GATE Electrical Engineering

Sample Paper – 9

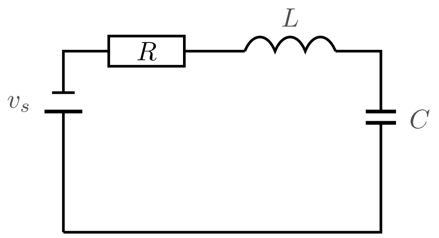
Duration: 128 Minutes **Maximum Marks: 72**

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 circuit is driven by an a.c. source as shown, with $L = 0.1$ H and $C = 0.1\ \mu$F. The resonant angular frequency $\omega_0 = \dfrac{1}{\sqrt{LC}}$ is: [1 mark]



(A) 1000 rad/s

(B) 100 rad/s

(C) 5000 rad/s

(D) 10000 rad/s

Q2. For a series RLC resonant circuit with $R = 10\ \Omega$, $L = 0.1$ H and $C = 0.1\ \mu$F, the quality factor at resonance, $Q = \dfrac{1}{R}\sqrt{\dfrac{L}{C}}$, is: **[1 mark]**

(A) 100

(B) 10

(C) 1000

(D) 1

Q3. A series RLC resonant circuit has $R = 20\ \Omega$ and $L = 0.1$ H. Its half-power bandwidth in angular measure, $\text{BW} = \dfrac{R}{L}$, is: **[1 mark]**

(A) 200 rad/s

(B) 2000 rad/s

(C) 20 rad/s

(D) 100 rad/s

Q4. A series RLC circuit with $R = 15\ \Omega$ is operated exactly at its resonant frequency. At resonance the inductive and capacitive reactances cancel, so the total impedance seen by the source is: **[1 mark]**

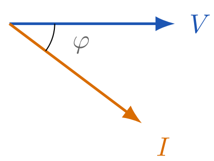
(A) $0\ \Omega$

(B) $30\ \Omega$

(C) $7.5\ \Omega$

(D) $15\ \Omega$

Q5. An a.c. load draws an rms current of 5 A from a 100 V (rms) supply at a lagging power factor of 0.8, as the phasor diagram indicates. The average (real) power drawn, $P = VI\cos\varphi$, is: **[1 mark]**



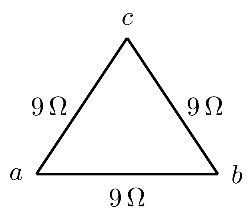
(A) 500 W

(B) 400 W

(C) 300 W

(D) 200 W

Q6. Three equal resistors of $9\ \Omega$ each are connected in a delta (Δ), as shown. The resistance of each arm of the equivalent star (Y) network, $R_Y = \dfrac{R_\Delta}{3}$, is: **[1 mark]**



(A) $27\ \Omega$

(B) $9\ \Omega$

(C) $1\ \Omega$

(D) $3\ \Omega$

Q7. An inductor of $L = 2$ H carries a steady current of $I = 3$ A. The magnetic energy stored in the inductor, $W = \frac{1}{2}LI^2$, is: **[1 mark]**

(A) 18 J

(B) 9 J

(C) 6 J

(D) 3 J

Electromagnetic Fields

Q8. By Gauss's law in the form $\oint \vec{D} \cdot d\vec{A} = Q_{enc}$, the total electric-flux (ψ) of $\vec{D}$ leaving any closed surface equals the charge enclosed. If a closed surface encloses a net charge of $10\ \mu$C, the total flux of $\vec{D}$ leaving it is: **[1 mark]**

(A) $5\ \mu$C

(B) $10\ \mu$C

(C) 0

(D) $20\ \mu$C

Q9. Using Gauss's law, an infinite line charge of linear density $\lambda = 1$ nC/m produces a radial field $E = \dfrac{\lambda}{2\pi\varepsilon_0 r}$. Taking $\dfrac{1}{2\pi\varepsilon_0} = 2 \times (9 \times 10^9)$, the field magnitude at $r = 1$ m is: **[1 mark]**

(A) 18 V/m

(B) 9 V/m

(C) 36 V/m

(D) 4.5 V/m

Q10. A parallel-plate capacitor has a uniform field between its plates. A voltage of 100 V is applied across a plate separation of $d = 2$ mm. The uniform electric field magnitude, $E = \dfrac{V}{d}$, is: **[1 mark]**

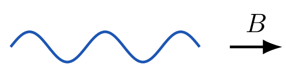
(A) 25 kV/m

(B) 50 kV/m

(C) 100 kV/m

(D) 200 kV/m

Q11. A long solenoid has $n = 1000$ turns per metre and carries a current $I = 2$ A, as sketched. The axial magnetic flux density inside it, $B = \mu_0 n I$, is nearest to: **[1 mark]**



$n = 1000/\text{m},\ \ I = 2\ \text{A}$

(A) 2.51 mT

(B) 25.1 mT

(C) 0.251 mT

(D) 5.03 mT

Signals and Systems

Q12. A periodic signal possesses half-wave symmetry, i.e. $x\left(t \pm \frac{T}{2}\right) = -x(t)$. Its trigonometric Fourier series contains: **[1 mark]**

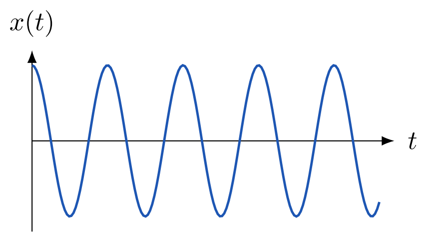
(A) only even harmonics

(B) all harmonics and a d.c. term

(C) only a d.c. term

(D) only odd harmonics

Q13. A continuous-time signal is $x(t) = \cos(400\pi t)$, one cycle of which is sketched below. Its fundamental period T is: **[1 mark]**



(A) 10 ms

(B) 20 ms

(C) 5 ms

(D) 2.5 ms

Q14. A periodic signal is $x(t) = 4\cos(\omega_0 t)$. Using $P = \dfrac{A^2}{2}$ for a sinusoid, the average power of $x(t)$ over one period is: **[1 mark]**

(A) 16 W

(B) 4 W

(C) 8 W

(D) 2 W

Q15. Two finite-length discrete sequences of lengths 6 and 3 samples respectively are linearly convolved. The length (number of samples) of the resulting sequence is: **[1 mark]**

