GATE Electrical Engineering

Sample Paper – 1

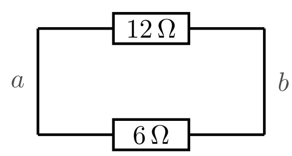
Duration: 128 Minutes **Maximum Marks: 72**

Instructions

- This paper contains **46 questions** covering the core **Electrical 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 $\varepsilon_0 = 8.854 \times 10^{-12}$ F/m, $\mu_0 = 4\pi \times 10^{-7}$ H/m and $c = 3 \times 10^8$ m/s.

Electric Circuits

Q1. Two resistors of $12\ \Omega$ and $6\ \Omega$ are connected in parallel between nodes a and b, as shown. The equivalent resistance seen between a and b is: **[1 mark]**



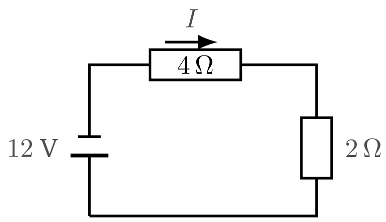
(A) $18\ \Omega$

(B) $6\ \Omega$

(C) $2\ \Omega$

(D) $4\ \Omega$

Q2. In the single-loop circuit shown, a 12 V d.c. source drives a series combination of $4\ \Omega$ and $2\ \Omega$. Using mesh (loop) analysis, the loop current I is: **[1 mark]**



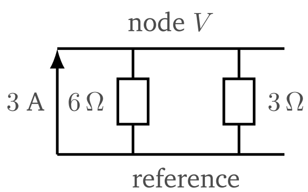
(A) 3 A

(B) 2 A

(C) 1 A

(D) 6 A

Q3. In the circuit shown, an ideal 3 A current source feeds two resistors of $6\ \Omega$ and $3\ \Omega$ connected in parallel to the reference node. By nodal analysis the node voltage V is: **[1 mark]**



(A) 3 V

(B) 9 V

(C) 18 V

(D) 6 V

Q4. A series RC circuit is switched on to a d.c. source at $t = 0$, with $R = 2$ kΩ and $C = 5\ \mu$F. The time constant of the charging transient is: **[1 mark]**

(A) 1 ms

(B) 100 ms

(C) 10 ms

(D) 0.1 ms

Q5. A source-free series RL circuit has $L = 100$ mH and $R = 25\ \Omega$. The time constant of the natural (transient) response is: **[1 mark]**

(A) 2.5 ms

(B) 0.25 ms

(C) 40 ms

(D) 4 ms

Q6. A one-port network is reduced to its Thevenin equivalent with open-circuit voltage $V_{th} = 10$ V and Thevenin resistance $R_{th} = 5\ \Omega$. When a load is connected for maximum power transfer, the power delivered to the load is: **[1 mark]**

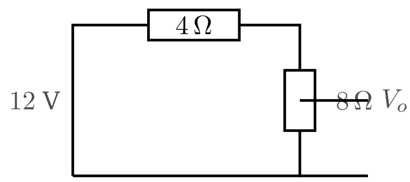
(A) 20 W

(B) 10 W

(C) 5 W

(D) 2.5 W

Q7. For the resistive voltage divider shown, a 12 V source is applied across the series combination of $4\ \Omega$ and $8\ \Omega$. The voltage V_o across the $8\ \Omega$ resistor is: **[1 mark]**



(A) 4 V

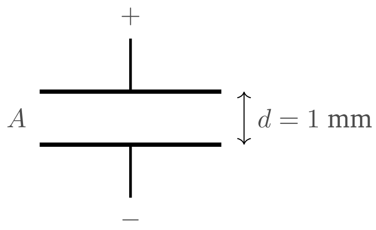
(B) 6 V

(C) 12 V

(D) 8 V

Electromagnetic Fields

Q8. A parallel-plate capacitor has plate area $A = 0.01$ m^2 and plate separation $d = 1$ mm with air (vacuum) dielectric, as shown. Using $C = \varepsilon_0 A/d$, the capacitance is nearest to: **[1 mark]**



(A) 8.85 pF

(B) 885 pF

(C) 88.5 pF

(D) 0.885 pF

Q9. By Gauss's law, a point charge $Q = 1$ μC in free space produces a radial electric field of magnitude $E = \dfrac{Q}{4\pi\varepsilon_0 r^2}$. At a distance $r = 3$ m (take $\dfrac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N·m^2/C^2), the field magnitude is: **[1 mark]**

(A) 1000 V/m

(B) 3000 V/m

(C) 333 V/m

(D) 9000 V/m

Q10. A capacitor of $C = 100$ μF is charged to a voltage of 100 V. The electrostatic energy stored in the capacitor, $W = \frac{1}{2}CV^2$, is: **[1 mark]**

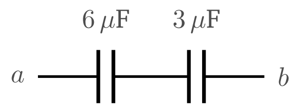
(A) 0.5 J

(B) 1 J

(C) 0.05 J

(D) 5 J

Q11. Two capacitors of $6\ \mu$F and $3\ \mu$F are connected in series, as shown. The equivalent capacitance of the combination is: **[1 mark]**



(A) $9\ \mu$F

(B) $2\ \mu$F

(C) $18\ \mu$F

(D) $4.5\ \mu$F

Signals and Systems

Q12. Two finite-length discrete sequences of lengths 5 and 4 samples respectively are linearly convolved. The length (number of samples) of the resulting sequence is: **[1 mark]**

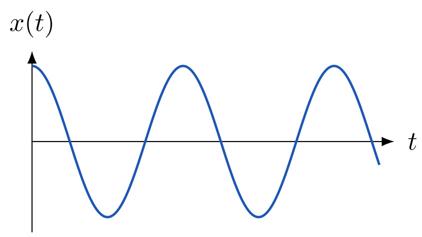
(A) 9

(B) 20

(C) 5

(D) 8

Q13. A continuous-time signal is $x(t) = \cos(100\pi t)$, one cycle of which is sketched below. Its fundamental period T is: **[1 mark]**



(A) 10 ms

(B) 20 ms

(C) 5 ms

(D) 100 ms

Q14. An input $x(t)$ is applied to an LTI system whose impulse response is a shifted impulse $h(t) = \delta(t-3)$. Using the sifting property of convolution, the output $y(t) = x(t) * \delta(t-3)$ is: **[1 mark]**

