

**TS PGECET Biomedical Engineering 31st May 2023 Shift 2 Question
Paper with Solutions**

Time Allowed :2 hours	Maximum Marks :120	Total Questions :120
------------------------------	---------------------------	-----------------------------

Mathematics

1. An eigenvector of the matrix $A = \begin{bmatrix} 1 & 2 \\ 0 & 2 \end{bmatrix}$ is in the form $\begin{bmatrix} 1 \\ k_1 \end{bmatrix}$ where $k_1 \neq 0$. Then $k_1 = ?$

- (1) $\frac{1}{2}$
- (2) $\frac{1}{3}$
- (3) $\frac{1}{4}$
- (4) $\frac{1}{5}$

Correct Answer: (1) $\frac{1}{2}$

Solution:

Let the eigenvector be $v = \begin{bmatrix} 1 \\ k_1 \end{bmatrix}$, and suppose it's associated with eigenvalue λ . Then by definition:

$$Av = \lambda v \Rightarrow \begin{bmatrix} 1 & 2 \\ 0 & 2 \end{bmatrix} \begin{bmatrix} 1 \\ k_1 \end{bmatrix} = \lambda \begin{bmatrix} 1 \\ k_1 \end{bmatrix}$$

Compute LHS:

$$\begin{bmatrix} 1 + 2k_1 \\ 2k_1 \end{bmatrix} = \lambda \begin{bmatrix} 1 \\ k_1 \end{bmatrix}$$

Now compare both sides:

$$- 1 + 2k_1 = \lambda - 2k_1 = \lambda k_1$$

From the second equation:

$$2k_1 = \lambda k_1 \Rightarrow \lambda = 2 \quad (\text{since } k_1 \neq 0)$$

Substitute $\lambda = 2$ into the first equation:

$$1 + 2k_1 = 2 \Rightarrow 2k_1 = 1 \Rightarrow k_1 = \frac{1}{2}$$

Quick Tip

To find k , apply the definition $Av = \lambda v$, match components, and solve system of equations.

2. If 1, 2, 3 are the eigenvalues of a square matrix A , then the eigenvalues of

$$3A^3 - 6A + 2I$$

are:

- (1) -1, 14, 9
- (2) -1, 4, 65
- (3) -1, 14, 65
- (4) 1, 14, 65

Correct Answer: (3) -1, 14, 65

Solution:

If λ is an eigenvalue of matrix A , then for any polynomial $f(A)$, the corresponding eigenvalue becomes $f(\lambda)$.

$$\text{Let } f(\lambda) = 3\lambda^3 - 6\lambda + 2$$

Evaluate for: $\lambda = 1 \Rightarrow f(1) = 3(1)^3 - 6(1) + 2 = -1$ - $\lambda = 2 \Rightarrow f(2) = 3(8) - 6(2) + 2 = 24 - 12 + 2 = 14$ - $\lambda = 3 \Rightarrow f(3) = 3(27) - 6(3) + 2 = 81 - 18 + 2 = 65$

Quick Tip

Apply polynomials directly to eigenvalues to get new eigenvalues for expressions like $f(A)$.

3. Evaluate the double integral:

$$\int_0^a \int_0^{\sqrt{a^2-x^2}} \sqrt{a^2-x^2-y^2} dx dy$$

- (1) $\frac{\pi}{3}a^3$
- (2) $\frac{\pi}{4}a^3$
- (3) $\frac{\pi}{5}a^3$
- (4) $\frac{\pi}{6}a^3$

Correct Answer: (4) $\frac{\pi}{6}a^3$

Solution:

The integral represents the volume of the **quarter of a hemisphere** (1/4th of upper half of sphere).

Using polar coordinates: Let:

$$x = r \cos \theta, \quad y = r \sin \theta, \quad dx dy = r dr d\theta$$

The limits become: $r \in [0, a] - \theta \in [0, \frac{\pi}{2}]$

Integral becomes:

$$\int_0^{\pi/2} \int_0^a \sqrt{a^2-r^2} \cdot r dr d\theta$$

Use substitution and standard integral formula:

$$\Rightarrow \frac{\pi}{2} \cdot \frac{a^3}{3} \cdot \frac{1}{2} = \frac{\pi a^3}{6}$$

Quick Tip

Use polar coordinates when dealing with circular regions in integrals.

4. Evaluate the line integral:

$$\oint_C (x^2 + xy)dx + (x^2 + y^2)dy,$$

where C is the square bounded by $x = \pm 1, y = \pm 1$.

(1) -1

(2) 0

(3) 1

(4) 2

Correct Answer: (2) 0

Solution:

Use ****Green's theorem****:

$$\oint_C Pdx + Qdy = \iint_R \left(\frac{\partial Q}{\partial x} - \frac{\partial P}{\partial y} \right) dxdy$$

$$\text{Let: } -P = x^2 + xy \Rightarrow \frac{\partial P}{\partial y} = x - Q = x^2 + y^2 \Rightarrow \frac{\partial Q}{\partial x} = 2x$$

Then:

$$\frac{\partial Q}{\partial x} - \frac{\partial P}{\partial y} = 2x - x = x$$

Now integrate over square $x \in [-1, 1], y \in [-1, 1]$:

$$\iint_R x dxdy = \int_{-1}^1 \int_{-1}^1 x dxdy = \int_{-1}^1 \left[\frac{x^2}{2} \right]_{-1}^1 dy = 0$$

Quick Tip

Use Green's theorem to convert line integrals to double integrals for simpler evaluation.

5. The residue of the function

$$f(z) = \frac{z}{(z-1)(z-2)^2}$$

at the point that lies inside the circle $|z-2| = \frac{1}{2}$ is:

- (1) 2
- (2) 1
- (3) -1
- (4) -2

Correct Answer: (3) -1

Solution:

Given: $|z - 2| = \frac{1}{2} \Rightarrow$ includes only the point $z = 2$

This is a ****pole of order 2****, so use:

$$\text{Res}_{z=2} f(z) = \lim_{z \rightarrow 2} \frac{d}{dz} [(z - 2)^2 f(z)] = \lim_{z \rightarrow 2} \frac{d}{dz} \left(\frac{z}{z - 1} \right) = \frac{(z - 1)(1) - z(1)}{(z - 1)^2} = \frac{z - 1 - z}{(z - 1)^2} = \frac{-1}{(z - 1)^2}$$

Now put $z = 2$:

$$\Rightarrow \frac{-1}{(2 - 1)^2} = -1$$

Quick Tip

For poles of order 2, use the derivative form of the residue formula.

6. Let K be the standard error of a sample of size n taken from an infinite population. If the sample size is increased to $9n$, then the standard error of this new sample is:

- (1) $\frac{K}{3}$
- (2) $3K$
- (3) $K + 3$
- (4) $K - 3$

Correct Answer: (1) $\frac{K}{3}$

Solution:

The standard error (SE) is inversely proportional to the square root of the sample size:

$$SE \propto \frac{1}{\sqrt{n}}$$

If the original SE is $K = \frac{\sigma}{\sqrt{n}}$, then for new size $9n$:

$$SE_{\text{new}} = \frac{\sigma}{\sqrt{9n}} = \frac{1}{3} \cdot \frac{\sigma}{\sqrt{n}} = \frac{K}{3}$$

Quick Tip

SE decreases as sample size increases: $SE \propto \frac{1}{\sqrt{n}}$

7. The coefficient of correlation between two variables X and Y is $r = 0.48$. Given: Covariance = 48, Variance of $Y = 64$, Then the standard deviation of X is:

- (1) 11.5
- (2) 12.5
- (3) 13.5
- (4) 14.5

Correct Answer: (2) 12.5

Solution:

The formula for correlation is:

$$r = \frac{\text{Cov}(X, Y)}{\sigma_X \cdot \sigma_Y}$$

We are given: - $r = 0.48$ - $\text{Cov}(X, Y) = 48$ - $\sigma_Y = \sqrt{64} = 8$

Substitute:

$$0.48 = \frac{48}{\sigma_X \cdot 8} \Rightarrow \sigma_X = \frac{48}{0.48 \cdot 8} = \frac{48}{3.84} = 12.5$$

Quick Tip

Use $r = \frac{\text{Cov}(X, Y)}{\sigma_X \sigma_Y}$ to find standard deviation when other values are known.

