GATE Electrical Engineering

Sample Paper – 2

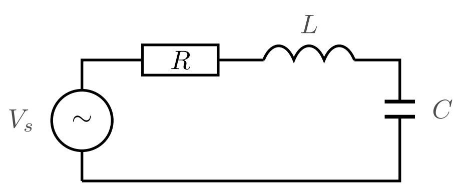
Duration: 128 Minutes **Maximum Marks: 72**

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. A series RLC resonant circuit shown below has $R = 10\ \Omega$, $L = 10$ mH and $C = 1\ \mu$F. Its resonant frequency $f_0 = \dfrac{1}{2\pi\sqrt{LC}}$ is nearest to: [1 mark]



(A) 1592 Hz

(B) 5000 Hz

(C) 100 Hz

(D) 3183 Hz

Q2. For the same series RLC circuit with $R = 10\,\Omega$, $L = 10$ mH and $C = 1\,\mu$F, the quality factor at resonance, $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$, is: **[1 mark]**

(A) 10

(B) 100

(C) 1

(D) 0.1

Q3. A series RLC resonant circuit has $R = 10\ \Omega$ and $L = 10$ mH. Its half-power bandwidth, BW $= \frac{R}{2\pi L}$ (in Hz), is nearest to: **[1 mark]**

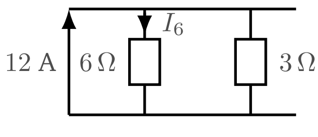
(A) 1592 Hz

(B) 100 Hz

(C) 318 Hz

(D) 159 Hz

Q4. In the circuit shown, an ideal 12 A current source feeds two resistors of $6\ \Omega$ and $3\ \Omega$ in parallel. By the current-divider rule the current I_6 through the $6\ \Omega$ branch is: **[1 mark]**



(A) 8 A

(B) 4 A

(C) 12 A

(D) 6 A

Q5. A source-free series RL circuit has $L = 150$ mH and $R = 30\ \Omega$. The time constant of its natural (transient) response is: **[1 mark]**

(A) 2 ms

(B) 0.2 ms

(C) 45 ms

(D) 5 ms

Q6. A one-port network is reduced to its Thevenin equivalent with open-circuit voltage $V_{th} = 20$ V and Thevenin resistance $R_{th} = 10\ \Omega$. When a matched load is connected for maximum power transfer, the power delivered to the load, $P_{\max} = \dfrac{V_{th}^2}{4R_{th}}$, is: **[1 mark]**

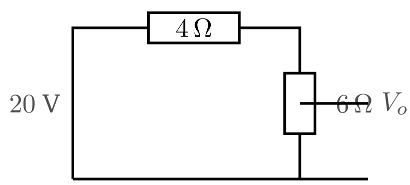
(A) 10 W

(B) 20 W

(C) 5 W

(D) 40 W

Q7. For the resistive voltage divider shown, a 20 V source is applied across the series combination of $4\ \Omega$ and $6\ \Omega$. The voltage V_o across the $6\ \Omega$ resistor is: **[1 mark]**



(A) 8 V

(B) 12 V

(C) 20 V

(D) 6 V

Electromagnetic Fields

Q8. An inductor of $L = 0.5$ H carries a steady current of $I = 4$ A. The magnetic energy stored in the field, $W = \frac{1}{2}LI^2$, is: **[1 mark]**

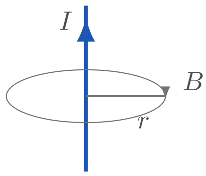
(A) 4 J

(B) 2 J

(C) 8 J

(D) 1 J

Q9. A long straight conductor carries a current $I = 10$ A in free space, as shown. By Ampere's law the magnetic flux density at a radial distance $r = 5$ cm is $B = \dfrac{\mu_0 I}{2\pi r}$, which is: **[1 mark]**



(A) 20 μT

(B) 80 μT

(C) 40 μT

(D) 4 μT

Q10. A coil of $N = 100$ turns links a magnetic flux of $\Phi = 0.2$ mWb when it carries a current of $I = 4$ A. Its self-inductance, $L = \dfrac{N\Phi}{I}$, is: **[1 mark]**

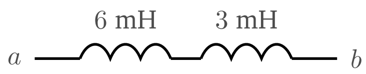
(A) 50 mH

(B) 0.5 mH

(C) 20 mH

(D) 5 mH

Q11. Two inductors of 6 mH and 3 mH with no mutual coupling are connected in series, as shown. The equivalent inductance between a and b is: **[1 mark]**



(A) 2 mH

(B) 18 mH

(C) 4.5 mH

(D) 9 mH

Signals and Systems

Q12. The Laplace transform of a signal is $X(s) = \dfrac{5}{s(s+2)}$. Using the final-value theorem $x(\infty) = \lim_{s\to 0} s\,X(s)$, the steady-state value $x(\infty)$ is: **[1 mark]**

(A) 5

(B) 2.5

(C) 0

(D) ∞

Q13. A first-order LTI system has the transfer function $H(s) = \dfrac{1}{s+5}$. The time constant of its step response is: **[1 mark]**

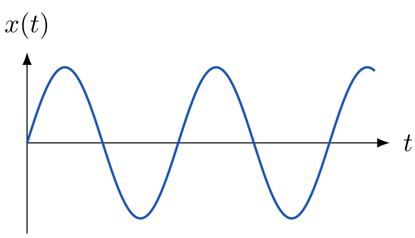
(A) 5 s

(B) 1 s

(C) 0.2 s

(D) 0.5 s

Q14. A continuous-time sinusoid $x(t) = \sin(200\pi t)$ is sketched below. Its fundamental frequency $f = \dfrac{\omega_0}{2\pi}$ is: **[1 mark]**



(A) 200 Hz

(B) 50 Hz

(C) 100 Hz

(D) 400 Hz

Q15. A continuous-time signal is band-limited to a maximum frequency of 4 kHz. By the sampling theorem the minimum (Nyquist) sampling rate needed to avoid aliasing is: **[1 mark]**