(A) $x(t+3)$

(B) $x(t-3)$

(C) $x(t)$

(D) $x(3t)$

Q15. The Fourier-series (average or d.c.) value of the periodic signal $x(t) = 5 + 4\cos(\omega_0 t)$ over one period is: **[1 mark]**

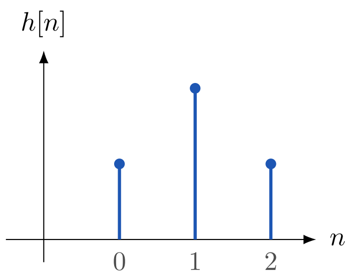
(A) 5

(B) 4

(C) 9

(D) 0

Q16. A discrete-time LTI system has the finite impulse response $h[n]$ shown ($h[0] = 1$, $h[1] = 2$, $h[2] = 1$). Its d.c. gain, $\sum_n h[n]$, is: **[1 mark]**



(A) 1

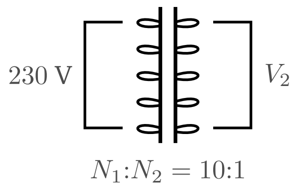
(B) 2

(C) 4

(D) 0

Electrical Machines

Q17. An ideal single-phase transformer has a turns ratio $N_1/N_2 = 10$ and is supplied at 230 V on the primary, as shown. The secondary (open-circuit) voltage is: **[1 mark]**



(A) 2300 V

(B) 23 V

(C) 230 V

(D) 46 V

Q18. A d.c. shunt motor is supplied at $V = 220$ V and draws an armature current $I_a = 20$ A. The armature-circuit resistance is $R_a = 0.5\ \Omega$. The back e.m.f. $E_b = V - I_aR_a$ is: **[1 mark]**

(A) 230 V

(B) 200 V

(C) 210 V

(D) 10 V

Q19. An ideal single-phase transformer has a turns ratio $N_1/N_2 = 2$. When the secondary delivers a load current of 10 A, the primary current (from $I_1/I_2 = N_2/N_1$) is: **[1 mark]**

(A) 5 A

(B) 20 A

(C) 10 A

(D) 2 A

Q20. A 5 kVA single-phase transformer has a rated secondary voltage of 250 V. The rated (full-load) secondary current is: **[1 mark]**

(A) 5 A

(B) 10 A

(C) 2 A

(D) 20 A

Q21. A d.c. motor develops a back e.m.f. of $E_b = 200$ V while carrying an armature current of $I_a = 25$ A. The gross mechanical power developed in the armature, $P = E_b I_a$, is: **[2 marks]**

(A) 5 kW

(B) 8 kW

(C) 0.2 kW

(D) 10 kW

Q22. A single-phase transformer delivers an output of 4 kW. Its core (iron) loss is 100 W and its copper loss at this load is 100 W. The efficiency $\eta = \dfrac{P_{out}}{P_{out} + P_{loss}}$ is nearest to: **[2 marks]**

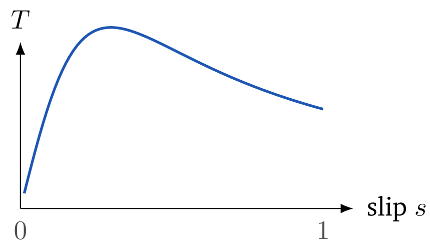
(A) 90%

(B) 98%

(C) 95.2%

(D) 80%

Q23. A 4-pole, 50 Hz three-phase induction motor runs at a rotor speed of 1440 rpm. Its torque–slip characteristic is sketched below. The per-unit slip $s = \dfrac{N_s - N}{N_s}$ is: **[2 marks]**



(A) 2%

(B) 4%

(C) 6%

(D) 8%

Power Systems

Q24. In per-unit analysis, a base of 100 MVA and 11 kV is chosen. The base impedance $Z_{base} = \dfrac{(kV_{base})^2}{MVA_{base}}$ is: **[2 marks]**

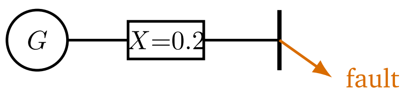
(A) $0.121\ \Omega$

(B) $1.21\ \Omega$

(C) $12.1\ \Omega$

(D) $121\ \Omega$

Q25. A generator is connected to a bus of base 100 MVA through a reactance of $X = 0.2$ pu, as shown by the single-line diagram. For a three-phase symmetrical fault at the bus the fault level $\text{MVA}_{fault} = \dfrac{\text{MVA}_{base}}{X_{pu}}$ is: **[2 marks]**



(A) 100 MVA

(B) 20 MVA

(C) 500 MVA

(D) 200 MVA

Q26. A generator reactance is given as 0.1 pu on a base of 50 MVA. Converting it to a new base of 100 MVA at the same voltage, using $X_{new} = X_{old} \times \dfrac{MVA_{new}}{MVA_{old}}$, gives: **[2 marks]**

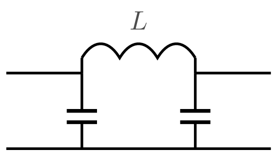
(A) 0.2 pu

(B) 0.05 pu

(C) 0.1 pu

(D) 0.4 pu

Q27. A lossless transmission line is modelled by the π-section shown with series inductance $L = 0.9$ mH/km and shunt capacitance $C = 0.01$ μF/km. Its surge (characteristic) impedance $Z_c = \sqrt{L/C}$ is: **[2 marks]**



(A) $150\ \Omega$

(B) $300\ \Omega$

(C) $400\ \Omega$

(D) $75\ \Omega$

Q28. Two buses of a lossless line are held at $V_1 = V_2 = 1.0$ pu, and the line reactance is $X = 0.5$ pu. The theoretical maximum power transferable, $P_{max} = \dfrac{V_1 V_2}{X}$ (at $\delta = 90°$), is: **[2 marks]**

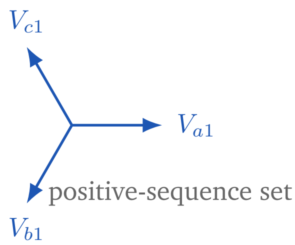
(A) 2 pu

(B) 0.5 pu

(C) 1 pu

(D) 4 pu

Q29. A single-line-to-ground fault occurs on an unloaded generator. The sequence reactances are $Z_1 = Z_2 = Z_0 = 0.1$ pu and the pre-fault e.m.f. is $E = 1.0$ pu. The fault current $I_f = \dfrac{3E}{Z_1 + Z_2 + Z_0}$ is: **[2 marks]**