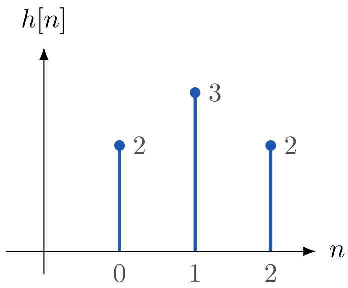
(A) 9

(B) 18

(C) 3

(D) 8

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 induction machine has 6 poles and is supplied at 50 Hz. Its synchronous speed, $N_s = \dfrac{120f}{P}$, is: **[1 mark]**

(A) 1000 rpm

(B) 1500 rpm

(C) 3000 rpm

(D) 750 rpm

Q18. A three-phase induction machine, driven by a prime mover, is made to run *above* its synchronous speed while still connected to the grid. It then operates as an induction generator. The corresponding per-unit slip $s = \dfrac{N_s - N}{N_s}$ satisfies: **[1 mark]**

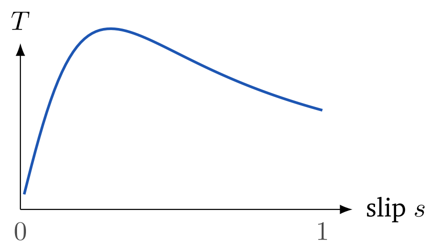
(A) $s > 1$

(B) $s = 1$

(C) $0 < s < 1$

(D) $s < 0$

Q19. A 4-pole, 50 Hz three-phase induction motor runs at a rotor speed of 1425 rpm; its torque–slip curve is sketched below. The per-unit slip $s = \dfrac{N_s - N}{N_s}$ is: **[1 mark]**



(A) 2%

(B) 5%

(C) 10%

(D) 8%

Q20. A three-phase squirrel-cage induction motor is started with a star–delta starter. Compared with direct-on-line (DOL) starting, the starting line current drawn from the supply is reduced to: **[1 mark]**

(A) the same value as DOL

(B) $\dfrac{1}{\sqrt{3}}$ of the DOL value

(C) $\dfrac{1}{3}$ of the DOL value

(D) 3 times the DOL value

Q21. A three-phase induction motor has an air-gap (rotor input) power of $P_{ag} = 10$ kW while running at a slip of $s = 0.04$. The rotor copper loss, $P_{cu} = s\,P_{ag}$, is: **[2 marks]**

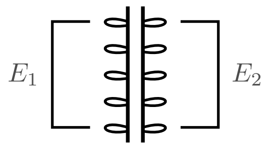
(A) 0.4 kW

(B) 9.6 kW

(C) 10 kW

(D) 4 kW

Q22. A single-phase transformer winding shown has $N = 100$ turns and links a sinusoidal peak flux of $\Phi_m = 0.02$ Wb at $f = 50$ Hz. Its induced r.m.s. e.m.f., $E = 4.44\,fN\Phi_m$, is: **[2 marks]**



$N = 100$, $\Phi_m = 0.02$ Wb

(A) 111 V

(B) 222 V

(C) 333 V

(D) 444 V

Q23. A 4-pole, 50 Hz three-phase induction motor runs at a slip of $s = 0.03$. The frequency of the induced rotor currents, $f_r = s\,f$, is: **[2 marks]**

(A) 1.5 Hz

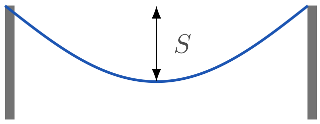
(B) 50 Hz

(C) 3 Hz

(D) 0.03 Hz

Power Systems

Q24. An overhead line conductor of weight $w = 2$ N/m is strung between two equal-height supports $L = 100$ m apart at a horizontal tension $T = 1000$ N, as shown. The mid-span sag, $S = \dfrac{wL^2}{8T}$, is: **[2 marks]**



(A) 2.5 m

(B) 5 m

(C) 1.25 m

(D) 10 m

Q25. A suspension insulator string has 4 identical discs. Measurement shows the voltage across the disc nearest the line conductor (the most stressed unit) is 10 kV, while the total voltage across the string is 30 kV. The string efficiency, $\eta = \frac{V_{string}}{n\,V_{max}} \times 100\%$, is: **[2 marks]**

(A) 100%

(B) 90%

(C) 25%

(D) 75%

Q26. To reduce corona power loss on an extra-high-voltage overhead transmission line, the single most effective conductor-design measure is to: **[2 marks]**

(A) use a conductor of smaller diameter

(B) use a larger-diameter or bundled conductor

(C) raise the supply frequency

(D) bring the phase conductors closer together

Q27. In per-unit analysis a base of 100 MVA and 22 kV is chosen. The base impedance, $Z_{base} = \frac{(\text{kV}_{base})^2}{\text{MVA}_{base}}$, is: **[2 marks]**

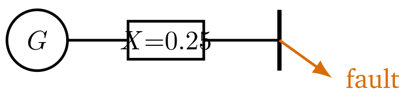
(A) 0.484 Ω

(B) 4.84 Ω

(C) $48.4\ \Omega$

(D) $484\ \Omega$

Q28. A generator is connected to a bus of base 100 MVA through a reactance of $X = 0.25$ pu, as shown on 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) 25 MVA

(B) 100 MVA

(C) 400 MVA

(D) 200 MVA

Q29. A three-phase system has a base of 100 MVA and a line voltage of 220 kV. The base current, $I_{base} = \dfrac{\text{MVA}_{base}}{\sqrt{3}\,\text{kV}_{base}}$, is nearest to: **[2 marks]**

(A) 758 A

(B) 262 A

(C) 437 A

(D) 100 A

Q30. A lossless line connects two buses held at $V_1 = V_2 = 1.0$ pu, with a series reactance $X = 0.4$ pu. The theoretical maximum power transferable, $P_{max} = \dfrac{V_1 V_2}{X}$ (at $\delta = 90°$), is: **[2 marks]**

(A) 1 pu

(B) 4 pu

(C) 2.5 pu

(D) 0.4 pu

Control Systems

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

(A) 0.5

(B) 0.25

(C) 1

(D) 0.125

Q32. From a measured open-loop frequency response, at the gain-crossover frequency the phase of $G(j\omega)$ is $-135°$. The phase margin, PM $= 180° + \angle G(j\omega_{gc})$, is: **[2 marks]**

(A) $135°$

(B) $90°$

(C) $45°$

(D) $0°$

Q33. For an open-loop transfer function the magnitude $|G(j\omega)|$ at the phase-crossover frequency (where the phase is $-180°$) is 0.5. The gain margin in decibels, GM $= -20\log_{10}|G(j\omega_{pc})|$, is nearest to: **[2 marks]**

