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ESE 2026
Prelims Solutions

Electrical Engineering

SET-B

Exam held on 08-02-2026

Detailed Solutions of
ESE 2026 Preliminary Exam | Set-B

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Electrical Engineering

Exam Date
08-02-2026

ELECTRICAL ENGINEERING
Paper Analysis of ESE 2026 Preliminary Examination

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UPSC ESE Prelims 2026

ELECTRICAL ENGINEERING Solutions
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Q.1 Consider the following statements with respect to the change in torque angle whenever a disturbance occurs:
1. There is no change in torque angle when the speed of the rotor is the synchronous speed.
2. The angle decreases in case of a motor, if $P_S > P_e$, i.e., the mechanical output is more than the electrical input and the speed goes down.
3. The angle increases, if the speed is more than the synchronous speed.
Which of the above statements is/are correct?
(a) 2 and 3
(b) 3 only
(c) 1 only
(d) 1 and 3

Ans. **(c)**

End of Solution

Q.2 Which one of the following is **not** a feature of ideal control system for an HVDC converter?
(a) Control should be such that it should require less reactive power.
(b) The DC current is constant, i.e., ripple-free.
(c) Under steady-state conditions, the valve must be fired symmetrically.
(d) There should have continuous operating range from full rectification to full inversion.

Ans. **(c)**
Valve must be fired symmetrically is not practical hence not correct.

End of Solution

Q.3 Consider the following statements regarding Static Synchronous Compensator (STATCOM):
1. It is insensitive to transmission system harmonics.
2. It has difficulty in operating with a very weak AC system.
3. It can be used for small amount of energy storage.
Which of the above statements is/are correct?
(a) 2 and 3
(b) 3 only
(c) 1 only
(d) 1 and 3

Ans. **(d)**
1. STATCOM is insensitive to harmonics.
2. Due to presence of capacitor small energy storage is possible.
3. Preferred to use all strong and weak systems. Statement (2) is wrong.
Hence, 1, 3 are correct → option (d).

End of Solution

Q.4 A diode circuit consists of a diode in series with switch (S_1), resistance ($R = 44\ \Omega$) and capacitance ($C = 0.1\ \mu F$). The capacitor has an initial voltage $V_{C0} = V_C(t = 0) = 220$ V. If switch S_1 is closed at $t = 0$, what is the energy dissipated in the resistor R?
(a) 3.86 mJ
(b) 5 mJ
(c) 139·64 mJ
(d) 2.42 mJ

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Ans. (d)

$$\frac{1}{2}CV_{CO}^2 = I^2 Rt \quad \text{(energy balance)}$$

$$\therefore \quad \frac{1}{2}CV_{CO}^2 = \frac{1}{2} \times (0.1 \times 10^{-6})(220)^2 = 2.42 \, \text{mJ}$$

End of Solution

Q.5 Which of the following is not a limitation of MOSFET?
(a) High on-state drop, as high as 10 V.
(b) Unipolar voltage device.
(c) Slower switching speed.
(d) Lower off-state voltage capability.

Ans. (b)

MOSFET is unipolar device.

∴ Conduction is only due to majority carriers only which leads to fast switching frequency.

∴ This is an Advantage (Not a limitation).

End of Solution

Q.6 Two BJTs are connected in parallel to share the total current 25 A. The collector-to-emitter voltage of T_1 and T_2 are 1.5 V and 1.75 V respectively. What is the difference in emitter current sharing by the two transistors, when the current-sharing series resistances are $R_{E1} = 0.25 \, \Omega$ and $R_{E2} = 0.35 \, \Omega$?
(a) 0.5 A   (b) 5 A
(c) 0.25 A   (d) 2.5 A

Ans. (b)

$$I_1 + I_2 = 25$$

$$1.5 + I_1 \times R_{E_1} = 1.75 + I_2 \times R_{E_2}$$

$$I_1 R_{E_1} - (25 - I_1) R_{E_2} = 0.25$$

$$I_1 \times 0.25\ \Omega - 25 \times 0.35 + I_1 \times 0.35\ \Omega = 0.25$$

$$I_1 \times 0.6 - 8.75 = 0.25$$

$$I_1 \times 0.6 = 0.25 + 8.75$$

$$I_1 = \frac{9}{0.6} = 15\ A$$

$$I_1 = 10\ A$$

Difference $I_1 - I_2 = 15\ A - 10\ A = 5\ A$

Alternate Solution:

$$1.5 + (I_1 \times 0.25) = 1.75 + (I_2 \times 0.35)$$

$$0.25 I_1 - 0.35 I_2 = 0.25$$

$$5 I_1 - 7 I_2 = 5 \qquad\qquad ...(1)$$

$$I_1 + I_2 = 25 \qquad\qquad ...(2)$$

$$I_1 = 15\ A,\ I_2 = 10\ A$$

$$\therefore \qquad \Delta I = I_1 - I_2 = 5\ A$$

End of Solution

Q.7 The typical upper ratings of power transistor (MOSFET) are
(a) 600 V/40 A (b) 800 V/40 A
(c) 1000 V/50 A (d) 1200 V/50 A

Ans. **(a)**

Typical upper ratings for a standard power MOSFET in power electronics are around 600 V/40 A.

End of Solution

Q.8 The firing frequency of relaxation oscillator is varied by changing the value of charging resistance R. What are the maximum and minimum values of R? (Assume $\eta = 0.65$, $I_P = 0.65$ mA, $V_P = 12$ V, $I_v = 2.0$ mA, $V_v = 1.5$ V, $V_{BB} = 20$ V and $C = 0.047$ µF.

(a) $R_{min} = 9.25$ kΩ and $R_{max} = 12.3076$ kΩ
(b) $R_{min} = 835$ kΩ and $R_{max} = 4.5$ kΩ
(c) $R_{min} = 425$ kΩ and $R_{max} = 18.2469$ kΩ
(d) $R_{min} = 11.86$ kΩ and $R_{max} = 19.2751$ kΩ

Ans. (a)
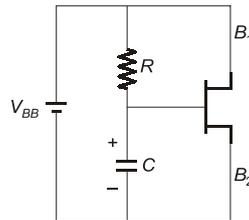
When UJT → OFF, capacitor charges till peak point voltage.

∴ $\qquad V_{BB} \geq I_P R + V_P$

∴ $\qquad R \leq \dfrac{V_{BB} - V_P}{I_P}$

∴ $\qquad R_{max} = \dfrac{V_{BB} - V_P}{I_P} = \dfrac{20 - 12}{0.65 \times 10^{-3}} = 12.3$ kΩ

When UJT → ON, capacitor discharges till valley voltage.

∴ $\qquad V_{BB} \leq I_V R + V_V$

∴ $\qquad R \geq \dfrac{V_{BB} - V_V}{I_V}$

∴ $\qquad R_{min} = \dfrac{V_{BB} - V_V}{I_V} = \dfrac{20 - 1.5}{2 \times 10^{-3}} = 9.25$ kΩ

Q.9 The capacitance (C_{J2}) value of reverse-biased junction $J2$ of a thyristor is independent of off-state voltage. The limit value of the charging current to turn the thyristor is about 15 mA. If the critical value of dv/dt is 750 V/µs, what is the value of the junction capacitance (C_{J2})?

(a) 200 pF
(b) 200 µF
(c) 50 pF
(d) 50 µF

Ans. (c)

$$I_C = C \cdot \dfrac{dv}{dt}$$

$$C = \dfrac{I_C}{dv/dt} = \dfrac{15.10^{-3}}{750 \text{ V/µs}} = 20 \text{ pF}$$

$C = 50$ pF (nearest)

Q.10 A single-phase, half-wave controlled rectifier with R load is supplied from a 230 V, 50 Hz AC source. When the average DC output voltage is 50% of maximum possible average DC output voltage, what are the firing angle of thyristor and average DC output voltage respectively?

(a) 45° and 37.32 V 　　　　　 (b) 90° and 36.61 V

(c) 90° and 51.78 V 　　　　　 (d) 45° and 26.39 V

Ans. (c)

$$V_0 = \frac{V_m}{2\pi}(1+\cos\alpha) \text{ and } (V_0)_{max} = \frac{V_m}{\pi}$$

Given: 　　　　　 $V_0 = 50\% \text{ of } (V_0)_{max}$

$$V_0 = \frac{V_m}{2\pi} = \frac{V_m}{2\pi}(1+\cos\alpha)$$

∴ 　　　　　 $\alpha = 90°$

$$V_0 = \frac{V_m}{2\pi} = \frac{230\sqrt{2}}{2\pi} = 51.77 \text{ V}$$

End of Solution

Q.11 A single-phase semi-converter is supplied by 200 V, 50 Hz and it is connected with an R-L-E load, where $R = 15\ \Omega$, $E = 80$ V and L is very large such that the load current is ripple-free. What is the average output current at $\alpha = 90°$?

(a) 5.58 A 　　　　　 (b) 3.95 A

(c) 0.66 A 　　　　　 (d) 0.24 A

Ans. (c)

1-ϕ semi converter fed RLE load

$$V_0 = \frac{V_m}{\pi}(1+\cos\alpha) = E + IR$$

$$\frac{200\sqrt{2}}{\pi}(1+\cos 90) = 80 + I \times 15$$
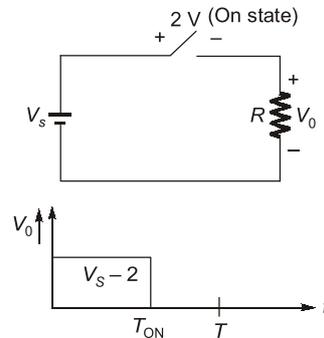
$$90.03 \text{ V} = 80 + I \times 15$$

$$I = \frac{90.03 - 80}{15} = 0.668 \text{ A}$$

End of Solution

Q.12 A step-down chopper has a load resistance of 20 Ω and input DC voltage is 200 V. When the chopper switch is ON, the voltage across load switches to 2 V. If the chopping frequency is 1.5 kHz and duty ratio is 40%, what is the average DC output voltage?

(a) 40 V 　　　　　 (b) 80 V

(c) 39.6 V 　　　　　 (d) 174.4 V

Ans. **(b)**

$$V_0 = (V_S - 2)\frac{T_{ON}}{T} = (200 - 2) \times 0.4 = 79.2 \text{ V}$$

$$V_0 \simeq 80 \text{ V}$$

End of Solution

Q.13 What is the expression for distortion factor (DF) in inverters?

(a) $DF = \dfrac{\left[\sum_{n=2,3,4,5,\ldots}^{\infty}\left(\dfrac{V_n}{n^2}\right)^2\right]^{1/2}}{V_1}$

(b) $DF = \dfrac{\left[\sum_{n=2,3,4,5,\ldots}^{\infty}\left(\dfrac{V_n}{n^2}\right)\right]^{1/2}}{V_1}$

(c) $DF = \dfrac{\left[\sum_{n=2,3,4,5,\ldots}^{\infty}\left(\dfrac{V_n}{n}\right)^2\right]^{1/2}}{V_1}$

(d) $DF = \dfrac{\left[\sum_{n=2,3,4,5,\ldots}^{\infty}\left(\dfrac{V_n}{n}\right)\right]^{1/2}}{V_1}$

Ans. **(c)**

$$\text{Distortion factor} = \sqrt{\frac{\sum_{n=2,3,4,\ldots}^{\infty}\left(\dfrac{V_n}{n}\right)^2}{V_1}}$$

End of Solution

Q.14 A separately excited DC motor is controlled by a single-phase full converter which is supplied from 440 V, 50 Hz AC supply. If the field circuit is fed through a single-phase half converter with 0° firing angle, the delay angle of armature converter is 30° and load current is 20 A, what is the field current? Assume that the armature resistance $R_a = 0.5\ \Omega$, the field resistance $R_f = 140\ \Omega$, and the current waveform is ripple-free.

(a) 2.83 A
(b) 20 A
(c) 20.19
(d) 0.79 A

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Ans. (a)

$$V_F = \frac{2V_M}{\pi} \cdot \cos\alpha_F$$

$$V_F = \frac{2V_M}{\pi} = \frac{2.440\sqrt{2}}{\pi} = 396.139 \text{ V}$$

$$I_F = \frac{V_F}{R_F} = \frac{396.139}{140} = 2.829$$

$$I_F = 2.83 \text{ A}$$

End of Solution

Q.15 Consider the following statements regarding AC drives:
1. AC drives require simple control algorithms than DC drives.
2. Power converters used in AC drives are relatively simple and less expensive.
3. VSI, CSI, AC voltage controllers, PWM inverters are used in variable speed induction motor drives.

Which of the above statements is/are correct?
(a) 2 and 3   (b) 3 only
(c) 1 only   (d) 1 and 3

Ans. (b)

End of Solution

Q.16 Which one of the following is **not** the remedy for reducing cross-magnetizing effect of the armature reaction?
(a) Introducing saturation in the teeth and pole shoe.
(b) By chamfering the pole shoes which increases the air gap at the pole tips.
(c) By making the field circuit resistance more than the critical value.
(d) Compensating the armature reaction mmf by a compensating winding located in the pole shoes.

Ans. (c)

Making the field resistance higher than the critical value, prevents machine to operate correctly as generator. This is related to voltage buildup condition, not a mitigation of armature reaction.

End of Solution

Q.17 The total iron losses in the armature of a DC machine running at 875 rpm are 1100 W. What is the approximate braking torque due to iron losses?
(a) 8 N-m
(b) 16.42 N-m
(c) 8.85 N-m
(d) 12 N-m

Ans. **(d)**

$$T = \frac{1100}{\frac{2\pi \times 875}{60}} = \frac{1100 \times 60}{2\pi \times 875} = 12 \text{ Nm}$$

Q.18 A 0.5 hp, 6-pole induction motor is excited by a 3-phase, 60 Hz source. If the full-load speed is 1140 rpm, what is the percentage of slip?
(a) 6%
(b) 12%
(c) 5%
(d) 3%

Ans. **(c)**

$$P = 60$$
$$F = 60 \text{ Hz}$$

$$N_S = \frac{120 \times 60}{6} = 1200 \text{ rpm}$$

Given, Speed = 1140 rpm

$$\% \text{ speed} = \frac{N_S - N}{N_S} \times 100 = \frac{1200 - 1140}{1200} \times 100$$

$$= 5\%$$

Q.19 A 50 Hz induction motor wound for pole-amplitude modulation has 20 initial poles and the modulating function has 8 poles. At what two speeds will the motor run?
(a) 300 rpm and 214.286 rpm
(b) 400 rpm and 318.524 rpm
(c) 150 rpm and 414.495 rpm
(d) 450 rpm and 115.359 rpm

Ans. **(a)**

$$P_1 = 20$$
$$P = P_i \pm P_m$$
$$P = 20 \pm 8$$

$$N_s = \frac{120 \times 50}{20} = 300 \text{ rpm}$$

$$P_1 = 12, \quad N_s = \frac{120 \times 50}{12} = 500 \text{ rpm}$$

$$P_2 = 28, \quad N_s = \frac{120 \times 50}{28} = 214.286 \text{ rpm}$$

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Q.20 A 3-phase synchronous generator produces an open-circuit line voltage of 6928 V, when the DC exciting current is 50 A. The AC terminals are then short-circuited and the three line currents are found to be 800 A. What is the synchronous reactance per phase?