(A) 10 pu

(B) 3.33 pu

(C) 30 pu

(D) 1 pu

Q30. A three-phase system has a base of 100 MVA and a line voltage of 132 kV. The base current $I_{base} = \dfrac{\text{MVA}_{base}}{\sqrt{3}\,\text{kV}_{base}}$ is nearest to: [2 marks]

(A) 758 A

(B) 437 A

(C) 220 A

(D) 100 A

Control Systems

Q31. A standard second-order system has the characteristic equation $s^2 + 6s + 25 = 0$. Comparing with $s^2 + 2\zeta\omega_n s + \omega_n^2 = 0$, the damping ratio ζ is: [2 marks]

(A) 0.3

(B) 1

(C) 0.5

(D) 0.6

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

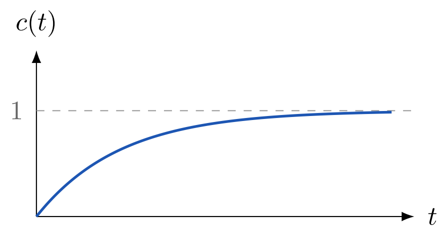
(A) 0

(B) 1

(C) 2

(D) 3

Q33. A unity-feedback second-order system has damping ratio $\zeta = 0.5$. For a unit-step input the peak percentage overshoot $M_p = e^{-\pi\zeta/\sqrt{1-\zeta^2}} \times 100\%$ (illustrated below) is nearest to: **[2 marks]**



(A) 5%

(B) 25%

(C) 16.3%

(D) 50%

Q34. A unity-feedback system has open-loop transfer function $G(s) = \dfrac{10}{s(s+2)}$. For a unit-step input the steady-state error (a type-1 system, $e_{ss} = 1/(1 + K_p)$ with $K_p = \lim_{s\to 0} G(s) = \infty$) is: **[2 marks]**

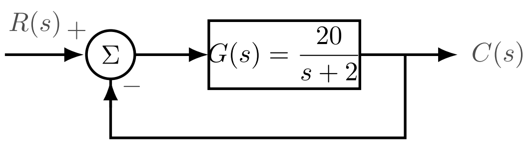
(A) 0

(B) 0.5

(C) 0.1

(D) 1

Q35. For the unity-feedback control system shown, the forward-path transfer function is $G(s) = \dfrac{20}{s+2}$. The d.c. gain of the closed-loop transfer function $\dfrac{C(s)}{R(s)} = \dfrac{G(s)}{1+G(s)}$ (its value at $s = 0$) is nearest to: **[2 marks]**



(A) 10

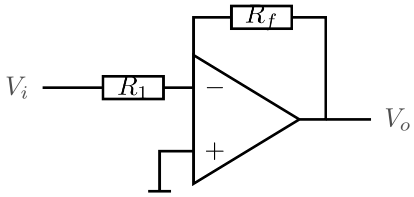
(B) 1

(C) 0.5

(D) 0.909

Analog, Digital and Measurements

Q36. For the ideal-op-amp inverting amplifier shown, $R_1 = 10$ kΩ and $R_f = 50$ kΩ. The magnitude of the closed-loop voltage gain $|V_o/V_i| = R_f/R_1$ is: **[2 marks]**



(A) 0.2

(B) 6

(C) 5

(D) 50

Q37. The unsigned binary number $(10110)_2$ has the decimal (base-10) value: **[2 marks]**

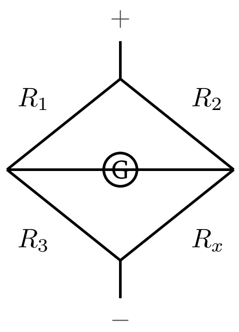
(A) 11

(B) 44

(C) 26

(D) 22

Q38. The Wheatstone bridge shown is balanced with $R_1 = 100\ \Omega$, $R_2 = 200\ \Omega$ and $R_3 = 300\ \Omega$. The unknown resistance, from the balance condition $R_x = \dfrac{R_2R_3}{R_1}$, is: **[2 marks]**



(A) 150 Ω

(B) 600 Ω

(C) 66.7 Ω

(D) 900 Ω

Q39. The hexadecimal number $(1\text{A})_{16}$ has the decimal (base-10) value: **[2 marks]**

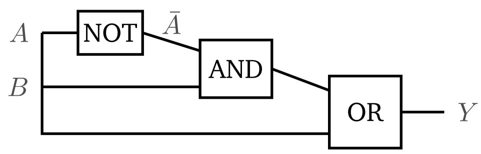
(A) 26

(B) 16

(C) 10

(D) 32

Q40. The Boolean output of the gate network shown is $Y = A + \bar{A}B$. Applying the absorption/redundancy law, the simplified expression is: **[2 marks]**



(A) A

(B) B

(C) AB

(D) $A + B$

Q41. A sinusoidal voltage has a peak (amplitude) value of $V_m = 10$ V. Its true root-mean-square (RMS) value, as read by a true-RMS meter, is $V_{rms} = V_m/\sqrt{2}$, which is: **[2 marks]**

(A) 10 V

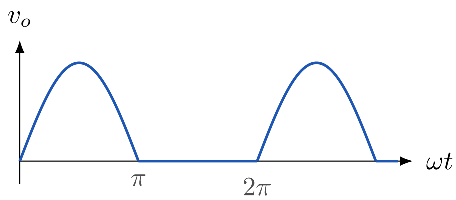
(B) 14.14 V

(C) 7.07 V

(D) 5 V

Power Electronics

Q42. A single-phase half-wave diode rectifier feeds a resistive load from a supply of peak voltage $V_m = 100$ V, giving the output waveform shown. The average (d.c.) output voltage $V_{dc} = V_m/\pi$ is: **[2 marks]**



(A) 63.66 V

(B) 31.83 V

(C) 45 V

(D) 100 V

Q43. A single-phase full-wave (centre-tapped or bridge) diode rectifier feeds a resistive load from a supply of peak voltage $V_m = 100$ V. The average (d.c.) output voltage $V_{dc} = \dfrac{2V_m}{\pi}$ is: **[2 marks]**