(A) 0.5 dB

(B) -6 dB

(C) 6 dB

(D) 2 dB

Q34. A first-order block has transfer function $G(s) = \dfrac{1}{1+s\tau}$ with time constant $\tau = 0.02$ s. On its Bode magnitude plot the corner (break) frequency, $\omega_c = \dfrac{1}{\tau}$, is: **[2 marks]**

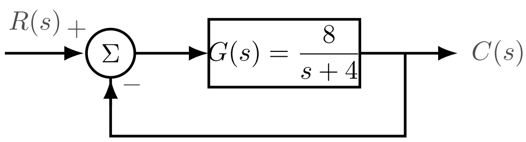
(A) 0.02 rad/s

(B) 20 rad/s

(C) 100 rad/s

(D) 50 rad/s

Q35. For the unity-feedback control system shown, the forward-path transfer function is $G(s) = \dfrac{8}{s+4}$. 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) 2

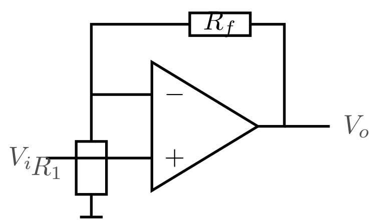
(B) 1

(C) 0.667

(D) 0.5

Analog, Digital and Measurements

Q36. For the ideal-op-amp non-inverting amplifier shown, $R_1 = 10$ kΩ and $R_f = 20$ kΩ. The closed-loop voltage gain, $\dfrac{V_o}{V_i} = 1 + \dfrac{R_f}{R_1}$, is: [2 marks]



(A) 3

(B) 2

(C) 0.5

(D) 20

Q37. A 4-bit serial-in serial-out (SISO) shift register is loaded serially with a 4-bit word. The number of clock pulses required for the first loaded bit to appear at the serial output is: [2 marks]

(A) 4

(B) 1

(C) 8

(D) 16

Q38. A digital voltmeter uses a $3\frac{1}{2}$-digit display (three full digits plus a leading half-digit that shows only 0 or 1). Its maximum displayable count (full-scale reading) is: **[2 marks]**

(A) 999

(B) 9999

(C) 1999

(D) 3999

Q39. The unsigned binary number $(11011)_2$ has the decimal (base-10) value: **[2 marks]**

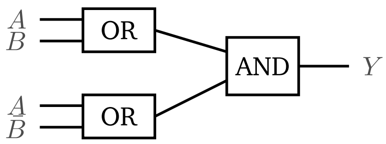
(A) 26

(B) 27

(C) 25

(D) 32

Q40. The gate network shown implements $Y = (A + B)(A + \bar{B})$. Applying the distributive and complement laws, the simplified expression is: **[2 marks]**



(A) B

(B) $A + B$

(C) A

(D) AB

Q41. A moving-iron (or thermal) instrument reads r.m.s. values, while a moving-coil (PMMC) rectifier instrument responds to the average value. For a pure sinusoid the form factor, $k_f = \dfrac{V_{rms}}{V_{avg}}$ (with V_{avg} the full-wave average), is: [2 marks]

(A) 1

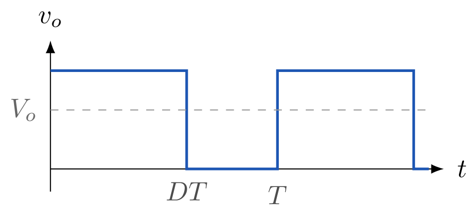
(B) 1.414

(C) 0.707

(D) 1.11

Power Electronics

Q42. A step-down (buck) d.c. chopper operates from a supply $V_s = 100$ V at a duty ratio $D = 0.6$, producing the output-voltage waveform shown. The average output voltage, $V_o = D\,V_s$, is: [2 marks]



(A) 60 V

(B) 40 V

(C) 166.7 V

(D) 100 V

Q43. A step-up (boost) d.c. chopper operates from a supply $V_s = 50$ V at a duty ratio $D = 0.5$. Its ideal average output voltage, $V_o = \dfrac{V_s}{1 - D}$, is: [2 marks]

(A) 100 V

(B) 25 V

(C) 75 V

(D) 50 V

Q44. A Class E (type-E) d.c. chopper is used to drive a separately-excited d.c. motor. In terms of the motor's operating regions in the torque–speed plane, the number of quadrants in which this chopper can control the machine is: **[2 marks]**

(A) 1

(B) 4

(C) 2

(D) 3

Q45. A step-down d.c. chopper supplies an average output voltage of 180 V from an input of 300 V. The required duty ratio, $D = \frac{V_o}{V_s}$, is: **[2 marks]**

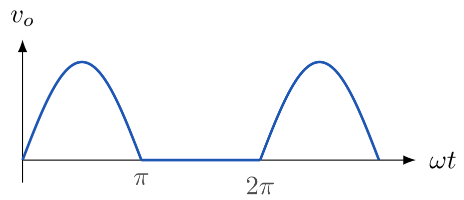
(A) 0.4

(B) 0.3

(C) 0.5

(D) 0.6

Q46. A single-phase fully controlled bridge rectifier feeds a highly inductive load from a supply of peak voltage $V_m = 200$ V, at a firing angle $\alpha = 60°$; its output waveform is indicated below. The average output voltage, $V_{dc} = \frac{2V_m}{\pi}\cos\alpha$, is: **[2 marks]**



(A) 127.3 V

(B) 63.66 V

(C) 31.83 V

(D) 0 V

Detailed Solutions

Q1.

Solution

Concept – resonance of a series RLC circuit: At resonance the inductive and capacitive reactances are equal, and the resonant angular frequency is $\omega_0 = \dfrac{1}{\sqrt{LC}}$.

Step 1 – list the data in base units: $L = 0.1$ H.

$C = 0.1\ \mu\text{F} = 0.1 \times 10^{-6}\ \text{F} = 1 \times 10^{-7}\ \text{F}$.

Step 2 – form the product LC: $LC = (0.1) \times (1 \times 10^{-7})$

$LC = 1 \times 10^{-8}$

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

$\sqrt{LC} = 1 \times 10^{-4}$

Step 4 – take the reciprocal: $\omega_0 = \dfrac{1}{1 \times 10^{-4}}$

$\omega_0 = 10000\ \text{rad/s}$

Final Answer: $\omega_0 = 10000\ \text{rad/s} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q1

Q2.

Solution

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

Step 1 – list the data: $R = 10\ \Omega$, $L = 0.1$ H, $C = 1 \times 10^{-7}$ F.