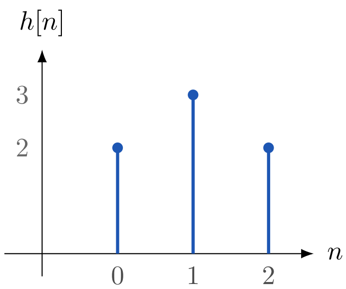
(A) 4 kHz

(B) 8 kHz

(C) 2 kHz

(D) 16 kHz

Q16. A discrete-time LTI system has the finite impulse response $h[n]$ shown ($h[0] = 2$, $h[1] = 3$, $h[2] = 2$). Its d.c. gain, $\sum_n h[n]$, is: **[1 mark]**



(A) 2

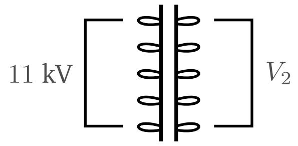
(B) 3

(C) 7

(D) 0

Electrical Machines

Q17. A three-phase transformer is connected star–star with a per-phase turns ratio $N_1/N_2 = 10$, as shown. The primary line voltage is 11 kV. Because both sides are star-connected, the secondary line voltage is $\frac{11 \text{ kV}}{10}$, i.e.: **[1 mark]**



star–star, $N_1{:}N_2 = 10{:}1$

(A) 11 kV

(B) 110 V

(C) 6.35 kV

(D) 1.1 kV

Q18. A d.c. shunt motor is supplied at $V = 250$ V and draws an armature current $I_a = 40$ A. The armature-circuit resistance is $R_a = 0.25\ \Omega$. The back e.m.f. $E_b = V - I_a R_a$ is: **[1 mark]**

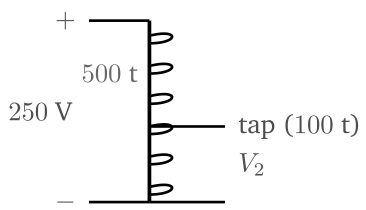
(A) 260 V

(B) 250 V

(C) 240 V

(D) 10 V

Q19. A step-down autotransformer has a single tapped winding of 500 turns, with the secondary taken across 100 turns from the neutral end, as shown. With 250 V applied across the full winding, the secondary voltage $V_2 = V_1 \cdot \dfrac{N_2}{N_1}$ is: **[1 mark]**



(A) 250 V

(B) 1250 V

(C) 100 V

(D) 50 V

Q20. A 10 kVA single-phase transformer has a rated secondary voltage of 400 V. The rated (full-load) secondary current, $I_2 = \dfrac{\text{VA rating}}{V_2}$, is: **[1 mark]**

(A) 25 A

(B) 10 A

(C) 40 A

(D) 4 A

Q21. A d.c. motor develops a back e.m.f. of $E_b = 250$ V while carrying an armature current of $I_a = 40$ A. The gross mechanical power developed in the armature, $P = E_b I_a$, is: **[2 marks]**

(A) 10 kW

(B) 8 kW

(C) 0.25 kW

(D) 5 kW

Q22. A single-phase transformer delivers an output of 9 kW. Its core (iron) loss is 250 W and its copper loss at this load is 250 W. The efficiency $\eta = \dfrac{P_{out}}{P_{out} + P_{loss}}$ is nearest to: **[2 marks]**

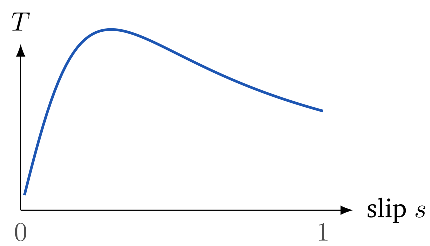
(A) 90%

(B) 94.7%

(C) 98%

(D) 80%

Q23. A 6-pole, 50 Hz three-phase induction motor runs at a rotor speed of 950 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) 5%

(D) 8%

Power Systems

Q24. In per-unit analysis, a base of 200 MVA and 20 kV is chosen. The base impedance $Z_{base} = \dfrac{(kV_{base})^2}{MVA_{base}}$ is: **[2 marks]**

(A) 0.2 Ω

(B) 20 Ω

(C) 2 Ω

(D) 200 Ω

Q25. Two thermal units supply a total load of 200 MW (losses neglected). Their incremental fuel costs are $\dfrac{dC_1}{dP_1} = 0.1P_1 + 20$ and $\dfrac{dC_2}{dP_2} = 0.1P_2 + 15$ (Rs/MWh). For the economic-dispatch condition of equal incremental cost, the optimum output P_1 is: **[2 marks]**

(A) 100 MW

(B) 75 MW

(C) 125 MW

(D) 150 MW

Q26. A generator reactance is specified as 0.15 pu on a base of 25 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]**

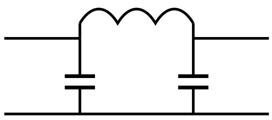
(A) 0.15 pu

(B) 0.0375 pu

(C) 0.3 pu

(D) 0.6 pu

Q27. A lossless transmission line is modelled by the π-section shown with series inductance $L = 1.6$ mH/km and shunt capacitance $C = 0.01$ μF/km. Its surge (characteristic) impedance $Z_c = \sqrt{L/C}$ is: **[2 marks]**



(A) $400\ \Omega$

(B) $300\ \Omega$

(C) $150\ \Omega$

(D) $200\ \Omega$

Q28. Two buses of a lossless line are held at $V_1 = V_2 = 1.0$ pu, and the line reactance is $X = 1.0$ 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 $Z_1 = Z_2 = Z_0 = 0.15$ 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 nearest to: **[2 marks]**

(A) 6.67 pu

(B) 3.33 pu

(C) 20 pu

(D) 1 pu

Q30. A three-phase system has a base of 100 MVA and a line voltage of 33 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) 1750 A

(D) 100 A

Control Systems

Q31. A standard second-order system has the characteristic equation $s^2 + 8s + 16 = 0$. Comparing with $s^2 + 2\zeta\omega_n s + \omega_n^2 = 0$, the damping ratio ζ is: **[2 marks]**

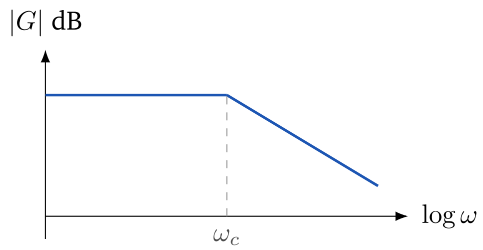
(A) 0.5

(B) 1

(C) 0.25

(D) 2

Q32. The open-loop transfer function is $G(s) = \dfrac{10}{1 + 0.05s}$, whose asymptotic Bode magnitude plot is sketched below. Its corner (break) frequency ω_c is: **[2 marks]**