(a) 138.5 Ω   (b) 8.6 Ω

(c) 80 Ω   (d) 5 Ω

Ans. **(d)**

$$(X_s)_{ph} = \frac{6928/\sqrt{3}}{800} = \frac{8.66}{\sqrt{3}} = 5\ \Omega/\text{Phase}$$

End of Solution

Q.21 Consider the following advantages of hydrogen cooling of alternators in steam power generation:

1. Less noise due to the lower density of hydrogen
2. Ventilation losses (fan power absorbed) are higher by 10%
3. The heat transfer is more than that of air.

Which of the above advantages is/are correct?

(a) 2 and 3   (b) 2 only

(c) 1 only   (d) 1 and 3

Ans. **(d)**

Large size generation uses hydrogen as cooling medium which has

1. Low density causes has noise.
3. Better heat transfer.

Alternate Solution:

Hydrogen density is $\frac{1}{14}$th of air. So, less windage or friction loss. So results in much quieter operation. Hydrogen thermal conductivity is very high.

End of Solution

Q.22 Match the following lists regarding Surge Impedance loading (SIL) of AC lines:

List-I (Conductor configuration and line voltage)	List-II [(SIL (MW)]
P. Quad Bersimis - 400 kV	1. 647
Q. Twin Moose - 400 kV	2. 605
R. Quad Zebra - 400 kV	3. 691
S. Triple Snowbird - 400 kV	4. 515

Select the correct answer using the code given below.

	P	Q	R	S
(a)	3	4	1	2
(b)	2	1	4	3
(c)	1	4	2	3
(d)	4	3	2	1

Ans. (a)

$$SIL = \frac{V^2}{Z_s}$$

Quad bundle has less resistance compared to triple and twin.

End of Solution

Q.23 If *d* is the distance between the conductors and e is Euler's number, then the maximum critical disruptive voltage occurs when the radius (*r*) of the conductors is:
(a) $d \times e$
(b) $d/(1-e)$
(c) d/e
(d) $d/(1+e)$

Ans. (c)

In corona disruptive voltage,

$$V_c = m_o\, g\, r\, \delta \ln\!\left(\frac{d}{r}\right)$$

For maximum, $\quad V_c \Rightarrow \dfrac{d}{r} = e \;\Rightarrow\; r = \left(\dfrac{d}{e}\right)$

End of Solution

Q.24 Match the following Lists regarding cable conductors:

List-I (Property)		List-II (Value)
P. Specific gravity of copper	1.	15 kg/mm²
Q. Ultimate tensile strength of copper	2.	8.890
R. Specific gravity of aluminium	3.	40 kg/mm²
S. Ultimate tensile strength of aluminium	4.	2.71

Select the correct answer using the code given below.

	P	Q	R	S
(a)	3	4	1	2
(b)	2	3	4	1
(c)	1	3	4	2
(d)	4	1	2	3

Ans. (b)

Copper is much denser and has higher mechanical strength than Aluminium.

P. Specific gravity of copper	2. 8.890
Q. Ultimate tensile strength of copper	3. 40 kg/mm²
R. Specific gravity of aluminium	4. 2.71
S. Ultimate tensile strength of aluminium	1. 15 kg/mm²

End of Solution

Q.25 Match the following Lists regarding percentage distribution of faults in various elements of a power system:

List-I (Element)		List-II (% of total fault)	
P.	Overhead lines	1.	10
Q.	Underground cables	2.	50
R.	Transformers	3.	7
S.	Generators	4.	9

Select the correct answer using the code given below.

	P	Q	R	S
(a)	3	4	1	2
(b)	2	1	4	3
(c)	2	4	1	3
(d)	2	3	4	1

Ans. **(b)**

Overhead lines – 50% highest

Underground cables – 10%

Transformers – 9%

Generators – 7%

End of Solution

Q.26 For a 735 kV line with a fault current of 4 kA, what is the arc resistance? (Assume no resistance in the ground return path)

(a) 4 Ω

(b) 8 Ω

(c) 183.75 Ω

(d) 0.183 Ω

Ans. **(c)**

$$R_{\text{arc}} = \frac{V_{cc}}{I_f} = \frac{735\,\text{kV}}{4\,\text{kA}} = 183.75\,\Omega$$

End of Solution

Q.27 Consider the following statements regarding static relays compared with electromechanical relays:

1. In static relays, frequent operations cause deterioration.
2. In static relays, there is a quick resetting and absence of overshoot.
3. Static relays are sensitive to voltage transients.

Which of the above statements is/are correct?

(a) 2 and 3

(b) 2 only

(c) 1 only

(d) 1 and 3

Ans. **(a)**

2 and 3 are correct.

End of Solution

Q.28 What is the maximum value of restriking voltage across the contacts of the circuit breaker in a 132 kV system?

(a) 107.78 kV (b) 215.56 kV

(c) 93.35 kV (d) 186.64 kV

Ans. **(b)**

Restriking voltage = $1.632 \times 132 = 215.524$ kV

End of Solution

Q.29 Consider the following statements regarding radial distribution system:

1. Distributor far away from the substation is highly loaded.
2. Severe voltage variation to the consumers nearest to the substation is due to load variations.
3. Consumers are dependent on a single feeder and a single distributor, and a fault on either of them causes interruption of supply to all the consumers away from the fault.

Which of the above statements is/are correct?

(a) 2 and 3 (b) 3 only

(c) 1 only (d) 1 and 3

Ans. **(b)**

- In radial distribution system, distributor is most heavily loaded nearest to the feeding point.
- Consumer farthest from substation experience most severe voltage variation due to cumulative voltage drop across entire length of line as load changes.

Only statement 3 is correct.

End of Solution

Q.30 Match the following Lists regarding bus classifications:

List-I (Bus type)	List-II (Quantities to be obtained)
P. Generator bus	1. Real power, reactive power
Q. Load bus	2. Reactive power, phase angle
R. Slack bus	3. Voltage magnitude, phase angle

Select the correct answer using the code given below.

	P	Q	R
(a)	2	3	1
(b)	3	2	1
(c)	2	1	3
(d)	1	3	2

Ans. **(a)**

| Bus	Known	Unknown
Slack	$\lvert V_i \rvert, \delta$	P, Q
Gen Bus	$P, \lvert V \rvert$	Q, δ
Load Bus	P, Q	$\lvert V \rvert, \delta$

Peak to peak input voltage = 2Vm = 0.398 V

Q.31 The signal space should be divided as
(a) periodic only, whereas the system should be either time scaling or shifting.
(b) non-periodic only, whereas the system should be either time shifting.
(c) either periodic or non-periodic, whereas the system should be either time scaling or shifting.
(d) neither periodic nor non-periodic, whereas the system should be time scaling.

Ans. **(c)**

The signal space can either be periodic or non-periodic and the system should be capable of either time scaling or shifting.

Q.32 Consider a non-recursive filter with the impulse response h(n) shown in the figure:
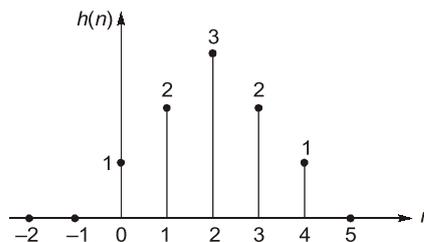
What is the group delay in terms of frequency?
(a) 1   (b) 2
(c) 3   (d) 4

Ans. **(b)**

Let $\quad h_1(n) =$ real and even $\iff H_1(e^{j\omega}) =$ real and even
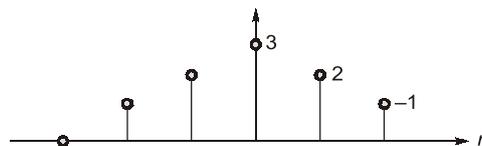
So, $\qquad \angle H_1(e^{j\omega}) = 0°$

Now, $\qquad h(n) = h_1(n - 2)$

$\qquad\qquad H(e^{j\omega}) = H_1(e^{j\omega}) \times e^{-j2\omega}$

So, $\qquad \angle H(e^{j\omega}) \simeq \angle H_1(e^{j\omega}) + (-2\omega)$

$\qquad\qquad\qquad = 0 - 2\omega = -2\omega$

Now, group dealy of system

$$\tau_g = -\frac{d\angle H(e^{j\omega})}{d\omega} = -\frac{d}{d\omega}(-2\omega) = 2$$

Q.33 If $h(t) = \left[-\dfrac{2}{3}e^t + \dfrac{2}{3}e^{-2t}\right]u(-t) + \delta(t)$, then the function is

(a) causal and stable

(b) non-causal and stable

(c) causal and unstable

(d) non-causal and unstable

Ans. (d)

$$h(t) = \left[-\frac{2}{3}e^t + \frac{2}{3}e^{-2t}\right]u(-t) + \delta(t)$$

$$= -\frac{2}{3}e^t u(-t) + \frac{2}{3}e^{-2t}u(-t) + \delta(t)$$

ROC : $(\sigma < 1) \cap (\sigma < -2) \cap$ (Entire S-plane)

: $(\sigma < 2)$

Since, ROC excludes $j\omega$-axis. So, the system is unstable.

System is non-causal because $h(t) \neq 0$, $t < 0$

End of Solution

Q.34 The unit impulse response of an LTI system is $h(t) = e^{-t}\sin 2t\, u(t)$. What is the response to $x(t) = \sin(t)$ by using the Laplace transform?

(a) $y(t) = \sin(2t)$

(b) $y(t) = \dfrac{\sin(2t)}{s+1}$

(c) $y(t) = 0.447\sin(t)$

(d) $y(t) = 0.447\sin(t - 26.6°)$

Ans. (d)

$$h(t) = e^{-t}\sin 2t\, u(t) \rightleftharpoons h(t) = \frac{2}{(s+1)^2 + 4}$$

$$x(t) = \sin(t),\ \omega_0 = 1$$

Now, let us calculate $H(\omega_0)$.

$$H(\omega_0) = \left[\frac{2}{(j\omega + 1)^2 + 4}\right]_{\omega=\omega_0} = \frac{2}{(j\omega_0 + 1)^2 + 4}$$

$$= \frac{2}{(j + 1)^2 + 4} = \frac{2}{-1 + 1 + 2j + 4} = \frac{1}{j+2}$$

$$|H(\omega_0)| = \frac{1}{\sqrt{1+4}} = \frac{1}{\sqrt{5}} = 0.447$$

$$\angle H(\omega_0) = -\tan^{-1}\left(\frac{1}{2}\right) = -26.6°$$

Output $y(t)$ is given by

$$y(t) = |H(\omega_0)|\sin[t + \angle H(\omega_0)]$$

$$= 0.447\sin(t - 26.6°)$$

End of Solution

Q.35 If $x(n) = \{...,0, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0, ...\}$ what is the value of $y(n) = x(2n)$?

(a) $y(n) = x(2n) + x(n)$ (b) $y(n) = u(n) - u(n - 7)$

(c) $y(n) = u(n) - u(n - 4)$ (d) $y(n) = x(n) - x(n - 7)$

Ans. **(c)**

$$x(n) = \{0, 1, 1, 1, 1, 1, 1, 1, 0, 0\}$$

$$y(n) = x(2n) = \{1, 1, 1, 1, 1\} = u(n) - u(n - 4)$$

End of Solution

Q.36 Consider a finite-duration sequence such as $x(n) = \{1, 2, 4, 8, 16\}$. What is the new sequence produced, when it revolves 4 units in the circular shift operation?

(a) $\{4, 8, 16, 1, 2\}$ (b) $\{2, 4, 8, 16, 1\}$

(c) $\{1, 2, 4, 8, 16\}$ (d) $\{16, 1, 2, 4, 8\}$

Ans. **(b, d)**

$$x(n) = \{1, 2, 4, 8, 16\}$$

Circular right-shifting by '4'

$$x(n-4)\big|_{\text{mod}5} = \{2, 4, 8, 16, 1\}$$

Circular left-shifting by '4'

$$x(n+4)\big|_{\text{mod}5} = \{16, 1, 2, 4, 8\}$$

End of Solution

Q.37 What is the linear convolution response $y(5)$ of the given sequence?

$$x(n) = \begin{cases} \dfrac{2}{\sqrt{3}}\sin\left(\dfrac{\pi n}{3}\right), & 0 \le n \le 5 \\ 0 & , \text{ elsewhere} \end{cases} \quad \text{and } h(n) = \{1, 2, 3, 2, 1\}.$$

(a) 0   (b) 9

(c) 14   (d) 28

Ans. **(a)**

$$x(n) = \{0, 1, 1, 0, -1, -1\}$$
$$\uparrow$$
$$h(n) = \{1, 2, 3, 2, 1\}$$
$$\uparrow$$

Tabular method:

$x(n)$ / $h(n)$	0	1	1	0	−1	−1
1	0	1	1	0	−1	−1
2	0	2	2	0	−2	−2
3	0	3	3	0	−3	−3
2	0	2	2	0	−2	−2
1	0	1	1	0	−1	−1

$$y(n) = \{0, \ 1, \ 3, \ 5, \ 4, \ 0, \ -4, \ -5, \ -3, \ -1\}$$
$$\uparrow$$
$$y(n) = 0$$

End of Solution

Q.38 By using the 3-point DFT of the sequence $h(n) = a^{-n}$, $0 \le n \le 2$, for $a = 1.369$, what is the relationship between the output sequence?

(a) $H(0) + H(1) + H(2) = 4$ (b) $H(0) + H(1) = H(2)$

(c) $H(1) = H(2)$ (d) $H(2) = H^*(1)$

Ans. **(d)**

$$h(n) = \{1, a^{-1}, a^{-2}\}, \text{ where } a = 1.369, \ N = 3$$
$$\uparrow$$

∵ $h(n)$ is real signal

∴ $H(k)$ will be conjugate symmetric signal

i.e., $H(k) = H^*(N-K)$

$$\downarrow K = 1, \ N = 3$$

$$H(1) = H^*(2)$$

or $H(2) = H^*(1)$

End of Solution

Q.39 If $X(s) = L\{x(t)\}$, what is the initial value $x(0)$ and the final value $x(\infty)$ respectively, for the given signal $X(s) = \dfrac{7s+6}{s(3s+5)}$, using initial value and final value theorems?