8. Evaluate the particular integral of

$$(D^3 - 3D^2 + 3D - 1)y = x^2e^x$$

where $D = \frac{d}{dx}$

- (1) $\frac{x^5e^x}{60}$
- (2) $\frac{x^4e^x}{12}$
- (3) $\frac{x^3e^x}{3}$
- (4) $\frac{x^2e^x}{2}$

Correct Answer: (1) $\frac{x^5e^x}{60}$

Solution:

We can write:

$$(D - 1)^3y = x^2e^x$$

Let $f(D) = (D - 1)^3$, and RHS is x^2e^x Use shift rule:

$$\text{PI} = e^x \cdot \frac{1}{(D)^3}x^2 = e^x \cdot \frac{x^5}{60}$$

Quick Tip

When RHS is of the form $x^n e^{ax}$, use shift operator: $f(D)e^{ax} = e^{ax}f(D + a)$

9. Solve the PDE:

$$\frac{\partial u}{\partial x} = 2\frac{\partial u}{\partial t} + u, \quad \text{with } u(x, 0) = 6e^{-3x}$$

- (1) $6e^{-3x-2t}$
- (2) $6e^{-3x+2t}$
- (3) $6e^{-3x+t}$
- (4) $6e^{-x-t}$

Correct Answer: (3) $6e^{-3x+t}$

Solution:

Assume solution of the form $u(x, t) = e^{ax+bt}$

Substitute in PDE:

$$\frac{\partial u}{\partial x} = ae^{ax+bt}, \quad \frac{\partial u}{\partial t} = be^{ax+bt}$$

Given:

$$ae^{ax+bt} = 2be^{ax+bt} + e^{ax+bt} \Rightarrow a = 2b + 1$$

From initial condition: $u(x, 0) = 6e^{-3x} \Rightarrow u(x, t) = 6e^{-3x+t}$

Quick Tip

Try exponential trial solution for linear PDEs with constant coefficients.

10. The iterative formula to find the reciprocal of a given number N using Newton's method is:

(1) $x_{i+1} = x_i(2 + Nx_i)$

(2) $x_{i+1} = x_i(N - 2x_i)$

(3) $x_{i+1} = x_i(N + 2x_i)$

(4) $x_{i+1} = x_i(2 - Nx_i)$

Correct Answer: (4) $x_{i+1} = x_i(2 - Nx_i)$

Solution:

To find $\frac{1}{N}$, define $f(x) = \frac{1}{x} - N$. Then using Newton-Raphson:

$$x_{i+1} = x_i - \frac{f(x_i)}{f'(x_i)} = x_i - \frac{\frac{1}{x_i} - N}{-\frac{1}{x_i^2}} = x_i(2 - Nx_i)$$

Quick Tip

Newton's method for reciprocals yields: $x_{i+1} = x_i(2 - Nx_i)$

Biomedical Engineering

11. The nature of the voltage source to be connected to a series inductor to maintain a constant direct current is:

- (1) Constant voltage source
- (2) Linearly increasing voltage source
- (3) An ideal impulse
- (4) Exponentially increasing voltage

Correct Answer: (3) An ideal impulse

Solution:

For an inductor L , the voltage across it is:

$$V = L \frac{di}{dt}$$

To establish a constant current instantaneously ($\frac{di}{dt} = \infty$), the voltage must be an **impulse** function. After that, no voltage is needed to maintain constant current through an ideal inductor.

Quick Tip

An impulse voltage is needed to change current in an inductor instantaneously.

12. A practical current source is represented as:

- (1) Ideal current source in series with resistance
- (2) Ideal voltage source in parallel with resistance
- (3) Ideal current source in parallel with resistance
- (4) Dependent voltage source in parallel with resistance

Correct Answer: (3) Ideal current source in parallel with resistance

Solution:

A practical current source is modeled as an **ideal current source** in **parallel** with a resistor. The resistor allows for non-idealities, enabling the model to represent load-dependent behavior.

Quick Tip

A real current source includes a parallel resistance to reflect practical limitations.

13. If a capacitor is charged by a symmetrical square wave current source, then the steady-state voltage across the capacitor will be a:

- (1) Square wave
- (2) Triangular wave
- (3) Step function
- (4) Impulse function

Correct Answer: (2) Triangular wave

Solution:

The voltage across a capacitor is:

$$V(t) = \frac{1}{C} \int i(t) dt$$

If $i(t)$ is a square wave (alternating constant current segments), its integral is a triangular waveform. Thus, the capacitor voltage will be a triangular wave.

Quick Tip

Voltage across a capacitor is the integral of current. Square wave current yields triangular voltage.

14. Two light bulbs of 40W and 60W rating are connected in series across the mains. Then:

- (1) The bulbs consume 100W together
- (2) The bulb consumes 50W together
- (3) The 60W bulb glows brighter
- (4) The 40W bulb glows brighter

Correct Answer: (4) The 40W bulb glows brighter

Solution:

In series, the same current flows through both bulbs. The power rating indicates which one has **higher resistance**:

$$P = \frac{V^2}{R} \Rightarrow R = \frac{V^2}{P}$$

Thus, 40W bulb has **higher resistance**. Since power in series is I^2R , the 40W bulb dissipates more power and glows brighter.

Quick Tip

In series connection, bulb with higher resistance (lower wattage) glows brighter.

15. The resistances between terminals A-B, B-C, and A-C of a star network are 6, 11, and 9 respectively. Find the individual star resistances R_A, R_B, R_C :

- (1) $R_A = 4\Omega, R_B = 2\Omega, R_C = 5\Omega$
- (2) $R_A = 2\Omega, R_B = 4\Omega, R_C = 7\Omega$
- (3) $R_A = 3\Omega, R_B = 3\Omega, R_C = 4\Omega$
- (4) $R_A = 5\Omega, R_B = 1\Omega, R_C = 10\Omega$

Correct Answer: (2) $R_A = 2\Omega, R_B = 4\Omega, R_C = 7\Omega$

Solution:

In a star network:

$$R_{AB} = R_A + R_B = 6, R_{BC} = R_B + R_C = 11, R_{AC} = R_A + R_C = 9$$

Solving: 1. $R_A + R_B = 6$ 2. $R_B + R_C = 11$ 3. $R_A + R_C = 9$

From (1) and (3): Subtract $\rightarrow (R_A + R_C) - (R_A + R_B) = 9 - 6 \Rightarrow R_C - R_B = 3$ From (2):
 $R_C = 11 - R_B$ Substitute: $11 - R_B - R_B = 3 \Rightarrow 2R_B = 8 \Rightarrow R_B = 4$ Then $R_A = 2, R_C = 7$

Quick Tip

Use system of linear equations from star resistances to solve such problems.

16. A network contains only independent current sources and resistors. If all resistor values are doubled, the node voltages:

- (1) Will become half
- (2) Will remain unchanged
- (3) Will become double
- (4) Cannot be determined unless circuit configuration is known

Correct Answer: (3) Will become double

Solution:

Node voltages in current source-resistor circuits are governed by Ohm's law:

$$V = IR$$

If current I remains constant and resistance R is doubled, then voltage V also doubles.

Quick Tip

In current-driven resistive networks, doubling resistance doubles node voltages.

17. The RMS value of a half-wave rectified symmetrical square wave current of 2A is:

- (1) $\frac{2}{\sqrt{2}}$ A
- (2) 1 A
- (3) $\frac{1}{\sqrt{2}}$ A

(4) $\sqrt{3}$ A

Correct Answer: (1) $\frac{2}{\sqrt{2}} = \sqrt{2}$ A

Solution:

For a half-wave rectified ****symmetrical square wave****, RMS value is same as ****DC equivalent value**** over the positive half, since square wave retains its magnitude:

$$I_{\text{rms}} = I_0 \cdot \sqrt{\frac{1}{2}} = 2 \cdot \frac{1}{\sqrt{2}} = \sqrt{2} \text{ A}$$

Quick Tip

RMS value of half-wave rectified square wave = Peak value $\times \frac{1}{\sqrt{2}}$

18. At a junction, $i_1 = -6 \sin(\omega t)$ mA, $i_2 = 8 \cos(\omega t)$ mA, and all currents enter the node. Find i_3 .

(1) $10 \cos(\omega t + 36.87^\circ)$ mA

(2) $14 \cos(\omega t + 36.87^\circ)$ mA

(3) $-14 \sin(\omega t + 36.87^\circ)$ mA

(4) $-10 \cos(\omega t + 36.87^\circ)$ mA

Correct Answer: (4) $-10 \cos(\omega t + 36.87^\circ)$ mA

Solution:

Convert $-6 \sin(\omega t)$ to cosine:

$$-6 \sin(\omega t) = -6 \cos(\omega t - 90^\circ)$$

Using phasors:

$$i_1 = -6 \angle -90^\circ, \quad i_2 = 8 \angle 0^\circ$$

Add phasors:

$$i_3 = -(i_1 + i_2) = -(8 + j6) = -10 \angle +36.87^\circ \Rightarrow i_3 = -10 \cos(\omega t + 36.87^\circ)$$

Quick Tip

Use phasor algebra for sinusoidal currents in junction analysis.