(A) 5 rad/s

(B) 10 rad/s

(C) 0.05 rad/s

(D) 20 rad/s

Q33. A first-order system has frequency response $G(j\omega) = \dfrac{1}{j\omega + 1}$. At the frequency $\omega = 1$ rad/s, the magnitude of $G(j\omega)$ expressed in decibels, $20 \log_{10} |G(j\omega)|$, is nearest to: **[2 marks]**

(A) 0 dB

(B) -3 dB

(C) -6 dB

(D) $+3$ dB

Q34. A unity-feedback system has open-loop transfer function $G(s) = \dfrac{20}{s(s+5)}$. 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]**

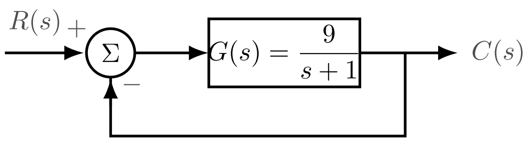
(A) 0

(B) 0.5

(C) 0.1

(D) 1

Q35. For the unity-feedback control system shown, the forward-path transfer function is $G(s) = \dfrac{9}{s+1}$. 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: **[2 marks]**



(A) 0.9

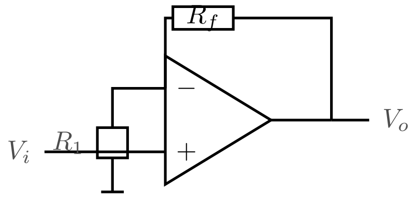
(B) 1

(C) 0.5

(D) 10

Analog, Digital and Measurements

Q36. For the ideal-op-amp non-inverting amplifier shown, $R_1 = 10$ kΩ and $R_f = 50$ kΩ. The closed-loop voltage gain $\dfrac{V_o}{V_i} = 1 + \dfrac{R_f}{R_1}$ is: **[2 marks]**



(A) 5

(B) 6

(C) 0.2

(D) 50

Q37. The unsigned binary number $(101100)_2$ has the decimal (base-10) value: **[2 marks]**

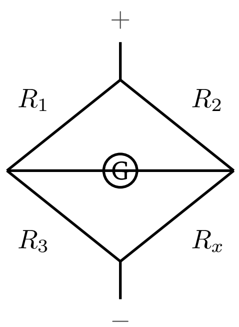
(A) 22

(B) 44

(C) 26

(D) 11

Q38. The Wheatstone bridge shown is balanced with $R_1 = 200\ \Omega$, $R_2 = 400\ \Omega$ and $R_3 = 300\ \Omega$. The unknown resistance, from the balance condition $R_x = \dfrac{R_2 R_3}{R_1}$, is: **[2 marks]**



(A) 150 Ω

(B) 900 Ω

(C) 600 Ω

(D) 66.7 Ω

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

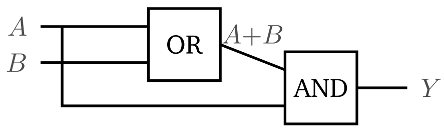
(A) 47

(B) 32

(C) 15

(D) 16

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



(A) A

(B) B

(C) AB

(D) $A + B$

Q41. A three-op-amp instrumentation amplifier has its difference stage set to unity, so the overall gain is $A = 1 + \dfrac{2R}{R_g}$, with $R = 50$ kΩ (the two feedback resistors of the input stage) and $R_g = 25$ kΩ (the gain-setting resistor). The overall gain is: **[2 marks]**

(A) 2

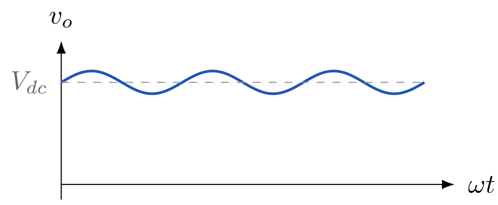
(B) 3

(C) 101

(D) 5

Power Electronics

Q42. A three-phase, six-pulse (full-wave) uncontrolled bridge rectifier feeds a resistive load; its pulsating output is sketched below. The supply has a per-phase peak voltage $V_m = 100$ V. The average (d.c.) output voltage $V_{dc} = \dfrac{3\sqrt{3}\,V_m}{\pi}$ is nearest to: **[2 marks]**



(A) 63.66 V

(B) 270 V

(C) 100 V

(D) 165.4 V

Q43. A single-phase full-wave (bridge) uncontrolled diode rectifier feeds a resistive load from a supply of peak voltage $V_m = 150$ V. The average (d.c.) output voltage $V_{dc} = \dfrac{2V_m}{\pi}$ is nearest to: **[2 marks]**

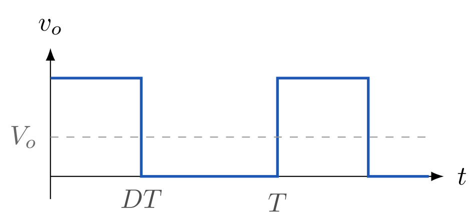
(A) 47.75 V

(B) 95.49 V

(C) 150 V

(D) 106 V

Q44. A step-down (buck) d.c. chopper operates from a supply $V_s = 250$ 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) 250 V

(B) 100 V

(C) 500 V

(D) 80 V

Q45. A step-down d.c. chopper supplies an average output voltage of 180 V from an input of 240 V. The required duty ratio, $D = V_o/V_s$, is: **[2 marks]**

(A) 0.25

(B) 0.5

(C) 1.33

(D) 0.75

Q46. A three-phase, fully controlled (six-pulse) bridge converter feeds a highly inductive load from a supply of per-phase peak voltage $V_m = 100$ V, at a firing angle $\alpha = 60°$. The average output voltage $V_{dc} = \dfrac{3\sqrt{3}\,V_m}{\pi}\cos\alpha$ is nearest to: **[2 marks]**

(A) 165.4 V

(B) 143.2 V

(C) 82.7 V

(D) 0 V

Detailed Solutions

Q1.