Step 2 – form the ratio L/C: $\dfrac{L}{C} = \dfrac{0.1}{1 \times 10^{-7}}$

$\dfrac{L}{C} = 1 \times 10^{6}$

Step 3 – take the square root: $\sqrt{\dfrac{L}{C}} = \sqrt{1 \times 10^{6}} = 1000$

Step 4 – divide by R: $Q = \dfrac{1000}{10}$

$Q = 100$

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

Answer: (A) Go Back to Q2

Q3.

Solution

Concept – bandwidth of a series resonant circuit: The half-power (3 dB) bandwidth of a series RLC circuit in angular units is $\text{BW} = \dfrac{R}{L}$.

Step 1 – list the data: $R = 20\ \Omega$, $L = 0.1$ H.

Step 2 – substitute into the bandwidth formula: $\text{BW} = \dfrac{20}{0.1}$

Step 3 – evaluate: $\text{BW} = 200$ rad/s

Step 4 – consistency note: A larger R (more damping) widens the bandwidth, which is why BW is directly proportional to R.

Final Answer: $\text{BW} = 200$ rad/s $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q3

Q4.

Solution

Concept – impedance of a series RLC circuit at resonance: The total impedance is $Z = R + j(X_L - X_C)$.

Step 1 – apply the resonance condition: At resonance $X_L = X_C$, so the reactive part is zero.

$X_L - X_C = 0$

Step 2 – reduce the impedance: $Z = R + j(0)$

$Z = R$

Step 3 – substitute the value of R: $Z = 15\ \Omega$

Step 4 – interpret: At resonance the circuit looks purely resistive; the current is maximum and in phase with the source voltage.

Final Answer: $Z = 15\ \Omega \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept – average (real) power in an a.c. circuit: The real power absorbed by a load is $P = VI\cos\varphi$, where $\cos\varphi$ is the power factor.

Step 1 – list the data: $V = 100$ V (rms), $I = 5$ A (rms), $\cos\varphi = 0.8$.

Step 2 – multiply voltage and current: $VI = 100 \times 5 = 500$

Step 3 – multiply by the power factor: $P = 500 \times 0.8$

Step 4 – evaluate: $P = 400$ W

Why the other options are wrong:

- A, 500 W: that is the apparent power VI, not the real power.
- C and D: use incorrect power-factor values.

Final Answer: $P = 400 \text{ W} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q5

Q6.

Solution

Concept – balanced delta-to-star conversion: When three equal resistors R_Δ form a delta, the equivalent star has arm resistance $R_Y = \dfrac{R_\Delta}{3}$.

Step 1 – list the data: $R_\Delta = 9\ \Omega$ on each delta arm.

Step 2 – apply the balanced conversion formula: $R_Y = \dfrac{9}{3}$

Step 3 – evaluate: $R_Y = 3\ \Omega$

Step 4 – consistency note: For the general (unbalanced) case $R_Y = \dfrac{R_a R_b}{R_a + R_b + R_c}$; with all three equal this reduces to $R_\Delta/3$, confirming the result.

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

Answer: (D) Go Back to Q6

Q7.

Solution

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

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 equation: $W = \frac{1}{2} \times 2 \times 9$

Step 4 – multiply $\frac{1}{2} \times 2$: $\frac{1}{2} \times 2 = 1$

Step 5 – complete the product: $W = 1 \times 9$

$W = 9$ J

Final Answer: $W = 9 \text{ J} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q7

Q8.

Solution

Concept – Gauss's law for electric flux: The flux of the displacement vector through a closed surface equals the net charge enclosed, $\oint \vec{D} \cdot d\vec{A} = Q_{enc}$.

Step 1 – identify the enclosed charge: $Q_{enc} = 10\ \mu$C.

Step 2 – apply Gauss's law directly: $\psi = Q_{enc}$

Step 3 – substitute: $\psi = 10\ \mu$C

Step 4 – interpret: The result is independent of the shape of the surface and of any external charges; only the enclosed charge matters.

Why the other options are wrong:

- A and D: no factor of $\frac{1}{2}$ or 2 appears; the flux equals the enclosed charge exactly.
- C, 0: would require zero net enclosed charge.

Final Answer: $\psi = 10\ \mu\text{C} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q8

Q9.

Solution

Concept – field of an infinite line charge (Gauss's law): A cylindrical Gaussian surface gives $E = \dfrac{\lambda}{2\pi\varepsilon_0 r}$.

Step 1 – list the data: $\lambda = 1$ nC/m $= 1\times10^{-9}$ C/m, $r = 1$ m, $\dfrac{1}{2\pi\varepsilon_0} = 2\times(9\times10^9) = 1.8\times10^{10}$.

Step 2 – write the field with the given constant: $E = \left(\dfrac{1}{2\pi\varepsilon_0}\right)\dfrac{\lambda}{r}$

Step 3 – substitute the values: $E = (1.8\times10^{10}) \times \dfrac{1\times10^{-9}}{1}$

Step 4 – multiply: $E = 1.8\times10^{10}\times10^{-9}$

$E = 1.8\times10^{1}$

$E = 18$ V/m

Final Answer: $E = 18$ V/m $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q9

Q10.

Solution

Concept – uniform field of a parallel-plate capacitor: The field between the plates is uniform and equals $E = \dfrac{V}{d}$.

Step 1 – list the data in base units: $V = 100$ V, $d = 2$ mm $= 2 \times 10^{-3}$ m.

Step 2 – substitute into the field equation: $E = \dfrac{100}{2 \times 10^{-3}}$

Step 3 – simplify the numerator: $E = \dfrac{100}{0.002}$

Step 4 – evaluate: $E = 50000$ V/m

Step 5 – convert to kV/m: $E = 50$ kV/m

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

Answer: (B) Go Back to Q10

Q11.

Solution

Concept – field inside a long solenoid: Ampere's law gives the axial flux density $B = \mu_0 n I$, where n is turns per metre.

Step 1 – list the data: $\mu_0 = 4\pi \times 10^{-7}$ H/m, $n = 1000$ turns/m, $I = 2$ A.

Step 2 – evaluate μ_0 numerically: $\mu_0 = 4\pi \times 10^{-7} = 1.2566 \times 10^{-6}$ H/m

Step 3 – multiply by n: $\mu_0 n = (1.2566 \times 10^{-6}) \times 1000 = 1.2566 \times 10^{-3}$

Step 4 – multiply by the current: $B = (1.2566 \times 10^{-3}) \times 2$

$B = 2.513 \times 10^{-3}$ T

Step 5 – express in millitesla: $B \approx 2.51$ mT

Final Answer: $B \approx 2.51$ mT $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q11

Q12.