(a) $\dfrac{6}{5}, \dfrac{7}{3}$ (b) $2, \dfrac{7}{3}$

(c) $\dfrac{7}{3}, 2$ (d) $\dfrac{7}{3}, \dfrac{6}{5}$

Ans. **(d)**

Given,

$$X(s) = \frac{7s+6}{s(3s+5)}$$

$$x(0) = \lim_{s\to\infty}\left[s\,X(s)\right] = \lim_{s\to\infty}\frac{7s^2}{3s^2} = \frac{7}{3}$$

$$x(\infty) = \lim_{s\to 0}\left[s\,X(s)\right] = \lim_{s\to 0}\frac{s(7s+6)}{s(3s+5)}$$

$$= \lim_{s\to 0}\frac{7s+6}{3s+5} = \frac{6}{5}$$

End of Solution

Q.40 If $X(s) = L\{x(t)\}$, what is the inverse Laplace transform of the signal $X(s) = \dfrac{2}{s(s+1)(s+2)^2}$?

(a) $x(t) = (0.5 - 2e^{-t} + te^{-2t} + 1.5e^{-2t})u(t)$

(b) $x(t) = (0.5 - 2e^{-t} + te^{-2t} + 2e^{-2t})u(t)$

(c) $x(t) = (0.5 - e^{-t} + te^{-2t} + 2e^{-2t})u(t)$

(d) $x(t) = (1 - e^{-t} + te^{-2t})u(t)$

Ans. **(a)**

$$X(s) = \frac{2}{s(s+1)(s+2)^2}$$

$$= \frac{A}{s} + \frac{B}{s+1} + \frac{C}{s+2} + \frac{D}{(s+2)^2}$$

$$= \frac{1}{2}\cdot\frac{1}{2} - 2\cdot\frac{1}{s+1} + 1.5\cdot\left(\frac{1}{s+1}\right) + \frac{1}{(s+2)^2}$$

$$x(t) = 0.5u(t) - 2e^{-t}\,u(t) + 1.5e^{-2t}\,u(t) + te^{-2t}\,u(t)$$

$$= (0.5 - 2e^{-t} + 1.5e^{-2t} + te^{-2t})\,u(t)$$

End of Solution

Q.41 What is the DC gain (zero frequency) for a system which has a transfer function of $G(s) = (s + 2)/((s + 1)(s + 3)(s + 4))$?

(a) $\dfrac{1}{6}$

(b) $\dfrac{2}{3}$

(c) $\dfrac{1}{3}$

(d) $\dfrac{1}{2}$

Ans. **(a)**

$$\text{DC gain} = \left.G(s)\right|_{s=0} = \left.\frac{s+2}{(s+1)(s+3)(s+4)}\right|_{s=0}$$

$$= \frac{2}{3\times 4} = \frac{1}{6}$$

End of Solution

Q.42 Match the following Lists:

List-I (Input function)　　　　**List-II (Use)**

P. $\delta(t)$　　　　　　　　　　　　**1.** Steady-state error

Q. $u(t)$　　　　　　　　　　　　**2.** Transient response

R. $\sin\omega t$　　　　　　　　　　**3.** Transient response, steady-state error

S. $(1/2)t^2\,u(t)$　　　　　　　　**4.** Transient response modeling, steady-state error

Select the correct answer using the code given below.

	P	Q	R	S
(a)	1	2	3	4
(b)	2	3	4	1
(c)	4	2	3	1
(d)	2	4	3	1

Ans. **(*)**

End of Solution

Q.43 Consider the following steps regarding multiple-node electrical networks:

1. Replace passive elements' values with their admittance.
2. Replace all sources and time variables with their Laplace transform.
3. Replace transformed voltage sources with transformed current sources.

Which of the above steps are correct?

(a) 1 and 2 only　　　　　　　　(b) 1 and 3 only

(c) 2 and 3 only　　　　　　　　(d) 1, 2 and 3

Ans. **(d)**

All three statements are correct.

End of Solution

Q.44 What is the transfer function $T(s)$ from the state-space input matrix $\dot{x} = [A]x + [B]u$ and output matrix $y = [C]x$, where $T(s) = Y(s)/U(s)$, while $U(s)$ is input and $Y(s)$ is output?

$$\dot{x} = \begin{bmatrix} 0 & 1 & 1 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{bmatrix} x + \begin{bmatrix} 10 \\ 0 \\ 0 \end{bmatrix} u\,;\ y = [1\ 0\ 0]x$$

(a) $T(s) = \dfrac{10\left(s^2 + 3s + 2\right)}{s^3 + 3s^2 + 2s + 1}$ 　　　　(b) $T(s) = \dfrac{10\left(s^2 + 3s + 2\right)}{s^3 + 3s^2 + 3s + 1}$

(c) $T(s) = \dfrac{10\left(s^2 + 3s + 2\right)}{s^3 + 6s^2 + 5s + 1}$ 　　　　(d) $T(s) = \dfrac{10\left(s^2 + 3s + 2\right)}{s^3 + 2s^2 + 3s + 1}$

Ans. (b)

$$TF = C(SI - A)^{-1} B$$

$$= \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} s & -1 & -1 \\ 0 & s & -1 \\ 1 & 2 & s+3 \end{bmatrix}^{-1} \begin{bmatrix} 10 \\ 0 \\ 0 \end{bmatrix}$$

$$= \frac{\begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} s^2 + 3s + 2 & s+1 & s+1 \\ -1 & s^2 + 3s + 1 & s \\ -s & -(2s+1) & s^2 \end{bmatrix} \begin{bmatrix} 10 \\ 0 \\ 0 \end{bmatrix}}{s(s^2 + 3s + 2) + 1(0 + 1) - 1(-s)}$$

$$= \frac{\begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} 10(s^2 + 3s + 2) \\ -10 \\ -10s \end{bmatrix}}{s^3 + 3s^2 + 3s + 1} = \frac{10(s^2 + 3s + 2)}{s^3 + 3s^2 + 3s + 1}$$

End of Solution

Q.45 Consider the following statements regarding first-order systems:
1. The time constant of the system can be described as the time for e^{-at} to decay to 63% of initial value or it is the time taken for the step response to rise to 37% of its final value.
2. Rise time is found to be the time for waveform to go from 0.1 to 0.9 of its final value.
3. Settling time is defined as the time for the response to reach and stay within 4% of its final value.

Which of the above statements is/are **not** correct?
(a) 1 only   (b) 2
(c) 3 only   (d) 1 and 3

Ans. (a)

Time constant of the system is time for e^{-at} to decay to 37% of its initial value or it is the time taken for step response to rise to 63% of its final value. So, statement-1 is incorrect.

End of Solution

Q.46 Consider the following characteristics regarding ideal operational amplifier:
1. An infinite output impedance and zero input impedance.
2. The Op-Amp must have an extremely high inherent voltage gain.
3. Zero slew rate.

Which of the above characteristics is/are correct?
(a) 1 and 3   (b) 3 only
(c) 2 only   (d) 1 and 2

Ans. (c)

End of Solution

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Q.47 An inverting amplifier using the 741C must have a flat response up to 40 kHz. The gain of the amplifier is 10. What maximum peak-to-peak input signal can be applied without distorting the output?

(a) 0.398 V
(b) 3.98 V
(c) 30.98 V
(d) 0.0398 V

Ans. **(a)**

Assume SR = 0.5 V/µs

$$\frac{A_{CL}\, V_m\, \omega_o}{10^6} \leq SR$$

$$V_m = \frac{SR \times 10^6}{A_{CL}\, \omega_o} = \frac{0.5 \times 10^6}{10 \times 2\pi \times 40 \times 10^3} = 0.199 \text{ V}$$

Peak to peak input voltage,

$$= 2V_m = 0.398 \text{ V}$$

End of Solution

Q.48 Consider the following statements regarding bistable multivibrator:

1. The bistable multivibrator is used as memory elements in shift registers, counters.
2. It is used to generate sine wave by sending regular triggering pulse to the input.
3. It can also be used as a frequency divider.

Which of the above statements is/are correct?

(a) 1 and 3
(b) 3 only
(c) 2 only
(d) 1 and 2

Ans. **(a)**

Multivibrators are switching circuits, the produce square/rectangular waves, not sine wave.

End of Solution

Q.49 What is the percentage of resolution of the eight-bit DAC?

(a) 0.0244%
(b) 0.392%
(c) 0.568%
(d) 0.0148%

Ans. **(b)**

$$\%\text{resolution} = \frac{1}{2^n - 1} \times 100$$

$$= \frac{1}{2^8 - 1} \times 100 = \frac{100}{255} = 0.392\%$$

End of Solution

Q.50 What is the value of the capacitance to use in a capacitor filter connected to a full-wave rectifier operating at a standard aircraft power frequency of 400 Hz, if the ripple factor is 10% for a load of 500 Ω?

(a) 72.2 µF
(b) 87.6 µF
(c) 25.2 µF
(d) 102.4 µF

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Ans. (∗)

$$\text{r.f.} = \frac{1}{4\sqrt{3}\, f_o\, R_L\, C}$$

$$C = \frac{1}{4\sqrt{3}\, f_o\, R_L\, r \cdot f} = \frac{1}{4\sqrt{3} \times 400 \times 500 \times 0.1}$$

$$C = \frac{1}{138564.06} = 7.22\,\mu\text{F}$$

End of Solution

Q.51 Match the following Lists regarding R-C filter circuit:

List-I (Component)　　　　　List-II (Output voltage (V_{out}))

P. Low-pass filter　　　　1. $\dfrac{1}{RC}\int_0^t V_{in}\,dt$

Q. R-C circuit as integrator　　2. $V_{in}\dfrac{\omega RC}{\sqrt{1+(\omega RC)^2}}$

R. High-pass filter　　　　3. $RC\dfrac{dV_{in}}{dt}$

S. R-C circuit as differentiator　4. $V_{in}\dfrac{1}{\sqrt{1+(\omega RC)^2}}$

Select the correct answer using the code given below.

	P	Q	R	S
(a)	4	3	2	1
(b)	1	3	2	4
(c)	4	1	2	3
(d)	2	1	4	3

Ans. (c)

End of Solution

Q.52 Match the following Lists:

List-I (Name of the flag)　　List-II (Bit position in flag register)
P. Auxiliary carry flag　　　1. D_0
Q. Parity flag　　　　　　2. D_2
R. Zero flag　　　　　　　3. D_4
S. Carry flag　　　　　　　4. D_6

Select the correct answer using the code given below.

	P	Q	R	S
(a)	4	3	2	1
(b)	1	3	2	4
(c)	2	3	4	1
(d)	3	2	4	1

Ans. (d)

End of Solution

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Q.53 Match the following Lists regarding interfacing the 8155 memory section:

List-I (Address lines)		List-II (Function used for)	
P.	A11 to A15	1.	Don't Care
Q.	A0 to A7	2.	Chip Enable
R.	A8 to A10	3.	Register Select

Select the correct answer using the code given below.

	P	Q	R
(a)	2	3	1
(b)	1	3	2
(c)	3	1	2
(d)	3	2	1

Ans. **(b)**

P.	A11 to A15	1.	Don't care
Q.	A0 to A7	3.	Register select
R.	A8 to A10	2.	Chip select

End of Solution

Q.54 The emission current of a diode is 12.5 mA. What is the rms value of shot noise current for a 10 MHz bandwidth?

(a) 18.2 µA (b) 1.3 µA
(c) 0.2 µA (d) 2.7 µA

Ans. **(c)**

RMS shot noise current $i_n = \sqrt{2qI\Delta f}$

q is the electronic charge = 1.6×10^{-19} C
I is the direct current (i.e. emission current)
Δf is the bandwidth in Hz.

$$i_n = \sqrt{2\times(1.6\times10^{-19})\times(12.5\times10^{-3})\times(10^7)}$$

$$= 2 \times 10^{-7} = 0.2 \text{ µA}$$

End of Solution

Q.55 A transmitter supplies 10 kW power to an aerial, when unmodulated. What is the power radiated, when modulated to 30%?

(a) 3 kW (b) 10.45 kW
(c) 14.8 kW (d) 4 kW

Ans. **(b)**

$$P_c = 10 \text{ kW}$$
$$\mu = 0.3$$

$$P_t = P_c\left[1+\frac{\mu^2}{2}\right] = 10\,K\left[1+\frac{0.09}{2}\right] = 10.45\,\text{kW}$$

End of Solution

Q.56 Consider the following statements regarding AM versus FM broadcasting:

1. The process of demodulation is complex in AM broadcasting than that of in FM broadcasting.
2. In FM broadcasting, stereophonic transmission is possible.
3. The AM broadcasting system has poor noise performance.

Which of the above statements is/are correct?

(a) 2 and 3
(b) 3 only
(c) 1 only
(d) 1 and 2

Ans. **(a)**

AM demodulation is simple compared to FM

So, statement 1 is incorrect.

End of Solution

Q.57 The signal voltage and noise voltage of a system are 0.923 mV and 0.267 mV respectively. What is the signal-to-noise ratio (SNR) in number?

(a) 3.45
(b) 10.77
(c) 0.29
(d) 11.95

Ans. **(d)**

Given, V_s = 0.923 mV

V_n = 0.267 mV

$$\text{SNR} = \frac{P_s}{P_n} = \left(\frac{V_s}{V_n}\right)^2 = \left(\frac{0.923 \times 10^{-3}}{0.267 \times 10^{-3}}\right)^2 = 11.95$$

End of Solution

Q.58 Match the following Lists regarding sampling techniques:

List-I (Sampling technique)	List-II (Principle)
P. Natural sampling	1. It uses sample-hold principle
Q. Flat-top sampling	2. It uses multiplication
R. Ideal sampling	3. It uses multiplication or chopping principle

Select the correct answer using the code given below.

	P	Q	R
(a)	2	3	1
(b)	1	3	2
(c)	3	1	2
(d)	3	2	1

Ans. **(c)**

P – 3:

In natural sampling the message signal is multiplied by a pulse train. The top of the resulting samples follows the shape of the analog message during the 'ON' period. This is often implemented using a switching (chopping) circuit.

Q – 1:

Flat top samplig uses sample-hold principle. Flat top sampling involves taking a sample and holding its instantaneous value constant for the duration of the pulse.