Solution

Concept – resonant frequency of a series RLC circuit: At resonance the inductive and capacitive reactances cancel, giving $f_0 = \dfrac{1}{2\pi\sqrt{LC}}$ (the resistance does not affect the resonant frequency).

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

$C = 1\ \mu\text{F} = 1 \times 10^{-6}\text{ F}$

Step 2 – form the product LC: $LC = (10 \times 10^{-3}) \times (1 \times 10^{-6}) = 1 \times 10^{-8}$

Step 3 – take the square root: $\sqrt{LC} = \sqrt{1 \times 10^{-8}} = 1 \times 10^{-4}$

Step 4 – form the denominator $2\pi\sqrt{LC}$: $2\pi \times (1 \times 10^{-4}) = 6.283 \times 10^{-4}$

Step 5 – take the reciprocal: $f_0 = \dfrac{1}{6.283 \times 10^{-4}}$

$f_0 = 1591.5\text{ Hz} \approx 1592\text{ Hz}$

Final Answer: $f_0 \approx 1592\text{ Hz} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q1

Q2.

Solution

Concept – quality factor of a series RLC circuit: The quality factor at resonance is $Q = \dfrac{1}{R}\sqrt{\dfrac{L}{C}}$; it measures the sharpness of the resonance.

Step 1 – form the ratio L/C in base units: $\dfrac{L}{C} = \dfrac{10 \times 10^{-3}}{1 \times 10^{-6}}$

Step 2 – simplify the powers of ten: $\dfrac{L}{C} = 10 \times 10^{3} = 1 \times 10^{4}$

Step 3 – take the square root: $\sqrt{L/C} = \sqrt{1 \times 10^{4}} = 100$

Step 4 – divide by the resistance: $Q = \dfrac{1}{10} \times 100$

$Q = 10$

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

Answer: (A) Go Back to Q2

Q3.

Solution

Concept – bandwidth of a series resonant circuit: The half-power bandwidth is $\text{BW} = \dfrac{R}{2\pi L}$ (in hertz); equivalently $\text{BW} = f_0/Q$.

Step 1 – list the data in base units: $R = 10\ \Omega$, $L = 10\ \text{mH} = 0.01\ \text{H}$.

Step 2 – form the denominator $2\pi L$**:** $2\pi \times 0.01 = 0.06283$

Step 3 – divide: $\text{BW} = \dfrac{10}{0.06283}$

$\text{BW} = 159.15\ \text{Hz}$

Step 4 – cross-check with f_0/Q**:** Using $f_0 = 1591.5$ Hz and $Q = 10$, $f_0/Q = 159.15$ Hz, which agrees.

Final Answer: $\text{BW} \approx 159\ \text{Hz} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q3

Q4.

Solution

Concept – current-divider rule: For two resistors in parallel, the current in one branch is the source current times the *opposite* resistance over the sum, $I_6 = I \times \dfrac{R_3}{R_6 + R_3}$.

Step 1 – list the data: $I = 12$ A, $R_6 = 6\ \Omega$, $R_3 = 3\ \Omega$.

Step 2 – form the sum of the two resistances: $R_6 + R_3 = 6 + 3 = 9$

Step 3 – form the divider ratio (opposite branch on top): $\dfrac{R_3}{R_6 + R_3} = \dfrac{3}{9} = \dfrac{1}{3}$

Step 4 – multiply by the source current: $I_6 = 12 \times \dfrac{1}{3}$

$I_6 = 4$ A

Step 5 – sanity check: The remaining 8 A flows in the $3\ \Omega$ branch, and $4 + 8 = 12$ A returns the full source current.

Final Answer: $I_6 = 4\ \text{A} \Rightarrow \boxed{\text{B}}$

Answer: (B) 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: $L = 150 \text{ mH} = 150 \times 10^{-3} \text{ H} = 0.15 \text{ H}$

Step 2 – substitute the values: $\tau = \dfrac{0.15}{30}$

Step 3 – evaluate: $\tau = 0.005 \text{ s} = 5 \text{ ms}$

Final Answer: $\tau = 5 \text{ ms} \Rightarrow \boxed{\text{D}}$

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: $V_{th} = 20$ V, $R_{th} = 10\ \Omega$.

Step 2 – square the Thevenin voltage: $V_{th}^2 = 20^2 = 400$

Step 3 – form the denominator: $4R_{th} = 4 \times 10 = 40$

Step 4 – divide: $P_{\max} = \dfrac{400}{40}$

$P_{\max} = 10 \text{ W}$

Final Answer: $P_{\max} = 10 \text{ W} \Rightarrow \boxed{\text{A}}$

Answer: (A) **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: $R_1 + R_2 = 4 + 6 = 10\ \Omega$

Step 2 – form the divider ratio for the $6\ \Omega$ resistor: $\dfrac{R_2}{R_1 + R_2} = \dfrac{6}{10}$

Step 3 – multiply by the source voltage: $V_o = 20 \times \dfrac{6}{10}$

Step 4 – evaluate: $V_o = 12 \text{ V}$

Final Answer: $V_o = 12\text{ V} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q7

Q8.

Solution

Concept – energy stored in an inductor: The magnetic energy held in an inductor's field is $W = \frac{1}{2}LI^2$.

Step 1 – list the data: $L = 0.5$ H, $I = 4$ A.

Step 2 – square the current: $I^2 = 4^2 = 16\text{ A}^2$

Step 3 – substitute into the energy equation: $W = \frac{1}{2} \times 0.5 \times 16$

Step 4 – multiply L by I^2: $0.5 \times 16 = 8$

Step 5 – take one-half: $W = \frac{1}{2} \times 8 = 4$ J

Final Answer: $W = 4\text{ J} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q8

Q9.

Solution

Concept – magnetic field of a long straight conductor: By Ampere's law the flux density at radius r is $B = \frac{\mu_0 I}{2\pi r}$.

Step 1 – list the data in base units: $\mu_0 = 4\pi \times 10^{-7}$ H/m, $I = 10$ A, $r = 5$ cm $= 0.05$ m.