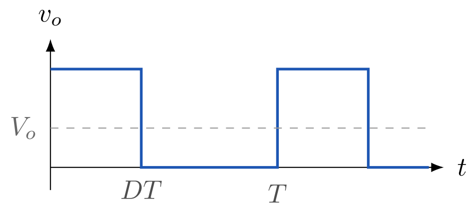
(A) 63.66 V

(B) 31.83 V

(C) 45 V

(D) 70.7 V

Q44. A step-down (buck) d.c. chopper operates from a supply $V_s = 200$ V at a duty ratio $D = 0.4$, producing the output-voltage waveform shown. The average output voltage $V_o = D\,V_s$ is: **[2 marks]**



(A) 200 V

(B) 120 V

(C) 500 V

(D) 80 V

Q45. A step-down d.c. chopper supplies an average output voltage of 150 V from an input of 300 V. The required duty ratio, $D = V_o/V_s$, is: **[2 marks]**

(A) 0.25

(B) 0.5

(C) 0.75

(D) 2

Q46. A single-phase full-wave controlled rectifier (fully controlled bridge) feeds a highly inductive load from a supply of peak voltage $V_m = 100$ V, at a firing angle $\alpha = 60°$. The average output voltage $V_{dc} = \dfrac{2V_m}{\pi}\cos\alpha$ is: **[2 marks]**

(A) 63.66 V

(B) 45 V

(C) 31.83 V

(D) 0 V

Detailed Solutions

Q1.

Solution

Concept – two resistors in parallel: The equivalent of two parallel resistors is their product over their sum, $R_{eq} = \dfrac{R_1 R_2}{R_1 + R_2}$.

Step 1 – list the data: $R_1 = 12\ \Omega$, $R_2 = 6\ \Omega$.

Step 2 – form the product of the resistances: $R_1 R_2 = 12 \times 6 = 72$

Step 3 – form the sum of the resistances: $R_1 + R_2 = 12 + 6 = 18$

Step 4 – divide: $R_{eq} = \dfrac{72}{18}$

$R_{eq} = 4\ \Omega$

Step 5 – sanity check: A parallel combination is always smaller than the smallest branch ($6\ \Omega$), and $4 < 6$, so the result is consistent.

Final Answer: $R_{eq} = 4\ \Omega \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q1

Q2.

Solution

Concept – mesh analysis of a single loop: For one loop, Kirchhoff's voltage law gives the source equal to the sum of the resistive drops, $V = I(R_1 + R_2)$.

Step 1 – add the series resistances: $R_{total} = 4 + 2$

$R_{total} = 6\ \Omega$

Step 2 – write KVL around the loop: $12 = I \times 6$

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

$I = 2\ \text{A}$

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

Answer: (B) Go Back to Q2

Q3.

Solution

Concept – nodal analysis with a current source: The current source current all flows into the parallel resistors, so $V = I_s\,R_{eq}$ where R_{eq} is the parallel combination.

Step 1 – combine the two resistors in parallel: $R_{eq} = \dfrac{6 \times 3}{6 + 3}$

$R_{eq} = \dfrac{18}{9}$

$R_{eq} = 2\ \Omega$

Step 2 – apply the node equation (all source current through R_{eq}): $V = I_s \times R_{eq}$

Step 3 – substitute the values: $V = 3 \times 2$

$V = 6$ V

Final Answer: $V = 6\text{ V} \Rightarrow \boxed{\text{D}}$

Answer: (D) 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: $R = 2\text{ k}\Omega = 2 \times 10^3\ \Omega$

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

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

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

$\tau = 0.01\text{ s} = 10\text{ ms}$

Final Answer: $\tau = 10\text{ ms} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q4

Q5.

Solution

Concept – time constant of an RL circuit: For a first-order RL circuit the time constant is $\tau = \dfrac{L}{R}$.

Step 1 – convert the inductance to base units: $L = 100\text{ mH} = 100 \times 10^{-3}\text{ H} = 0.1$ H

Step 2 – substitute the values: $\tau = \dfrac{0.1}{25}$

Step 3 – evaluate: $\tau = 0.004 \text{ s} = 4 \text{ ms}$

Final Answer: $\tau = 4 \text{ ms} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q5

Q6.

Solution

Concept – maximum power transfer theorem: Maximum power is delivered when the load equals the Thevenin resistance, and then $P_{\max} = \dfrac{V_{th}^2}{4R_{th}}$.

Step 1 – list the data: $V_{th} = 10$ V, $R_{th} = 5\ \Omega$.

Step 2 – square the Thevenin voltage: $V_{th}^2 = 10^2 = 100$

Step 3 – form the denominator: $4R_{th} = 4 \times 5 = 20$

Step 4 – divide: $P_{\max} = \dfrac{100}{20}$

$P_{\max} = 5$ W

Final Answer: $P_{\max} = 5 \text{ W} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q6

Q7.

Solution

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

Step 1 – add the two resistances: $R_1 + R_2 = 4 + 8 = 12\ \Omega$

Step 2 – form the divider ratio for the $8\ \Omega$ resistor: $\dfrac{R_2}{R_1 + R_2} = \dfrac{8}{12}$

Step 3 – multiply by the source voltage: $V_o = 12 \times \dfrac{8}{12}$

Step 4 – evaluate: $V_o = 8$ V

Final Answer: $V_o = 8 \text{ V} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q7

Q8.

Solution

Concept – capacitance of a parallel-plate capacitor: $C = \dfrac{\varepsilon_0 A}{d}$ for a vacuum (air) dielectric.

Step 1 – list the data in base units: $\varepsilon_0 = 8.854 \times 10^{-12}$ F/m, $A = 0.01$ m^2, $d = 1$ mm $= 1 \times 10^{-3}$ m.

Step 2 – form the numerator $\varepsilon_0 A$**:** $\varepsilon_0 A = (8.854 \times 10^{-12}) \times (0.01)$

$\varepsilon_0 A = 8.854 \times 10^{-14}$

Step 3 – divide by the plate separation: $C = \dfrac{8.854 \times 10^{-14}}{1 \times 10^{-3}}$

Step 4 – combine the powers of ten: $C = 8.854 \times 10^{-11}$ F

Step 5 – convert to picofarads: $C = 88.54$ pF ≈ 88.5 pF

Final Answer: $C \approx 88.5$ pF $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q8

Q9.

Solution

Concept – Gauss's law for a point charge: The radial field of a point charge is $E = \dfrac{1}{4\pi\varepsilon_0} \cdot \dfrac{Q}{r^2}$.