R – 2

Ideal (or Impulse) sampling is a theoretical process where message signal is multiplied by a periodic train of impulses.

End of Solution

Q.59 The diode falls under which type of system?
- (a) Stable only
- (b) Unstable only
- (c) Either stable or unstable
- (d) Neither stable nor unstable

Ans. **(a)**

$$i_D = i_o \left[e^{\frac{V_D}{nV_T}} - 1 \right] \rightarrow \text{Stable}$$

End of Solution

Q.60 Which of the following properties of convolution system exhibits/exhibit the result of superposition principle for unit impulse response in linear time-invariant systems?
- (a) Commutativity only
- (b) Distributivity only
- (c) Associativity only
- (d) Both distributivity and associativity

Ans. **(d)**

End of Solution

Q.61 Consider the following statements regarding behavior of second-order underdamped system:
1. The peak time is inversely proportional to the imaginary part of the complex pole.
2. Percent overload is a function of only the damping ratio.
3. Settling time is directly proportional to the real part of the complex pole.

Which of the above statements are correct?
- (a) 1 and 3 only
- (b) 1, 2 and 3
- (c) 1 and 2 only
- (d) 2 and 3 only

Ans. **(c)**

1. $$t_p = \frac{\pi}{\omega_d}$$

and complex pole $= -\alpha \pm j\omega_d = -\xi\omega_n \pm j\omega_d$

So, $$t_p \propto \frac{1}{\text{img(complex pole)}}$$

2. $$\%M_P = e^{-\xi\pi/\sqrt{1-\xi^2}}$$

So, $\%M_P = f(\xi)$

3. $$t_s = \frac{4}{\xi\omega_n}$$

i.e. $\qquad t_s \propto \dfrac{1}{\text{real (complex pole)}}$

So, statement-3 is incorrect.

Q.62 For the closed-loop transfer function given below, what is the system condition based on the number of poles in the left-half plane, the right-half plane and the $j\omega$-axis.

$$T(s) = \frac{200}{s^4 + 6s^3 + 11s^2 + 6s + 200}$$

(a) The system is stable with four poles on the left-half of the plane.

(b) The system is unstable, since it has two right-half plane poles and two left-half plane poles.

(c) The system is marginally stable, since it has two left-half plane poles and two on $j\omega$-axis.

(d) The system is unstable, since it has one right-half plane pole and three left-half plane poles.

Ans. **(b)**

$$\begin{array}{c|ccc}
s^4 & 1 & 11 & 200 \\
s^3 & 6 & 6 & \\
s^2 & 10 & 200 & \\
s^1 & -114 & & \\
s^0 & 200 & &
\end{array}$$

Since there are two sign changes.

So, $\qquad$ LHS pole = 2

and $\qquad$ RHS pole = 2

and system is unstable.

Q.63 Consider the following statements regarding stability for linear, time-invariant systems using natural response:

1. A system is marginally stable, if the natural response neither decays nor grows but remains constant or oscillates.

2. A system is unstable, if the natural response approaches infinity as time approaches zero.

3. A system is unstable, if any bounded input yields an unbounded output.

Which of the above statements is/are **not** correct?

(a) 1 only $\qquad\qquad\qquad\qquad$ (b) 2 only

(c) 3 only $\qquad\qquad\qquad\qquad$ (d) 1, 2 and 3

Ans. **(b)**

Instability is defined by the behavior of the system as $t \to \infty$, not zero. A system is $t \to 0$, value of response is the initial condition of system and for an LTI system it is zero.

Q.64 What are the values of positive constant (K_p), velocity constant (K_v) and acceleration constant (K_a) for a type '0' unity feedback system which has the transfer function $G(s)$

$$= \frac{1000(s+8)}{(s+7)(s+9)} ?$$

(a) $K_P = 0;\ K_v = 0;\ K_a = 127$ (b) $K_P = 0;\ K_v = 0;\ K_a = 0$
(c) $K_P = 0;\ K_v = 127;\ K_a = 127$ (d) $K_P = 127;\ K_v = 0;\ K_a = 0$

Ans. (d)

$$K_P = \lim_{s \to 0} G(s)H(s) = \lim_{s \to 0} \frac{1000(s+8)}{(s+7)(s+9)}$$

$$= \frac{1000 \times 8}{7 \times 9} = 127$$

Since type 0 system,
So, $\qquad K_v = 0, \quad K_a = 0$

End of Solution

Q.65 Consider the following statements regarding properties of a transfer function:
1. The unit of a transfer function is related to the units of the system input and output. A unit is essential.
2. The transfer function can be applied to describe only time-invariant linear systems whose parameters do not change or change only a little during operation.
3. The transfer function is dependent of the input to the system, since the characteristics of the system are modified by the input signal.
Which of the above statements is/are correct?
(a) 1, 2 and 3   (b) 1 and 3 only
(c) 2 and 3 only   (d) 2 only

Ans. (d)

A transfer function doesn't *hv* unit and it does not depend upon input.

End of Solution

Q.66 Consider the following and give the order of the steps to be followed in performing the block diagram reduction to get the final transfer function for that system:
Step 1 : Combine all serial blocks
Step 2 : Close all inner loops
Step 3 : Combine all parallel blocks
Step 4 : Move summing junctions to the left or right of a block and tie points to the left or right
Select the correct sequence for the above steps.
(a) Step 1, Step 2, Step 3, Step 4
(b) Step 1, Step 3, Step 2, Step 4
(c) Step 3, Step 2, Step 1, Step 4
(d) Step 2, Step 3, Step 1, Step 4

Ans. **(b)**

Steps for block diagram reduction:
Step 1 : Combine all serial blocks
Step 2 : Close all inner loops
Step 3 : Combine all parallel blocks
Step 4 : Move summing junctions tie points.

End of Solution

Q.67 Consider the following statements regarding representation of block diagrams through signal flow diagrams:
1. The signal at a node is equal to the sum of all signals transmitted to the node. Sometimes, the transmittance may be positive.
2. The transmittances are simply related to the transfer functions.
3. The transmittances connected to the input/output nodes are both unity, and merely help to make the diagram clearer.

Which of the above statements is/are correct?
(a) 2 and 3   (b) 1 and 3
(c) 1 and 2   (d) 1 only

Ans. **(b)**

Transmittance are not simply transfer function.

End of Solution

Q.68 Consider the following statements regarding Nyquist stability criterion:
1. The Nyquist stability criterion is one of the geometric criterion and graphical method in frequency domain.
2. It uses open-loop Nyquist diagram to judge the stability of the closed-loop system.
3. Instead of solving the characteristic roots of the open-loop system, the Nyquist criterion gets the stability of the closed-loop system by means of an open-loop frequency characteristic diagram.

Which of the above statements are correct?
(a) 1, 2 and 3   (b) 1 and 3 only
(c) 1 and 2 only   (d) 2 and 3 only

Ans. **(a)**

All 3 statements are correct regarding Nyquist stability criteria.

End of Solution

Q.69 A transformer on no load has a core loss of 50 W, draws a current of 2 A (rms) and 230 V (rms). What is the core loss current?
(a) 0.216 A   (b) 1.988 A
(c) 2.328 A   (d) 0.456 A

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Ans. **(a)**

Given data : $I_0 = 2$ A
$W_0 = 50$ W
$V = 230$ V
$W_0 = V I_0 \cos \phi_0$

$\Rightarrow$ $\cos \phi_0 = \dfrac{W_0}{V I_0}$

$\cos \phi_0 = \dfrac{50}{2 \times 230} = 0.108$

Core loss current, $I_C = I_C \cos \phi_0 = 2 \times 0.108$
$= 0.216$

End of Solution

Q.70 A 500 kVA transformer has an efficiency of 95% at full load and also at 60% of full load; both at unity power factor. Separate out the losses of the transformer.
(a) $P_i = 12.42$ kW and $P_c = 18.52$ kW
(b) $P_i = 2.45$ kW and $P_c = 8.35$ kW
(c) $P_i = 8.43$ kW and $P_c = 13.25$ kW
(d) $P_i = 9.87$ kW and $P_c = 16.45$ kW

Ans. **(d)**

Given:

Efficiency of full load UPF is 95%

Efficiency of 60% full load UPF is 95%

$\dfrac{1 \times 500 \times 1}{1 \times 500 \times 1 + P_i + P_{cu}} = 0.95$ ...(i)

$\dfrac{0.6 \times 500 \times 1}{0.6 \times 500 \times 1 + P_i + (0.6)^2 P_{cu}} = 0.95$ ...(ii)

By solving (i) and (ii) we get,
$0.95\ P_i + 0.95\ P_{cu} = 25$
$0.95\ P_i + 0.342\ P_{cu} = 15$

By solving the above equation,
$P_i = 9.868$ kW
$P_{cu} = 16.447$ kW

End of Solution

Q.71 Consider the following statements regarding three-phase transformer connections:
1. Delta/delta is economical for small HV transformers.
2. Star/star suits large LV transformers.
3. Star/delta is the most commonly used connection for power systems.
Which of the above statements is/are correct?

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(a) 2 and 3   (b) 3 only
(c) 1 only   (d) 1 and 2

Ans. **(b)**

1. Delta is economical for LV.
2. Star connection is best suitable for HV.
3. Star/Delta (or) Delta/Star is commonly used connection in power system depending on step-down (or) step-up requirements.

HV side-star and LV side Delta

Delta suppress 3rd harmonics.

End of Solution

Q.72 A 240 V/120 V, 12 kVA transformer has full-load unity power factor efficiency of 96.2%. It is connected as an auto-transformer to feed a load at 360 V. What is the auto-transformer rating?

(a) 36 kVA   (b) 18 kVA
(c) 54 kVA   (d) 34.63 kVA

Ans. **(a)**
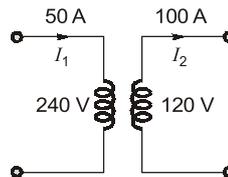
Given :

240/120 V, 12 kVA transformer reconnected as auto transformer to feed a load at 360 V.

In such case, two possibilities are available HV as common LV as common winding (Both additive polarity)

1. HV as common, additive
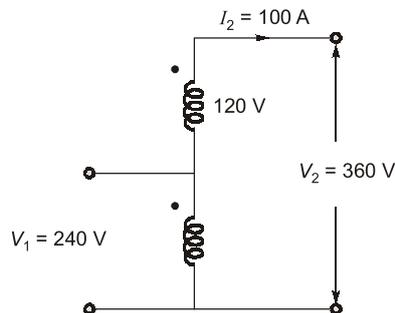
Rating : $V_2 \, I_2$

$360 \times 100 = 36$ kVA

2. LV common, additive
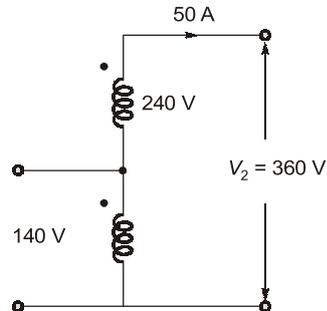
Rating : $V_2 \, I_2$
360 × 50 = 18 kVA

Conclusion:
Answer is provided for both connections. But consider the best possible rating.

Q.73 The magnetic flux density on the surface of an iron face is 1.6 T, which is a typical saturation level value for ferromagnetic material. What is the force density on the iron face?

(a) 1.6×10^6 N/m²   (b) 1.02×10^6 N/m²

(c) 1.02×10^7 N/m²   (d) 1.6×10^7 N/m²

Ans. **(b)**

Given:

$$B = 1.6 \text{ T}$$

Magnetic force, $\quad F = \dfrac{B^2}{2\mu_0}$

$\Rightarrow \qquad\qquad F = \dfrac{(1.6)^2}{2 \times 4\pi \times 10^{-7}}$

$$F = 1.02 \times 10^6 \text{ N/m}^2$$

Q.74 For a 6-pole DC armature with 16 slots having two coil sides per slot and single-turn coils, what is the commutator pitch (y_c) for a wave winding?

(a) 8 segments   (b) 9 segments

(c) 6 segments   (d) 5 segments

Ans. **(c)**

$$Y_c = \dfrac{c \pm 1}{(P/2)} \qquad (\text{Coils, } c = \text{solts} = 16)$$

$$Y_c = \dfrac{16 + 1}{(6/2)} = \dfrac{17}{3} \approx 6$$

$$\therefore \qquad Y_c = \frac{16-1}{3} = 5$$

In general convention we take additive polarity,

So, $\qquad Y_c = 6$

Q.75 Consider the following statements regarding speed control of DC motors:
1. In field control method, speeds higher than the rated speed cannot be obtained.
2. For motors requiring a wide range of speed control, field control method leads to unstable operating conditions or poor commutation.
3. Field control method is not suited to applications needing speed reversal.

Which of the above statements is/are correct?

(a) 2 and 3   (b) 3 only

(c) 1 only   (d) 1 and 2

Ans. **(a)**

In field control method, speeds higher than rated is obtained. So, statement 1 is incorrect.

Q.76 The page fault occurs
(a) when a page currently in a memory is accessed
(b) when a page currently not in a memory is accessed
(c) when an existing page in a memory to replace with a new page is accessed
(d) when a page from any process in the system for replacement is accessed

Ans. **(b)**

CPU referred page is not present in the RAM is called as page fault.

Q.77 Suppose that the failures of two drives are independent; that is, the failure of one is not connected to the failure of the other. Then, if the mean time between failures of a single drive is 100000 hours and the mean time to repair is 10 hours, the approximate mean time to data loss of a mirrored drive system is

(a) 17000 years   (b) 77000 years

(c) 47000 years   (d) 57000 years

Ans. **(d)**

$\qquad$ MTTF of one drive = 100000 hrs

$\qquad\qquad$ MTTR = 10 hr

In Raid-1, data loss happens only if the second drive fails while the first one is under repair

Failure rate of one drive $\lambda = \dfrac{1}{MTTF} = \dfrac{1}{100000}$ per hr

$\therefore$ Mean time to data loss (MTDL) for mirrored

$$MTTDL \approx \frac{MTTF^2}{2 \times MTTR} = \frac{(100000)^2}{2 \times 10}$$

$$= \frac{10^{10}}{20} \Rightarrow 5 \times 10^8 \text{ hrs}$$

Convert hours into years

$$1 \text{ year} \approx 8760 \text{ hrs}$$

$\therefore \quad$ MTTDL in years $= \dfrac{5 \times 10^8 \text{ hrs}}{8760} = 57000$ years

End of Solution

Q.78 Which one of the following modifiers tells the compiler that a variable's value may be changed in ways not explicitly specified by the program?
(a) Volatile
(b) Identifier
(c) Const
(d) Typedef

Ans. (a)

Volatile tells the compiler that don't assume" this variable stays the same between access.
Because, the value may change due to,
– H/w registers
– Interrupts
– DMA
– another thread/process.