Step 2 – form the numerator $\mu_0 I$: $\mu_0 I = (4\pi \times 10^{-7}) \times 10 = 4\pi \times 10^{-6}$

Step 3 – form the denominator $2\pi r$: $2\pi \times 0.05 = 0.1\pi$

Step 4 – divide (the π cancels): $B = \frac{4\pi \times 10^{-6}}{0.1\pi} = \frac{4 \times 10^{-6}}{0.1}$

Step 5 – evaluate: $B = 4 \times 10^{-5}\text{ T} = 40\ \mu\text{T}$

Final Answer: $B = 40\ \mu\text{T} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q9

Q10.

Solution

Concept – self-inductance from flux linkage: The self-inductance is the flux linkage per unit current, $L = \dfrac{N\Phi}{I}$.

Step 1 – list the data in base units: $N = 100$, $\Phi = 0.2$ mWb $= 0.2 \times 10^{-3}$ Wb, $I = 4$ A.

Step 2 – form the flux linkage $N\Phi$: $N\Phi = 100 \times (0.2 \times 10^{-3}) = 0.02$ Wb-turns

Step 3 – divide by the current: $L = \dfrac{0.02}{4}$

Step 4 – evaluate: $L = 0.005$ H $= 5$ mH

Final Answer: $L = 5$ mH $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q10

Q11.

Solution

Concept – inductors in series (no mutual coupling): With no coupling the series equivalent inductance is simply the sum, $L_{eq} = L_1 + L_2$.

Step 1 – list the data: $L_1 = 6$ mH, $L_2 = 3$ mH.

Step 2 – add the two inductances: $L_{eq} = 6 + 3$

$L_{eq} = 9$ mH

Step 3 – sanity check: Unlike parallel capacitors, series inductors add directly (like series resistors), so the total must exceed the larger inductance (6 mH), and $9 > 6$.

Final Answer: $L_{eq} = 9$ mH $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q11

Q12.

Solution

Concept – final-value theorem of the Laplace transform: If the system is stable, $\lim_{t\to\infty} x(t) = \lim_{s\to 0} s\,X(s)$.

Step 1 – write the product $s\,X(s)$: $s\,X(s) = s \times \dfrac{5}{s(s+2)} = \dfrac{5}{s+2}$

Step 2 – take the limit as $s \to 0$: $x(\infty) = \lim_{s\to 0} \dfrac{5}{s+2} = \dfrac{5}{0+2}$

Step 3 – evaluate: $x(\infty) = \frac{5}{2} = 2.5$

Why the other options are wrong:

- A, 5: forgets the $(s+2)$ term (would need $X(s) = 5/s$).
- C, 0: would apply if there were no pole at the origin to sustain a d.c. term.
- D, ∞: the system is stable, so the response settles to a finite value.

Final Answer: $x(\infty) = 2.5 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q12

Q13.

Solution

Concept – time constant from a first-order transfer function: For $H(s) = \frac{1}{s+a}$ the pole is at $s = -a$, and the time constant is $\tau = \frac{1}{a}$.

Step 1 – identify the pole location: The denominator $s+5$ gives a pole at $s = -5$, so $a = 5$.

Step 2 – form the time constant: $\tau = \frac{1}{a} = \frac{1}{5}$

Step 3 – evaluate: $\tau = 0.2$ s

Final Answer: $\tau = 0.2 \text{ s} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q13

Q14.

Solution

Concept – frequency of a sinusoid: For $x(t) = \sin(\omega_0 t)$ the ordinary frequency is $f = \frac{\omega_0}{2\pi}$.

Step 1 – identify the angular frequency: $\omega_0 = 200\pi$ rad/s.

Step 2 – substitute into the frequency formula: $f = \frac{200\pi}{2\pi}$

Step 3 – cancel π and simplify: $f = \frac{200}{2}$

Step 4 – evaluate: $f = 100$ Hz

Final Answer: $f = 100 \text{ Hz} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q14

Q15.

Solution

Concept – Nyquist sampling theorem: To reconstruct a signal without aliasing, it must be sampled at a rate at least twice its highest frequency, $f_s \geq 2f_{\max}$.

Step 1 – identify the maximum frequency: $f_{\max} = 4$ kHz.

Step 2 – apply the Nyquist rate: $f_{s,\min} = 2 \times f_{\max} = 2 \times 4$

Step 3 – evaluate: $f_{s,\min} = 8$ kHz

Why the other options are wrong:

- A, 4 kHz: equals $f_{\max}$, which only just meets, not exceeds, half the rate and causes aliasing.
- C, 2 kHz: is below $f_{\max}$, badly under-sampled.
- D, 16 kHz: is valid but not the *minimum* rate.

Final Answer: $f_{s,\min} = 8$ kHz $\Rightarrow \boxed{\text{B}}$

Answer: (B) 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: $h[0] = 2$, $h[1] = 3$, $h[2] = 2$.

Step 2 – add the first two: $2 + 3 = 5$

Step 3 – add the last sample: $5 + 2 = 7$

Step 4 – state the d.c. gain: $\sum_n h[n] = 7$

Final Answer: d.c. gain $= 7 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q16

Q17.

Solution

Concept – three-phase star–star transformer voltages: In a star–star transformer the line-voltage ratio equals the per-phase turns ratio, because both windings have the same $\sqrt{3}$ factor between phase and line quantities. Hence $V_{2,\text{line}} = \dfrac{V_{1,\text{line}}}{N_1/N_2}$.

Step 1 – list the data: $V_{1,\text{line}} = 11$ kV, $\dfrac{N_1}{N_2} = 10$.

Step 2 – note why the $\sqrt{3}$ factors cancel: Primary phase voltage $= 11/\sqrt{3}$ kV; secondary phase voltage $= (11/\sqrt{3})/10$ kV; multiplying back by $\sqrt{3}$ for the secondary line voltage removes the $\sqrt{3}$.

Step 3 – divide the line voltage by the turns ratio: $V_{2,\text{line}} = \dfrac{11 \text{ kV}}{10}$

Step 4 – evaluate: $V_{2,\text{line}} = 1.1$ kV

Final Answer: $V_{2,\text{line}} = 1.1 \text{ kV} \Rightarrow \boxed{\text{D}}$

Answer: (D) 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: $V = 250$ V, $I_a = 40$ A, $R_a = 0.25\ \Omega$.