Step 1 – list the data: $\dfrac{1}{4\pi\varepsilon_0} = 9 \times 10^9$, $Q = 1\ \mu$C $= 1 \times 10^{-6}$ C, $r = 3$ m.

Step 2 – square the distance: $r^2 = 3^2 = 9$ m^2

Step 3 – substitute into the field equation: $E = \dfrac{(9 \times 10^9) \times (1 \times 10^{-6})}{9}$

Step 4 – evaluate the numerator: $(9 \times 10^9) \times (1 \times 10^{-6}) = 9 \times 10^3$

Step 5 – divide by r^2**:** $E = \dfrac{9 \times 10^3}{9}$

$E = 1000$ V/m

Final Answer: $E = 1000$ V/m $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q9

Q10.

Solution

Concept – energy stored in a capacitor: $W = \frac{1}{2}CV^2$.

Step 1 – list the data in base units: $C = 100\ \mu\text{F} = 100 \times 10^{-6}$ F, $V = 100$ V.

Step 2 – square the voltage: $V^2 = 100^2 = 10000\ \text{V}^2$

Step 3 – substitute into the energy equation: $W = \frac{1}{2} \times (100 \times 10^{-6}) \times 10000$

Step 4 – multiply the capacitance by V^2: $(100 \times 10^{-6}) \times 10000 = 1$

Step 5 – take one-half: $W = \frac{1}{2} \times 1$

$W = 0.5$ J

Final Answer: $W = 0.5\ \text{J} \Rightarrow \boxed{\text{A}}$

Answer: (A) **Go Back to Q10**

Q11.

Solution

Concept – capacitors in series: For two series capacitors the equivalent is $C_{eq} = \frac{C_1C_2}{C_1 + C_2}$.

Step 1 – list the data: $C_1 = 6\ \mu\text{F}$, $C_2 = 3\ \mu\text{F}$.

Step 2 – form the product: $C_1C_2 = 6 \times 3 = 18$

Step 3 – form the sum: $C_1 + C_2 = 6 + 3 = 9$

Step 4 – divide: $C_{eq} = \frac{18}{9}$

$C_{eq} = 2\ \mu\text{F}$

Step 5 – sanity check: A series capacitance is smaller than the smallest capacitor ($3\ \mu$F), and $2 < 3$, so the result is consistent.

Final Answer: $C_{eq} = 2\ \mu\text{F} \Rightarrow \boxed{\text{B}}$

Answer: (B) **Go Back to Q11**

Q12.

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: $L_1 = 5$, $L_2 = 4$.

Step 2 – add the lengths: $L_1 + L_2 = 5 + 4 = 9$

Step 3 – subtract one: $L = 9 - 1$

$L = 8$

Final Answer: length $= 8$ samples $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q12

Q13.

Solution

Concept – period of a cosine: For $x(t) = \cos(\omega_0 t)$ the fundamental period is $T = \dfrac{2\pi}{\omega_0}$.

Step 1 – identify the angular frequency: $\omega_0 = 100\pi$ rad/s.

Step 2 – substitute into the period formula: $T = \dfrac{2\pi}{100\pi}$

Step 3 – cancel π: $T = \dfrac{2}{100}$

Step 4 – evaluate: $T = 0.02$ s $= 20$ ms

Final Answer: $T = 20$ ms $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q13

Q14.

Solution

Concept – convolution with a shifted impulse (sifting property): Convolving any signal with $\delta(t - t_0)$ simply shifts it: $x(t) * \delta(t - t_0) = x(t - t_0)$.

Step 1 – identify the shift: Here $h(t) = \delta(t - 3)$, so $t_0 = 3$.

Step 2 – apply the sifting property: $y(t) = x(t) * \delta(t - 3)$

Step 3 – write the result: $y(t) = x(t - 3)$

Why the other options are wrong:

- A, $x(t + 3)$: an advance; convolving with $\delta(t - 3)$ delays, not advances.

- C, $x(t)$: would require $h(t) = \delta(t)$ (no shift).
- D, $x(3t)$: time-scaling is not produced by convolution with an impulse.

Final Answer: $y(t) = x(t-3) \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q14

Q15.

Solution

Concept – d.c. term of a Fourier series: The average value of a signal is the constant (a_0) term; a pure cosine averages to zero over a period.

Step 1 – separate the signal: $x(t) = 5 + 4\cos(\omega_0 t)$

Step 2 – average the constant part: The average of the constant 5 over a period is 5.

Step 3 – average the cosine part: $\dfrac{1}{T}\displaystyle\int_0^T 4\cos(\omega_0 t)\,dt = 0$

Step 4 – add the two contributions: average $= 5 + 0$

average $= 5$

Final Answer: average value $= 5 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q15

Q16.

Solution

Concept – d.c. gain of a discrete FIR system: The d.c. (zero-frequency) gain equals the sum of all impulse-response samples, $H(e^{j0}) = \sum_n h[n]$.

Step 1 – read the samples from the stem plot: $h[0] = 1$, $h[1] = 2$, $h[2] = 1$.

Step 2 – add the first two: $1 + 2 = 3$

Step 3 – add the last sample: $3 + 1 = 4$

Step 4 – state the d.c. gain: $\sum_n h[n] = 4$

Final Answer: d.c. gain $= 4 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q16

Q17.

Solution

Concept – ideal transformer voltage ratio: For an ideal transformer $\frac{V_1}{V_2} = \frac{N_1}{N_2}$, so $V_2 = V_1 \cdot \frac{N_2}{N_1}$.

Step 1 – list the data: $V_1 = 230$ V, $\frac{N_1}{N_2} = 10$.

Step 2 – write the secondary voltage: $V_2 = \frac{V_1}{N_1/N_2}$

Step 3 – substitute: $V_2 = \frac{230}{10}$

Step 4 – evaluate: $V_2 = 23$ V

Why the other options are wrong:

- A, 2300 V: multiplies instead of divides (that would be a step-up ratio).
- C, 230 V: assumes a 1:1 ratio.
- D, 46 V: uses a ratio of 5 instead of 10.

Final Answer: $V_2 = 23 \text{ V} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q17

Q18.

Solution

Concept – back e.m.f. of a d.c. motor: The armature back e.m.f. is $E_b = V - I_a R_a$.

Step 1 – list the data: $V = 220$ V, $I_a = 20$ A, $R_a = 0.5\ \Omega$.