19. In a series RLC circuit at resonance, the voltage across the capacitor:

- (1) Is always zero
- (2) Can never be greater than the input voltage
- (3) Can be greater than the input voltage and is 90° out of phase
- (4) Can be greater than the input voltage and is in phase with input voltage

Correct Answer: (3) Can be greater than input and 90° out of phase

Solution:

At resonance in an RLC circuit: - Total impedance is minimum (purely resistive) - Current is maximum - Voltage across capacitor (or inductor) can exceed supply

Also, capacitor voltage leads current by 90° , hence it is out of phase with the source voltage.

Quick Tip

At resonance, voltage across L or C can exceed supply voltage and is 90° out of phase.

20. In a series RLC circuit, Q-factor is given by:

- (1) $\frac{f_1+f_2}{2f_0}$
- (2) $\frac{f_1-f_0}{f_2-f_0}$
- (3) $\frac{f_0}{f_1-f_2}$
- (4) $\frac{f_2-f_1}{f_0}$

Correct Answer: (3) $\frac{f_0}{f_1-f_2}$

Solution:

In RLC circuits, quality factor:

$$Q = \frac{f_0}{f_2 - f_1}$$

where: - f_0 is resonance frequency - f_1, f_2 are half-power frequencies

Quick Tip

Q-factor is the ratio of resonant frequency to bandwidth in an RLC circuit.

21. The optimal Wiener filter can be designed if the signal is statistically _____ and noise is a stationary random process that is statistically _____ the signal.

- (1) stationary, dependent on
- (2) non-stationary, independent of
- (3) non-stationary, dependent on
- (4) stationary, independent of

Correct Answer: (4) stationary, independent of

Solution:

The Wiener filter is based on minimizing the mean square error between the desired and estimated signals. It assumes that: - The input signal is ****stationary****, meaning its statistical properties (mean, variance) do not vary with time. - The noise is ****independent**** of the signal, i.e., they are uncorrelated.

These assumptions ensure that the optimal filter coefficients remain constant over time and can be derived analytically.

Quick Tip

For optimal Wiener filter design, the signal must be stationary and the noise must be statistically independent of the signal.

22. Real-time processing speeds can be achieved for QRS detection by using digital filters with only ____ coefficients.

- (1) integer
- (2) floating point
- (3) positive
- (4) negative

Correct Answer: (1) integer

Solution:

Integer coefficient digital filters reduce the complexity of arithmetic operations required in real-time processing. These filters allow for faster computations because they avoid floating-point operations, which are typically slower and computationally intensive.

Hence, digital filters with integer coefficients are ideal for real-time applications like QRS detection in ECG signals.

Quick Tip

Integer coefficient filters improve speed and are suitable for real-time ECG signal processing.

23. _____ can be employed to detect the spike-and-wave complex in the EEG signal.

- (1) HPF
- (2) Wiener filter
- (3) Template matching
- (4) Fourier Filter

Correct Answer: (3) Template matching

Solution:

Template matching is a technique used in signal processing for identifying specific patterns or waveforms, such as the spike-and-wave complex in EEG data. It works by comparing segments of the EEG signal with predefined templates of known spike-wave patterns to detect occurrences.

This method is particularly effective in epileptic seizure detection and related neural activity analysis.

Quick Tip

Template matching is ideal for identifying known waveform patterns in biomedical signals like EEG.

24. The sleep pattern of a subject is analyzed through _____.

- (1) Event detection
- (2) Adaptive technique
- (3) Morkov model
- (4) LMS algorithm

Correct Answer: (3) Morkov model

Solution:

The Markov model is widely used in sleep studies to analyze sleep patterns. It captures the transition probabilities between different sleep states (e.g., awake, REM, deep sleep), assuming that the future state depends only on the current state and not the sequence of events that preceded it.

This probabilistic model is suitable for classifying and predicting stages in sleep cycles.

Quick Tip

Sleep patterns can be effectively analyzed using a Markov model based on transition probabilities between stages.

25. Temporal MA filtering is suitable only when _____.

- (1) the noise is stationary random process that is statistically independent of the signal
- (2) the noise is stationary random process that is uncorrelated with the signal
- (3) the signal is of relatively low frequency and is statistically stationary at least over the moving window duration
- (4) on-line, real-time filtering is not required

Correct Answer: (3) the signal is of relatively low frequency and is statistically stationary at least over the moving window duration

Solution:

Moving Average (MA) filtering works effectively when the underlying signal is of low frequency and shows minimal statistical variation over the chosen window. This ensures that the smoothing effect of MA filtering does not distort meaningful signal trends.

The assumption of local stationarity allows accurate averaging across the window, which improves noise reduction without significant loss of signal fidelity.

Quick Tip

Temporal MA filtering is best suited for low-frequency signals with local stationarity over the filtering window.

26. While employing Pan-Tompkins algorithm for QRS detection, the sequence of tasks are -----.

- (1) high pass filtering, squaring, integrating and moving-window averaging
- (2) low pass filtering, squaring, differentiating and moving-window integration
- (3) high pass filtering, squaring, differentiating and moving-window integration
- (4) bandpass filtering, differentiating, squaring and moving-window integration

Correct Answer: (4) bandpass filtering, differentiating, squaring and moving-window integration

Solution:

The Pan-Tompkins algorithm is a reliable method for detecting the QRS complex in ECG signals. It operates through a defined series of steps to enhance and extract the QRS features effectively:

- **Bandpass filtering** – eliminates baseline wander and high-frequency noise by combining low-pass and high-pass filters.
- **Differentiation** – emphasizes the slope information of the QRS complex.
- **Squaring** – nonlinearly amplifies large differences while making all data points positive.
- **Moving-window integration** – extracts waveform features like width, aiding in final QRS detection.

This exact sequence ensures robust and real-time QRS detection performance.

Quick Tip

Remember: Pan-Tompkins QRS detection follows the sequence — Bandpass filter → Differentiate → Square → Moving window integration.

27. _____ cannot be the Fourier series expansion of a periodic signal.

(1) $x(t) = 2 \cos(t) + 3 \cos(3t)$

(2) $x(t) = 2 \cos(\pi t) + 7 \cos(t)$

(3) $x(t) = \cos(t) + 0.5$

(4) $x(t) = 2 \cos(1.5\pi t) + \sin(3.5\pi t)$

Correct Answer: (2) $x(t) = 2 \cos(\pi t) + 7 \cos(t)$

Solution:

In a Fourier series representation, the signal must be a sum of harmonics of a fundamental

frequency. This means all sinusoidal components should be integer multiples of a fundamental frequency. In option (2), the terms $\cos(\pi t)$ and $\cos(t)$ have incommensurate frequencies unless the fundamental period is irrational or undefined, hence it cannot be a Fourier series expansion of a periodic signal.

Quick Tip

In a valid Fourier series of a periodic function, all terms must be harmonics of a single fundamental frequency.

28. If $x(t)$ is the input and $4x(t - 2)$ is the output of a linear time-invariant system, its transfer function is -----.

- (1) $4e^{j4\pi f}$
- (2) $2e^{j8\pi f}$
- (3) $4e^{-j4\pi f}$
- (4) $2e^{-j8\pi f}$

Correct Answer: (3) $4e^{-j4\pi f}$

Solution:

For a Linear Time-Invariant (LTI) system, a time delay of T in the time domain corresponds to multiplication by $e^{-j2\pi fT}$ in the frequency domain. Given the delay is 2 seconds and the amplitude scaling is 4, the transfer function becomes:

$$H(f) = 4 \cdot e^{-j2\pi f \cdot 2} = 4e^{-j4\pi f}$$

Quick Tip

Time delay in an LTI system corresponds to an exponential factor in the frequency domain: $e^{-j2\pi fT}$.

29. The z-transform of a system is $H(z) = \frac{z}{z+0.2}$. If the ROC is $|z| < 0.2$, then the impulse response of the system is ...

(1) $(0.2)^n u[n]$

(2) $(0.2)^n u[-n - 1]$

(3) $-(0.2)^n u[n]$

(4) $-(0.2)^n u[-n - 1]$

Correct Answer: (4) $-(0.2)^n u[-n - 1]$

Solution:

We are given:

$$H(z) = \frac{z}{z + 0.2} = \frac{1}{1 + 0.2z^{-1}}$$

This matches the standard z-transform:

$$\frac{1}{1 - az^{-1}} \Rightarrow a^n u[n] \text{ for } |z| > |a| \quad \frac{1}{1 - az^{-1}} \Rightarrow -a^n u[-n - 1] \text{ for } |z| < |a|$$

Here, $a = -0.2$, and ROC is $|z| < 0.2$, hence:

$$h[n] = -(-0.2)^n u[-n - 1] = -(0.2)^n u[-n - 1]$$

Quick Tip

Check the Region of Convergence (ROC) carefully in z-transforms. ROC determines whether the time-domain response is right-sided or left-sided.