End of Solution

Q.79 Consider the following statements regarding applications of a p-n junction diode:
1. It is used as a switch in DC power supplies.
2. It is used as rectifiers in voltage stabilizing circuits.
3. It is used as signal diodes in communication circuits.
Which of the above statements is/are correct?
(a) 2 only
(b) 2 and 3
(c) 3 only
(d) 1 and 3

Ans. (d)

Statement 1 and 3 are correct.

End of Solution

Q.80 Consider the following statements regarding transistors:
1. They can be made to oscillate with very small power consumption.
2. They cannot sustain mechanical shocks.
3. Their application is limited up to a few megacycles only.
Which of the above statements is/are correct?
(a) 2 only
(b) 2 and 3
(c) 3 only
(d) 1 and 3

Ans. **(d)**

Statement 1 and 3 are correct.

Q.81 A field-effect transistor operates with a drain current of 100 mA and a gate source bias of –1 V. The device has dynamic forward transconductance value of 0.25 S. If the bias voltage decreases to –1.2 V, what is the new value of the drain current?

(a) 50 mA   (b) 75 mA

(c) 150 mA   (d) 125 mA

Ans. **(a)**

$$g_m = \frac{\Delta I_D}{\Delta V_{GS}} = \frac{I_{D2} - I_{D1}}{V_{GS2} - V_{GS1}}$$

$$I_{D_2} - I_{D_1} = g_m \times \Delta V_{GS}$$

$$I_{D_2} - 0.1 = -0.25 \times 0.2$$

$$I_{D_2} = 0.1 - 0.05 = 0.05 \text{ A} = 50 \text{ mA}$$

Q.82 Match the following Lists regarding bipolar junction transistors:

List-I (Type of transistor)	List-II (Application)
P. BC108 (n-p-n)	1. Switching
Q. BF180 (n-p-n)	2. General-purpose small-signal amplifier
R. 2N3904 (n-p-n)	3. Low-frequency power
S. 2N3055 (n-p-n)	4. RF amplifier

Select the correct answer using the code given below.

	P	Q	R	S
(a)	4	2	1	3
(b)	4	3	2	1
(c)	3	4	1	2
(d)	2	4	1	3

Ans. **(d)**

- BC108 (n-p-n) → This is classic silicon transistor used as a general purpose small-signal amplifier due to its low noise and moderate gain.
- BF180 (n-p-n) → 'BF' prefix typically denote high-frequency transistors. This specific model is used in RF amplifier.
- 2N3904 (n-p-n) → One of the most common transistor used for switching application and low power amplification.
- 2N3055 (n-p-n) → This is high-power transistor used for low-frequency power application such as power supplies or audio amplifier.

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Q.83 Consider the following statement regarding p-n-p transistor:

1. The base-collector junction is reverse biased to holes in the base region and electrons in the collector region.
2. The base region is very thin and is only lightly doped with electrons.
3. A large proportion of the electrons in the base region cross the base-collector junction into the collector region, creating a collector current.

Which of the above statements is/are correct?

(a) 2 only
(b) 2 and 3
(c) 3 only
(d) 1 and 3

Ans. **(a)**

Statement 1 incorrect

Statement 2 correct

Statement 3 incorrect

End of Solution

Q.84 For a JFET, the typical values of amplification factor and transconductance are specified as 80 and 200 µS respectively. What is the dynamic drain resistance of this JFET?

(a) 25 kΩ
(b) 25 µΩ
(c) 400 kΩ
(d) 400 µΩ

Ans. **(c)**

$$\mu = g_m \, r_d$$

$$r_d = \frac{\mu}{g_m} = \frac{80}{0.2 \text{ mS}} = 400 \text{ k}\Omega$$

End of Solution

Q.85 There is no need of a driver stage, if FET is used as power amplifier instead of BJT, because

(a) FET digital circuits need much less power compared to BJT circuits
(b) there is no risk of thermal runaway in FET circuits
(c) power gain of an FET is much higher than that of a BJT
(d) FET is essentially a voltage-operated device

Ans. **(d)**

Statement 4 is correct

End of Solution

Q.86 Match the following Lists regarding field-effect transistor amplifiers:

List-I (Configuration)	List-II (Typical application)
P. Common source	1. Impedance matching stages
Q. Common drain	2. General-purpose, AF and RF amplifiers
R. Common gate	3. RF and VHF amplifiers

Select the correct answer using the code given below.

	P	Q	R
(a)	2	1	3
(b)	1	3	2
(c)	3	2	1
(d)	2	3	1

Ans. **(a)**

End of Solution

Q.87 Match the following Lists regarding bipolar transistor amplifiers:

List-I (Configuration)	List-II (Typical application)
P. Common emmiter	1. RF and VHF amplifiers
Q. Common collector	2. Impedance matching, input and output stages
R. Common base	3. General-purpose, AF and RF amplifiers

Select the correct answer using the code given below.

	P	Q	R
(a)	2	1	3
(b)	1	3	2
(c)	3	2	1
(d)	3	1	2

Ans. **(c)**

End of Solution

Q.88 Consider the following statements regarding frequency response of BJT amplifiers:
1. The CE amplifier has a high gain but a relatively narrow bandwidth.
2. The CC amplifier has a lower gain but a larger bandwidth.
3. The CB amplifier has a higher gain and a larger bandwidth.

Which of the above statements is/are correct?
(a) 2 only
(b) 2 and 3
(c) 3 only
(d) 1 and 2

Ans. **(d)**

Statement 1 and 2 are correct.

End of Solution

Q.89 In a common-collector amplifier stage, the impedance between base and emitter is magnified because of
(a) source resistance
(b) negative feedback
(c) Miller effect
(d) high-frequency response

Ans. **(b)**

Because of negative f_B.

End of Solution

Q.90 In Colpitts oscillator circuits, the amount of feedback is controlled by the
(a) position of the coil tap
(b) ratio of inductances
(c) ratio of capacitances
(d) ratio of resistances

Ans. **(c)**

$$\beta = \text{Feedback ratio} = \frac{C_2}{C_1}$$

Q.91 An electrodynamometer-type wattmeter has a current coil with a resistance of 0.1 Ω and a pressure coil with resistance of 6.5 kΩ. What is the percentage error while the meter is connected as current coil to the load side, if the load is specified as 12 A at 250 V with unity power factor?
(a) 14.4%
(b) 0.48%
(c) 4.8%
(d) 1.44%

Ans. **(b)**

Given,
Current coil resistance,
$$R_C = 0.1 \ \Omega$$
Load current, $\qquad I = 12$ A
Load voltage, $\qquad V = 250$ V
Power consumed by current coil
$$P_C = I^2 R_C = 12^2 \times 0.1 = 14.4 \text{ W}$$
True load power:
$$P = VI = 250 \times 12 = 3000 \text{ W}$$
$$\% \text{ error} = \frac{14.4}{3000} \times 100 = 0.48\%$$

Q.92 What is the expression for deflecting torque in single-phase induction-type energy meter?

(a) $T_d \propto \dfrac{\phi_P \phi_S \omega}{Z} \sin\beta \cos\alpha$

(b) $T_d \propto \dfrac{\phi_{1m} \phi_{2m}}{\omega Z} \sin(\alpha - \theta) \cos\beta$

(c) $T_d \propto \dfrac{\phi_{1m} \phi_{2m} \omega}{Z} \sin\alpha \cos\beta$

(d) $T_d \propto \dfrac{\phi_P \phi_S}{\omega Z} \sin\alpha \cos\beta$

Ans. **(a)**

Q.93 When secondary winding of current transformer is open circuited with primary winding still energized, the large flux greatly increases the
(a) flux density in the core and pushes it towards saturation
(b) power loss in the secondary winding
(c) leakage flux manifolds
(d) power loss in the primary winding

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Ans. (a)

When the secondary of a current transformer (CT) is open and the primary is energized, the secondary current becomes zero. To maintain ampere-turn balance, the primary draws heavy magnetizing current producing very large flux that drives the core toward saturation.

End of Solution

Q.94 The purpose of the start bit in digital voltmeter is to
(a) hold the digital word in the display for a particular time
(b) provide the display of the information that comes from the A/D conversion
(c) give zero indication on the display during start of conversion
(d) give information about polarity of the measurand voltage given by the A/D converter

Ans. (c)

End of Solution

Q.95 In general, the range of digital multimeter display is
(a) −199 to +199
(b) −999 to +999
(c) −9999 to +9999
(d) −1999 to +1999

Ans. (d)

Most digital multimeters are $3\frac{1}{2}$ digit displays, meaning the maximum count is 1999.

Range : −1999 to +1999

End of Solution

Q.96 Which one of the following code counters is used to remove the ambiguity during the change from one state of the counter to the next during the state transition?
(a) Gray code counter
(b) BCD code counter
(c) Excess-3 code counter
(d) Binary code counter

Ans. (a)

A gray code counter ensures only one bit changes at a time, removing ambiguity during state transition.

End of Solution

Q.97 Which one of the following gates is most commonly used in the design of a bus system?
(a) OR gate
(b) NOT gate
(c) XOR gate
(d) Buffer gate

Ans. (d)

A tri-state buffer is used in bus system to allow multiple devices to share a common bus without conflict.

End of Solution

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Q.98 Consider the following characteristics of CISC architecture:
1. A large number of instructions
2. A large variety of addressing modes
3. Instructions that manipulate operands in memory
4. Fixed-length instruction formats

Which of the above characteristics are correct?
(a) 1 and 2 only
(b) 2, 3 and 4
(c) 1, 2 and 4
(d) 1, 2 and 3

Ans. **(d)**

CISC supports variable length Instructions so, 4th statement is false, and remaining are the characteristics of a CISC CPU.

End of Solution

Q.99 Match the following Lists related to the registers with their functions:

List-I (Register name)	List-II (Function)
P. Data Register (DR)	1. Holds instruction code
Q. Address Register (AR)	2. Processor register
R. Accumulator (AC)	3. Holds address of instruction
S. Instruction Register (IR)	4. Holds memory operand
T. Program Counter (PC)	5. Holds address for memory

Select the correct answer using the code given below.

	P	Q	R	S	T
(a)	4	5	2	1	3
(b)	5	4	3	1	2
(c)	3	5	1	2	4
(d)	1	4	5	2	3

Ans. **(a)**

- Data register holds memory content.
- Address register holds memory Address.
- Accumulator holds ALU input and output.
- IR holds opcode.
- PC holds Instruction Address.

End of Solution

Q.100 Which one of the following types of instructions is useful for initializing registers to assign a constant value?
(a) Implied mode instructions
(b) Direct mode instructions
(c) Immediate mode instructions
(d) Indirect mode instructions

Ans. **(c)**

Immediate AM is used to access the constants.

End of Solution

Q.101 Which one of the following is **not** an operation performed by call subroutine instruction?
 (a) The address of the next instruction available in the program counter is stored in a temporary location, so the subroutine knows where to return.
 (b) Control is transferred to the beginning of the subroutine.
 (c) The instruction return from subroutine, transfers the return address from the temporary location into the program counter.
 (d) The address of the next instruction available in the program counter is stored in an accumulator and returns whenever it is required.

Ans. **(d)**
 Call instruction
 1. PC → Stack memory.
 2. PC → Updated with subroutine address.

End of Solution

Q.102 Which of the following lines/diagrams are used when the data transfer is between an interface and an I/O device?
 (a) Strobe lines   (b) Handshaking lines
 (c) Timing diagrams   (d) State diagrams

Ans. **(b)**
 For data transfer between an interface and an I/O device, handshaking signals are used. They provide a two-way synchronization (e.g. data ready and data acknowledged) to ensure reliable communication.

End of Solution

Q.103 In which one of the following data transfer schemes, the CPU stays in a program loop until the I/O unit indicates that it is ready for data transfer while transferring data to and from peripherals?
 (a) Programmed I/O
 (b) Interrupt-initiated I/O
 (c) Direct memory access
 (d) Programmed interrupt I/O

Ans. **(b)**
 When the CPU keeps running a program loop, it receives an interrupt from I/O, when I/O is ready, because of which the corresponding interrupt service routine executes. This methodology is known as interrupt initiated I/O, which avoids CPU wasting time for enquiring I/O continuously.

End of Solution

Q.104 Which one of the following methods is used to detect burst errors occurring in the communication channel?
 (a) Cyclic redundancy check   (b) Bit stuffing
 (c) Pulse code checking   (d) Bit spoofing

Ans. (a)

CRC is standard error detection method in digital communication. It is design to detect burst errors, which are sequence of consecutive bits corrupted by noise. Bit stuffing is a technique used in data link layer protocols to prevent data from being interpreted as control bits. It is used for frame synchronization, not for error detection. Pulse code checking is not a standard term for an error detection. Pulse code modulation exits for digitizing analog signals. Bit spoofing is generally refers to a security attack where a person or program succesfully pretending as another by falsifying data.

End of Solution

Q.105 In operating systems, which one of the following approaches is used to keep track of system activities such as the number of system calls made or the number of operations performed to a network device or disk?
(a) Counters
(b) Tracing
(c) Scheduling
(d) Pipelining

Ans. (a)
- Counters are Explicitly used to count the" occurrences of events like system calls, disk IO operations and N/W packets.
- OS kernel maintain counters for performance "monitoring and Accounting.

End of Solution

Q.106 What is the drift velocity of electrons knowing that in metals, the free electron concentration in about $n_0 = 10^{28}$ electrons/m³?
(Take maximum admitted value of the density of electric current for metals as $J = 10^7$ A/m² and electrical charge of the electron as $q_0 = 1.602 \times 10^{-19}$ C)
(a) 1.6×10^{-3} m/s
(b) 6.24×10^{-22} m/s
(c) 1.6×10^{-22} m/s
(d) 6.24×10^{-3} m/s

Ans. (d)

$$J = nqv_d$$

$$v_d = \frac{J}{nq} = \frac{10^7}{10^{28} \times 1.602 \times 10^{-19}} = 0.624 \times 10^{-2} = 6.24 \times 10^{-3} \text{ m/s}$$

End of Solution

Q.107 Which one of the following is generated by the supplementary (precession) movements of the conduction electrons that appear when the material is introduced in a magnetic field?
(a) Langevin diamagnetism
(b) Landau diamagnetism
(c) Lorentz diamagnetism
(d) Larmor diamagnetism

Ans. (b)
Langevin diamagnetism → due to bound electrons
Landau diamagnetism → due to free electrons i.,e conduction electrons
Larmor diamagnetism → Classical atomic orbital precession

End of Solution

Q.108 The cermet of Au/SiO is obtained by
- (a) the deposition on glass support and consists in conductive particles of gold spread in amorphous matrix of SiO_2.
- (b) transforming the silicon monoxide at the deposition in a reactive component (Si) and in an insulating one SiO_2.
- (c) the mixture of α-Cr, Cr_3Si and SiO_2 amorphous
- (d) the expansion of both nonconductive and conductive zones of a reactive component (Si)

Ans. **(a)**

Cermet of Au SiO consists of conductive gold particles dispressed in amorphous SiO_2 matrix.