Solution

Concept – Fourier series and half-wave symmetry: A periodic waveform that satisfies $x\left(t \pm \frac{T}{2}\right) = -x(t)$ is said to have half-wave symmetry.

Step 1 – recall the harmonic rule: For a half-wave-symmetric signal, all even harmonics (and the d.c. term) vanish.

Step 2 – state the reason: Shifting by half a period and negating reproduces the signal; even harmonics repeat with the same sign after a half-period shift, so they must be zero to satisfy the condition.

Step 3 – conclude: Only odd harmonics ($n = 1, 3, 5, \ldots$) survive in the series.

Why the other options are wrong:

- A: even harmonics are the ones that are absent, not the ones retained.
- B and C: a d.c. term (a zeroth even harmonic) is also eliminated.

Final Answer: only odd harmonics $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q12

Q13.

Solution

Concept – period of a sinusoid: For $x(t) = \cos(\omega_0 t)$ the angular frequency is $\omega_0 = 2\pi f$ and the period is $T = \dfrac{1}{f}$.

Step 1 – read off the angular frequency: $\omega_0 = 400\pi$ rad/s.

Step 2 – find the ordinary frequency: $f = \dfrac{\omega_0}{2\pi} = \dfrac{400\pi}{2\pi}$

$f = 200$ Hz

Step 3 – take the reciprocal to get the period: $T = \dfrac{1}{200}$

Step 4 – evaluate: $T = 0.005$ s $= 5$ ms

Final Answer: $T = 5$ ms $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q13

Q14.

Solution

Concept – average power of a sinusoid: A sinusoid $A\cos(\omega_0 t)$ delivers average power $P = \dfrac{A^2}{2}$ (into a $1\ \Omega$ reference).

Step 1 – identify the amplitude: $A = 4$.

Step 2 – square the amplitude: $A^2 = 4^2 = 16$

Step 3 – divide by two: $P = \dfrac{16}{2}$

Step 4 – evaluate: $P = 8$ W

Step 5 – cross-check with rms: $V_{rms} = \dfrac{4}{\sqrt{2}} = 2.828$, and $V_{rms}^2 = 8$, confirming $P = 8$ W.

Final Answer: $P = 8$ W $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q14

Q15.

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: $L_1 = 6$, $L_2 = 3$.

Step 2 – add the two lengths: $L_1 + L_2 = 6 + 3 = 9$

Step 3 – subtract one: $L = 9 - 1$

Step 4 – evaluate: $L = 8$ samples

Why the other options are wrong:

- A, 9: forgets the "minus one" in the length rule.
- B, 18: that is the product $L_1 L_2$, not the convolution length.

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

Answer: (D) Go Back to Q15

Q16.

Solution

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

Step 1 – read off the samples: $h[0] = 2$, $h[1] = 3$, $h[2] = 2$.

Step 2 – add the samples: $\sum_n h[n] = 2 + 3 + 2$

Step 3 – evaluate: $\sum_n h[n] = 7$

Step 4 – interpret: A constant (d.c.) input is scaled by 7 at the output, so the d.c. gain is 7.

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

Answer: (C) Go Back to Q16

Q17.

Solution

Concept – synchronous speed of a rotating machine: The synchronous speed is $N_s = \dfrac{120f}{P}$, with f in Hz and P the number of poles.

Step 1 – list the data: $f = 50$ Hz, $P = 6$.

Step 2 – form the numerator: $120f = 120 \times 50 = 6000$

Step 3 – divide by the number of poles: $N_s = \dfrac{6000}{6}$

Step 4 – evaluate: $N_s = 1000$ rpm

Final Answer: $N_s = 1000$ rpm $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q17

Q18.

Solution

Concept – induction machine operating as a generator: The slip is $s = \dfrac{N_s - N}{N_s}$. Its sign tells the mode of operation.

Step 1 – consider the running condition: The rotor is driven above synchronous speed, so $N > N_s$.

Step 2 – evaluate the numerator sign: $N_s - N < 0$

Step 3 – conclude the slip sign: $s = \dfrac{N_s - N}{N_s} < 0$

Step 4 – interpret: With negative slip the machine feeds power back to the grid; it acts as an induction generator.

Why the other options are wrong:

- B, $s = 1$: standstill (starting) condition.
- C, $0 < s < 1$: normal motoring.
- A, $s > 1$: plugging (reverse braking).

Final Answer: $s < 0 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q18

Q19.

Solution

Concept – slip of an induction motor: The per-unit slip is $s = \dfrac{N_s - N}{N_s}$, where $N_s = \dfrac{120f}{P}$.

Step 1 – find the synchronous speed: $N_s = \dfrac{120 \times 50}{4} = \dfrac{6000}{4} = 1500$ rpm

Step 2 – form the speed difference: $N_s - N = 1500 - 1425 = 75$ rpm

Step 3 – divide by the synchronous speed: $s = \dfrac{75}{1500}$

Step 4 – evaluate: $s = 0.05$

Step 5 – convert to percent: $s = 5\%$

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

Answer: (B) Go Back to Q19

Q20.

Solution

Concept – star–delta starter: During starting the stator is connected in star; at run it is switched to delta. This reduces the phase voltage by $\dfrac{1}{\sqrt{3}}$ and hence the line current.

Step 1 – compare phase voltages: In star the phase voltage is $\dfrac{V_L}{\sqrt{3}}$; in delta it is V_L.

Step 2 – relate the currents: Starting current is proportional to phase voltage, so the star starting current per phase falls by $\dfrac{1}{\sqrt{3}}$.

Step 3 – account for the line-current relation: The line current in star equals the phase current, whereas the equivalent delta line current is $\sqrt{3}$ times its phase current; combining gives a net reduction factor of $\frac{1}{\sqrt{3}} \times \frac{1}{\sqrt{3}} = \frac{1}{3}$.

Step 4 – conclude: The DOL starting line current is reduced to $\frac{1}{3}$ of its value.

Final Answer: $\frac{1}{3}$ of the DOL value $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q20

Q21.

Solution

Concept – power split in an induction motor: The air-gap power divides as rotor copper loss $P_{cu} = s\,P_{ag}$ and mechanical power $P_{mech} = (1-s)P_{ag}$.

Step 1 – list the data: $P_{ag} = 10$ kW, $s = 0.04$.

