F/m, $\mu_0 = 4\pi \times 10^{-7}$ H/m and $c = 3 \times 10^8$ m/s.

Networks and Circuit Analysis

Q1. A d.c. current source of 3 A drives a single node that is connected to ground through two resistors of 4 Ω and 12 Ω in parallel, as shown. By nodal analysis the node voltage V is: **[1 mark]**



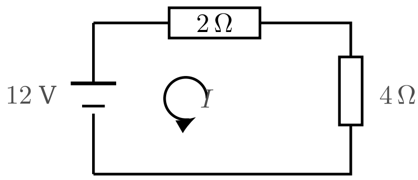
(A) 9 V

(B) 3 V

(C) 27 V

(D) 6 V

Q2. In the single-loop circuit shown a 12 V source drives a 2 Ω and a 4 Ω resistor in series. By mesh analysis (KVL round the loop) the mesh current I is: **[1 mark]**



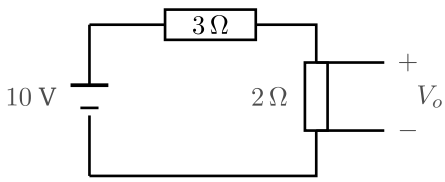
(A) 6 A

(B) 3 A

(C) 1 A

(D) 2 A

Q3. For the resistive voltage divider shown, a 10 V source is applied across a 3 Ω resistor in series with a 2 Ω resistor. The output voltage V_o taken across the 2 Ω resistor is: **[1 mark]**



(A) 6 V

(B) 10 V

(C) 4 V

(D) 5 V

Q4. A series RC circuit has $R = 2$ kΩ and $C = 5$ μF. The time constant $\tau = RC$ of the circuit is: **[1 mark]**

(A) 0.1 s

(B) 0.01 s

(C) 1 s

(D) 0.001 s

Q5. An ideal capacitor of $C = 1\ \mu$F is driven by a sinusoidal source of angular frequency $\omega = 1000$ rad/s. The magnitude of the capacitive reactance $X_C = 1/(\omega C)$ is: **[1 mark]**

(A) $1\ \Omega$

(B) $1000\ \Omega$

(C) $100\ \Omega$

(D) $0.001\ \Omega$

Q6. An inductor of $L = 2$ H carries a steady current of $I = 3$ A. The energy stored in its magnetic field, $E = \frac{1}{2}LI^2$, is: **[1 mark]**

(A) 9 J

(B) 18 J

(C) 6 J

(D) 3 J

Electronic Devices

Q7. A silicon sample is uniformly doped p-type with acceptor concentration $N_a = 10^{17}$ cm^{-3}. Taking $n_i = 1.5 \times 10^{10}$ cm^{-3} and full ionisation, the equilibrium electron (minority) concentration is nearest to: **[1 mark]**

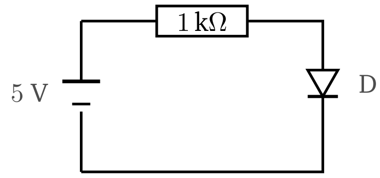
(A) 1×10^{17} cm^{-3}

(B) 2.25×10^{3} cm^{-3}

(C) 2.25×10^{20} cm^{-3}

(D) 1.5×10^{10} cm^{-3}

Q8. In the circuit shown a silicon PN junction diode (constant forward drop 0.7 V) is connected in series with a 1 kΩ resistor across a 5 V source. The forward current through the diode is: **[1 mark]**



(A) 5 mA

(B) 0.7 mA

(C) 4.3 mA

(D) 5.7 mA

Q9. A silicon PN junction diode is forward biased so that it carries a d.c. current $I_D = 1$ mA. Taking $V_T = 25$ mV, the small-signal (dynamic) resistance $r_d = V_T/I_D$ of the diode is: **[1 mark]**

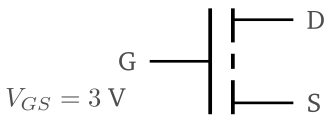
(A) $1\ \Omega$

(B) $25\ \Omega$

(C) $40\ \Omega$

(D) $250\ \Omega$

Q10. An n-channel enhancement MOSFET has threshold voltage $V_t = 1$ V and is biased with $V_{GS} = 3$ V, as shown. The minimum drain-to-source voltage $V_{DS,\text{sat}} = V_{GS} - V_t$ that just keeps the device in saturation (the saturation boundary) is: **[1 mark]**



(A) 3 V

(B) 1 V

(C) 4 V

(D) 2 V

Q11. A silicon bar is doped n-type. Its electron mobility is $\mu_n = 1000 \text{ cm}^2/\text{V}\cdot\text{s}$ and the thermal voltage is $V_T = 25$ mV. Using the Einstein relation $D_n = \mu_n V_T$, the electron diffusion coefficient is: **[1 mark]**

(A) $25 \text{ cm}^2/\text{s}$

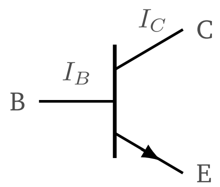
(B) $40 \text{ cm}^2/\text{s}$

(C) $1000 \text{ cm}^2/\text{s}$

(D) $0.025 \text{ cm}^2/\text{s}$

Analog Circuits

Q12. In the npn BJT stage shown the base current is $I_B = 20\ \mu$A and the current gain is $\beta = 100$. In the active region the collector current $I_C = \beta I_B$ is: **[1 mark]**



(A) $20\ \mu$A

(B) 100 mA

(C) 2 mA

(D) 0.2 mA

Q13. In the base-bias network of a BJT, a 5 V supply drives the base through a resistor $R_B = 430\ \text{k}\Omega$, and the base–emitter drop is $V_{BE} = 0.7$ V. The base current $I_B = (V_{BB} - V_{BE})/R_B$ is: **[1 mark]**

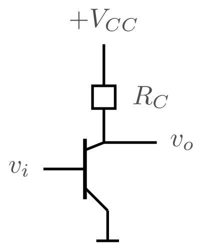
(A) $5\ \mu$A

(B) $100\ \mu$A

(C) $43\ \mu$A

(D) $10\ \mu$A

Q14. A common-emitter BJT amplifier operates at a quiescent collector current $I_C = 2$ mA with a collector resistor $R_C = 1$ kΩ, as shown. Taking $V_T = 25$ mV and neglecting r_o, the magnitude of the small-signal voltage gain $|A_v| = g_m R_C$ is: **[1 mark]**



(A) 40

(B) 80

(C) 200

(D) 25

Q15. An op-amp has a gain–bandwidth product (unity-gain frequency) of 10 MHz. When it is connected for a closed-loop gain of 10, the resulting -3 dB bandwidth is: **[1 mark]**