End of Solution

Q.109 Match the following Lists:

List-I (Class of the material) | List-II (Limiting working temperature)
P. A | 1. 120° C
Q. E | 2. 180° C
R. H | 3. 90° C
S. Y | 4. 105° C

Select the correct answer using the code given below.

	P	Q	R	S
(a)	3	2	4	1
(b)	4	1	3	2
(c)	3	1	2	4
(d)	4	1	2	3

Ans. **(d)**

Class	Limiting temperature
A	105°C
E	120°C
H	180°C
Y	90°C

End of Solution

Q.110 A transformer core is wound with a coil carrying an alternating current at a frequency of 50 Hz. The hysteresis loop has an area of 70000 units, when the axes are drawn in units of 10^{-4} Wb-m^2 and 10^2 A-m^{-1}. What is the hysteresis loss by assuming the magnetization to be uniform throughout the core volume of 0.02 m^3 ?
- (a) 350 W
- (b) 700 W
- (c) 3500 W
- (d) 7000 W

Ans. (b)
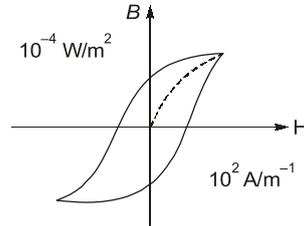
Hysteresis loop area given : 70000 units

$$f = 50 \text{ Hz}$$

Core volume = 0.02 m³

Area of B-H loop is Hysteresis loss per cycle per unit volume

From given Hysteresis loop area:

Hysteresis loss per cycle per unit volume is:

$70000 \times 10^{-4} \times 10^2 = 700$ J/m³ per cycle

As frequency is given 50 Hz

Hysteresis loss per unit volume = $700 \times 50 = 35000$ W/m³

Total volume of core is 0.02 m³

$\therefore$ Hysteresis loss = $34000 \times 0.02 = 700$ W

End of Solution

Q.111 L is measured value of inductance with magnetic core, L_0 is measured value of inductance without magnetic core, μ_0 is magnetic permeability of free space, h is height of the material under test, c is outer diameter of the material under test, d is inner diameter of the material under test. What is the formula for relative magnetic permeability (μ_r)?

(a) $\mu_r = \dfrac{\mu_0}{2\pi} \dfrac{L - L_0}{h\ln\left(\dfrac{c}{d}\right)}$

(b) $\mu_r = \dfrac{L - L_0}{\mu_0} \dfrac{2\pi}{h\ln\left(\dfrac{c}{d}\right)}$

(c) $\mu_r = \dfrac{\mu_0}{2\pi} \dfrac{L - L_0}{h\ln\left(\dfrac{d}{c}\right)}$

(d) $\mu_r = \dfrac{L - L_0}{\mu_0} \dfrac{2\pi}{h\ln\left(\dfrac{d}{c}\right)}$

Ans. (b)

Given data,

inner diameter = d;   outer diameter = c;   height = h

Magnetic field due to a toroid,

$$H = \frac{I}{2\pi r}; \ r = \text{mean radius}$$

$\Rightarrow$ $\qquad B = \mu H = \dfrac{\mu I}{2\pi r}; \mu = \mu_0\mu_r$

$\Rightarrow$ $\qquad d\phi = \overline{B} \cdot \overline{ds} = B \times h dr$

$\Rightarrow$ $\qquad d\phi = \dfrac{\mu I}{2\pi r} h dr$

$$\Rightarrow \qquad \phi = \frac{\mu I h}{2\pi} = \ln r \Big|_{d/2}^{c/2}$$

$$\Rightarrow \qquad \phi = \frac{\mu I h}{2\pi}\ln\left(\frac{c}{d}\right)$$

$$\Rightarrow \qquad L = \frac{\phi}{I} = \frac{\mu h}{2\pi}\ln\left(\frac{c}{d}\right)$$

$$L\Big|_{\text{with core '}\mu\text{'}} = \frac{\mu_0 \mu_r h}{2\pi}\ln\left(\frac{c}{d}\right)$$

$$L\Big|_{\text{with core}} = \frac{\mu_0 h}{2\pi}\ln\left(\frac{c}{d}\right) = L_0$$

$$\therefore \qquad L - L_0 = \frac{\mu_0 h}{2\pi}(\mu_r - 1)\ln\left(\frac{c}{d}\right)$$

As $\mu_r \gg 1$

$$\therefore \qquad L - L_0 = \frac{\mu_0 \mu_r h}{2\pi}\ln\left(\frac{c}{d}\right)$$

$$\therefore \qquad \mu_r = \frac{L - L_0}{\mu_0} \times \frac{2\pi}{h\ln(c/d)}$$

End of Solution

Q.112 Consider the following statements regarding ferrites:
1. Ferrites are linear materials and present hysteresis cycle.
2. The values of saturation induction and remanent induction are lower.
3. Magnetic permeability is lower and more sensitive at the action of external magnetic fields.

Which of the above statements is/are correct?
(a) 1 and 2
(b) 2 only
(c) 3 only
(d) 2 and 3

Ans. (b)

Ferrites exhibit hysteresis curve, so non-linear material and have high permeability.

End of Solution

Q.113 What is the conductivity of copper at 300 K, if the collision time τ for electron scattering is 2×10^{-14} s at this temperature? (Take the number of free electrons per m³ of copper as 8.5×10^{28}, electron charge as 1.602×10^{-19} C and mass of free electron as 9.1×10^{-31} kg)
(a) 4.8×10^7 ohm⁻¹ -m⁻¹
(b) 6×10^{-11} ohm⁻¹ -m⁻¹
(c) 4.8×10^{-17} ohm⁻¹ -m⁻¹
(d) 6×10^7 ohm⁻¹ -m⁻¹

Ans. (a)

$$\sigma = \frac{nq^2\tau_c}{m} = \frac{8.5 \times 10^{28} \times (1.6 \times 10^{-19})^2 \times 2 \times 10^{-14}}{9.1 \times 10^{-31}}$$

$$= 4.78 \times 10^{28 - 38 - 14 + 31}$$

$$= 4.78 \times 10^7 = 4.8 \times 10^7 \text{ ohm}^{-1} - \text{m}^{-1}$$

End of Solution

Q.114 Match the following Lists:

List-I (Material)	List-II (Density)
P. Silver	1. 2.70×10^3 kg-m^{-3}
Q. Copper	2. 8.96×10^3 kg-m^{-3}
R. Gold	3. 10.49×10^3 kg-m^{-3}
S. Aluminium	4. 19.32×10^3 kg-m^{-3}

Select the correct answer using the code given below.

	P	Q	R	S
(a)	3	2	1	4
(b)	4	1	3	2
(c)	3	2	4	1
(d)	4	1	2	3

Ans. (c)

Aluminium has lowest density among all these metals.

End of Solution

Q.115 The resistivity of pure copper at room temperature is 1.8×10^{-8} ohm-m. The resistivity of Cu–4% Ni alloy at room temperature is 7.0×10^{-8} ohm-m. What is the resistivity due to impurity scattering by 1% of nickel in the copper lattice?

(a) 2.2×10^{-8} ohm-m (b) 6.5×10^{-8} ohm-m

(c) 0.2×10^{-8} ohm-m (d) 1.3×10^{-8} ohm-m

Ans. (d)

$$\rho_{cu} = 1.8 \times 10^{-8} \ \Omega\text{-m}$$

$$\rho_{alloy} = \rho_{pure} + \rho_{impurity}$$

$$\rho_{impurity} = 7 \times 10^{-8} - 1.8 \times 10^{-8}$$

$$= 5.2 \times 10^{-8} \ \Omega\text{-m with 4\% Ni}$$

∵ For 4% Ni → $5.2 \times 10^{-8} \ \Omega$-m

∵ For 1% Ni → $\frac{5.2 \times 10^{-8}}{4} = 1.3 \times 10^{-8} \ \Omega$-m

End of Solution

Q.116 What is the power supplied by each element in the circuit shown below?
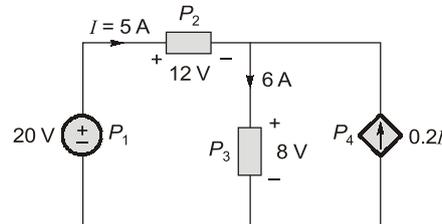
(a) $P_1 = -100$ W; $P_2 = 60$ W; $P_3 = -48$ W; $P_4 = -8$ W

(b) $P_1 = 100$ W; $P_2 = -60$ W; $P_3 = -48$ W; $P_4 = 8$ W

(c) $P_1 = -100$ W; $P_2 = -60$ W; $P_3 = 48$ W; $P_4 = -8$ W

(d) $P_1 = -100$ W; $P_2 = 60$ W; $P_3 = 48$ W; $P_4 = -8$ W

Ans. **(d)**

$$P_1 = V_1 I_1$$
$$P_1 = (20)(5) = 100 \text{ W}$$

Power delivering is 100 watts

$$P_1 = -100 \text{ W}$$
$$P_2 = 12.5 = 60 \text{ W}$$

Power absorbing is 60 W

$$P_2 = 60 \text{ W}$$
$$P_3 = 8 \times 6 = 48 \text{ W}$$

Power absorbing is 48 W

$$P_3 = 48 \text{ W}$$
$$P_4 = (0.2 I)(8)$$
$$= (0.2)(5)(8)$$
$$P_4 = 8 \text{ Watts}$$

Power delivering is 8 W

$$P_4 = -8 \text{ W}$$

End of Solution

Q.117 What are V_0 and i respectively in the circuit shown below?
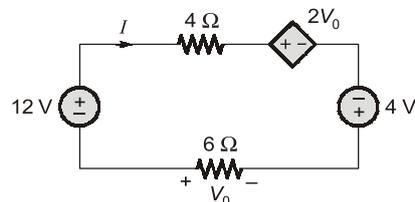
(a) +48 V, −8 A   (b) +24 V, −4 A

(c) −48 V, +8 A   (d) −24 V, +4 A

Ans. **(a)**

Write KVL equation,

$$12 - 4i - 2V_0 + 4 - 6i = 0$$
$$16 - 10i - 2V_0 = 0 \qquad \qquad ...(i)$$
$$V_0 = -6i$$

Substitute V_0 in equation (i),

$$i = -8A$$
$$V_0 = -6i = (-6)(-8) = 48 \text{ V}$$

End of Solution

Q.118 The electron beam in a TV picture tube carries 10^{15} electrons per second. What is the voltage V_0 needed to accelerate the electron beam to achieve 4 W?
(a) 10 kV
(b) 15 kV
(c) 30 kV
(d) 25 kV

Ans. **(d)**

$$I = \frac{Q}{t} = \frac{ne}{t} = \frac{10^{15}\left(1.602 \times 10^{-19}\right)}{1}$$

$$I = 10^{-4}(1.602)$$
$$P = VI$$

$$V = \frac{P}{I} = \frac{4}{(1.602)\left(10^{-4}\right)} \simeq 25 \text{ kV}$$

End of Solution

Q.119 Consider the following statements regarding network theorems:
1. With independent sources, superposition theorem can be used only when the control functions are external to the network containing the sources, so that the controls are unchanged as the sources act one at a time.
2. A linear, active, resistive network, which contains one or more voltage or current sources, can be replaced by a single voltage source and a series resistance or by a single current source and a parallel resistance. The voltage is called the Thevenin equivalent voltage and the current is Norton current.
3. The two resistances are the same in both Thévenin's and Norton's theorems which are obtained by deactivating all the sources.

Which of the above statements is/are correct?
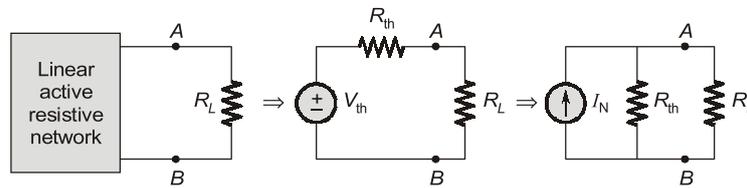(a) 1 only
(b) 2 only
(c) 1 and 2
(d) 2 and 3

Ans. **(d)**

Statement 1 is incorrect.
Statement 2 and 3 are correct.

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End of Solution

Q.120 A 10-ohm resistor has a current of $i = 2.5 \sin\omega t$ (A). What are the values of voltage and power respectively over one cycle of $\omega = 500$ rad/s?

(a) $25 \sin\omega t$ (V); $62.5 \sin^2 \omega t$ (W) (b) $250 \sin\omega t$ (V); $625 \sin^2 \omega t$ (W)

(c) $2.5 \sin\omega t$ (V); $62.5 \sin^2 \omega t$ (W) (d) $25 \sin\omega t$ (V); $625 \sin^2 \omega t$ (W)

Ans. (a)

$$V = iR = (2.5 \sin\omega t)(10)$$
$$v(t) = 25 \sin \omega t$$
$$P(t) = v(t) \cdot i(t)$$
$$= (25 \sin \omega t)(2.5 \sin\omega t)$$
$$P(t) = 62.5 \sin^2 \omega t$$

End of Solution

Q.121 A box contains 10 screws, three of which are defective. If two screws are drawn at random without replacement, then what is the probability that neither of the two screws is defective?

(a) 49/100 (b) 14/30

(c) 9/10 (d) 2/3

Ans. (b)

$$\boxed{\begin{array}{c} 3D \\ 7ND \end{array}} \Rightarrow \qquad \frac{7C_2}{10C_2} = \frac{7 \times 6}{10 \times 9} = \frac{14}{30}$$

End of Solution

Q.122 If the random variable X, which is the sum of the two numbers of two fair dice turned up, is discrete, then what is the probability of sum of at least 4 and at most 8?

(a) 26/36 (b) 1/6

(c) 23/36 (d) 1/12

Ans. (c)

$$4 \le P(X = \text{sum of both dice}) \le 8$$
$$P(4) + P(5) + P(6) + P(7) + P(8)$$
$$= \frac{3+4+5+6+5}{36} = \frac{23}{36}$$

End of Solution

Q.123 A bag contains 7 green and 5 yellow balls. Two balls are selected at random, one at a time. What is the probability that the two balls are of different colors, if the selection is made with replacement?