Step 2 – compute the armature resistive drop: $I_a R_a = 20 \times 0.5$

$I_a R_a = 10$ V

Step 3 – subtract from the supply voltage: $E_b = 220 - 10$

$E_b = 210$ V

Final Answer: $E_b = 210 \text{ V} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q18

Q19.

Solution

Concept – ideal transformer current ratio: For an ideal transformer the currents scale inversely with the turns, $\frac{I_1}{I_2} = \frac{N_2}{N_1}$.

Step 1 – list the data: $\frac{N_1}{N_2} = 2$, $I_2 = 10$ A.

Step 2 – write the primary current: $I_1 = I_2 \times \frac{N_2}{N_1}$

Step 3 – substitute the inverse ratio: $I_1 = 10 \times \frac{1}{2}$

Step 4 – evaluate: $I_1 = 5$ A

Step 5 – sanity check with power: A step-down in current means a step-up in voltage, keeping $V_1 I_1 = V_2 I_2$; the ampere-turns balance holds.

Final Answer: $I_1 = 5 \text{ A} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q19

Q20.

Solution

Concept – rated current from kVA rating: For a single-phase transformer the rated current on a winding is $I = \frac{\text{VA rating}}{\text{winding voltage}}$.

Step 1 – convert the rating to volt-amperes: $5 \text{ kVA} = 5000 \text{ VA}$

Step 2 – write the secondary current: $I_2 = \frac{5000}{250}$

Step 3 – evaluate: $I_2 = 20$ A

Final Answer: $I_2 = 20 \text{ A} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q20

Q21.

Solution

Concept – gross mechanical power in a d.c. machine: The power converted from electrical to mechanical form in the armature is $P = E_b I_a$.

Step 1 – list the data: $E_b = 200$ V, $I_a = 25$ A.

Step 2 – multiply: $P = 200 \times 25$

Step 3 – evaluate: $P = 5000$ W

Step 4 – convert to kilowatts: $P = 5$ kW

Final Answer: $P = 5 \text{ kW} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q21

Q22.

Solution

Concept – transformer efficiency: $\eta = \dfrac{P_{out}}{P_{out} + P_{loss}}$, where P_{loss} is the sum of core loss and copper loss.

Step 1 – list the data: $P_{out} = 4$ kW $= 4000$ W, core loss $= 100$ W, copper loss $= 100$ W.

Step 2 – add the losses: $P_{loss} = 100 + 100 = 200$ W

Step 3 – form the input power: $P_{in} = 4000 + 200 = 4200$ W

Step 4 – divide output by input: $\eta = \dfrac{4000}{4200}$

Step 5 – evaluate as a percentage: $\eta = 0.952 = 95.2\%$

Final Answer: $\eta \approx 95.2\% \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q22

Q23.

Solution

Concept – slip of an induction motor: First find the synchronous speed $N_s = \dfrac{120f}{P}$, then the slip $s = \dfrac{N_s - N}{N_s}$.

Step 1 – compute the synchronous speed: $N_s = \dfrac{120 \times 50}{4}$

$N_s = \dfrac{6000}{4} = 1500$ rpm

Step 2 – form the difference of speeds: $N_s - N = 1500 - 1440 = 60$ rpm

Step 3 – divide by the synchronous speed: $s = \dfrac{60}{1500}$

Step 4 – evaluate: $s = 0.04 = 4\%$

Final Answer: $s = 4\% \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q23

Q24.

Solution

Concept – base impedance in per-unit analysis: $Z_{base} = \dfrac{(kV_{base})^2}{MVA_{base}}$.

Step 1 – list the data: $kV_{base} = 11$ kV, $MVA_{base} = 100$ MVA.

Step 2 – square the base voltage: $(11)^2 = 121$

Step 3 – divide by the base MVA: $Z_{base} = \dfrac{121}{100}$

Step 4 – evaluate: $Z_{base} = 1.21\ \Omega$

Final Answer: $Z_{base} = 1.21\ \Omega \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q24

Q25.

Solution

Concept – fault level from per-unit reactance: For a three-phase symmetrical fault, $\text{MVA}_{fault} = \dfrac{\text{MVA}_{base}}{X_{pu}}$.

Step 1 – list the data: $\text{MVA}_{base} = 100$ MVA, $X_{pu} = 0.2$.

Step 2 – substitute into the fault-level formula: $\text{MVA}_{fault} = \dfrac{100}{0.2}$

Step 3 – evaluate: $\text{MVA}_{fault} = 500$ MVA

Final Answer: $\text{MVA}_{fault} = 500 \text{ MVA} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q25

Q26.

Solution

Concept – changing the per-unit base: At the same base voltage, per-unit impedance scales directly with the base MVA: $X_{new} = X_{old} \times \dfrac{MVA_{new}}{MVA_{old}}$.

Step 1 – list the data: $X_{old} = 0.1$ pu, $MVA_{old} = 50$, $MVA_{new} = 100$.

Step 2 – form the MVA ratio: $\dfrac{MVA_{new}}{MVA_{old}} = \dfrac{100}{50} = 2$

Step 3 – multiply: $X_{new} = 0.1 \times 2$

Step 4 – evaluate: $X_{new} = 0.2$ pu

Final Answer: $X_{new} = 0.2 \text{ pu} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q26

Q27.

Solution

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

Step 1 – list the data in base units: $L = 0.9$ mH/km $= 0.9 \times 10^{-3}$ H/km, $C = 0.01$ μF/km $= 0.01 \times 10^{-6}$ F/km.

Step 2 – form the ratio L/C: $\frac{L}{C} = \frac{0.9 \times 10^{-3}}{0.01 \times 10^{-6}}$

Step 3 – simplify the powers of ten: $\frac{0.9 \times 10^{-3}}{1 \times 10^{-8}} = 0.9 \times 10^5 = 90000$

Step 4 – take the square root: $Z_c = \sqrt{90000}$

$Z_c = 300\ \Omega$

Final Answer: $Z_c = 300\ \Omega \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q27

Q28.

Solution

Concept – maximum power transfer over a line: For a lossless line, $P = \frac{V_1 V_2}{X} \sin\delta$, which is greatest at $\delta = 90°$ where $\sin\delta = 1$.

Step 1 – list the data: $V_1 = V_2 = 1.0$ pu, $X = 0.5$ pu.