Step 2 – apply the copper-loss relation: $P_{cu} = s \times P_{ag}$

Step 3 – substitute: $P_{cu} = 0.04 \times 10$

Step 4 – evaluate: $P_{cu} = 0.4$ kW

Step 5 – cross-check: $P_{mech} = (1-0.04) \times 10 = 9.6$ kW, and $9.6 + 0.4 = 10$ kW $= P_{ag}$, so the split is consistent.

Why the other options are wrong:

- B, 9.6 kW: that is the mechanical power, not the copper loss.
- C, 10 kW: that is the whole air-gap power.

Final Answer: $P_{cu} = 0.4$ kW $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q21

Q22.

Solution

Concept – e.m.f. equation of a transformer: The r.m.s. induced e.m.f. in a winding is $E = 4.44\,fN\Phi_m$.

Step 1 – list the data: $f = 50$ Hz, $N = 100$, $\Phi_m = 0.02$ Wb.

Step 2 – multiply $4.44 \times f$: $4.44 \times 50 = 222$

Step 3 – multiply by the number of turns: $222 \times 100 = 22200$

Step 4 – multiply by the peak flux: $E = 22200 \times 0.02$

Step 5 – evaluate: $E = 444$ V

Final Answer: $E = 444 \text{ V} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q22

Q23.

Solution

Concept – rotor (slip) frequency: The frequency of the currents induced in the rotor is $f_r = s\,f$, where f is the supply frequency.

Step 1 – list the data: $s = 0.03$, $f = 50$ Hz.

Step 2 – apply the slip-frequency relation: $f_r = s \times f$

Step 3 – substitute: $f_r = 0.03 \times 50$

Step 4 – evaluate: $f_r = 1.5$ Hz

Step 5 – interpret: At starting ($s = 1$) the rotor frequency equals the supply frequency (50 Hz); as the motor speeds up the rotor frequency falls, here to 1.5 Hz.

Final Answer: $f_r = 1.5 \text{ Hz} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q23

Q24.

Solution

Concept – sag of an overhead line (level supports): For a small sag the mid-span sag is $S = \dfrac{wL^2}{8T}$.

Step 1 – list the data: $w = 2$ N/m, $L = 100$ m, $T = 1000$ N.

Step 2 – square the span: $L^2 = 100^2 = 10000 \text{ m}^2$

Step 3 – form the numerator wL^2: $wL^2 = 2 \times 10000 = 20000$

Step 4 – form the denominator $8T$: $8T = 8 \times 1000 = 8000$

Step 5 – divide: $S = \dfrac{20000}{8000}$

$S = 2.5$ m

Final Answer: $S = 2.5 \text{ m} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q24

Q25.

Solution

Concept – string efficiency of a suspension insulator: $\eta = \dfrac{V_{string}}{n\,V_{max}} \times 100\%$, where V_{max} is the voltage across the most stressed (line-end) disc and n is the number of discs.

Step 1 – list the data: $V_{string} = 30$ kV, $V_{max} = 10$ kV, $n = 4$.

Step 2 – form the denominator $n\,V_{max}$: $n\,V_{max} = 4 \times 10 = 40$ kV

Step 3 – form the ratio: $\dfrac{V_{string}}{n\,V_{max}} = \dfrac{30}{40}$

Step 4 – convert to percent: $\eta = 0.75 \times 100\%$

$\eta = 75\%$

Step 5 – interpret: An ideal (perfectly equalised) string would have $\eta = 100\%$; the uneven voltage distribution here drops it to 75%.

Final Answer: $\eta = 75\% \Rightarrow \boxed{\text{D}}$

$\boxed{\textbf{Answer: (D)}}$ **Go Back to Q25**

Q26.

Solution

Concept – corona loss and conductor design: Corona begins when the surface voltage gradient exceeds the breakdown gradient of air. A larger conductor radius lowers the surface gradient for a given voltage.

Step 1 – recall the disruptive-gradient dependence: The surface field of a conductor of radius r varies roughly as $\dfrac{V}{r\ln(d/r)}$; increasing r reduces it.

Step 2 – link to corona onset: A lower surface gradient raises the critical disruptive voltage, delaying corona.

Step 3 – apply the practical measure: Large-diameter conductors, hollow conductors, or bundled sub-conductors are used to present a bigger effective radius.

Step 4 – conclude: The most effective conductor-design measure is a larger-diameter or bundled conductor.

Why the other options are wrong:

- A: a smaller diameter raises the gradient and worsens corona.
- C: higher frequency increases corona loss.
- D: closer spacing raises the gradient and increases corona.

Final Answer: larger-diameter/bundled conductor $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q26

Q27.

Solution

Concept – base impedance in per-unit analysis: $Z_{base} = \dfrac{(\text{kV}_{base})^2}{\text{MVA}_{base}}$, valid for a three-phase system with line-to-line kV and three-phase MVA.

Step 1 – list the data: $\text{kV}_{base} = 22$, $\text{MVA}_{base} = 100$.

Step 2 – square the base voltage: $(22)^2 = 484$

Step 3 – divide by the base MVA: $Z_{base} = \dfrac{484}{100}$

Step 4 – evaluate: $Z_{base} = 4.84\ \Omega$

Final Answer: $Z_{base} = 4.84\ \Omega \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q27

Q28.

Solution

Concept – symmetrical three-phase fault level: The fault MVA at a bus fed through a per-unit reactance is $\text{MVA}_{fault} = \dfrac{\text{MVA}_{base}}{X_{pu}}$.

Step 1 – list the data: $\text{MVA}_{base} = 100$, $X_{pu} = 0.25$.

Step 2 – substitute into the fault-level formula: $\text{MVA}_{fault} = \dfrac{100}{0.25}$

Step 3 – evaluate: $\text{MVA}_{fault} = 400$ MVA

Step 4 – consistency note: The fault current in per-unit is $I_f = \dfrac{1.0}{0.25} = 4$ pu, and $4 \times 100 = 400$ MVA, confirming the result.

Final Answer: $\text{MVA}_{fault} = 400\text{ MVA} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q28

Q29.

Solution

Concept – base current of a three-phase system: $I_{base} = \dfrac{\text{MVA}_{base}}{\sqrt{3}\,\text{kV}_{base}}$, with MVA and kV in their base units.

Step 1 – list the data: $\text{MVA}_{base} = 100$, $\text{kV}_{base} = 220$.

Step 2 – form the denominator $\sqrt{3}\,\text{kV}_{base}$: $\sqrt{3} \times 220 = 1.732 \times 220 = 381.05$

Step 3 – write the current in amperes: $I_{base} = \dfrac{100 \times 10^6}{381.05 \times 10^3}$

Step 4 – combine the powers of ten: $I_{base} = \dfrac{100}{381.05} \times 10^3$

Step 5 – evaluate: $I_{base} = 0.2624 \times 10^3 \approx 262$ A

Final Answer: $I_{base} \approx 262$ A $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q29

Q30.