(a) 5/12   (b) 37/72

(c) 5/72   (d) 35/72

Ans. **(d)**

$$\boxed{\begin{array}{c}7G\\5Y\end{array}} \Rightarrow \frac{G}{\frac{7}{12}}\times\frac{Y}{\frac{5}{12}}+\frac{YG}{\frac{5}{12}\times\frac{7}{12}} = \frac{35\times2}{12\times12} = \frac{35}{72}$$

End of Solution

Q.124 If the events A and B are such that $P(A) = 0.6$, $P(B) = 0.2$ and $P(A \cup B) = 0.7$, then $P(B \mid A)$ is

(a) 1/4   (b) 1/6

(c) 2/3   (d) 1/7

Ans. **(b)**

$$P(B/A) = \frac{P(A \cap B)}{P(A)} = \frac{0.1}{0.6} = \frac{1}{6}$$

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$$0.7 = 0.6 + 0.2 - P(A \cap B)$$

$$P(A \cap B) = 0.1$$

End of Solution

Q.125 If $X \sim$ Binomial $\left(16, \frac{1}{2}\right)$, then what is the variance of the random variable?

(a) 8   (b) 4

(c) 2   (d) 6

Ans. **(b)**

$$\left.\begin{array}{c}X \sim B(n,P)\\X \sim B(16, 1/2)\end{array}\right\} \quad n = 16$$

$$p = \frac{1}{2}$$

$$q = 1-\frac{1}{2} = \frac{1}{2}$$

$$\text{Variance} = npq$$

$$= 16\times\frac{1}{2}\times\frac{1}{2} = 4$$

End of Solution

Q.126 If $X \sim N(15, 6.25)$, then what is the value of X, which is 1.2 standard deviations below the mean?
(a) 12 (b) 15
(c) 16 (d) 14

Ans. **(a)**

$$X \sim N(15, 6.25)$$
$$\mu = 15, \sigma^2 = 6.25$$
$$\sigma = 2.5$$
$$X = \mu - 1.2\sigma$$
$$= 15 - 1.2 \times 2.5$$
$$= 15 - 3 = 12$$

End of Solution

Q.127 If the height h in metres of a swing above the ground at time t seconds is given by $h = 2 - 1.5 \sin t$ for $0 < t < 3$, then the maximum height of the swing is
(a) 4 m (b) 1.79 m
(c) 2 m (d) 6 m

Ans. **(c)**

$$h = 2 - 1.5 \sin t \quad 0 < t < 3$$

From h_{max} ,
minimum value of $\sin t = 0$ in $0 < t < 3$
$$h_{max} = 2 - 1.5 \times 0$$
$$= 2$$

End of Solution

Q.128 Consider the following statements regarding rank in terms of column vectors:
1. The rank r of a matrix A equals the maximum number of linearly independent column vectors of A.
2. The matrix A and its transpose A^T have the same rank.
3. Consider p vectors each having n components; if $n < p$, then these vectors are linearly independent.
Which of the above statements is/are **not** correct?
(a) 1 and 2 (b) 1 and 3
(c) 2 and 3 (d) 3 only

Ans. **(d)**

$$A = [\quad]_{m \times n}$$
$$\rho(A) = \text{number of linearly independent column}$$
$$\rho(A) = \rho(A^T)$$
Statement 3 is wrong.

End of Solution

Q.129 The eigenvector X_i of the $n \times n$ matrix A, corresponding to the eigenvalues $\lambda = \lambda_i$, is a solution of the homogeneous equation, if

(a) $(A - \lambda_i I)X_i = 0$

(b) $A - \lambda_i I = 0$

(c) $(A + \lambda_i I)X_i = 1$

(d) $A - \lambda_i I = 1$

Ans. **(a)**

$$(A - \lambda_i I)X_i = 0$$

Q.130 What is the value of the Fourier coefficient α_0 for the function given below?

$$f(x) = \begin{cases} \sin 2x, & -\pi < x < \dfrac{-\pi}{2} \\ 0, & \dfrac{-\pi}{2} \le x \le 0 \\ \sin 2x, & 0 < x \le \pi \end{cases}$$

(a) $\dfrac{1}{(2\pi)}$

(b) $\dfrac{1}{\pi}$

(c) $\dfrac{3}{(4\pi)}$

(d) $\dfrac{2}{\pi}$

Ans. **(b)**

$$f(x) = \begin{cases} \sin 2x, & -\pi < x < \dfrac{-\pi}{2} \\ 0, & \dfrac{-\pi}{2} \le x \le 0 \\ \sin 2x, & 0 < x \le \pi \end{cases}$$

$$a_0 = \frac{1}{\pi}\int_{-\pi}^{\pi} f(x)dx = \frac{1}{\pi}\left[\int_{-\pi}^{-\pi/2}\sin 2x\,dx - \int_{\pi/2}^{0} 0\,dx + \int_{0}^{\pi}\sin 2x\,dx\right]$$

$$= \left[\frac{1}{\pi}\left[\frac{-\cos 2x}{2}\right]_{-\pi}^{-\pi/2} + 0 + \left(\frac{-\cos 2x}{2}\right)_{0}^{\pi}\right]$$

$$= \frac{1}{\pi}\left[\frac{1}{2} + \frac{1}{2} + 0\right] = \frac{1}{\pi}\times 1 = \frac{1}{\pi}$$

Q.131 The straight line $r(t) = at\,\hat{i} + bt\,\hat{j} + ct\,\hat{k} + c$ with a, b and c as scalar constants and c as a constant vector, has

(a) a finite radius of curvature at every point

(b) zero radius of curvature at every point

(c) an infinite radius of curvature at every point

(d) an infinite radius of curvature at a single point

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Ans. **(c)**

$$r(t) = at\hat{i} + bt\hat{j} + ct\hat{k} + c$$

End of Solution

Q.132 Consider the following statements regarding properties of eigenvalues:
1. Any square matrix A and its transpose A^T have the same eigenvalues.
2. The eigenvalues of a triangular matrix are just the diagonal elements of the matrix.
3. The sum of the eigenvalues of a matrix is the product of the elements of the principal diagonal.

Which of the above statements are correct?
(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

Ans. **(a)**

Statement 1 and 2 are correct.

End of Solution

Q.133 Let r be the rank for the coefficient matrix A of the system of homogeneous linear equations having m number of equations and n number of variables.
1. If $r < n$, then the equations have $(n - r)$ linearly independent solutions.
2. If $m < n$, the number of solutions is finite.
3. If $m = n$, then such solution is non-trivial solution.

Which of the above statements is/are **not** correct?
(a) 1 and 2
(b) 2 only
(c) 1 only
(d) 2 and 3

Ans. **(d)**

$[A]_{m \times n}$
$$AX = 0$$

1. If $r < n \implies n - r \implies$ linearly independent solution
2. $m < n \implies$ Number of solution in infinite
3. $m = n \implies$ k

End of Solution

Q.134 Consider the following statements regarding atomic bonds:
1. If two ions with same ionization potential form a bond, then this bond will most probably be ionic.
2. With the increase in the difference of the ionization potentials, the bond will be more and more ionic.
3. If the atom or molecule has completely filled outer shell, then the bonding between the atoms or molecules will be a primary bond at the time of solidification.

Which of the above statements is/are correct?
(a) 1 and 2
(b) 2 only
(c) 3 only
(d) 2 and 3

Ans. **(b)**

Same ionization potential → Covalent bond

Completely filled outer sheet (e.g. : Inert gases) → Vander Wall's force → Secondary bond.

End of Solution

Q.135 Match the following Lists:

List-I (Metal)	List-II (Resistivity)
P. Li	1. 4.34×10^{-8} Ω-m
Q. Na	2. 1.56×10^{-8} Ω-m
R. Cu	3. 8.33×10^{-8} Ω-m
S. Ag	4. 1.47×10^{-8} Ω-m

Select the correct answer using the code given below.

	P	Q	R	S
(a)	3	2	4	1
(b)	3	1	4	2
(c)	3	1	2	4
(d)	3	2	1	4

Ans. **(c)**

Silver is the best conductor followed by copper among all these metals.

End of Solution

Q.136 For the network given below, what are the Norton's current and Thévenin's voltage at the terminals a and b?
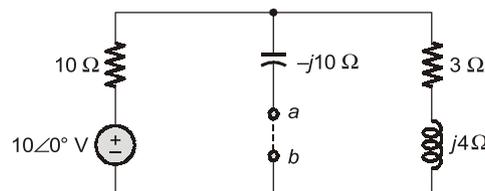
(a) $I_{ab} = \left[\dfrac{10\angle 0°}{10 + \dfrac{(-j10)(3 - j4)}{3 + j6}}\right]\left(\dfrac{3 - j4}{3 + j6}\right)$A and $V_{ab} = \dfrac{3 - j4}{13 + j4}(10\angle 0°)$V

(b) $I_{ab} = \left[\dfrac{10\angle 0°}{10 + \dfrac{(-j10)(3 + j4)}{3 + j6}}\right]\left(\dfrac{3 - j4}{3 + j6}\right)$A and $V_{ab} = \dfrac{3 - j4}{13 + j4}(10\angle 0°)$V

(c) $I_{ab} = \left[\dfrac{10\angle 0°}{10 + \dfrac{(-j10)(3 - j4)}{3 - j6}}\right]\left(\dfrac{3 - j4}{3 - j6}\right)$A and $V_{ab} = \dfrac{3 + j4}{13 - j14}(10\angle 0°)$V

(d) $I_{ab} = \left[\dfrac{10\angle 0°}{10 + \dfrac{(-j10)(3+j4)}{3-j6}} \right] \left(\dfrac{3+j4}{3-j6} \right) A$ and $V_{ab} = \dfrac{3+j4}{13+j4}(10\angle 0°)V$

Ans. (d)

Using voltage division

$$V_{ab} = 10 \times \frac{3+j4}{10+3+j4}$$

$$V_{ab} = 10 \times \frac{(3+j4)}{13+j4} V$$

$$Z_{th} = \frac{(10)(3+j4)}{10+3+j4} - j10$$

$$Z_{th} = \frac{(10)(3+j4)}{13+j4} - 10$$

$$= \frac{10(3+j4)-10(13+j4)}{13+j4} \Omega$$

$$I_{ab} \Rightarrow \qquad \frac{V_{ab}}{Z_{th}} = \frac{10(3+j4)}{10(3+j4)-10(13+j4)} A$$

End of Solution

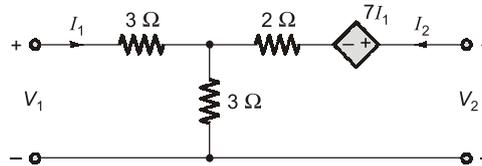**Q.137** Consider the following statements regarding power measurement by two-wattmeter method :

1. Two wattmeters connected in any two lines of a three-phase, three-wire system will correctly indicate the total three-phase power by the sum of the two meter readings.
2. A meter will attempt to go downscale if the phase angle between the voltage and current exceeds 180°.
3. In practical case, the balanced load is usually known to be inductive ($\theta > 0°$).

Which of the above statements is/are correct?

(a) 1 and 2   (b) 1 and 3

(c) 2 and 3   (d) 2 only

Ans. (b)

*   A wattmeter reads negative when the phase angle between voltage and current is greater than 90°.
*   In practice most loads are inductive, so $\theta > 0°$.
*   Two wattmeters connected in any two lines of a 3-phase, 3-wire system measure total power as the sum of their readings.

End of Solution

Q.138 What are the Z-parameters for the network given below?

(a) $Z_{11} = 6$; $Z_{12} = 3$; $Z_{21} = 10$; $Z_{22} = 5$
(b) $Z_{11} = 5$; $Z_{12} = 10$; $Z_{21} = 3$; $Z_{22} = 6$
(c) $Z_{11} = 6$; $Z_{12} = 10$; $Z_{21} = 10$; $Z_{22} = 5$
(d) $Z_{11} = 6$; $Z_{12} = 3$; $Z_{21} = 3$; $Z_{22} = 5$

Ans. **(a)**

Write kVL equation input port loop

$$V_1 = 3I_1 + 3(I_1 + I_2)$$
$$V_1 = 6I_1 + 3I_2 \qquad \qquad ...(i)$$

Write kVL equation in output port loop.
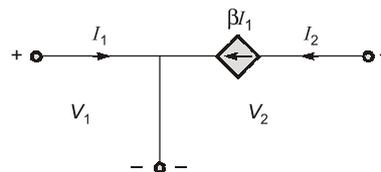
$$V_2 = 7I_1 + 3(I_1 + I_2) + 2I_2$$
$$V_2 = 10I_1 + 5I_2 \qquad \qquad ...(ii)$$

$$[Z] = \begin{bmatrix} 6 & 3 \\ 10 & 5 \end{bmatrix}$$

$Z_{11} = 6\Omega$ $Z_{12} = 3\Omega$, $Z_{21} = 10\Omega$, $Z_{22} = 5\Omega$

End of Solution

Q.139 The simplified model of a bipolar junction transistor for small signals is shown in the figure below:

What are the *h*-parameters?
(a) $h_{11} = h_{22} = h_{21} = 0$ and $h_{12} = \beta$
(b) $h_{22} = h_{12} = h_{21} = 0$ and $h_{11} = \beta$
(c) $h_{11} = h_{12} = h_{21} = 0$ and $h_{22} = \beta$
(d) $h_{11} = h_{12} = h_{21} = 0$ and $h_{22} = \beta$

Ans. **(c)**

$$V_1 = 0\, I_1 + 0\, V_2$$
$$I_2 = \beta\, I_1 + 0\, V_2$$

Comparing it with stable equations

$$h_{11} = h_{12} = h_{21} = 0$$

and $$h_{22} = \beta$$

End of Solution

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Q.140 Which one of the following statements is **not** correct regarding mutual inductance and transformers?

(a) When the assumed currents both enter or both leave a pair of coupled coils by the dotted terminals, the signs on the M-terms will be the same as the signs on the L-terms.

(b) When one current enters by a dotted terminal while the other leaves by a dotted terminal, the signs on the M-terms will be opposite to the signs on the L-terms.

(c) The term 'close coupling' is used to describe the case where most of the flux links the coils, either by way of a magnetic core to contain the flux or by interleaving the turns of the coils directly over one another. Coils placed side-by-side without a core are loosely coupled and have correspondingly high values of k.