(A) 1 MHz

(B) 10 MHz

(C) 100 kHz

(D) 10 kHz

Q16. An ideal op-amp is used as an inverting summing amplifier with feedback resistor $R_f = 10$ kΩ and two input branches $R_1 = 10$ kΩ (carrying $V_1 = 1$ V) and $R_2 = 5$ kΩ (carrying $V_2 = 2$ V). The output $V_o = -\left(\frac{R_f}{R_1}V_1 + \frac{R_f}{R_2}V_2\right)$ is: **[1 mark]**

(A) -3 V

(B) -6 V

(C) -5 V

(D) -1 V

Q17. An amplifier with open-loop gain $A = 10000$ is placed in a negative-feedback loop with feedback factor $\beta = 0.01$. The closed-loop gain $A_f = A/(1 + A\beta)$ is nearest to: **[1 mark]**

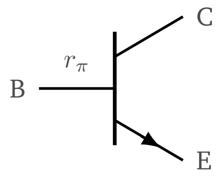
(A) 99

(B) 100

(C) 9.9

(D) 0.01

Q18. The common-emitter BJT stage shown has current gain $\beta = 100$ and operates at a quiescent collector current $I_C = 1$ mA. Taking $V_T = 25$ mV, the small-signal input resistance $r_\pi = \beta V_T / I_C$ looking into the base is: **[1 mark]**



(A) 250 Ω

(B) 2.5 kΩ

(C) 25 kΩ

(D) 40 Ω

Digital Circuits

Q19. The unsigned binary number $(10110)_2$ has the decimal (base-10) value: **[1 mark]**

(A) 20

(B) 26

(C) 11

(D) 22

Q20. Using the rules of Boolean algebra, the expression $Y = AB + A\bar{B}$ simplifies to: **[1 mark]**

(A) B

(B) AB

(C) $A + B$

(D) A

Q21. The hexadecimal number $(2F)_{16}$ has the decimal (base-10) value: **[2 marks]**

(A) 31

(B) 47

(C) 44

(D) 62

Q22. The four-variable function $F(A, B, C, D) = \sum m(0, 2, 8, 10)$ is plotted on the Karnaugh map shown (rows AB, columns CD). The four ones sit at the corners of the map. The minimal sum-of-products expression for F is: **[2 marks]**

$AB \backslash CD$	00	01	11	10
00	1	0	0	1
01	0	0	0	0
11	0	0	0	0
10	1	0	0	1

(A) BD

(B) $\bar{B}D$

(C) $B\bar{D}$

(D) $\bar{B}\,\bar{D}$

Q23. A random-access memory is organised as $1\text{K} \times 8$ (that is, 1024 words of 8 bits each). The number of address lines needed to address every word uniquely is: **[2 marks]**

(A) 8

(B) 1024

(C) 10

(D) 11

Q24. A synchronous modulo-60 counter (as used in the seconds stage of a digital clock) must step through 60 distinct states. The minimum number of flip-flops required is: **[2 marks]**

(A) 5

(B) 6

(C) 60

(D) 7

Signals and Systems

Q25. Two finite-length discrete sequences of lengths 5 and 6 samples respectively are linearly convolved. The length (number of samples) of the resulting sequence is: **[2 marks]**

(A) 11

(B) 30

(C) 9

(D) 10

Q26. A discrete-time LTI system has impulse response $h[n] = (0.9)^n\, u[n]$. Because $\sum_{n=-\infty}^{\infty} |h[n]|$ converges and $h[n] = 0$ for $n < 0$, the system is best described as: **[2 marks]**

(A) unstable and causal

(B) stable and causal

(C) stable and non-causal

(D) unstable and non-causal

Q27. A discrete-time signal is $x[n] = (0.25)^n u[n]$. The sum of all its samples, $\sum_{n=-\infty}^{\infty} x[n]$, is: **[2 marks]**

(A) 0.25

(B) 0.75

(C) 4

(D) 1.333

Q28. A periodic voltage signal is $x(t) = 6\cos(\omega_0 t)$ volts across a $1\ \Omega$ resistor. The average power of the signal, $P = A^2/2$, is: **[2 marks]**

(A) 18 W

(B) 36 W

(C) 9 W

(D) 6 W

Q29. Two discrete sequences $x[n] = \{2, 1\}$ and $h[n] = \{1, 3\}$ (both starting at $n = 0$) are linearly convolved to give $y[n] = x[n] * h[n]$. The value of the sample $y[1]$ is: **[2 marks]**

(A) 2

(B) 3

(C) 7

(D) 5

Q30. A discrete-time sinusoid is $x[n] = \cos\left(\frac{\pi}{4}n\right)$. Its fundamental period N (the smallest positive integer number of samples over which it repeats) is: **[2 marks]**

(A) 4

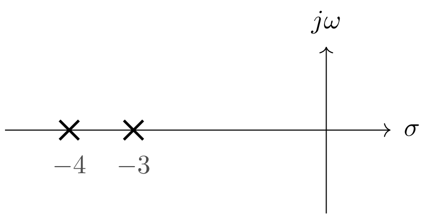
(B) 8

(C) 16

(D) 2

Control Systems

Q31. A stable LTI system has transfer function $H(s) = \dfrac{5}{s^2 + 7s + 12}$, whose pole–zero plot is shown (poles marked $\times$). The two poles of the system are located at: **[2 marks]**



(A) -1 and -2

(B) $+3$ and $+4$

(C) -2 and -6

(D) -3 and -4

Q32. The characteristic equation of a feedback system is $s^3 + 6s^2 + 11s + 6 = 0$. Using the Routh–Hurwitz criterion, the number of closed-loop poles lying in the right half of the s-plane is: **[2 marks]**

(A) 0

(B) 3

(C) 1

(D) 2

Q33. A unity-feedback system has open-loop transfer function $G(s) = \dfrac{20}{(s+2)(s+5)}$. The steady-state error for a unit-step input, $e_{ss} = 1/(1 + K_p)$ with $K_p = \lim_{s\to 0} G(s)$, is nearest to: **[2 marks]**

(A) 0

(B) 0.5

(C) 0.333

(D) 1

Q34. A standard second-order system has the characteristic equation $s^2+6s+9=0$. Based on its damping ratio, the nature of the transient response is: **[2 marks]**

(A) critically damped

(B) underdamped

(C) overdamped

(D) undamped

Q35. A unity-feedback second-order system has damping ratio $\zeta = 0.707$. For a unit-step input the peak percentage overshoot, $M_p = e^{-\pi\zeta/\sqrt{1-\zeta^2}} \times 100\%$, is nearest to: **[2 marks]**