Solution

Concept – maximum power transfer on a lossless line: The steady-state power transfer is $P = \dfrac{V_1V_2}{X}\sin\delta$, which is maximum at $\delta = 90^\circ$, giving $P_{max} = \dfrac{V_1V_2}{X}$.

Step 1 – list the data: $V_1 = V_2 = 1.0$ pu, $X = 0.4$ pu.

Step 2 – form the numerator V_1V_2: $V_1V_2 = 1.0 \times 1.0 = 1.0$

Step 3 – divide by the reactance: $P_{max} = \dfrac{1.0}{0.4}$

Step 4 – evaluate: $P_{max} = 2.5$ pu

Final Answer: $P_{max} = 2.5$ pu $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q30

Q31.

Solution

Concept – damping ratio of a second-order system: Compare the characteristic equation with the standard form $s^2 + 2\zeta\omega_n s + \omega_n^2 = 0$.

Step 1 – match the constant term: $\omega_n^2 = 16$

$\omega_n = 4$ rad/s

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

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

Step 4 – evaluate: $\zeta = \dfrac{2}{8} = 0.25$

Step 5 – interpret: Since $0 < \zeta < 1$ the system is underdamped, consistent with a pair of complex poles.

Final Answer: $\zeta = 0.25 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q31

Q32.

Solution

Concept – phase margin: The phase margin is $\text{PM} = 180° + \angle G(j\omega_{gc})$, measured at the gain-crossover frequency where $|G| = 1$.

Step 1 – list the data: $\angle G(j\omega_{gc}) = -135°$.

Step 2 – substitute into the phase-margin definition: $\text{PM} = 180° + (-135°)$

Step 3 – evaluate: $\text{PM} = 45°$

Step 4 – interpret: A positive phase margin means the closed loop is stable; $45°$ is a healthy, well-damped margin.

Why the other options are wrong:

- A, $135°$: uses the phase magnitude directly instead of $180°$ minus it.
- D, $0°$: would require $\angle G = -180°$ at gain crossover (marginal stability).

Final Answer: $\text{PM} = 45° \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q32

Q33.

Solution

Concept – gain margin in decibels: The gain margin is $\text{GM} = -20\log_{10}|G(j\omega_{pc})|$, evaluated at the phase-crossover frequency where $\angle G = -180°$.

Step 1 – list the data: $|G(j\omega_{pc})| = 0.5$.

Step 2 – take the logarithm: $\log_{10}(0.5) = -0.301$

Step 3 – multiply by -20: $\text{GM} = -20 \times (-0.301)$

Step 4 – evaluate: $\text{GM} = 6.02 \approx 6$ dB

Step 5 – interpret: The gain can be raised by about 6 dB (a factor of 2) before $|G| = 1$ at the phase-crossover, so the system is stable.

Why the other options are wrong:

- A, 0.5: that is the raw magnitude, not the dB gain margin.
- B, -6 dB: wrong sign; a magnitude below one gives a *positive* gain margin.

Final Answer: GM ≈ 6 dB $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q33

Q34.

Solution

Concept – corner frequency of a first-order Bode plot: For $G(s) = \dfrac{1}{1 + s\tau}$ the break (corner) frequency is $\omega_c = \dfrac{1}{\tau}$.

Step 1 – list the data: $\tau = 0.02$ s.

Step 2 – take the reciprocal: $\omega_c = \dfrac{1}{0.02}$

Step 3 – evaluate: $\omega_c = 50$ rad/s

Step 4 – interpret: Below 50 rad/s the magnitude is flat at 0 dB; above it the plot falls at -20 dB/decade, and the phase is $-45°$ exactly at the corner.

Final Answer: $\omega_c = 50$ rad/s $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q34

Q35.

Solution

Concept – d.c. gain of a closed-loop system: The closed-loop transfer function is $T(s) = \dfrac{G(s)}{1 + G(s)}$; its d.c. gain is $T(0)$.

Step 1 – evaluate the forward path at $s = 0$: $G(0) = \dfrac{8}{0 + 4} = \dfrac{8}{4} = 2$

Step 2 – form the numerator of $T(0)$: numerator $= G(0) = 2$

Step 3 – form the denominator of $T(0)$: denominator $= 1 + G(0) = 1 + 2 = 3$

Step 4 – divide: $T(0) = \dfrac{2}{3}$

Step 5 – evaluate: $T(0) = 0.667$

Why the other options are wrong:

- A, 2: that is the open-loop d.c. gain $G(0)$, not the closed-loop value.
- B, 1: only holds when $G(0) \to \infty$ (a type-1 or higher loop).

Final Answer: $T(0) = 0.667 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q35

Q36.

Solution

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

Step 1 – list the data: $R_1 = 10\ \text{k}\Omega$, $R_f = 20\ \text{k}\Omega$.

Step 2 – form the resistor ratio: $\dfrac{R_f}{R_1} = \dfrac{20}{10} = 2$

Step 3 – add one: $A_v = 1 + 2$

Step 4 – evaluate: $A_v = 3$

Step 5 – note the sign: A non-inverting amplifier gives a positive gain, and its minimum possible gain is 1 (when $R_f = 0$).

Why the other options are wrong:

- B, 2: that is R_f/R_1, forgetting the "+1" of the non-inverting configuration.
- C, 0.5: that is R_1/R_f, an inverted ratio.

Final Answer: $A_v = 3 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q36

Q37.

Solution

Concept – serial-in serial-out (SISO) shift register: In an n-bit SISO register each clock pulse shifts the stored word by one stage; the first bit entered reaches the output after n pulses.

Step 1 – identify the register length: $n = 4$ stages.

Step 2 – track the first bit: After 1 pulse it is in stage 1, after 2 in stage 2, and so on.

Step 3 – count the pulses to the output: The first bit reaches the final (output) stage after $n = 4$ clock pulses.

Step 4 – conclude: 4 clock pulses are required.

Why the other options are wrong:

- B, 1: only shifts the word by one stage, not fully through.
- C, 8: that is $2n$, twice the needed count.

Final Answer: 4 clock pulses $\Rightarrow$ $\boxed{\text{A}}$

$\boxed{\textbf{Answer: (A)}}$ **Go Back to Q37**

Q38.