(d) If all the flux links the coil without any leakage flux, then $k = 1$. On the other extreme, the coil axes may be oriented such that no flux from one can induce a voltage in the other, which results in $k = 0$.

Ans. **(c)**

Close coupling means high flux linkage. However the statement says loosely coupled coils have high value of K. So, (c) is incorrect.

End of Solution

Q.141 Consider the following statements regarding factors affecting the capacitance :

1. The area of the plates is directly proportional to the charge; the larger the plate area, the more electric charges that can be stored.

2. The longer the distance between the two plates, the stronger the produced electric field that will increase the ability to store charges. Therefore, the distance between the two plates is directly proportional to the capacitance.

3. Different insulating materials will have different impacts on the capacitance. The dielectric constant is directly proportional to the capacitance.

Which of the above statements is/are correct?

(a) 2 and 3   (b) 1 and 2

(c) 1 and 3   (d) 3 only

Ans. **(c)**

$$C = \frac{A \in}{d}$$

$$C \propto \frac{1}{d}$$

So, statement-2 is incorrect.

End of Solution

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4 Streams 4 Toppers all 4 MADE EASY Students

39 selections in Top 10

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CE — 9 in Top 10

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MOHAMMAD SHAQUIB	PRAKHAR SHRI	ARJUN SHARMA	BOLLA U NANDAN	KESHAV	TUSHAR AGGARWAL	AYUSH JAIN	ADITYA P SINGH	PUSHPENDRA RATHORE
Live Online Foundation Course	Classroom Foundation Course	Mains Online Course	Classroom Foundation Course	Test Series & IGP	Classroom Foundation Course	Classroom Foundation Course	Test Series & IGP	Test Series & IGP

ME — 10 in Top 10

AIR 1	AIR 2	AIR 3	AIR 4	AIR 5	AIR 6	AIR 7	AIR 8	AIR 9	AIR 10
NIMESH CHANDRA	ASHOK KUMAR	HARI SINGH	SIDDESH RAO	GOLLANGI SATEESH	AVINASH VERMA	PRASHANT SINGH	MONU KUMAR	NIKHIL KUMAR SAHA	AMIT KUMAR SINGH
Classroom Foundation Course	Classroom Foundation Course	Mains Online Course	GS Online Course	Mains Online Course	Mains Online Course	Mains Offline Course	Classroom Foundation Course	Test Series & IGP	Classroom Foundation Course

EE — 10 in Top 10

AIR 1	AIR 2	AIR 3	AIR 4	AIR 5	AIR 6	AIR 7	AIR 8	AIR 9	AIR 10
RAJAN KUMAR	VISHNU SAINI	OMPRAKASH RAJPUT	TUSHAR CHAUDHARY	RAM KUMAR	PUNIT MEENA	JYOTI K. PANDA	D A SAI RAM REDDY	DHRUV KAWAT	AKSHIT PARASHARI
Classroom Foundation Course	Live Online Foundation Course	Classroom Foundation Course	Classroom Foundation Course	Test Series & IGP	Classroom Foundation Course	Classroom Foundation Course	Test Series & IGP	Classroom Foundation Course	Live Online Foundation Course

E&T — 10 in Top 10

AIR 1	AIR 2	AIR 3	AIR 4	AIR 5	AIR 6	AIR 7	AIR 8	AIR 9	AIR 10
UTKARSH PATHAK	RAJESH TIWARI	PRASHANT LAVANIA	PRADEEP SHUKLA	ASHISH SINGH PATEL	TANYA TYAGI	PALAK MISHRA	HAYAT ALI	VIDHU SHREE	RAM PAL SINGH
Live Online Foundation Course	Live Online Foundation Course	Classroom Foundation Course	Mains Online Course	Classroom Foundation Course	Mains Online Course	Mains Online Course	Classroom Foundation Course	Live Online Foundation Course	Classroom Foundation Course

MADE EASY students top in GATE 2025

5 All India Rank 1 (CE, ME, IN, ES & EE)

45 Selections in Top 10

399 Selections in Top 100

AIR	Name	Stream	Course
1	Abhay Singh	CE	Classroom Course
1	Rajneesh Bijarniya	ME	Classroom Course
1	Pradip Chauhan	EE	Test Series
1	Kailash Goyal	IN	Classroom Course
1	Yash Jain	ES	Classroom Course
2	Harshvardhan Singh	CE	Classroom Course
2	Gollangi Sateesh	ME	Online Course
2	Kailash Goyal	EE	Classroom Course
2	Ankush Philip John	EC	Postal Package & Test Series
2	S. Bhattacharya	IN	Test Series
2	Jitesh Choudhary	ES	Classroom Course
2	Tarun Yadav	ES	Classroom Course
3	Pankaj Meena	CE	Classroom Course
3	Nimesh Chandra	ME	Classroom Course
3	Aditya Kr. Prasad	PI	Classroom Course
3	Rohan Kr. Biswal	XE	Test Series
5	Kartik Pokhriyal	CE	Classroom Course
5	Kuldeep Singh Naruka	PI	Classroom Course
5	Sachin Yadav	IN	Test Series
5	M. M. Nafeez	EC	Test Series
5	Sachin Kumar	ES	Classroom Course
6	Kaushal Kr. Kaushik	PI	Online Course
6	Shivanand Chaurasia	CE	Online Course
6	Nimish Upadhyay	CE	Online Course
6	Puneet Soni	EE	Test Series
6	Shivam Kr. Gupta	EE	Test Series
6	Pentela J. Bhavani	EC	Test Series
6	Utkarsh P. Patil	IN	Classroom Course
7	Waleed Shaikh	PI	Test Series
7	Abhinn	ME	Online Course
7	Dev J. Patel	IN	Test Series
7	Ankit Kumar	ES	Classroom Course
8	Goutam Kumar	ME	Test Series
9	Tarun Yadav	CE	Classroom Course
9	Omhari	CS	Test Series
9	Chilukuri S. Charan	EC	Test Series
9	Apar Harsh Chandra	XE	Classroom Course
10	Adnan Quasain	CE	Classroom Course
10	Rahul Singh	CE	Online Course
10	Ashutosh Kumar	ME	Classroom Course
10	Jetti Ganateja	ME	Test Series
10	Muhammed Sinan K	ME	Test Series
10	Pitchika Kr. Vasu	ME	Online Course
10	M Gopu Ganesh	PI	Test Series
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Q.142 Which of the following is/are **not** discharging equation/equations for an R-C circuit?

1. Capacitor voltage $v_C = V_0 e^{-\frac{t}{RC}}$.

2. Resistor voltage $v_R = E e^{-\frac{t}{RC}}$.

3. Discharging current $i = \frac{V_0}{R} e^{-\frac{t}{RC}}$.

Select the correct answer using the code given below.
(a) 1 and 2   (b) 2 and 3
(c) 1 and 3   (d) 1 only

Ans. **(b)**

Discharging current,

$$i = \frac{-V_0}{R} e^{-t/RC}$$

$$V_R = -V_0\, e^{-t/RC}$$

$$V_C = V_0\, e^{-t/RC}$$

End of Solution

Q.143 Match the following Lists regarding bipolar junction transistors:

List-I (Time constant)	List-II (Capacitor discharging voltage)
P. 1τ	1. 0.67% of E
Q. 2τ	2. 36.8% of E
R. 3τ	3. 13.5% of E
S. 4τ	4. 5% of E
T. 5τ	5. 1.87% of E

Select the correct answer using the code given below.

	P	Q	R	S	T
(a)	1	2	3	4	5
(b)	5	2	3	4	1
(c)	1	3	2	4	5
(d)	2	3	4	5	1

Ans. **(d)**

Capacitor discharging equation

$$V_C = E\, e^{-t/RC}$$

Time constant $(\tau) = R_C$

$$V_C = E\, e^{-t/\tau}$$

At $t = \tau$,

$$V_C = E\, e^{-1} = 0.368\, E = 36.8\% \text{ of } E$$

At $t = 2\tau$,

$$V_C = E\, e^{-2} = 0.135\, E = 13.5\% \text{ of } E$$

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At $t = 3\tau$,

$$V_C = E\ e^{-3} = 0.05\ E = 5\%\ \text{of}\ E$$

At $t = 4\tau$,

$$V_C = E\ e^{-4} = 0.0187\ E = 1.87\%\ \text{of}\ E$$

At $t = 5\tau$,

$$V_C = E\ e^{-5} = 0.0007\ E = 0.67\%\ \text{of}\ E$$

End of Solution

Q.144 A single-range laboratory-type potentiometer has an 18-step dial switch where each step represents 0.1 V. The dial resistors are 10 Ω each. The slide wire of the potentiometer is circular and has 11 turns and a resistance of 1 Ω per turn. The slide wire has 100 divisions and interpolation can be done to one-fourth of a division. What is the measuring range of the potentiometer?

(a) 1.1 V   (b) 0.25 V

(c) 1.91 V   (d) 0.01 V

Ans.   (c)

18-step dial, each step = 0.1 V

Maximum dial voltage = 18 × 0.1 = 1.8 V

Slide wire resistance,

11 turns = 11 Ω

Total dial resistance = 18 × 10 = 180 Ω

$$\text{Voltage per ohm} = \frac{0.1}{10} = 0.01\ \text{V/}\Omega$$

$$\text{Resistance per division} = \frac{1\Omega}{100} = 0.01\Omega$$

Since interpolation is upto $\frac{1}{4}$ division

$$\frac{0.01}{4} = 0.0025\ \Omega$$

Smallest voltage = 0.0025 × 0.01

= 0.000025 V

Very small indicates high resolution

Total range = Dial range + Slide wire voltage

= 1.8 + 11 × 0.01

= 1.91 V

End of Solution

Q.145 Consider the following statements regarding Maxwell's bridge:

1. Maxwell's bridge is limited to measurement of low Q inductors.
2. The final balance equations of Maxwell's bridge are dependent of frequency.
3. The balance equation of Maxwell's bridge is dependent of losses associated with the inductor.

Which of the above statements is/are correct?

(a) 2 and 3   (b) 2 only
(c) 1 only   (d) 1 and 3

Ans.   (c)

- Maxwell's bridge works best for medium $Q(1 - 10)$ coils. It is not suitable for high Q coils (Hay's bridge is used there). So effectively it is used for relatively low Q inductors.
- One major advantage of Maxwell bridge is that the balance condition does not depend on frequency.

End of Solution

Q.146 Match the following Lists:

List-I (Name of the bridge)   List-II (Inductance equation)

P.   Maxwell's inductance bridge   1. $L_1 = \dfrac{R_2 R_3 C_4}{1 + \omega^2 R_4^2 C_4^2}$

Q.   Hay's bridge   2. $L_1 = C\dfrac{R_3}{R_4}[r(R_2 + R_4) + R_2 R_4]$

R.   Anderson's bridge   3. $L_1 = L_2 \dfrac{R_3}{R_4}$

S.   Owen's bridge   4. $L_1 = R_2 R_3 C_4$

Select the correct answer using the code given below.

	P	Q	R	S
(a)	3	1	2	4
(b)	4	1	3	2
(c)	3	2	4	1
(d)	3	2	1	4

Ans.   (a)

End of Solution

Q.147 The coil of a moving-coil voltmeter is 40 mm long and 30 mm wide, and has 100 turns on it. The control spring exerts a torque of 240×10^{-6} N-m when the deflection is 100 divisions on full scale. If the flux density of the magnetic field in the air gap is 1 Wb/m^2, what is the resistance that must be put in series with the coil to give one volt per division? (The resistance of the voltmeter coil may be neglected)

(a) $120 \times 10^3\ \Omega$ (b) $50 \times 10^3\ \Omega$
(c) $5 \times 10^3\ \Omega$ (d) $12 \times 10^3\ \Omega$

Ans.   (b)

Given,   Length, l = 40 mm = 0.04 m
Width, b = 30 mm = 0.03 m
Turn, N = 100
Flux density, B = 1 Wb/m^2

Control torque at full scale $T_C = 240 \times 10^{-6}$ N-m

Full scale voltage = 100 V

$T_d = NBIA$

$A = l \times b = 0.04 \times 0.03 = 0.0012 \text{ m}^2$

$240 \times 10^{-6} = 100 \times 1 \times I \times 0.0012$

$I = 2 \times 10^{-3}$ A

Series resistance, $R = \dfrac{V}{I} = \dfrac{100}{0.002} = 50 \times 10^3 \ \Omega$

End of Solution

Q.148 Consider the following statements regarding moving-iron instruments:

1. Moving-iron instruments have their deflection proportional to the square of the current flowing through the coil.
2. Moving-iron instruments have uniform scale marking.
3. Whatever be the polarity of the current in the coil, the deflection of a moving-iron instrument is in the same direction.

Which of the above statements is/are correct?

(a) 2 and 3   (b) 2 only

(c) 1 only   (d) 1 and 3

Ans. **(d)**

- Deflection $\propto$ square of current.
- Moving-Iron has non-uniform scale.
- Deflection independent of current polarity.

End of Solution

Q.149 What is the equation for deflection of the pointer in an electrodynamometer-type instrument when it is operated with AC?

(a) $\theta = \dfrac{I_1 I_2}{k} \cos\phi \dfrac{dM}{d\theta}$

(b) $\theta = \dfrac{I^2}{k} \dfrac{dM}{d\theta} \int_0^T i^2 dt$

(c) $\theta = \dfrac{I_1 I_2}{k} \dfrac{dM}{d\theta}$

(d) $\theta = \dfrac{1}{k} \dfrac{dM}{d\theta} \dfrac{1}{T} \int_0^T i^2 dt$

Ans. **(a)**

Deflection is proportional to:

$$\theta \propto I_1 I_2 \cos\phi \dfrac{dM}{d\theta}$$

Including spring constant K:

$$\theta = \dfrac{I_1 I_2 \cos\phi}{K} \dfrac{dM}{d\theta}$$

End of Solution

Q.150 Consider the following statements regarding induction-type instruments:
1. If $\alpha = 0$, i.e., if two fluxes are in phase, then the net torque is maximum. If, on the other hand, $\alpha = 90°$, the net torque is maximum for given values of ϕ_{1m} and ϕ_{2m}.
2. The net torque is in such direction as to rotate the disc from the pole with lagging flux towards the pole with leading flux.
3. The expression for torque has a steady value at all times.

Which of the above statements is/are correct?

(a) 1 and 2   (b) 2 and 3

(c) 1 only   (d) 1 and 3

Ans. **(b)**
- Torque maximum at $\alpha = 90°$
- Disc move from lagging flux pole to leading flux pole.
- Torque has average (steady) value.

End of Solution

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