(A) 4.3%

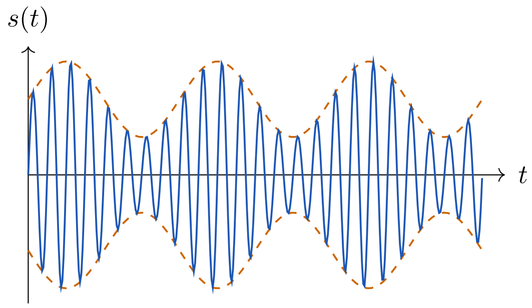
(B) 16.3%

(C) 0%

(D) 50%

Communications

Q36. A carrier of power 200 W is amplitude-modulated to a modulation index $\mu = 0.5$, giving the envelope shown. The total transmitted power, $P_t = P_c\left(1+\frac{\mu^2}{2}\right)$, is: **[2 marks]**



(A) 200 W

(B) 250 W

(C) 225 W

(D) 300 W

Q37. An AM waveform observed on an oscilloscope has a maximum envelope value $E_{\max} = 15$ V and a minimum envelope value $E_{\min} = 5$ V. The modulation index $\mu = (E_{\max} - E_{\min})/(E_{\max} + E_{\min})$ is: **[2 marks]**

(A) 0.33

(B) 0.67

(C) 0.5

(D) 0.75

Q38. A speech signal is sampled at 10 kHz and each sample is encoded with 128 uniform quantization levels in a PCM system. The output bit rate is: **[2 marks]**

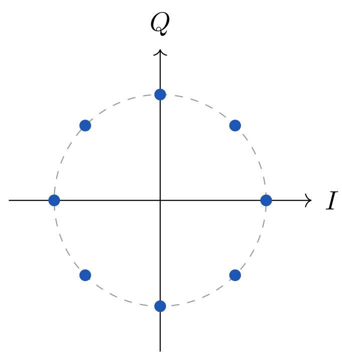
(A) 10 kbps

(B) 70 kbps

(C) 128 kbps

(D) 80 kbps

Q39. A digital link transmits data at a bit rate of 3 Mbps using 8-PSK, whose eight signal points are shown. Since 8-PSK carries $\log_2 8 = 3$ bits per symbol, the symbol rate is: **[2 marks]**



(A) 3 Msym/s

(B) 6 Msym/s

(C) 1 Msym/s

(D) 0.5 Msym/s

Q40. A discrete memoryless source emits three symbols with probabilities $\{\frac{1}{2}, \frac{1}{4}, \frac{1}{4}\}$. The entropy $H = -\sum p_i \log_2 p_i$ of the source is: **[2 marks]**

(A) 1.5 bits/symbol

(B) 2 bits/symbol

(C) 1 bit/symbol

(D) 0.5 bit/symbol

Q41. A communication channel of bandwidth 4 kHz has a signal-to-noise ratio of 15 (as a power ratio). By the Shannon–Hartley law $C = B \log_2(1 + \text{SNR})$, the channel capacity is: **[2 marks]**

(A) 4 kbps

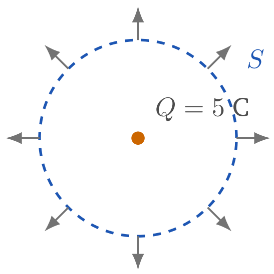
(B) 8 kbps

(C) 12 kbps

(D) 16 kbps

Electromagnetics

Q42. A closed (Gaussian) surface S encloses a total charge of 5 C, as shown. By Gauss's law in terms of the electric flux density, the net electric displacement flux $\Psi = \oint_S \vec{D} \cdot d\vec{S}$ leaving the surface equals the enclosed charge, which is: **[2 marks]**



(A) 5 C

(B) 0 C

(C) $5/\varepsilon_0$ C

(D) 10 C

Q43. Two large parallel conducting plates are separated by $d = 2$ mm and a potential difference of 100 V is applied between them. The uniform electric field between the plates, $E = V/d$, is: **[2 marks]**

(A) 200 kV/m

(B) 0.05 kV/m

(C) 50 kV/m

(D) 100 kV/m

Q44. A uniform plane wave of frequency 1 GHz propagates in free space. Its wavelength $\lambda = c/f$ (with $c = 3 \times 10^8$ m/s) is: **[2 marks]**

(A) 10 cm

(B) 30 cm

(C) 3 cm

(D) 100 cm

Q45. A transmission line of characteristic impedance $Z_0 = 75\ \Omega$ is terminated in a load $Z_L = 25\ \Omega$. Using $\Gamma = (Z_L - Z_0)/(Z_L + Z_0)$ and VSWR $=$ $(1 + |\Gamma|)/(1 - |\Gamma|)$, the voltage standing-wave ratio on the line is: **[2 marks]**

(A) 1

(B) 0.5

(C) 2

(D) 3

Q46. A lossless transmission line has distributed inductance $L = 1\ \mu$H/m and distributed capacitance $C = 100$ pF/m. Its characteristic impedance $Z_0 = \sqrt{L/C}$ is: **[2 marks]**

(A) $100\ \Omega$

(B) $50\ \Omega$

(C) $75\ \Omega$

(D) $25\ \Omega$

Detailed Solutions

Q1.

Solution

Concept – nodal analysis at a single node: The current injected by the source leaves through the resistors, and the node voltage is $V = I_s R_{eq}$, where R_{eq} is the parallel combination to ground.

Step 1 – combine the two grounded resistors in parallel: $R_{eq} = \dfrac{R_1 R_2}{R_1 + R_2} = \dfrac{4 \times 12}{4 + 12}$

Step 2 – evaluate the product and the sum: $R_1 R_2 = 48$ and $R_1 + R_2 = 16$

Step 3 – form the equivalent resistance: $R_{eq} = \dfrac{48}{16} = 3\ \Omega$

Step 4 – apply the node equation $V = I_s R_{eq}$**:** $V = 3 \times 3$

$V = 9$ V

Step 5 – sanity check: All 3 A flows out through a 3 Ω equivalent, so $V = 9$ V; the current splits 2.25 A through 4 Ω and 0.75 A through 12 Ω, which sums back to 3 A.

Final Answer: $V = 9$ V $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q1

Q2.

Solution

Concept – mesh analysis of a single loop: KVL round the loop gives (source voltage) = (sum of resistor voltage drops), so $V = I(R_1 + R_2)$.