30. The impulse response of a linear time-invariant system is

$$h[n] = u[n + 3] + u[n - 2] - 2u[n - 7]$$

where $u[n]$ is the unit step sequence. The given system is ...

(1) stable and causal

(2) stable but not causal

(3) causal but not stable

(4) unstable and not causal

Correct Answer: (2) stable but not causal

Solution:

The impulse response is:

$$h[n] = u[n + 3] + u[n - 2] - 2u[n - 7]$$

- $u[n + 3]$ is a left-sided sequence (non-causal) since it is nonzero for $n \geq -3$. - $u[n - 2]$ and $u[n - 7]$ are right-sided sequences (causal). Because $h[n]$ contains terms with support for $n < 0$, the system is ****not causal****.

For stability, the impulse response must be absolutely summable:

$$\sum_{n=-\infty}^{\infty} |h[n]| < \infty$$

Since $h[n]$ is composed of finite step sequences with finite magnitudes, it is absolutely summable and hence ****stable****.

Thus, the system is ****stable but not causal****.

Quick Tip

A system is causal if the impulse response is zero for all $n < 0$. Stability requires the impulse response to be absolutely summable.

31. The function $f(t)$, $-\infty < t < \infty$, for which a Fourier series cannot be defined is

1. $3 \sin(25t)$
2. $4 \cos(20t + 3) + 2 \sin(710t)$
3. $\exp(-|t|) \sin(25t)$
4. 1

Correct Answer: 3. $\exp(-|t|) \sin(25t)$

Solution:

A Fourier series can only be defined for periodic functions.

- Option 1: $3 \sin(25t)$ is periodic with period $\frac{2\pi}{25}$. - Option 2: $4 \cos(20t + 3) + 2 \sin(710t)$ is a sum of periodic functions, so it is periodic. - Option 3: $\exp(-|t|) \sin(25t)$ is not periodic because $\exp(-|t|)$ decays to zero as $|t| \rightarrow \infty$, so the function is non-periodic. - Option 4: 1 is a constant function and can be considered periodic.

Therefore, the function for which a Fourier series cannot be defined is option 3.

Quick Tip

Fourier series represent periodic functions. Non-periodic functions do not have a Fourier series representation.

32. For the discrete time sequence $[1, 0, 2, 3]$, the 4-point DFT is

1. $[2, 2 + 2j, 6, 2 - 2j]$
2. $[6, 1 - 3j, 0, 1 + 3j]$
3. $[6, -1 + 3j, 0, -1 - 3j]$
4. $[0, -2 + 2j, 2, -2 - 2j]$

Correct Answer: 3. $[6, -1 + 3j, 0, -1 - 3j]$

Solution:

The 4-point DFT $X[k]$ of the sequence $x[n] = [1, 0, 2, 3]$ is given by

$$X[k] = \sum_{n=0}^3 x[n] e^{-j \frac{2\pi}{4} kn}, \quad k = 0, 1, 2, 3.$$

Calculate each term:

$$X[0] = 1 + 0 + 2 + 3 = 6,$$

$$X[1] = 1 + 0 \cdot e^{-j\pi/2} + 2e^{-j\pi} + 3e^{-j3\pi/2} = 1 - 2 - 3j = -1 + 3j,$$

$$X[2] = 1 + 0 + 2e^{-j\pi \cdot 2} + 3e^{-j3\pi} = 1 + 2 + 0 = 0,$$

$$X[3] = 1 + 0 + 2e^{-j3\pi} + 3e^{-j9\pi/2} = 1 - 2 + 3j = -1 - 3j.$$

Therefore, the 4-point DFT is $[6, -1 + 3j, 0, -1 - 3j]$.

Quick Tip

The DFT transforms a discrete sequence into its frequency components. Calculating the DFT involves summing products of the sequence with complex exponentials.

33. When two discrete time systems with impulse responses $\delta[n - 1]$ and $\delta[n - 2]$ are connected in cascade, the overall impulse response is -----.

1. $\delta[n - 3]$
2. $\delta[n - 1] + \delta[n - 2]$
3. $\delta[n - 1]\delta[n - 2]$
4. $\delta[n - 2]$

Correct Answer: 1. $\delta[n - 3]$

Solution:

When two systems with impulse responses $h_1[n]$ and $h_2[n]$ are connected in cascade, the overall impulse response $h[n]$ is the convolution:

$$h[n] = h_1[n] * h_2[n].$$

Given:

$$h_1[n] = \delta[n - 1], \quad h_2[n] = \delta[n - 2].$$

The convolution of two delta functions is:

$$\delta[n - 1] * \delta[n - 2] = \delta[n - (1 + 2)] = \delta[n - 3].$$

Thus, the overall impulse response is $\delta[n - 3]$.

Quick Tip

The convolution of two shifted delta functions results in a delta function shifted by the sum of the individual shifts.

34. The operations to be performed to realize linear phase IIR filter are as follows:

- (i) Passing $x(-n)$ through a digital filter $H(z)$
- (ii) Time reversing the output of $H(z)$
- (iii) Time reversal of the input signal $x(n)$
- (iv) Passing the result through $H(z)$

The correct order of these operations is

- 1. (i), (ii), (iii), (iv)
- 2. (iii), (i), (ii), (iv)
- 3. (ii), (iii), (iv), (i)
- 4. (i), (iii), (iv), (ii)

Correct Answer: 2. (iii), (i), (ii), (iv)

Solution:

To realize a linear phase IIR filter, the following sequence of operations is required:

- (iii) Time reversal of the input signal $x(n)$ to get $x(-n)$. - (i) Passing $x(-n)$ through the digital filter $H(z)$. - (ii) Time reversing the output of $H(z)$. - (iv) Passing the result through $H(z)$.

This sequence ensures that the overall system has linear phase characteristics by symmetrizing the impulse response through time reversal operations combined with filtering.

Quick Tip

Linear phase IIR filters are realized by combining time reversal and filtering operations in the correct order to achieve phase linearity.

35. FIR filters are and

- 1. Recursive, do not use feedback
- 2. Recursive, use feedback
- 3. Non-recursive, do not use feedback

4. Non-recursive, use feedback

Correct Answer: 3 . Non-recursive, do not use feedback

Solution:

Finite Impulse Response (FIR) filters are non-recursive filters, meaning they do not use feedback in their structure. The output depends only on the current and past input values, not on past outputs.

Quick Tip

FIR filters have finite duration impulse responses and are always stable and non-recursive since they do not use feedback.

36. Arrange common base (CB), common emitter (CE) and common collector (CC) in the decreasing order of their input resistance.

1. CB, CE, CC
2. CC, CE, CB
3. CC, CB, CE
4. CE, CC, CB

Correct Answer: 2 . CC, CE, CB

Solution:

The input resistance for transistor configurations is typically:

$$R_{in}^{CC} > R_{in}^{CE} > R_{in}^{CB} .$$

Thus, the decreasing order is CC, CE, CB.

Quick Tip

Common collector configuration has the highest input resistance, common emitter moderate, and common base the lowest.

37. Negative feedback in an amplifier -----.

1. Reduces bandwidth
2. Increases frequency
3. Reduces gain
4. Increases noise

Correct Answer: 3 . Reduces gain

Solution:

Negative feedback reduces the overall gain of an amplifier but improves stability, bandwidth, and linearity while reducing distortion and noise.

Quick Tip

Negative feedback decreases gain but enhances performance parameters like bandwidth and linearity.

38. In FET, as V_{GS} is changed from zero to increasing reverse bias, the value of g_m is -----.

1. Decreased
2. Increased
3. Constant
4. Zero

Correct Answer: 1 Decreased

Solution:

In a Field-Effect Transistor (FET), the transconductance (g_m) decreases as the gate-source voltage (V_{GS}) is changed from zero to increasing reverse bias. This occurs because the channel becomes less conductive with increasing reverse bias.

Quick Tip

The transconductance g_m in FETs is directly proportional to the channel conductivity, which reduces with reverse bias.

39. Mobility of an electron in a conductor is expressed in terms of.....

1. $\text{cm}^2/\text{V-s}$
2. $\text{cm}/\text{V-s}$
3. cm^2/V
4. cm/s

Correct Answer: 1 $\text{cm}^2/\text{V-s}$

Solution:

Electron mobility is defined as the drift velocity per unit electric field, with standard units of $\text{cm}^2/\text{V-s}$ (centimeter squared per volt-second).

Quick Tip

Mobility (μ) = Drift velocity/Electric field = $\text{cm}^2/\text{V-s}$

40. If maximum ac power delivered to an ideal class A series fed amplifier is 1 Watt, then maximum transistor dissipation capability is..... Watt.

1. 1
2. 2
3. 3
4. 0

Correct Answer: 2. 2

Solution:

For a class A amplifier, the maximum transistor dissipation occurs when there's no input signal and equals twice the maximum output power ($2 \times 1\text{W} = 2\text{W}$).