Solution

Concept – maximum count of a digital voltmeter display: A $3\frac{1}{2}$-digit display has three full decimal digits (each 0–9) plus a leading half-digit that shows only 0 or 1.

Step 1 – find the maximum of the three full digits: Three full digits read up to 999.

Step 2 – add the half-digit contribution: The leading half-digit can add 1000 at most.

Step 3 – combine: Maximum count $= 1000 + 999$

Step 4 – evaluate: Maximum count $= 1999$

Step 5 – interpret: This is why a $3\frac{1}{2}$-digit meter on a "2 V" range reads up to 1.999 V.

Why the other options are wrong:

- A, 999: ignores the half-digit.
- D, 3999: that is a $3\frac{3}{4}$-digit display, not $3\frac{1}{2}$.

Final Answer: $1999 \Rightarrow$ $\boxed{\text{C}}$

$\boxed{\textbf{Answer: (C)}}$ **Go Back to Q38**

Q39.

Solution

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

Step 1 – write the bits with their weights: $(11011)_2$: bits are $1, 1, 0, 1, 1$ for weights $2^4, 2^3, 2^2, 2^1, 2^0$.

Step 2 – evaluate the nonzero weights: $2^4 = 16$, $2^3 = 8$, $2^1 = 2$, $2^0 = 1$ (the 2^2 bit is 0).

Step 3 – add the contributions: $16 + 8 + 2 + 1$

Step 4 – evaluate: $= 27$

Final Answer: $(11011)_2 = 27 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q39

Q40.

Solution

Concept – Boolean simplification (distributive law): Use $(X + Y)(X + Z) = X + YZ$.

Step 1 – apply the distributive identity with $X = A$, $Y = B$, $Z = \bar{B}$: $Y = (A + B)(A + \bar{B}) = A + B\bar{B}$

Step 2 – use the complement law: $B\bar{B} = 0$

Step 3 – substitute: $Y = A + 0$

Step 4 – use the identity law: $Y = A$

Why the other options are wrong:

- A, B: ignores that $B\bar{B}$ collapses to 0.
- B, $A + B$ and D, AB: do not follow from the complement law once $B\bar{B} = 0$.

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

Answer: (C) Go Back to Q40

Q41.

Solution

Concept – form factor of a sinusoid: The form factor is $k_f = \dfrac{V_{rms}}{V_{avg}}$, using the full-wave average.

Step 1 – write the rms value of a sine of peak V_m: $V_{rms} = \dfrac{V_m}{\sqrt{2}} = 0.707\,V_m$

Step 2 – write the full-wave average value: $V_{avg} = \dfrac{2V_m}{\pi} = 0.637\,V_m$

Step 3 – form the ratio: $k_f = \dfrac{0.707\,V_m}{0.637\,V_m}$

Step 4 – cancel V_m and divide: $k_f = \dfrac{0.707}{0.637}$

Step 5 – evaluate: $k_f = 1.11$

Why the other options are wrong:

- B, 1.414: that is the peak factor V_m/V_{rms} for a sine.
- C, 0.707: that is V_{rms}/V_m, not the form factor.

Final Answer: $k_f = 1.11 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q41

Q42.

Solution

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

Step 1 – list the data: $V_s = 100$ V, $D = 0.6$.

Step 2 – substitute into the buck relation: $V_o = 0.6 \times 100$

Step 3 – evaluate: $V_o = 60$ V

Step 4 – sanity check: A buck (step-down) chopper always gives $V_o \leq V_s$, and $60 < 100$, so the result is consistent.

Why the other options are wrong:

- B, 40 V: uses $(1-D)V_s$ instead of DV_s.
- C, 166.7 V: uses the boost relation $V_s/(1-D)$, which exceeds the supply.

Final Answer: $V_o = 60\text{ V} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q42

Q43.

Solution

Concept – average output of a step-up (boost) chopper: For an ideal boost chopper $V_o = \dfrac{V_s}{1-D}$.

Step 1 – list the data: $V_s = 50$ V, $D = 0.5$.

Step 2 – form the denominator: $1 - D = 1 - 0.5 = 0.5$

Step 3 – substitute: $V_o = \dfrac{50}{0.5}$

Step 4 – evaluate: $V_o = 100$ V

Step 5 – sanity check: A boost chopper always gives $V_o \geq V_s$, and $100 > 50$, confirming step-up action.

Why the other options are wrong:

- D, 50 V: ignores the boost factor $1/(1-D)$.
- B, 25 V: uses DV_s, the buck relation.

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

Answer: (A) **Go Back to Q43**

Q44.

Solution

Concept – multiquadrant chopper (Class E): Chopper classes are defined by the polarity combinations of output voltage and current they allow.

Step 1 – recall the class definitions: Class A (type A): one quadrant; Class C: two quadrants; Class E: full four-quadrant.

Step 2 – identify the Class E capability: A Class E chopper permits both output-voltage polarities and both output-current polarities.

Step 3 – map to motor operation: This allows forward motoring, forward braking, reverse motoring and reverse braking.

Step 4 – conclude: The machine can be controlled in all 4 quadrants of the torque–speed plane.

Why the other options are wrong:

- A, 1: that is a Class A (type-A) chopper.
- C, 2: that is a Class C (two-quadrant) chopper.

Final Answer: 4 quadrants $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q44

Q45.

Solution

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

Step 1 – list the data: $V_o = 180$ V, $V_s = 300$ V.

Step 2 – form the ratio: $D = \dfrac{180}{300}$

Step 3 – evaluate: $D = 0.6$

Step 4 – sanity check: A valid duty ratio lies between 0 and 1, and 0.6 does, so the result is physically consistent.

Why the other options are wrong:

- A, 0.4: that is $1 - D$, the off-time fraction.
- C, 0.5: corresponds to $V_o = 150$ V, not 180 V.

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

Answer: (D) Go Back to Q45

Q46.

Solution

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

Step 1 – list the data: $V_m = 200$ V, $\alpha = 60°$, $\pi = 3.1416$.

Step 2 – evaluate the uncontrolled part: $\dfrac{2V_m}{\pi} = \dfrac{2 \times 200}{3.1416} = \dfrac{400}{3.1416} = 127.32$ V

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

Step 4 – multiply: $V_{dc} = 127.32 \times 0.5$

Step 5 – evaluate: $V_{dc} = 63.66$ V

Why the other options are wrong:

- A, 127.3 V: forgets the $\cos\alpha$ factor (the $\alpha = 0$ value).
- D, 0 V: would need $\alpha = 90°$, where $\cos\alpha = 0$.

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

Answer: (B) Go Back to Q46

Answer Key

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