Step 1 – add the series resistances: $R_1 + R_2 = 2 + 4 = 6\ \Omega$

Step 2 – write the loop (mesh) equation: $12 = I \times 6$

Step 3 – solve for the mesh current: $I = \dfrac{12}{6}$

$I = 2$ A

Step 4 – sanity check: The drops are $2 \times 2 = 4$ V and $2 \times 4 = 8$ V, and $4 + 8 = 12$ V equals the source, so KVL is satisfied.

Final Answer: $I = 2$ A $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q2

Q3.

Solution

Concept – voltage divider rule: For two series resistors across a source, the voltage across one of them is $V_o = V\dfrac{R_2}{R_1+R_2}$.

Step 1 – add the series resistances: $R_1 + R_2 = 3 + 2 = 5\ \Omega$

Step 2 – form the divider ratio for the $2\ \Omega$ resistor: $\dfrac{R_2}{R_1+R_2} = \dfrac{2}{5}$

Step 3 – multiply by the source voltage: $V_o = 10 \times \dfrac{2}{5}$

Step 4 – evaluate: $V_o = \dfrac{20}{5} = 4\ \text{V}$

Step 5 – sanity check: The $3\ \Omega$ resistor takes 6 V and the $2\ \Omega$ resistor takes 4 V, summing to 10 V.

Final Answer: $V_o = 4\ \text{V} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q3

Q4.

Solution

Concept – time constant of an RC circuit: For a first-order RC circuit the time constant is $\tau = RC$.

Step 1 – convert the values to base units: $R = 2\ \text{k}\Omega = 2 \times 10^3\ \Omega$

$C = 5\ \mu\text{F} = 5 \times 10^{-6}\ \text{F}$

Step 2 – multiply: $\tau = (2 \times 10^3) \times (5 \times 10^{-6})$

Step 3 – combine the powers of ten: $\tau = 10 \times 10^{-3}$

$\tau = 0.01\ \text{s}$

Final Answer: $\tau = 0.01\ \text{s} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q4

Q5.

Solution

Concept – capacitive reactance: The reactance of a capacitor is $X_C = \dfrac{1}{\omega C}$.

Step 1 – convert the capacitance: $C = 1\ \mu\text{F} = 1 \times 10^{-6}\ \text{F}$

Step 2 – form the product ωC: $\omega C = 1000 \times (1 \times 10^{-6})$

$\omega C = 1 \times 10^{-3}$

Step 3 – take the reciprocal: $X_C = \dfrac{1}{1 \times 10^{-3}}$

Step 4 – evaluate: $X_C = 1000\ \Omega$

Final Answer: $X_C = 1000\ \Omega \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q5

Q6.

Solution

Concept – energy stored in an inductor: The magnetic energy stored is $E = \frac{1}{2}LI^2$.

Step 1 – list the data: $L = 2$ H, $I = 3$ A.

Step 2 – square the current: $I^2 = 3^2 = 9$

Step 3 – substitute into the energy formula: $E = \dfrac{1}{2} \times 2 \times 9$

Step 4 – evaluate: $E = 1 \times 9 = 9$ J

Final Answer: $E = 9\text{ J} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q6

Q7.

Solution

Concept – mass-action law in a doped semiconductor: At equilibrium $n\,p = n_i^2$. For a p-type sample $p \approx N_a$, so the minority electron concentration is $n = \dfrac{n_i^2}{N_a}$.

Step 1 – square the intrinsic concentration: $n_i^2 = (1.5 \times 10^{10})^2$

$n_i^2 = 2.25 \times 10^{20}\ \text{cm}^{-6}$

Step 2 – take the majority-carrier concentration: $p \approx N_a = 1 \times 10^{17}\ \text{cm}^{-3}$

Step 3 – divide to get the electron concentration: $n = \dfrac{2.25 \times 10^{20}}{1 \times 10^{17}}$

Step 4 – combine the powers of ten: $n = 2.25 \times 10^{3}\ \text{cm}^{-3}$

Why the other options are wrong:

- A, 10^{17}: is the majority hole concentration p, not the minority electrons.
- C, 2.25×10^{20}: is n_i^2 itself, before dividing by N_a.
- D, 1.5×10^{10}: is the intrinsic value n_i, valid only for undoped silicon.

Final Answer: $n = 2.25 \times 10^{3}\ \text{cm}^{-3} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q7

Q8.

Solution

Concept – diode with a constant forward drop: Model the conducting diode as a fixed 0.7 V drop; the loop current is $I = \dfrac{V_S - V_D}{R}$.

Step 1 – write KVL around the loop: $V_S = IR + V_D$

Step 2 – rearrange for the current: $I = \dfrac{V_S - V_D}{R}$

Step 3 – substitute the numbers: $I = \dfrac{5 - 0.7}{1\ \text{k}\Omega} = \dfrac{4.3\ \text{V}}{1000\ \Omega}$

Step 4 – evaluate: $I = 4.3 \times 10^{-3}$ A $= 4.3$ mA

Why the other options are wrong:

- A, 5 mA: ignores the 0.7 V diode drop.
- D, 5.7 mA: wrongly adds the drop instead of subtracting it.

Final Answer: $I = 4.3$ mA $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q8

Q9.

Solution

Concept – dynamic resistance of a forward-biased diode: The small-signal resistance about the operating point is $r_d = \dfrac{V_T}{I_D}$.

Step 1 – list the data: $V_T = 25$ mV $= 25 \times 10^{-3}$ V, $I_D = 1$ mA $= 1 \times 10^{-3}$ A.

Step 2 – form the ratio: $r_d = \dfrac{25 \times 10^{-3}}{1 \times 10^{-3}}$

Step 3 – cancel the powers of ten: $r_d = 25\ \Omega$

Final Answer: $r_d = 25\ \Omega \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q9

Q10.

Solution

Concept – saturation boundary of a MOSFET: A MOSFET stays in saturation while $V_{DS} \geq V_{GS} - V_t$; the boundary value is $V_{DS,\text{sat}} = V_{GS} - V_t$ (the overdrive voltage).

Step 1 – list the data: $V_{GS} = 3$ V, $V_t = 1$ V.

Step 2 – subtract to get the overdrive: $V_{DS,\text{sat}} = V_{GS} - V_t = 3 - 1$

Step 3 – evaluate: $V_{DS,\text{sat}} = 2$ V

Why the other options are wrong:

- A, 3 V: is V_{GS} itself, not the overdrive.
- B, 1 V: is the threshold V_t alone.

Final Answer: $V_{DS,\text{sat}} = 2 \text{ V} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q10

Q11.

Solution

Concept – Einstein relation: The diffusion coefficient and mobility are linked by $D_n = \mu_n V_T$, with V_T the thermal voltage.