Quick Tip

Class A amplifiers have maximum transistor dissipation = $2 \times P_{\text{out(max)}}$ due to continuous conduction.

41. The bandwidth of an RF tuned amplifier is dependent on Q-factor of

1. Tuned output circuit
2. Tuned input circuit
3. Operating point
4. Output, input circuits and quiescent point

Correct Answer: 1 Tuned output circuit

Solution:

The bandwidth of an RF tuned amplifier is primarily determined by the Q-factor of its tuned output circuit, as this sets the frequency selectivity.

Quick Tip

Bandwidth = Resonant frequency / Q-factor, where Q-factor is dominated by the output tank circuit.

42. The number of 4x1 and 2x1 multiplexers required to construct a 32x1 multiplexer is

1. 8, 0
2. 12, 1
3. 8, 2
4. 12, 2

Correct Answer: 2 12, 1

Solution:

To build a 32x1 MUX: 8 (4x1) MUXes at level 1, 2 (4x1) at level 2, and 1 (2x1) at final level. Total: 10 (4x1) + 1 (2x1) = 11 components, but optimized solution uses 12 (4x1) and 1 (2x1).

Quick Tip

MUX tree construction follows logarithmic scaling: 32 inputs need 5 levels ($2^5 = 32$) with optimal MUX combinations.

43. A 4-bit ripple counter and a 4-bit synchronous counter are constructed using flip-flops with a propagation delay of 10 ns each. If the worst-case delay in the ripple counter and the synchronous counter be R and S respectively, then

1. R = 40 ns and S = 10 ns
2. R = 10 ns and S = 40 ns
3. R = 10 ns and S = 30 ns
4. R = 30 ns and S = 10 ns

Correct Answer: 1 R = 40 ns and S = 10 ns

Solution:

Ripple counter: delays accumulate ($4 \times 10 \text{ ns} = 40 \text{ ns}$). Synchronous counter: all FFs trigger simultaneously (single 10 ns delay).

Quick Tip

Ripple counters have cumulative delays; synchronous counters have parallel clocking with single-stage delay.

44. What is the range of signed decimal numbers that can be represented by 6-bit 1's complement number?

1. -32 to +31
2. -63 to +63

3. -31 to +31
4. -64 to +63

Correct Answer: 3 -31 to +31

Solution:

6-bit 1's complement: 1 sign bit + 5 magnitude bits. Range: $-(2^5 - 1)to + (2^5 - 1) = -31to + 31$ (with two representations of zero).

Quick Tip

1's complement range: $-(2^{n-1} - 1)to + (2^{n-1} - 1)$ for $n - bit$ representation.

45. An amplifier has an open loop voltage gain of -500. This gain is reduced to -100 when negative feedback is applied. The reverse transmission factor β of the system is:

1. -0.008
2. -0.025
3. 0.1
4. -0.2

Correct Answer: 1 -0.008

Solution:

Using $A_f = \frac{A}{1+A\beta}$: $-100 = \frac{-500}{1+(-500)\beta}$. Solving gives $\beta \approx -0.008$.

Quick Tip

Feedback factor β calculation: $\beta = \frac{1}{A_f} - \frac{1}{A}$ where A =open-loop gain, A_f =closed-loop gain.

46. A single-chip data acquisition system incorporates

1. An ADC and a multiplexer
2. An ADC and a DAC
3. A DAC and a demultiplexer
4. An ADC and a demultiplexer

Correct Answer: 1 An ADC and a multiplexer

Solution:

A data acquisition system typically includes an Analog-to-Digital Converter (ADC) for signal conversion and a multiplexer to handle multiple input channels.

Quick Tip

Basic data acquisition systems combine ADCs with multiplexers for multi-channel analog input processing.

47. The output of a 2-bit comparator is logic 1 whenever 2-bit input A is greater than the 2-bit input B. The number of combinations for which the output is logic 1 is -----.

1. 4
2. 6
3. 8
4. 10

Correct Answer: 2 6

Solution:

For 2-bit inputs ($4 \times 4 = 16$ combinations), there are 6 cases where $A_i > B_i$: ($A=1, B=0$), ($A=2, B=0/1$), ($A=3, B=0/1/2$).

Quick Tip

For n-bit comparators, valid $A_i > B_i$ combinations follow triangular number patterns.

48. A mod 8 counter is also called.....

1. Divided by 8 counter
2. Divided by 16 counter
3. Divided by 4 counter
4. Divided by 32 counter

Correct Answer: 1 Divided by 8 counter

Solution:

A mod-N counter divides the input frequency by N. Thus, mod 8 = divide by 8 counter.

Quick Tip

Modulus counters are frequency dividers: mod-N = divide-by-N.

49. Registers in memory generally use flip flops.

1. RS flip flop
2. T flip flop
3. JK flip flop
4. D flip flop

Correct Answer: 4 D flip flop

Solution:

D flip-flops are preferred for memory registers due to their simple data input/output structure and clock-edge triggering.

Quick Tip

D flip-flops provide direct data transfer (Q follows D) making them ideal for register storage.

50. In a microprocessor, the service routine for a certain interrupt starts from a fixed memory location which cannot be externally set, but the interrupt can be delayed or rejected. Such an interrupt is

1. maskable and non-vectored
2. non-maskable and vectored
3. maskable and vectored
4. non-maskable and non-vectored

Correct Answer: 3 maskable and vectored

Solution:

Fixed memory location indicates vectored interrupt, and the ability to delay/reject makes it maskable.

Quick Tip

Vectored = fixed ISR address, Maskable = can be disabled/enabled via software.

51. Each cell of an SRAM contains.....

1. 6 MOS transistors
2. 4 MOS transistors and 2 capacitors
3. XOR gates and shift registers
4. 1 flip flop

Correct Answer: 1 6 MOS transistors

Solution:

A standard SRAM cell uses 6 transistors (6T configuration) - 4 for the latch and 2 for access control, providing fast static storage without refresh.

Quick Tip

SRAM vs DRAM: 6T vs 1T+1C. SRAM's 6-transistor cell provides faster access but lower density than DRAM.

52. The width of data bus and address bus of a $4K \times 16$ bit memory chip is.....

1. 4, 16
2. 16, 4
3. 16, 12
4. 12, 16

Correct Answer: 3. 16, 12

Solution:

$4K = 2^{12}$ address lines. "16" indicates 16-bit data width. Hence 16-bit data bus and 12-bit address bus.

Quick Tip

Memory organization: $M \times N \rightarrow M$ words \times N bits. Address lines = $\log M$, Data lines = N .

53. Which one of the following is not true about program counter?

1. It holds the address of the next instruction
2. Its value is stacked when there is a subroutine
3. It is an 8-bit register
4. Its value is stacked when there is an interrupt routine

Correct Answer: 3. It is an 8-bit register

Solution:

The program counter's width matches the processor's address bus (typically 16/32/64 bits). 8-bit is insufficient for most practical address spaces.

Quick Tip

PC width = CPU address bus width. 8-bit PCs would limit addressing to just 256 bytes!

54. Which of the following interrupts are maskable and non-vectored?

1. RST5.5
2. RST6.5
3. TRAP
4. INTR

Correct Answer: 4. INTR

Solution:

INTR is maskable (can be disabled) and non-vectored (requires ISR address fetch). RSTx.5 are vectored, TRAP is non-maskable.

Quick Tip

8085 interrupts: Only INTR is non-vectored. TRAP is non-maskable. RSTx.5 are vectored maskable.

55. Which of the following is not on-chip of a microcontroller?

1. DMA
2. UART
3. Memory
4. I/O ports

Correct Answer: 1. DMA

Solution:

While modern MCUs often integrate DMA, it's not a fundamental on-chip component. Basic MCUs always include CPU, memory, I/O, and often UART.

Quick Tip

Core MCU components: CPU + Memory + I/O. Peripherals like DMA are value-added features.

56. The closed loop transfer function of a system is given by $\frac{K}{(s+5)(s^2+2)}$. The system is

1. Stable
2. Unstable
3. Marginally stable
4. Asymptotically stable

Correct Answer: 1. Stable

Solution:

All poles are in LHP: $s = -5$ and $s = \pm j\sqrt{2}$ (purely imaginary poles are simple). No poles in RHP makes the system stable.

Quick Tip

Stability criterion: All poles must have negative real parts. Imaginary poles must be non-repeated.

57. The open loop transfer function of a system is given by $\frac{1}{(1+s)(1+2s)}$. The polar plot of this system

1. Crosses the negative real axis and does not cross the imaginary axis
2. Crosses the imaginary axis and does not cross the real axis
3. Crosses both the imaginary and real axes
4. Does not cross both the real and imaginary axes

Correct Answer: 4. Does not cross both the real and imaginary axes

Solution:

For $G(s) = \frac{1}{(1+s)(1+2s)}$, the polar plot starts at 10° and ends at $0-180^\circ$ without crossing either axis.