Step 2 – compute the armature resistive drop: $I_a R_a = 40 \times 0.25$

$I_a R_a = 10$ V

Step 3 – subtract from the supply voltage: $E_b = 250 - 10$

$E_b = 240$ V

Final Answer: $E_b = 240 \text{ V} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q18

Q19.

Solution

Concept – autotransformer voltage ratio: An autotransformer behaves like an ordinary transformer for voltage: the secondary voltage is the applied voltage scaled by the tapped fraction of turns, $V_2 = V_1 \cdot \dfrac{N_2}{N_1}$.

Step 1 – list the data: $V_1 = 250$ V, $N_1 = 500$ turns (full winding), $N_2 = 100$ turns (tap).

Step 2 – form the turns fraction: $\dfrac{N_2}{N_1} = \dfrac{100}{500} = \dfrac{1}{5}$

Step 3 – multiply by the applied voltage: $V_2 = 250 \times \dfrac{1}{5}$

Step 4 – evaluate: $V_2 = 50$ V

Why the other options are wrong:

- A, 250 V: assumes the tap is the full winding.
- B, 1250 V: multiplies by 5 (a step-up), the wrong sense.
- C, 100 V: uses a ratio of 2.5 instead of 5.

Final Answer: $V_2 = 50\text{ V} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q19

Q20.

Solution

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

Step 1 – convert the rating to volt-amperes: $10\text{ kVA} = 10000\text{ VA}$

Step 2 – write the secondary current: $I_2 = \dfrac{10000}{400}$

Step 3 – evaluate: $I_2 = 25\text{ A}$

Final Answer: $I_2 = 25\text{ A} \Rightarrow \boxed{\text{A}}$

Answer: (A) 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: $E_b = 250$ V, $I_a = 40$ A.

Step 2 – multiply: $P = 250 \times 40$

Step 3 – evaluate: $P = 10000\text{ W}$

Step 4 – convert to kilowatts: $P = 10\text{ kW}$

Final Answer: $P = 10\text{ kW} \Rightarrow \boxed{\text{A}}$

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: $P_{out} = 9$ kW $= 9000$ W, core loss $= 250$ W, copper loss $= 250$ W.

Step 2 – add the losses: $P_{loss} = 250 + 250 = 500$ W

Step 3 – form the input power: $P_{in} = 9000 + 500 = 9500$ W

Step 4 – divide output by input: $\eta = \dfrac{9000}{9500}$

Step 5 – evaluate as a percentage: $\eta = 0.9474 = 94.7\%$

Final Answer: $\eta \approx 94.7\% \Rightarrow \boxed{\text{B}}$

Answer: (B) 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: $N_s = \dfrac{120 \times 50}{6}$

$N_s = \dfrac{6000}{6} = 1000$ rpm

Step 2 – form the difference of speeds: $N_s - N = 1000 - 950 = 50$ rpm

Step 3 – divide by the synchronous speed: $s = \dfrac{50}{1000}$

Step 4 – evaluate: $s = 0.05 = 5\%$

Final Answer: $s = 5\% \Rightarrow \boxed{\text{C}}$

Answer: (C) 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: $kV_{base} = 20$ kV, $MVA_{base} = 200$ MVA.

Step 2 – square the base voltage: $(20)^2 = 400$

Step 3 – divide by the base MVA: $Z_{base} = \frac{400}{200}$

Step 4 – evaluate: $Z_{base} = 2\ \Omega$

Final Answer: $Z_{base} = 2\ \Omega \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q24

Q25.

Solution

Concept – economic load dispatch (equal incremental cost): Neglecting losses, the total generation cost is least when every unit runs at the *same* incremental fuel cost λ, subject to $P_1 + P_2 = P_D$.

Step 1 – write the two incremental costs: $\frac{dC_1}{dP_1} = 0.1P_1 + 20$

$\frac{dC_2}{dP_2} = 0.1P_2 + 15$

Step 2 – impose the power-balance constraint: $P_1 + P_2 = 200 \ \Rightarrow\ P_2 = 200 - P_1$

Step 3 – set the two incremental costs equal: $0.1P_1 + 20 = 0.1(200 - P_1) + 15$

Step 4 – expand the right side: $0.1P_1 + 20 = 20 - 0.1P_1 + 15$

Step 5 – collect the P_1 terms: $0.1P_1 + 0.1P_1 = 35 - 20$

$0.2P_1 = 15$

Step 6 – solve for P_1: $P_1 = \frac{15}{0.2} = 75$ MW

Step 7 – back-check: $P_2 = 200 - 75 = 125$ MW, and $0.1(75) + 20 = 27.5 = 0.1(125) + 15$, so the incremental costs match.

Final Answer: $P_1 = 75$ MW $\Rightarrow \boxed{\text{B}}$

Answer: (B) 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: $X_{new} = X_{old} \times \frac{MVA_{new}}{MVA_{old}}$.

Step 1 – list the data: $X_{old} = 0.15$ pu, $MVA_{old} = 25$, $MVA_{new} = 100$.

Step 2 – form the MVA ratio: $\frac{MVA_{new}}{MVA_{old}} = \frac{100}{25} = 4$

Step 3 – multiply: $X_{new} = 0.15 \times 4$

Step 4 – evaluate: $X_{new} = 0.6$ pu

Final Answer: $X_{new} = 0.6$ pu $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q26

Q27.

Solution

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

Step 1 – list the data in base units: $L = 1.6$ mH/km $= 1.6 \times 10^{-3}$ H/km, $C = 0.01$ μF/km $= 0.01 \times 10^{-6}$ F/km.

Step 2 – form the ratio L/C: $\dfrac{L}{C} = \dfrac{1.6 \times 10^{-3}}{0.01 \times 10^{-6}}$

Step 3 – simplify the powers of ten: $\dfrac{1.6 \times 10^{-3}}{1 \times 10^{-8}} = 1.6 \times 10^{5} = 160000$

Step 4 – take the square root: $Z_c = \sqrt{160000}$

$Z_c = 400\ \Omega$

Final Answer: $Z_c = 400\ \Omega \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q27

Q28.

Solution

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

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

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

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

Step 4 – evaluate: $P_{max} = 1$ pu

Final Answer: $P_{max} = 1$ pu $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q28

Q29.