Step 1 – convert the thermal voltage to volts: $V_T = 25 \text{ mV} = 0.025 \text{ V}$

Step 2 – substitute into the Einstein relation: $D_n = \mu_n V_T = 1000 \times 0.025$

Step 3 – evaluate (units: $\text{cm}^2/\text{V}\cdot\text{s} \times \text{V} = \text{cm}^2/\text{s}$): $D_n = 25 \text{ cm}^2/\text{s}$

Final Answer: $D_n = 25 \text{ cm}^2/\text{s} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q11

Q12.

Solution

Concept – current gain of a BJT in the active region: The collector current is β times the base current, $I_C = \beta I_B$.

Step 1 – list the data: $\beta = 100$, $I_B = 20\ \mu\text{A} = 20 \times 10^{-6}$ A.

Step 2 – multiply: $I_C = 100 \times (20 \times 10^{-6})$

Step 3 – evaluate: $I_C = 2000 \times 10^{-6} \text{ A} = 2 \times 10^{-3} \text{ A}$

$I_C = 2$ mA

Why the other options are wrong:

- B, 100 mA: multiplies β by the numeric 1 mA instead of 20 μA.
- D, 0.2 mA: uses $I_B = 2$ μA by a place-value slip.

Final Answer: $I_C = 2 \text{ mA} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q12

Q13.

Solution

Concept – base current in a fixed-bias BJT: KVL round the base loop gives $I_B = \dfrac{V_{BB} - V_{BE}}{R_B}$.

Step 1 – find the voltage across the base resistor: $V_{BB} - V_{BE} = 5 - 0.7 = 4.3$ V

Step 2 – convert the base resistor: $R_B = 430 \text{ k}\Omega = 430 \times 10^3\ \Omega$

Step 3 – divide: $I_B = \dfrac{4.3}{430 \times 10^3}$

Step 4 – evaluate: $I_B = 1.0 \times 10^{-5} \text{ A} = 10\ \mu\text{A}$

Final Answer: $I_B = 10\ \mu\text{A} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q13

Q14.

Solution

Concept – voltage gain of a common-emitter stage: The transconductance is $g_m = \dfrac{I_C}{V_T}$ and the magnitude of the gain is $|A_v| = g_m R_C$.

Step 1 – compute the transconductance: $g_m = \dfrac{I_C}{V_T} = \dfrac{2 \text{ mA}}{25 \text{ mV}}$

$g_m = 0.08 \text{ A/V} = 80 \text{ mA/V}$

Step 2 – convert the collector resistor: $R_C = 1 \text{ k}\Omega = 1000\ \Omega$

Step 3 – form the gain: $|A_v| = g_m R_C = 0.08 \times 1000$

Step 4 – evaluate: $|A_v| = 80$

Final Answer: $|A_v| = 80 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q14

Q15.

Solution

Concept – constant gain–bandwidth product: For a dominant-pole op-amp, (closed-loop gain) $\times$ (bandwidth) $=$ unity-gain frequency (GBW).

Step 1 – list the data: $\text{GBW} = 10\ \text{MHz} = 1 \times 10^7\ \text{Hz}$, closed-loop gain $A_{CL} = 10$.

Step 2 – rearrange for bandwidth: $\text{BW} = \dfrac{\text{GBW}}{A_{CL}}$

Step 3 – substitute: $\text{BW} = \dfrac{1 \times 10^7}{10}$

Step 4 – evaluate: $\text{BW} = 1 \times 10^6\ \text{Hz} = 1\ \text{MHz}$

Final Answer: $\text{BW} = 1\ \text{MHz} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q15

Q16.

Solution

Concept – inverting summing amplifier: $V_o = -\left(\dfrac{R_f}{R_1}V_1 + \dfrac{R_f}{R_2}V_2\right)$.

Step 1 – form the two gain factors: $\dfrac{R_f}{R_1} = \dfrac{10}{10} = 1$ and $\dfrac{R_f}{R_2} = \dfrac{10}{5} = 2$

Step 2 – weight each input: $\dfrac{R_f}{R_1}V_1 = 1 \times 1 = 1$

$\dfrac{R_f}{R_2}V_2 = 2 \times 2 = 4$

Step 3 – add the weighted inputs: $1 + 4 = 5$

Step 4 – apply the inverting sign: $V_o = -5\ \text{V}$

Final Answer: $V_o = -5\ \text{V} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q16

Q17.

Solution

Concept – closed-loop gain with negative feedback: $A_f = \dfrac{A}{1 + A\beta}$.

Step 1 – form the loop gain: $A\beta = 10000 \times 0.01 = 100$

Step 2 – form the denominator: $1 + A\beta = 1 + 100 = 101$

Step 3 – divide: $A_f = \dfrac{10000}{101}$

Step 4 – evaluate: $A_f = 99.0$

Step 5 – interpret: The ideal value $1/\beta = 100$ is only approached for infinite loop gain; here the loop gain is finite, so $A_f = 99$ is slightly below 100.

Final Answer: $A_f \approx 99 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q17

Q18.

Solution

Concept – input resistance of a common-emitter stage: Looking into the base, $r_\pi = \dfrac{\beta}{g_m} = \dfrac{\beta V_T}{I_C}$.

Step 1 – list the data: $\beta = 100$, $V_T = 25$ mV, $I_C = 1$ mA.

Step 2 – form the numerator βV_T: $\beta V_T = 100 \times 25 \text{ mV} = 2500 \text{ mV} = 2.5 \text{ V}$

Step 3 – divide by the collector current: $r_\pi = \dfrac{2.5 \text{ V}}{1 \text{ mA}} = \dfrac{2.5}{1 \times 10^{-3}}$

Step 4 – evaluate: $r_\pi = 2500\ \Omega = 2.5\ \text{k}\Omega$

Final Answer: $r_\pi = 2.5\ \text{k}\Omega \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q18

Q19.

Solution

Concept – binary to decimal conversion: Each bit is weighted by a power of two, $(b_4 b_3 b_2 b_1 b_0)_2 = b_4\, 2^4 + b_3\, 2^3 + b_2\, 2^2 + b_1\, 2^1 + b_0\, 2^0$.

Step 1 – write the place values for 10110**:** bit $2^4 = 16$: 1; bit $2^3 = 8$: 0; bit $2^2 = 4$: 1; bit $2^1 = 2$: 1; bit $2^0 = 1$: 0.

Step 2 – multiply each bit by its weight: $1 \times 16 = 16$

$0 \times 8 = 0$

$1 \times 4 = 4$

$1 \times 2 = 2$

$0 \times 1 = 0$

Step 3 – add the contributions: $16 + 0 + 4 + 2 + 0 = 22$

Final Answer: $(10110)_2 = 22 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q19

Q20.