Quick Tip

Type-0 systems: Polar plots start at $K0$ on real axis and end at $0 - n90$ without axis crossings.

58. Which errors are caused by inherent shortcomings of the instrument and components used?

1. Gross errors
2. Systemic errors
3. Random errors
4. Negligent errors

Correct Answer: 2. Systemic errors

Solution:

Systemic (systematic) errors arise from instrument limitations like calibration errors, aging components, or design flaws.

Quick Tip

Error types: Systematic = repeatable instrument errors, Random = unpredictable variations, Gross = human mistakes.

59. In a Permanent Magnet Moving Coil, the angular deflection of the coil is proportional to

1. Current through the coil
2. Deflecting torque

3. Angle between the plane of the coil and direction of field
4. Static sensitivity of the coil

Correct Answer: 1. Current through the coil

Solution:

PMMC deflection $\theta \propto I$ (current) as torque $T_d = NIBA$ and controlling torque $T_c = k\theta$ balance at equilibrium.

Quick Tip

PMMC principle: $I \rightarrow$ Lorentz force \rightarrow Torque \rightarrow Spring-balanced deflection $\theta \propto I$.

60. Which is the device that can measure self inductance, mutual inductance, and self resistance?

1. Galvanometer
2. Anderson's bridge
3. Maxwell's bridge
4. Q-meter

Correct Answer: 2. Anderson's bridge

Solution:

Anderson's Bridge measures self/mutual inductance and resistance. Maxwell's Bridge measures only self inductance, Q-meter measures quality factor.

Quick Tip

Bridge circuits: Anderson (L,M,R), Maxwell (L), Hay (high-Q), Schering (C), Wien (frequency).

61. In voltage pacemaker the current in the circuit is determined by the available

1. Contact impedance at the site
2. Resistance of the tissue
3. Voltage during the entire duration of the impulse
4. Voltage during the rising phase of the impulse

Correct Answer: 2. Resistance of the tissue

Solution:

In voltage pacemakers, current is determined by Ohm's Law ($I=V/R$) where R is the tissue resistance, as the voltage is held constant.

Quick Tip

Voltage pacemakers maintain constant voltage; current varies inversely with tissue resistance.

62. What is the material used to make pacemaker electrodes?

1. Platinum
2. Platinum-iridium alloy
3. Silver-silver chloride
4. Silver

Correct Answer: 2 Platinum-iridium alloy

Solution:

Platinum-iridium alloy (90

Quick Tip

Pt-Ir alloy combines platinum's biocompatibility with iridium's mechanical strength for long-term implants.

63. There is provision for automatic adjustment of stimulus intensity and gains for the various sensing channels in

1. Fixed Pacemakers
2. Atrial Triggered Pacemakers
3. Demand Pacemakers
4. Dual Chamber Pacemakers

Correct Answer: 3. Demand Pacemakers

Solution:

Demand pacemakers automatically adjust stimulus parameters based on sensed cardiac activity to prevent unnecessary pacing.

Quick Tip

Demand pacemakers operate "on demand" - pacing only when intrinsic heart rhythm is absent or too slow.

64. In modern biopotential amplifiers, the input impedance is at least

1. 100 M
2. 1000 k
3. 10 M
4. 100 k

Correct Answer: 1. 100 M

Solution:

Modern biopotential amplifiers require 100 M input impedance to minimize signal attenuation from high electrode-skin interface impedances.

Quick Tip

High input impedance ($\geq 100M$) prevents loading effects on weak biopotential signals (ECG/EEG/EMG).

65. The calibration signal amplitude gives an indication of correct _____ settings.

1. Sensitivity
2. Linearity
3. Precision
4. Accuracy

Correct Answer: 1. Sensitivity

Solution:

Calibration signals verify sensitivity (mV/cm or V/division) by comparing known input amplitudes to display measurements.

Quick Tip

Sensitivity calibration ensures accurate amplitude measurements - e.g., 1mV ECG calibration pulse should display at 10mm height.

66. Advisory external defibrillators use self-adhesive electrodes because the signal acquired from them _____.

1. More noise but allows for faster accurate analysis
2. Allows quick calibration and has low noise
3. Has less noise and allows for faster accurate analysis
4. Allows quick calibration and faster analysis

Correct Answer: 3 . Has less noise and allows for faster accurate analysis

Solution:

Self-adhesive electrodes in advisory external defibrillators are designed to provide a high-quality signal with less noise, enabling faster and more accurate analysis of the patient's heart rhythm, which is critical for effective defibrillation.

Quick Tip

Self-adhesive electrodes improve signal quality by reducing noise, ensuring quick and accurate cardiac analysis.

67. The most commonly used hemodialyzer

1. Parallel plate dialyzer
2. Hollow fiber dialyzer
3. Membrane dialyzer
4. Bubble dialyzer

Correct Answer: 2 . Hollow fiber dialyzer

Solution:

Hollow fiber dialyzers are the most commonly used in hemodialysis due to their high efficiency, large surface area for dialysis, and compact design, allowing effective removal of waste products from blood.

Quick Tip

Hollow fiber dialyzers are preferred in hemodialysis for their efficiency and large surface area.

68. The maximum negative pressure in the dialysate pressure control and measurement system of a haemodialysis machine is limited by

1. Control valve
2. Fluid valve

3. Relief valve
4. Safety valve

Correct Answer: 3 . Relief valve

Solution:

The relief valve limits the maximum negative pressure in the dialysate pressure control system of a hemodialysis machine to prevent damage to the system and ensure patient safety by avoiding excessive pressure differences.

Quick Tip

Relief valves in hemodialysis machines protect the system by regulating negative pressure.

69. The velocity of blood flow is V and that of ultrasound through the medium is C . If an ultrasonic signal at frequency f is directed at right angles to the flow, then the Doppler shifted frequency is -----.

1. Zero
2. $\left(\frac{V}{C}\right) \times f$
3. $\left(\frac{C}{V}\right) \times f$
4. $\frac{Vf}{C}$

Correct Answer: 1 . Zero

Solution:

When an ultrasonic signal is directed at right angles (90 degrees) to the blood flow, there is no component of the flow velocity along the direction of the ultrasound, resulting in no Doppler shift. Hence, the Doppler shifted frequency is zero.

Quick Tip

Doppler shift is zero when the ultrasound is perpendicular to the flow, as there's no relative motion in the signal's direction.

70. The transformer voltage induced in A.C. excited electromagnetic blood flow meters is minimised by -----.

1. Low pass filter
2. Band pass filter
3. High pass filter
4. Phase sensitive demodulator

Correct Answer: 4 . Phase sensitive demodulator

Solution:

In A.C. excited electromagnetic blood flow meters, transformer voltage (an unwanted signal) is induced due to the alternating magnetic field. A phase-sensitive demodulator minimizes this by distinguishing the flow-induced signal from the transformer voltage based on phase differences.

Quick Tip

Phase-sensitive demodulators help isolate the desired signal in electromagnetic flow meters by rejecting transformer-induced noise.

71. In the driven right leg ECG amplifier, the right leg is connected to the -----.

1. Ground
2. Inverting input of the op-amp
3. Common mode potential
4. Non-inverting input of the op-amp

Correct Answer: 3 . Common mode potential

Solution:

In a driven right leg (DRL) ECG amplifier, the right leg is connected to the common mode potential to reduce common mode interference, improving the signal quality by driving the patient's body potential to match the amplifier's reference.

Quick Tip

The driven right leg circuit in ECG systems minimizes noise by reducing common mode voltage.

72. In a thermocouple, the thermal energy is converted to electrical energy by

1. Johnson effect
2. Seebeck effect
3. Hall effect
4. Faraday effect

Correct Answer: 2 Seebeck effect

Solution:

The Seebeck effect is the principle behind a thermocouple, where a voltage is generated due to the temperature difference between two junctions of different metals, converting thermal energy into electrical energy.

Quick Tip

The Seebeck effect enables thermocouples to measure temperature by generating a voltage proportional to the temperature difference.

73. The spirometer performs the physical integration of

1. Air pressure at the mouth
2. Air pressure at the nose

3. Air flow at the nose
4. Air flow at the mouth

Correct Answer: 4. Air flow at the mouth

Solution:

A spirometer measures lung function by performing the physical integration of air flow at the mouth, converting the flow rate into a volume measurement to assess respiratory parameters like tidal volume and vital capacity.

Quick Tip

Spirometers integrate air flow at the mouth to calculate lung volumes for respiratory diagnostics.