Step 2 – form the numerator: $V_1 V_2 = 1.0 \times 1.0 = 1.0$

Step 3 – divide by the reactance: $P_{max} = \frac{1.0}{0.5}$

Step 4 – evaluate: $P_{max} = 2$ pu

Final Answer: $P_{max} = 2$ pu $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q28

Q29.

Solution

Concept – single-line-to-ground fault current: Using symmetrical components, $I_f = \frac{3E}{Z_1 + Z_2 + Z_0}$.

Step 1 – list the data: $E = 1.0$ pu, $Z_1 = Z_2 = Z_0 = 0.1$ pu.

Step 2 – add the sequence impedances: $Z_1 + Z_2 + Z_0 = 0.1 + 0.1 + 0.1 = 0.3$

Step 3 – form the numerator: $3E = 3 \times 1.0 = 3$

Step 4 – divide: $I_f = \dfrac{3}{0.3}$

Step 5 – evaluate: $I_f = 10$ pu

Final Answer: $I_f = 10 \text{ pu} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q29

Q30.

Solution

Concept – base current of a three-phase system: $I_{base} = \dfrac{\text{MVA}_{base} \times 10^6}{\sqrt{3} \times \text{kV}_{base} \times 10^3}$.

Step 1 – list the data: $\text{MVA}_{base} = 100$, $\text{kV}_{base} = 132$, $\sqrt{3} = 1.732$.

Step 2 – form the denominator: $\sqrt{3} \times \text{kV} = 1.732 \times 132$

$= 228.6$

Step 3 – divide (in matching units of MVA and kV, current comes out in kA):
$I_{base} = \dfrac{100}{228.6}$
$= 0.4374$ kA

Step 4 – convert to amperes: $I_{base} = 437.4 \text{ A} \approx 437 \text{ A}$

Final Answer: $I_{base} \approx 437 \text{ A} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q30

Q31.

Solution

Concept – damping ratio of a second-order system: Comparing $s^2 + 2\zeta\omega_n s + \omega_n^2 = 0$ with the given equation gives ω_n from the constant term and ζ from the middle term.

Step 1 – read the constant term for ω_n: $\omega_n^2 = 25$

$\omega_n = \sqrt{25} = 5$ rad/s

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

Step 3 – solve for ζ: $\zeta = \dfrac{6}{2\omega_n} = \dfrac{6}{2 \times 5}$

Step 4 – evaluate: $\zeta = \dfrac{6}{10} = 0.6$

Final Answer: $\zeta = 0.6 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q31

Q32.

Solution

Concept – Routh–Hurwitz criterion: 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 coefficients of $s^3 + 6s^2 + 11s + 6$: Row s^3: $1,\ 11$

Row s^2: $6,\ 6$

Step 2 – compute the s^1 row: $b_1 = \dfrac{(6 \times 11) - (1 \times 6)}{6} = \dfrac{66 - 6}{6} = \dfrac{60}{6} = 10$

Step 3 – compute the s^0 row: $c_1 = \dfrac{(10 \times 6) - (6 \times 0)}{10} = \dfrac{60}{10} = 6$

Step 4 – list the first column: $1,\ 6,\ 10,\ 6$ – all positive.

Step 5 – count sign changes: There are no sign changes, so there are 0 poles in the right half-plane (the system is stable).

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

Answer: (A) Go Back to Q32

Q33.

Solution

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

Step 1 – compute $1 - \zeta^2$: $1 - (0.5)^2 = 1 - 0.25 = 0.75$

Step 2 – take the square root: $\sqrt{0.75} = 0.866$

Step 3 – form the exponent: $-\dfrac{\pi \times 0.5}{0.866} = -\dfrac{1.5708}{0.866} = -1.814$

Step 4 – take the exponential: $e^{-1.814} = 0.163$

Step 5 – convert to a percentage: $M_p = 0.163 \times 100 = 16.3\%$

Final Answer: $M_p \approx 16.3\% \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q33

Q34.

Solution

Concept – steady-state error of a type-1 system to a step: For a step input, $e_{ss} = \dfrac{1}{1+K_p}$ with $K_p = \lim_{s\to 0} G(s)$. A pole at the origin makes K_p infinite.

Step 1 – evaluate the position error constant: $K_p = \lim_{s\to 0} \dfrac{10}{s(s+2)}$

Step 2 – observe the behaviour as $s \to 0$: The s in the denominator drives $G(s) \to \infty$, so $K_p = \infty$.

Step 3 – substitute into the error formula: $e_{ss} = \dfrac{1}{1+\infty}$

Step 4 – evaluate the limit: $e_{ss} = 0$

Final Answer: $e_{ss} = 0 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q34

Q35.

Solution

Concept – d.c. gain of a unity-feedback closed loop: $\dfrac{C(s)}{R(s)} = \dfrac{G(s)}{1+G(s)}$; evaluate at $s = 0$.

Step 1 – evaluate the forward gain at $s = 0$: $G(0) = \dfrac{20}{0+2} = \dfrac{20}{2} = 10$

Step 2 – form the closed-loop expression at $s = 0$: $\left.\dfrac{C}{R}\right|_{s=0} = \dfrac{G(0)}{1+G(0)} = \dfrac{10}{1+10}$

Step 3 – simplify the denominator: $1 + 10 = 11$

Step 4 – divide: $\left.\dfrac{C}{R}\right|_{s=0} = \dfrac{10}{11}$

Step 5 – evaluate: $= 0.909$

Final Answer: d.c. gain $\approx 0.909 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q35

Q36.

Solution

Concept – gain of an inverting op-amp: For an ideal inverting amplifier the magnitude of the gain is $|A_v| = \dfrac{R_f}{R_1}$.

Step 1 – list the resistor values: $R_f = 50\ \text{k}\Omega$, $R_1 = 10\ \text{k}\Omega$.

Step 2 – form the ratio: $|A_v| = \dfrac{50\ \text{k}\Omega}{10\ \text{k}\Omega}$

Step 3 – evaluate: $|A_v| = 5$

Final Answer: $|A_v| = 5 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q36

Q37.

Solution

Concept – binary-to-decimal conversion: Each bit contributes its place value 2^k where the least-significant bit is $k = 0$.

Step 1 – write the bits with their weights $(10110)_2$**:** $1 \to 2^4,\ 0 \to 2^3,\ 1 \to 2^2,\ 1 \to 2^1,\ 0 \to 2^0$

Step 2 – evaluate each nonzero weight: $2^4 = 16$

$2^2 = 4$

$2^1 = 2$

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

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

Answer: (D) Go Back to Q37

Q38.