Solution

Concept – combining and complement law of Boolean algebra: $B + \bar{B} = 1$, and factoring a common variable simplifies the expression.

Step 1 – factor the common literal A**:** $Y = AB + A\bar{B} = A(B + \bar{B})$

Step 2 – apply the complement law $B + \bar{B} = 1$**:** $Y = A(1)$

Step 3 – simplify: $Y = A$

Why the other options are wrong:

- A, B: the output does not depend on B at all once simplified.
- C, $A + B$: over-states the function; here both terms share the literal A.

Final Answer: $Y = A \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q20

Q21.

Solution

Concept – hexadecimal to decimal conversion: Each hex digit is weighted by a power of 16, and the letter F stands for 15.

Step 1 – write the place values for $(2F)_{16}$**:** digit 16^1: 2; digit 16^0: F $= 15$.

Step 2 – multiply each digit by its weight: $2 \times 16 = 32$

$15 \times 1 = 15$

Step 3 – add the contributions: $32 + 15 = 47$

Final Answer: $(2F)_{16} = 47 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q21

Q22.

Solution

Concept – grouping ones on a Karnaugh map: Ones that stay together while some variables change are combined; the variables that remain constant over the group form its product term. Corner cells are logically adjacent and form one group.

Step 1 – place the minterms in $ABCD$ **order:** $m0 = 0000$, $m2 = 0010$, $m8 = 1000$, $m10 = 1010$; these are the four corner cells of the map.

Step 2 – read the bits shared by all four cells: In every one of these codes the bit $B = 0$ and the bit $D = 0$; the bits A and C each take both values.

Step 3 – keep only the constant literals: The constant literals are $\bar{B}$ and $\bar{D}$, so the group is $\bar{B}\,\bar{D}$.

Step 4 – verify against the minterms: $\bar{B}\,\bar{D}$ covers all cells with $B = 0$ and $D = 0$, namely $m0, m2, m8, m10$, exactly the given ones.

Final Answer: $F = \bar{B}\,\bar{D} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q22

Q23.

Solution

Concept – address lines of a memory: To address W distinct words a memory needs n address lines with $2^n = W$, so $n = \log_2 W$.

Step 1 – identify the number of words: $W = 1\text{K} = 1024$ (the $\times 8$ is the word width, not the count).

Step 2 – write 1024 as a power of two: $1024 = 2^{10}$

Step 3 – match the exponents: $2^n = 2^{10} \Rightarrow n = 10$

Why the other options are wrong:

- A, 8: is the data-bus width (bits per word), not the address width.
- B, 1024: is the number of words, not the number of lines.

Final Answer: $n = 10$ address lines $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q23

Q24.

Solution

Concept – number of flip-flops for a given modulus: n flip-flops give 2^n distinct states; the smallest n with $2^n \geq M$ is required.

Step 1 – write the requirement for a mod-60 counter: $2^n \geq 60$

Step 2 – test $n = 5$: $2^5 = 32$, and $32 < 60$, so 5 flip-flops are not enough.

Step 3 – test $n = 6$: $2^6 = 64$, and $64 \geq 60$, so 6 flip-flops suffice.

Step 4 – conclude: The minimum number of flip-flops is 6.

Final Answer: $n = 6 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q24

Q25.

Solution

Concept – length of a linear convolution: If two sequences have lengths L_1 and L_2, their linear convolution has length $L_1 + L_2 - 1$.

Step 1 – list the lengths: $L_1 = 5$, $L_2 = 6$.

Step 2 – add the lengths: $L_1 + L_2 = 5 + 6 = 11$

Step 3 – subtract one: $11 - 1 = 10$

Final Answer: length $= 10 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q25

Q26.

Solution

Concept – stability and causality of an LTI system: A system is BIBO stable if $\sum_n |h[n]| < \infty$, and causal if $h[n] = 0$ for $n < 0$.

Step 1 – test causality: $h[n] = (0.9)^n u[n]$ is multiplied by $u[n]$, so $h[n] = 0$ for $n < 0$; the system is **causal**.

Step 2 – write the sum of absolute values: $\sum_{n=0}^{\infty} |(0.9)^n| = \sum_{n=0}^{\infty} (0.9)^n$

Step 3 – sum the geometric series ($|0.9| < 1$): $\sum_{n=0}^{\infty} (0.9)^n = \frac{1}{1 - 0.9} = \frac{1}{0.1} = 10$

Step 4 – test stability: The sum is finite ($= 10$), so the system is **BIBO stable**.

Step 5 – combine the two findings: The system is stable and causal.

Final Answer: stable and causal $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q26

Q27.

Solution

Concept – sum of a geometric sequence: For $x[n] = a^n u[n]$ with $|a| < 1$, $\sum_{n=0}^{\infty} a^n = \frac{1}{1 - a}$.

Step 1 – identify the ratio: $a = 0.25$, and $u[n]$ makes the sum start at $n = 0$.

Step 2 – form the denominator: $1 - a = 1 - 0.25 = 0.75$

Step 3 – take the reciprocal: $\sum = \frac{1}{0.75}$

Step 4 – evaluate: $\sum = 1.333$

Final Answer: $\sum x[n] = 1.333 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q27

Q28.

Solution

Concept – average power of a sinusoid: For $x(t) = A\cos(\omega_0 t)$ the average power is $P = \frac{A^2}{2}$ (across a $1\ \Omega$ resistor).

Step 1 – identify the amplitude: $A = 6$ V.

Step 2 – square the amplitude: $A^2 = 6^2 = 36$

Step 3 – divide by two: $P = \frac{36}{2}$

Step 4 – evaluate: $P = 18$ W

Final Answer: $P = 18\text{ W} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q28

Q29.

Solution

Concept – linear convolution of two sequences: $y[n] = \sum_k x[k]\,h[n-k]$; here $x = \{2, 1\}$ and $h = \{1, 3\}$.

Step 1 – write the full convolution terms: $y[0] = x[0]h[0]$

$y[1] = x[0]h[1] + x[1]h[0]$

$y[2] = x[1]h[1]$

Step 2 – substitute the samples into $y[1]$: $y[1] = (2)(3) + (1)(1)$

Step 3 – evaluate each product: $(2)(3) = 6$ and $(1)(1) = 1$

Step 4 – add: $y[1] = 6 + 1 = 7$

Step 5 – cross-check the whole output: $y[0] = 2$, $y[1] = 7$, $y[2] = 3$, giving $y = \{2, 7, 3\}$, whose length $3 = 2 + 2 - 1$ is correct.