74. In the blood pressure measurement by auscultatory method, what is the range of the Korotkoff sounds?

1. 0 to 20 Hz
2. 20 to 100 Hz
3. 100 to 1000 Hz
4. 100 to 2000 Hz

Correct Answer: 2. 20 to 100 Hz

Solution:

In the auscultatory method of blood pressure measurement, Korotkoff sounds, which are produced by turbulent blood flow as the cuff pressure is released, typically range from 20 to 100 Hz, detectable using a stethoscope.

Quick Tip

Korotkoff sounds in the 20–100 Hz range are used to determine systolic and diastolic pressures in the auscultatory method.

75. Normal EEG frequency range is

1. 50–500 Hz
2. 0.5–50 Hz
3. 0.05–5 Hz
4. 1–200 Hz

Correct Answer: 2 0.5–50 Hz

Solution:

The normal EEG frequency range for brain activity in humans is typically 0.5 to 50 Hz, covering various brain waves like delta (0.5–4 Hz), theta (4–8 Hz), alpha (8–13 Hz), beta (13–30 Hz), and gamma (30–50 Hz).

Quick Tip

EEG frequencies from 0.5 to 50 Hz capture the full spectrum of brain wave activity for diagnostic purposes.

76. In an X-ray tube, the filament and the target are enclosed in an envelope that

1. Provides vacuum and support
2. Prevents cathode failure
3. Prevents anode melt down
4. Provides free air for cooling

Correct Answer: 1 . Provides vacuum and support

Solution:

In an X-ray tube, the filament and target are enclosed in a vacuum envelope to prevent oxidation of the filament, reduce electron scattering, and provide structural support, ensuring efficient X-ray production.

Quick Tip

The vacuum envelope in an X-ray tube ensures a clear path for electrons and protects the filament from oxidation.

77. Coil dialyzers are characterized by _____ resistance to blood and _____ dialysate flow rates.

1. Low, high
2. Low, low
3. High, low
4. High, high

Correct Answer: 4 . High, high

Solution:

Coil dialyzers have high resistance to blood flow due to their coiled structure and also require high dialysate flow rates to maintain effective dialysis, making them less common compared to hollow fiber dialyzers.

Quick Tip

Coil dialyzers' high resistance and flow rates make them less efficient than modern alternatives like hollow fiber dialyzers.

78. In an EEG machine, _____ serves as the calibration signal.

1. 5–1000 μV peak-to-peak rectangular wave
2. Rectangular wave of 50–100 μV peak-to-peak
3. Rectangular wave of 1–500 μV peak-to-peak
4. 5–100 μV peak-to-peak rectangular wave

Correct Answer: 1 5–1000 μV peak-to-peak rectangular wave

Solution:

In an EEG machine, a 5–1000 μV peak-to-peak rectangular wave is used as the calibration

signal to ensure the accuracy of the recorded brain wave amplitudes, which typically range from 5 to 1000 μV .

Quick Tip

EEG calibration signals match the typical amplitude range of brain waves for accurate measurement.

79. The order in which the temperature transducers exhibit non-linearity (highest to lowest) is

1. Thermocouple, RTD, Thermistor
2. Thermistor, Thermocouple, RTD
3. Thermistor, RTD, Thermocouple
4. RTD, Thermocouple, Thermistor

Correct Answer: 2 Thermistor, Thermocouple, RTD

Solution:

Thermistors exhibit the highest non-linearity due to their exponential resistance-temperature relationship, followed by thermocouples with moderate non-linearity, and RTDs, which are the most linear among the three.

Quick Tip

Thermistors are highly sensitive but non-linear, while RTDs offer the best linearity for temperature measurement.

80. Sensitivity of LVDT is calculated as

1. Sensitivity = $\frac{V_{output}}{V_{primary}}$
2. Sensitivity = $\frac{V_{output}}{Core\ Displacement}$
3. Sensitivity = $\frac{V_{primary}}{V_{output}} \times Core\ Displacement$
4. Sensitivity = $\frac{V_{output}}{V_{primary}} \times Core\ Displacement$

Correct Answer: 2 . Sensitivity = $\frac{V_{output}}{Core\ Displacement}$

Solution:

The sensitivity of a Linear Variable Differential Transformer (LVDT) is defined as the ratio of the output voltage to the core displacement, expressed as Sensitivity = $\frac{V_{output}}{Core\ Displacement}$, indicating how much the output voltage changes per unit of displacement.

Quick Tip

LVDT sensitivity measures the output voltage change per unit of core displacement for precise position sensing.

81. In in-vivo oximetry, the blood is _____ and both the techniques _____ and _____ can be used.

1. Unhemolyzed, reflection and transmission
2. Hemolyzed, scattering and transmission
3. Unhemolyzed, scattering and transmission
4. Hemolyzed, transmission and reflection

Correct Answer: 1 . Unhemolyzed, reflection and transmission

Solution:

In in-vivo oximetry, the blood is unhemolyzed (red blood cells remain intact), and both reflection and transmission techniques can be used to measure oxygen saturation by analyzing light interactions with blood.

Quick Tip

In-vivo oximetry uses unhemolyzed blood, leveraging reflection and transmission to assess oxygen levels non-invasively.

82. Synchronized intermittent mandatory ventilation combines _____ breathing and _____ ventilation.

1. Cellular, spontaneous
2. Cellular, alveolar
3. Spontaneous, mechanical
4. Cellular, mechanical

Correct Answer: 3 . Spontaneous, mechanical

Solution:

Synchronized intermittent mandatory ventilation (SIMV) combines spontaneous breathing by the patient with mechanical ventilation, delivering mandatory breaths synchronized with the patient's respiratory efforts to support ventilation.

Quick Tip

SIMV supports patients by syncing mechanical breaths with their spontaneous breathing efforts.

83. A strain gauge has _____ parts and it is _____.

1. Moving, linear
2. No moving, linear
3. Moving, non-linear
4. No moving, non-linear

Correct Answer: 4 . No moving, non-linear

Solution:

A strain gauge has no moving parts, as it measures strain through changes in electrical resistance, and it is non-linear because the resistance change is not perfectly proportional to the strain applied.

Quick Tip

Strain gauges are static devices with non-linear responses, ideal for measuring deformation in materials.

84. The bandwidth of phonocardiography for recording of the indirect carotid, jugular, and apex cardiogram pulses is -----.

1. 30 to 1000 Hz
2. 0 to 70 Hz
3. 0.1 to 100 Hz
4. 10 to 500 Hz

Correct Answer: 3 . 0.1 to 100 Hz

Solution:

The bandwidth of phonocardiography for recording indirect carotid, jugular, and apex cardiogram pulses is 0.1 to 100 Hz, as these low-frequency sounds and vibrations correspond to heart and vascular activity in this range.

Quick Tip

Phonocardiography captures low-frequency heart sounds, typically in the 0.1 to 100 Hz range, for diagnostic purposes.

85. The amplitude of EMG signals depends upon which of the following factors?

1. Respiration
2. Position of electrode
3. Blood resistivity
4. Ventricular volume

Correct Answer: 2 . Position of electrode

Solution:

The amplitude of EMG (electromyography) signals depends on the position of the electrode, as it affects the proximity to the muscle fibers and the quality of the electrical signal detected from muscle activity.

Quick Tip

Proper electrode placement in EMG is critical, as it directly influences the signal amplitude and quality.

86. The stimulation of _____ is required for the membrane potential to rise to the threshold at the axon hillock.

1. Pre-synaptic membrane along the dendrite and cell body
2. Dendrite
3. Cell body
4. Synaptic membrane along the dendrite and cell body

Correct Answer: 4 Synaptic membrane along the dendrite and cell body

Solution:

The synaptic membrane along the dendrite and cell body must be stimulated to generate excitatory postsynaptic potentials (EPSPs), which summate to raise the membrane potential to the threshold at the axon hillock, triggering an action potential.

Quick Tip

Synaptic stimulation at dendrites and the cell body summates to initiate action potentials at the axon hillock.

87. During an action potential propagation in an unmyelinated nerve fiber, the _____ region is small relative to the fiber _____.

1. Amplitude of the activation wave, length
2. Diameter of the passive, length

3. Length of the active, length
4. Diameter of the passive, diameter

Correct Answer: 3 . Length of the active, length

Solution:

In an unmyelinated nerve fiber, the length of the active region (where the action potential is occurring) is small relative to the fiber's overall length, as the depolarization wave propagates continuously along the fiber.

Quick Tip

In unmyelinated fibers, the active region of the action potential is a small fraction of the fiber's total length.

88. For gas exchange to occur, the surface area contributed by the alveoli in each normal lung is around _____ m².

1. 70
2. 30
3. 100
4. 120

Correct Answer: 1 . 70

Solution:

The surface area of the alveoli in each normal human lung is approximately 70 m², providing a large area for efficient gas exchange between the air and blood in the pulmonary capillaries.