Solution

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

Step 1 – list the data: $E = 1.0$ pu, $Z_1 = Z_2 = Z_0 = 0.15$ pu.

Step 2 – add the sequence impedances: $Z_1 + Z_2 + Z_0 = 0.15 + 0.15 + 0.15 = 0.45$

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

Step 4 – divide: $I_f = \dfrac{3}{0.45}$

Step 5 – evaluate: $I_f = 6.667 \approx 6.67$ pu

Final Answer: $I_f \approx 6.67$ 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: $\text{MVA}_{base} = 100$, $\text{kV}_{base} = 33$, $\sqrt{3} = 1.732$.

Step 2 – form the denominator: $\sqrt{3} \times \text{kV} = 1.732 \times 33$

$= 57.16$

Step 3 – divide (MVA over kV gives current in kA): $I_{base} = \dfrac{100}{57.16}$

$= 1.7497$ kA

Step 4 – convert to amperes: $I_{base} = 1749.7 \text{ A} \approx 1750 \text{ A}$

Final Answer: $I_{base} \approx 1750 \text{ A} \Rightarrow \boxed{\text{C}}$

Answer: (C) 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: $\omega_n^2 = 16$

$\omega_n = \sqrt{16} = 4$ rad/s

Step 2 – read the middle term: $2\zeta\omega_n = 8$

Step 3 – solve for ζ: $\zeta = \dfrac{8}{2\omega_n} = \dfrac{8}{2 \times 4}$

Step 4 – evaluate: $\zeta = \dfrac{8}{8} = 1$

Step 5 – interpret: $\zeta = 1$ means the system is critically damped (a repeated real pole at $s = -4$).

Final Answer: $\zeta = 1 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q31

Q32.

Solution

Concept – corner (break) frequency of a first-order factor: For a factor of the form $\dfrac{1}{1 + s\tau}$, the Bode magnitude plot breaks at the corner frequency $\omega_c = \dfrac{1}{\tau}$.

Step 1 – identify the time constant from the denominator: $1 + 0.05s \;\Rightarrow\; \tau = 0.05$ s

Step 2 – form the corner frequency: $\omega_c = \dfrac{1}{\tau} = \dfrac{1}{0.05}$

Step 3 – evaluate: $\omega_c = 20$ rad/s

Step 4 – interpret the plot: Below 20 rad/s the magnitude is flat at $20\log_{10} 10 = 20$ dB; above it the slope falls at -20 dB/decade, as sketched.

Final Answer: $\omega_c = 20$ rad/s $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q32

Q33.

Solution

Concept – magnitude of a first-order response in decibels: $|G(j\omega)| = \dfrac{1}{\sqrt{\omega^2 + 1}}$, and the decibel value is $20\log_{10}|G(j\omega)|$.

Step 1 – substitute $\omega = 1$ into the magnitude: $|G(j1)| = \dfrac{1}{\sqrt{1^2 + 1}}$

Step 2 – evaluate the square root: $\sqrt{1+1} = \sqrt{2} = 1.414$

Step 3 – form the magnitude: $|G(j1)| = \dfrac{1}{1.414} = 0.707$

Step 4 – convert to decibels: $20\log_{10}(0.707) = 20 \times (-0.1505)$

Step 5 – evaluate: $= -3.01 \approx -3$ dB

Step 6 – interpret: $\omega = 1$ rad/s is exactly the corner frequency of this pole, where the gain is always 3 dB below its low-frequency value.

Final Answer: magnitude ≈ -3 dB $\Rightarrow \boxed{\text{B}}$

Answer: (B) 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: $K_p = \lim_{s\to 0} \dfrac{20}{s(s+5)}$

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 $s = 0$: $G(0) = \dfrac{9}{0+1} = \dfrac{9}{1} = 9$

Step 2 – form the closed-loop expression at $s = 0$: $\left.\dfrac{C}{R}\right|_{s=0} = \dfrac{G(0)}{1+G(0)} = \dfrac{9}{1+9}$

Step 3 – simplify the denominator: $1 + 9 = 10$

Step 4 – divide: $\left.\dfrac{C}{R}\right|_{s=0} = \dfrac{9}{10}$

Step 5 – evaluate: $= 0.9$

Final Answer: d.c. gain $= 0.9 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q35

Q36.

Solution

Concept – gain of a non-inverting op-amp: For an ideal non-inverting amplifier the closed-loop gain is $A_v = 1 + \dfrac{R_f}{R_1}$.

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

Step 2 – form the feedback ratio: $\dfrac{R_f}{R_1} = \dfrac{50\ \text{k}\Omega}{10\ \text{k}\Omega} = 5$

Step 3 – add one: $A_v = 1 + 5$

Step 4 – evaluate: $A_v = 6$

Why the other options are wrong:

- A, 5: is R_f/R_1, the *inverting* gain magnitude, missing the $+1$.
- C, 0.2: inverts the resistor ratio.
- D, 50: uses only R_f in kilo-ohms.

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

Answer: (B) **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 $(101100)_2$**:** $1 \to 2^5,\ 0 \to 2^4,\ 1 \to 2^3,\ 1 \to 2^2,\ 0 \to 2^1,\ 0 \to 2^0$

Step 2 – evaluate each nonzero weight: $2^5 = 32$

$2^3 = 8$

$2^2 = 4$

Step 3 – add the contributions: $32 + 8 + 4 = 44$

Final Answer: $(101100)_2 = 44 \Rightarrow \boxed{\text{B}}$

Answer: (B) **Go Back to Q37**

Q38.

Solution

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

Step 1 – list the data: $R_1 = 200\ \Omega$, $R_2 = 400\ \Omega$, $R_3 = 300\ \Omega$.

Step 2 – form the numerator R_2R_3**:** $R_2R_3 = 400 \times 300 = 120000$

Step 3 – divide by R_1**:** $R_x = \dfrac{120000}{200}$

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

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

Answer: (C) Go Back to Q38

Q39.

Solution

Concept – hexadecimal-to-decimal conversion: Each hex digit has weight 16^k; the digit F equals 15.