Final Answer: $y[1] = 7 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q29

Q30.

Solution

Concept – period of a discrete-time sinusoid: $x[n] = \cos(\Omega_0 n)$ is periodic with the smallest integer N such that $\Omega_0 N = 2\pi k$ for some integer k, i.e. $N = \frac{2\pi k}{\Omega_0}$.

Step 1 – read the digital frequency: $\Omega_0 = \frac{\pi}{4}$ rad/sample.

Step 2 – form $N = \frac{2\pi k}{\Omega_0}$**:** $N = \frac{2\pi k}{\pi/4} = 8k$

Step 3 – take the smallest positive integer ($k = 1$**):** $N = 8$

Step 4 – verify: $\Omega_0 N = \frac{\pi}{4} \times 8 = 2\pi$, a whole number of cycles, so the sequence repeats every 8 samples.

Final Answer: $N = 8 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q30

Q31.

Solution

Concept – poles are the roots of the denominator: The poles of $H(s)$ are the values of s that make the denominator zero.

Step 1 – set the denominator to zero: $s^2 + 7s + 12 = 0$

Step 2 – factorise: $s^2 + 7s + 12 = (s + 3)(s + 4)$

Step 3 – solve each factor: $s + 3 = 0 \Rightarrow s = -3$

$s + 4 = 0 \Rightarrow s = -4$

Step 4 – match with the plot: The two crosses sit at $\sigma = -3$ and $\sigma = -4$ on the real axis, both in the left half-plane, confirming a stable system.

Final Answer: poles at -3 and $-4 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q31

Q32.

Solution

Concept – Routh–Hurwitz array: The number of sign changes in the first column of the Routh array equals the number of right-half-plane roots.

Step 1 – write the first two rows from the coefficients of $s^3 + 6s^2 + 11s + 6$: s^3 row: $1 \quad 11$

s^2 row: $6 \quad 6$

Step 2 – compute the s^1 row entry: $\dfrac{(6)(11) - (1)(6)}{6} = \dfrac{66 - 6}{6}$

$= \dfrac{60}{6} = 10$

Step 3 – write the s^0 row: s^0 row: 6

Step 4 – list the first column and its signs: $1,\ 6,\ 10,\ 6 \Rightarrow +,\ +,\ +,\ +$

Step 5 – count the sign changes: There are no sign changes in the first column.

Step 6 – interpret: Zero sign changes mean 0 poles in the right half-plane; the system is stable (its roots are $-1, -2, -3$).

Final Answer: 0 RHP poles $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q32

Q33.

Solution

Concept – steady-state error of a type-0 system to a step: $e_{ss} = \dfrac{1}{1 + K_p}$, where $K_p = \lim_{s\to 0} G(s)$ is the position error constant.

Step 1 – compute K_p by setting $s = 0$: $K_p = \dfrac{20}{(0+2)(0+5)}$

Step 2 – evaluate the denominator: $(2)(5) = 10$

Step 3 – finish K_p: $K_p = \dfrac{20}{10} = 2$

Step 4 – form $1 + K_p$: $1 + 2 = 3$

Step 5 – take the reciprocal: $e_{ss} = \dfrac{1}{3}$

Step 6 – evaluate: $e_{ss} = 0.333$

Final Answer: $e_{ss} = 0.333 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q33

Q34.

Solution

Concept – nature of a second-order response from ζ: Compare $s^2 + 2\zeta\omega_n s + \omega_n^2$ with the given equation; $\zeta = 1$ is critically damped, $\zeta < 1$ underdamped, $\zeta > 1$ overdamped, $\zeta = 0$ undamped.

Step 1 – match the constant term: $\omega_n^2 = 9 \Rightarrow \omega_n = 3$ rad/s

Step 2 – match the middle term: $2\zeta\omega_n = 6$

Step 3 – substitute $\omega_n = 3$: $2\zeta(3) = 6$

$6\zeta = 6$

Step 4 – solve for ζ: $\zeta = 1$

Step 5 – classify: $\zeta = 1$ corresponds to a critically damped response (a repeated real pole at $s = -3$).

Final Answer: critically damped $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q34

Q35.

Solution

Concept – peak overshoot of a second-order step response: $M_p = e^{-\pi\zeta/\sqrt{1-\zeta^2}} \times 100\%$.

Step 1 – compute $1 - \zeta^2$: $1 - (0.707)^2 = 1 - 0.5 = 0.5$

Step 2 – take its square root: $\sqrt{0.5} = 0.707$

Step 3 – form the exponent: $-\dfrac{\pi\zeta}{\sqrt{1-\zeta^2}} = -\dfrac{\pi \times 0.707}{0.707} = -\pi$

$= -3.1416$

Step 4 – take the exponential: $e^{-3.1416} = 0.0432$

Step 5 – convert to a percentage: $M_p = 0.0432 \times 100\% = 4.32\%$

Final Answer: $M_p \approx 4.3\% \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q35

Q36.

Solution

Concept – total power of an AM signal: $P_t = P_c\left(1 + \frac{\mu^2}{2}\right)$, where P_c is the carrier power and μ the modulation index.

Step 1 – square the modulation index: $\mu^2 = (0.5)^2 = 0.25$

Step 2 – halve it: $\frac{\mu^2}{2} = \frac{0.25}{2} = 0.125$

Step 3 – form the bracket: $1 + 0.125 = 1.125$

Step 4 – multiply by the carrier power: $P_t = 200 \times 1.125$

Step 5 – evaluate: $P_t = 225\ \text{W}$

Final Answer: $P_t = 225\ \text{W} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q36

Q37.

Solution

Concept – modulation index from the envelope extremes: $\mu = \frac{E_{\max} - E_{\min}}{E_{\max} + E_{\min}}$.

Step 1 – compute the numerator: $E_{\max} - E_{\min} = 15 - 5 = 10$

Step 2 – compute the denominator: $E_{\max} + E_{\min} = 15 + 5 = 20$

Step 3 – form the ratio: $\mu = \frac{10}{20}$

Step 4 – evaluate: $\mu = 0.5$

Final Answer: $\mu = 0.5 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q37

Q38.

Solution

Concept – PCM bit rate: $R_b = n \times f_s$, where $n = \log_2 L$ bits encode L quantization levels sampled at f_s.

Step 1 – find the number of bits per sample: $n = \log_2(128) = \log_2(2^7) = 7$ bits

Step 2 – list the sampling rate: $f_s = 10\ \text{kHz} = 10000$ samples/s

Step 3 – multiply: $R_b = 7 \times 10000$

Step 4 – evaluate: $R_b = 70000\ \text{bps} = 70\ \text{kbps}$

Final Answer: $R_b = 70\ \text{kbps} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q38

Q39.