Solution

Concept – balanced Wheatstone bridge: At balance the ratio arms satisfy $\dfrac{R_1}{R_3} = \dfrac{R_2}{R_x}$, giving $R_x = \dfrac{R_2 R_3}{R_1}$.

Step 1 – list the data: $R_1 = 100\ \Omega$, $R_2 = 200\ \Omega$, $R_3 = 300\ \Omega$.

Step 2 – form the numerator R_2R_3**:** $R_2R_3 = 200 \times 300 = 60000$

Step 3 – divide by R_1**:** $R_x = \dfrac{60000}{100}$

Step 4 – evaluate: $R_x = 600\ \Omega$

Final Answer: $R_x = 600\ \Omega \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q38

Q39.

Solution

Concept – hexadecimal-to-decimal conversion: Each hex digit has weight 16^k; the digit A equals 10.

Step 1 – write the digits with weights for $(1\mathbf{A})_{16}$: $1 \to 16^1,\ \mathrm{A} \to 16^0$

Step 2 – convert the digit A: $\mathrm{A} = 10$

Step 3 – evaluate each term: $1 \times 16 = 16$

$10 \times 1 = 10$

Step 4 – add: $16 + 10 = 26$

Final Answer: $(1\mathrm{A})_{16} = 26 \Rightarrow \boxed{\mathrm{A}}$

Answer: (A) Go Back to Q39

Q40.

Solution

Concept – redundancy (absorption) law of Boolean algebra: The identity $A + \bar{A}B = A + B$ removes the redundant $\bar{A}$.

Step 1 – start from the expression: $Y = A + \bar{A}B$

Step 2 – expand A using $A = A + AB$ (since $A + AB = A$): $Y = A + AB + \bar{A}B$

Step 3 – group the B terms: $Y = A + B(A + \bar{A})$

Step 4 – apply $A + \bar{A} = 1$: $Y = A + B(1)$

Step 5 – simplify: $Y = A + B$

Why the other options are wrong:

- A, A: drops the B contribution that survives when $A = 0, B = 1$.
- B, B: drops the A contribution.
- C, AB: is the AND, not the OR, of the variables.

Final Answer: $Y = A + B \Rightarrow \boxed{\mathrm{D}}$

Answer: (D) Go Back to Q40

Q41.

Solution

Concept – RMS value of a sinusoid: For a sine wave the RMS value is the peak divided by $\sqrt{2}$, $V_{rms} = \dfrac{V_m}{\sqrt{2}}$.

Step 1 – list the data: $V_m = 10$ V, $\sqrt{2} = 1.414$.

Step 2 – substitute: $V_{rms} = \dfrac{10}{1.414}$

Step 3 – evaluate: $V_{rms} = 7.07$ V

Why the other options are wrong:

- A, 10 V: is the peak value, not the RMS.
- B, 14.14 V: multiplies by $\sqrt{2}$ instead of dividing.
- D, 5 V: is the average of a half-cycle-ish guess, not $V_m/\sqrt{2}$.

Final Answer: $V_{rms} = 7.07 \text{ V} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q41

Q42.

Solution

Concept – average output of a half-wave rectifier: For a single-phase half-wave rectifier with resistive load, $V_{dc} = \dfrac{V_m}{\pi}$.

Step 1 – list the data: $V_m = 100$ V, $\pi = 3.1416$.

Step 2 – substitute: $V_{dc} = \dfrac{100}{3.1416}$

Step 3 – evaluate: $V_{dc} = 31.83$ V

Why the other options are wrong:

- A, 63.66 V: is $\dfrac{2V_m}{\pi}$, the *full-wave* average.
- C, 45 V: is close to the RMS of a half sine, not the average.
- D, 100 V: is the peak value.

Final Answer: $V_{dc} = 31.83 \text{ V} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q42

Q43.

Solution

Concept – average output of a full-wave rectifier: For a single-phase full-wave rectifier with resistive load, $V_{dc} = \frac{2V_m}{\pi}$.

Step 1 – list the data: $V_m = 100$ V, $\pi = 3.1416$.

Step 2 – form the numerator: $2V_m = 2 \times 100 = 200$

Step 3 – divide by π: $V_{dc} = \frac{200}{3.1416}$

Step 4 – evaluate: $V_{dc} = 63.66$ V

Final Answer: $V_{dc} = 63.66 \text{ V} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q43

Q44.

Solution

Concept – output of a step-down (buck) chopper: The average output voltage is $V_o = D\,V_s$, with D the duty ratio.

Step 1 – list the data: $V_s = 200$ V, $D = 0.4$.

Step 2 – multiply: $V_o = 0.4 \times 200$

Step 3 – evaluate: $V_o = 80$ V

Final Answer: $V_o = 80 \text{ V} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q44

Q45.

Solution

Concept – duty ratio of a step-down chopper: From $V_o = D\,V_s$, the required duty ratio is $D = \frac{V_o}{V_s}$.

Step 1 – list the data: $V_o = 150$ V, $V_s = 300$ V.

Step 2 – form the ratio: $D = \frac{150}{300}$

Step 3 – evaluate: $D = 0.5$

Step 4 – sanity check: A duty ratio must lie between 0 and 1; 0.5 is valid and gives half the input as output.

Final Answer: $D = 0.5 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q45

Q46.

Solution

Concept – average output of a full-wave controlled rectifier: For a single-phase fully controlled bridge with a highly inductive (continuous) load, $V_{dc} = \frac{2V_m}{\pi} \cos\alpha$.

Step 1 – list the data: $V_m = 100$ V, $\alpha = 60°$, $\pi = 3.1416$.

Step 2 – evaluate the uncontrolled part: $\frac{2V_m}{\pi} = \frac{200}{3.1416} = 63.66$ V

Step 3 – evaluate the cosine of the firing angle: $\cos 60° = 0.5$

Step 4 – multiply: $V_{dc} = 63.66 \times 0.5$

Step 5 – evaluate: $V_{dc} = 31.83$ V

Why the other options are wrong:

- A, 63.66 V: forgets the $\cos\alpha$ factor ($\alpha = 0$ case).
- B, 45 V: uses an incorrect firing-angle factor.
- D, 0 V: would need $\alpha = 90°$, where $\cos\alpha = 0$.

Final Answer: $V_{dc} = 31.83$ V $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q46

Answer Key

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