Step 1 – write the digits with weights for $(2\text{F})_{16}$**:** $2 \to 16^1,\ \text{F} \to 16^0$

Step 2 – convert the digit F: $\text{F} = 15$

Step 3 – evaluate each term: $2 \times 16 = 32$

$15 \times 1 = 15$

Step 4 – add: $32 + 15 = 47$

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

Answer: (A) Go Back to Q39

Q40.

Solution

Concept – absorption law of Boolean algebra: The identity $A(A + B) = A$ absorbs the B term.

Step 1 – start from the expression: $Y = A(A + B)$

Step 2 – expand the product (distributive law): $Y = A \cdot A + A \cdot B$

Step 3 – apply idempotence $A \cdot A = A$**:** $Y = A + AB$

Step 4 – factor out A**:** $Y = A(1 + B)$

Step 5 – apply $1 + B = 1$**:** $Y = A \cdot 1 = A$

Why the other options are wrong:

- B, B: drops the dominant A term.
- C, AB: is the AND, not the absorbed result.
- D, $A + B$: is the OR-form identity $A + \bar{A}B$, a different expression.

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

Answer: (A) Go Back to Q40

Q41.

Solution

Concept – gain of a three-op-amp instrumentation amplifier: With the difference (output) stage set to unity, the overall gain is fixed by the input stage: $A = 1 + \dfrac{2R}{R_g}$.

Step 1 – list the data: $R = 50\ \text{k}\Omega$, $R_g = 25\ \text{k}\Omega$.

Step 2 – form the ratio $2R/R_g$**:** $\dfrac{2R}{R_g} = \dfrac{2 \times 50\ \text{k}\Omega}{25\ \text{k}\Omega} = \dfrac{100}{25} = 4$

Step 3 – add one: $A = 1 + 4$

Step 4 – evaluate: $A = 5$

Why the other options are wrong:

- A, 2: uses R/R_g without the factor of 2 and the $+1$.
- B, 3: adds 1 to $R/R_g = 2$, forgetting the factor of 2.
- C, 101: is the classic $1+2R/R_g$ with R_g a hundred times smaller, not the case here.

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

Answer: (D) Go Back to Q41

Q42.

Solution

Concept – average output of a three-phase six-pulse bridge: For a three-phase full-wave (six-pulse) uncontrolled bridge fed from a per-phase peak voltage V_m, the average output is $V_{dc} = \dfrac{3\sqrt{3}\,V_m}{\pi}$.

Step 1 – list the data: $V_m = 100$ V (per-phase peak), $\sqrt{3} = 1.732$, $\pi = 3.1416$.

Step 2 – form the numerator $3\sqrt{3}\,V_m$**:** $3\sqrt{3} = 3 \times 1.732 = 5.196$

$3\sqrt{3}\,V_m = 5.196 \times 100 = 519.6$

Step 3 – divide by π**:** $V_{dc} = \dfrac{519.6}{3.1416}$

Step 4 – evaluate: $V_{dc} = 165.4$ V

Why the other options are wrong:

- A, 63.66 V: is the *single-phase* full-wave value $2V_m/\pi$.
- C, 100 V: is the peak phase voltage, not the average.
- D uses the wrong count of pulses.

Final Answer: $V_{dc} \approx 165.4\text{ V} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q42

Q43.

Solution

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

Step 1 – list the data: $V_m = 150$ V, $\pi = 3.1416$.

Step 2 – form the numerator: $2V_m = 2 \times 150 = 300$

Step 3 – divide by π**:** $V_{dc} = \dfrac{300}{3.1416}$

Step 4 – evaluate: $V_{dc} = 95.49$ V

Why the other options are wrong:

- A, 47.75 V: is the half-wave value V_m/π.
- C, 150 V: is the peak value.
- D, 106 V: is close to the RMS $V_m/\sqrt{2}$, not the average.

Final Answer: $V_{dc} = 95.49\text{ V} \Rightarrow \boxed{\text{B}}$

Answer: (B) 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: $V_s = 250$ V, $D = 0.4$.

Step 2 – multiply: $V_o = 0.4 \times 250$

Step 3 – evaluate: $V_o = 100$ V

Why the other options are wrong:

- A, 250 V: assumes $D = 1$ (switch always on).
- C, 500 V: divides by D rather than multiplying.
- D, 80 V: uses $D = 0.32$ instead of 0.4.

Final Answer: $V_o = 100 \text{ V} \Rightarrow \boxed{\text{B}}$

Answer: (B) 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 $D = \dfrac{V_o}{V_s}$.

Step 1 – list the data: $V_o = 180$ V, $V_s = 240$ V.

Step 2 – form the ratio: $D = \dfrac{180}{240}$

Step 3 – evaluate: $D = 0.75$

Step 4 – sanity check: A duty ratio must lie between 0 and 1; 0.75 is valid and gives three-quarters of the input as output.

Why the other options are wrong:

- A, 0.25: is $1 - D$, the off-time fraction.
- B, 0.5: uses 120 V instead of 180 V.
- C, 1.33: inverts the ratio and exceeds 1, which is impossible for a buck chopper.

Final Answer: $D = 0.75 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q45

Q46.

Solution

Concept – average output of a three-phase controlled bridge: For a three-phase fully controlled (six-pulse) converter with a highly inductive (continuous) load, $V_{dc} = \dfrac{3\sqrt{3}\,V_m}{\pi}\cos\alpha$.

Step 1 – list the data: $V_m = 100$ V (per-phase peak), $\alpha = 60°$, $\sqrt{3} = 1.732$, $\pi = 3.1416$.

Step 2 – evaluate the uncontrolled part $\dfrac{3\sqrt{3}\,V_m}{\pi}$: $3\sqrt{3}\,V_m = 5.196 \times 100 = 519.6$
$\dfrac{519.6}{3.1416} = 165.4$ V

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

Step 4 – multiply: $V_{dc} = 165.4 \times 0.5$

Step 5 – evaluate: $V_{dc} = 82.7$ V

Why the other options are wrong:

- A, 165.4 V: forgets the $\cos\alpha$ factor (the $\alpha = 0$ case).
- B, 143.2 V: uses $\cos 30°$ instead of $\cos 60°$.
- D, 0 V: would need $\alpha = 90°$, where $\cos\alpha = 0$.

Final Answer: $V_{dc} \approx 82.7$ V $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q46

Answer Key

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