Solution

Concept – symbol rate of an M-ary scheme: $R_s = \dfrac{R_b}{\log_2 M}$; 8-PSK has $M = 8$, so $\log_2 8 = 3$ bits per symbol.

Step 1 – list the data: $R_b = 3$ Mbps, bits per symbol $= 3$.

Step 2 – divide the bit rate by the bits per symbol: $R_s = \dfrac{3\text{ Mbps}}{3}$

Step 3 – evaluate: $R_s = 1$ Msymbol/s

Final Answer: $R_s = 1$ Msym/s $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q39

Q40.

Solution

Concept – entropy of a discrete source: $H = -\sum_i p_i \log_2 p_i$ bits/symbol.

Step 1 – list the probabilities: $p_1 = \frac{1}{2}$, $p_2 = \frac{1}{4}$, $p_3 = \frac{1}{4}$.

Step 2 – find each self-information $-\log_2 p_i$**:** $-\log_2 \frac{1}{2} = 1$

$-\log_2 \frac{1}{4} = 2$

$-\log_2 \frac{1}{4} = 2$

Step 3 – weight each by its probability: $\frac{1}{2} \times 1 = 0.5$

$\frac{1}{4} \times 2 = 0.5$

$\frac{1}{4} \times 2 = 0.5$

Step 4 – add the contributions: $H = 0.5 + 0.5 + 0.5 = 1.5$ bits/symbol

Why the other options are wrong:

- B, 2 bits/symbol: would be the entropy only if the symbols were equiprobable; here they are not, so the true value is lower.

Final Answer: $H = 1.5$ bits/symbol $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q40

Q41.

Solution

Concept – Shannon–Hartley channel capacity: $C = B\log_2(1 + \text{SNR})$.

Step 1 – form the term inside the logarithm: $1 + \text{SNR} = 1 + 15 = 16$

Step 2 – take the base-2 logarithm: $\log_2(16) = \log_2(2^4) = 4$

Step 3 – multiply by the bandwidth: $C = 4000 \times 4$

Step 4 – evaluate: $C = 16000$ bps $= 16$ kbps

Final Answer: $C = 16$ kbps $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q41

Q42.

Solution

Concept – Gauss's law in terms of flux density: The net displacement flux out of a closed surface equals the charge it encloses, $\oint_S \vec{D} \cdot d\vec{S} = Q_{enc}$.

Step 1 – identify the enclosed charge: $Q_{enc} = 5$ C.

Step 2 – apply Gauss's law directly: $\Psi = \oint_S \vec{D} \cdot d\vec{S} = Q_{enc}$

Step 3 – state the value: $\Psi = 5$ C

Why the other options are wrong:

- C, $5/\varepsilon_0$: is the flux of the electric field $\vec{E}$ (which equals Q/ε_0), not the $\vec{D}$ flux asked for.
- B, 0 C: would hold only if no net charge were enclosed.

Final Answer: $\Psi = 5$ C $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q42

Q43.

Solution

Concept – uniform field between parallel plates: For plates separated by d with a potential difference V, the field is $E = \dfrac{V}{d}$.

Step 1 – convert the spacing to metres: $d = 2$ mm $= 2 \times 10^{-3}$ m

Step 2 – substitute into $E = V/d$: $E = \dfrac{100}{2 \times 10^{-3}}$

Step 3 – evaluate: $E = 50000$ V/m

Step 4 – express in kV/m: $E = 50$ kV/m

Final Answer: $E = 50$ kV/m $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q43

Q44.

Solution

Concept – wavelength of a plane wave: $\lambda = \dfrac{c}{f}$, with c the speed of light.

Step 1 – list the data: $c = 3 \times 10^8$ m/s, $f = 1$ GHz $= 1 \times 10^9$ Hz.

Step 2 – divide: $\lambda = \dfrac{3 \times 10^8}{1 \times 10^9}$

Step 3 – simplify the powers of ten: $\lambda = 3 \times 10^{-1}$ m

Step 4 – convert to centimetres: $\lambda = 0.3$ m $= 30$ cm

Final Answer: $\lambda = 30$ cm $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q44

Q45.

Solution

Concept – reflection coefficient and VSWR: $\Gamma = \dfrac{Z_L - Z_0}{Z_L + Z_0}$ and VSWR $= \dfrac{1 + |\Gamma|}{1 - |\Gamma|}$.

Step 1 – compute the numerator of Γ: $Z_L - Z_0 = 25 - 75 = -50$

Step 2 – compute the denominator of Γ: $Z_L + Z_0 = 25 + 75 = 100$

Step 3 – form Γ and take its magnitude: $\Gamma = \dfrac{-50}{100} = -0.5 \Rightarrow |\Gamma| = 0.5$

Step 4 – form the VSWR numerator and denominator: $1 + |\Gamma| = 1 + 0.5 = 1.5$

$1 - |\Gamma| = 1 - 0.5 = 0.5$

Step 5 – divide: VSWR $= \dfrac{1.5}{0.5}$

VSWR $= 3$

Final Answer: VSWR $= 3 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q45

Q46.

Solution

Concept – characteristic impedance of a lossless line: $Z_0 = \sqrt{\frac{L}{C}}$, with L and C the per-unit-length inductance and capacitance.

Step 1 – convert the values to base units: $L = 1\ \mu\text{H/m} = 1 \times 10^{-6}$ H/m

$C = 100$ pF/m $= 100 \times 10^{-12} = 1 \times 10^{-10}$ F/m

Step 2 – form the ratio L/C**:** $\frac{L}{C} = \frac{1 \times 10^{-6}}{1 \times 10^{-10}}$

Step 3 – simplify: $= 1 \times 10^4 = 10000$

Step 4 – take the square root: $Z_0 = \sqrt{10000}$

$Z_0 = 100\ \Omega$

Final Answer: $Z_0 = 100\ \Omega \Rightarrow \boxed{\text{A}}$

Answer: (A)

Go Back to Q46

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	A	2	D	3	C	4	B	5	B
6	A	7	B	8	C	9	B	10	D
11	A	12	C	13	D	14	B	15	A
16	C	17	A	18	B	19	D	20	D
21	B	22	D	23	C	24	B	25	D
26	B	27	D	28	A	29	C	30	B
31	D	32	A	33	C	34	A	35	A
36	C	37	C	38	B	39	C	40	A
41	D	42	A	43	C	44	B	45	D
46	A								