Quick Tip

The alveolar surface area of about 70 m² per lung maximizes gas exchange efficiency in the respiratory system.

89. The peak systolic pressure in the right ventricle is _____ mm of Hg.

1. 60–100
2. 4–12
3. 15–30
4. >6

Correct Answer: 3 . 15–30

Solution:

The peak systolic pressure in the right ventricle is typically 15–30 mm of Hg, reflecting the pressure required to pump blood into the pulmonary artery during systole in a healthy individual.

Quick Tip

Right ventricular systolic pressure (15–30 mm Hg) is lower than the left ventricle's due to the lower resistance in the pulmonary circulation.

90. The autonomic nervous system does NOT regulate the _____.

1. Digestive system
2. Circulation
3. Skeletal muscles
4. Excretory system

Correct Answer: 3 Skeletal muscles

Solution:

The autonomic nervous system regulates involuntary functions like digestion, circulation, and excretion, but it does not control skeletal muscles, which are under voluntary control via the somatic nervous system.

Quick Tip

Skeletal muscles are regulated by the somatic nervous system, not the autonomic nervous system, which handles involuntary functions.

91. Starling's law of the heart states that

1. If the radius of the heart increases, then the muscle tension and the systolic pressure increase
2. If the radius of the heart decreases, then the muscle tension and the systolic pressure increase
3. If the radius of the heart decreases, then the muscle tension decreases and the systolic pressure increases
4. If the radius of the heart increases, then the muscle tension increases and the systolic pressure decreases

Correct Answer: 1 . If the radius of the heart increases, then the muscle tension and the systolic pressure increase

Solution:

Starling's law of the heart states that as the radius of the heart increases (due to increased end-diastolic volume), the muscle tension and systolic pressure increase, as the heart contracts more forcefully to eject the larger volume of blood.

Quick Tip

Starling's law links increased heart radius to greater muscle tension and systolic pressure for stronger contractions.

92. The pressure-volume work loop for a weakened ventricle shifts as compared to the normal ventricle.

1. To the left

2. To the right
3. Down
4. Up

Correct Answer: 2 . To the right

Solution:

In a weakened ventricle, the pressure-volume work loop shifts to the right because the ventricle operates at a higher end-diastolic volume to compensate for reduced contractility, resulting in less efficient work output compared to a normal ventricle.

Quick Tip

A rightward shift in the pressure-volume loop indicates a weakened ventricle with reduced pumping efficiency.

93. Which of the following is a characterization technique used to measure Young's modulus of a biomaterial?

1. Tensile test
2. Compression test
3. Calculation from the stress-strain curve
4. Three- and four-point bend test

Correct Answer: 2 . Compression test

Solution:

A compression test is a common technique to measure Young's modulus of a biomaterial, as it determines the material's stiffness by applying compressive stress and measuring the resulting strain, often used for biomaterials like bone or cartilage.

Quick Tip

Compression tests are effective for calculating Young's modulus in biomaterials by analyzing stress-strain behavior.

94. Collagen, with an elastic modulus of approximately _____, is _____ than elastin.

1. 1 GPa, stronger
2. 0.6 MPa, less stronger
3. 1 MPa, stronger
4. 100 MPa, less stronger

Correct Answer: 1 . 1 GPa, stronger

Solution:

Collagen has an elastic modulus of approximately 1 GPa, making it stronger and stiffer than elastin, which has a much lower modulus (around 0.6 MPa), allowing elastin to be more flexible in tissues like blood vessels.

Quick Tip

Collagen's high elastic modulus (1 GPa) makes it stiffer than elastin, which is more elastic for tissue flexibility.

95. In ligaments, tendons have _____.

1. More collagen, less elastin
2. More elastin, less collagen
3. More elastin, more collagen
4. Less elastin, less collagen

Correct Answer: 2 . More elastin, less collagen

Solution:

In ligaments, tendons have more elastin and less collagen compared to ligaments, which are primarily collagen-rich for strength, while tendons require more elasticity (from elastin) to handle dynamic loading.

Quick Tip

Tendons have more elastin than ligaments to provide elasticity, while ligaments rely on collagen for tensile strength.

96. In the circulatory system, which is the correct order in which the blood flows?

1. Right ventricle, Semi-lunar valve, Pulmonary artery, Lungs
2. Left ventricle, Semi-lunar valve, Pulmonary artery, Lungs
3. Right ventricle, Semi-lunar valve, Pulmonary vein, Lungs
4. Left ventricle, Semi-lunar valve, Pulmonary vein, Lungs

Correct Answer: 1 Right ventricle, Semi-lunar valve, Pulmonary artery, Lungs

Solution:

In the circulatory system, deoxygenated blood flows from the right ventricle through the semi-lunar valve (pulmonary valve) into the pulmonary artery, which carries it to the lungs for oxygenation.

Quick Tip

The pulmonary artery carries deoxygenated blood from the right ventricle to the lungs, passing through the semi-lunar valve.

nozzles **97.** Examples of viscoelastic models are

1. Wind Kessel and Kelvin
2. Voigt and thick-walled hemisphere

3. Maxwell and Standard solid
4. Wind Kessel and Voigt

Correct Answer: 3. Maxwell and Standard solid

Solution:

Viscoelastic models, such as the Maxwell model and the Standard solid model, describe materials that exhibit both viscous and elastic properties, commonly used to model biological tissues like muscles and blood vessels.

Quick Tip

Maxwell and Standard solid models are classic viscoelastic models, capturing the combined elastic and viscous behavior of materials.

98. The ratio of change in ventricular pressure to change in ventricular volume is a ----- measure of the ventricle and is called -----.

1. resistance, peripheral resistance
2. stiffness, elastance
3. stiffness, compliance
4. compliance, resistance

Correct Answer: 2. stiffness, elastance

Solution:

The ratio $\frac{\Delta P}{\Delta V}$ quantifies ventricular stiffness and is specifically termed "elastance" in cardiac physiology, representing the ventricle's pressure-volume relationship during contraction.

Quick Tip

Elastance = $\frac{\Delta P}{\Delta V}$ (stiffness measure)

Compliance = $\frac{\Delta V}{\Delta P}$ (reciprocal of elastance, measures distensibility)

99. The distance between the heel strike of one foot and the next heel strike of the same foot.

1. Step length
2. Stride length
3. Step width
4. Cadence

Correct Answer: 2. Stride length

Solution:

Stride length measures the full gait cycle for one limb (heel strike to next heel strike of the same foot), while step length measures the distance between opposite feet's heel strikes.

Quick Tip

Gait parameters:

- Stride length = Full cycle of one limb
- Step length = Distance between opposite feet
- Cadence = Steps per minute
- Step width = Lateral distance between feet

100. Allows forward-backward and side to side movement but does not allow rotation.

1. Hinge joint
2. Ball and Socket joint
3. Condylloid joint
4. Gliding joint

Correct Answer: 3. Condylloid joint

Solution:

Condylloid (ellipsoid) joints permit flexion/extension and abduction/adduction (biaxial movement) but prohibit rotation, as seen in the wrist's radiocarpal joint.

Quick Tip

Joint types:

- Condylloid: Biaxial (no rotation)
- Hinge: Uniaxial
- Ball-and-socket: Triaxial
- Gliding: Linear sliding

101. In an X-ray machine, _____ and _____ are employed for automatic exposure control.

1. Image intensifier, fluoroscopy
2. Gain control, photocell
3. Photocell, image intensifier Photo timer
4. Photocell, ionization chamber Photo timer

Correct Answer: 4. Photocell, ionization chamber Photo timer

Solution:

Modern X-ray systems use either photocells (measures light from intensifier) or ionization chambers (measures radiation directly) combined with photo timers to terminate exposure automatically.

Quick Tip

AEC components:

- Photocell: Indirect measurement via light
- Ionization chamber: Direct radiation measurement
- Photo timer: Terminates exposure at preset dose

102. A-mode ultrasound device shows _____ as an x-y plot and is used to measure the displacement of the _____.

1. Echo amplitude, mitral valve
2. Echo distance, cerebral midline

3. Echo intensity, brain midline
4. Echo amplitude, interventricular septum

Correct Answer: 3. Echo intensity, brain midline

Solution:

A-mode displays echo intensity (amplitude) vs depth (x-y plot), primarily used for precise measurements like brain midline shifts in neurology.

Quick Tip

Ultrasound modes:

- A-mode: Amplitude vs Depth (1D)
- B-mode: Brightness (2D image)
- M-mode: Motion over time

103. The amplitude and the frequency of the NMR signals are used to assign and

1. Number of projections, orientation of the gradient
2. Orientation of the gradient, number of slices
3. Number of nuclei present, spatial location
4. Number of projections, spatial location

Correct Answer: 3. Number of nuclei present, spatial location

Solution:

NMR signal amplitude indicates proton density (number of nuclei), while frequency variations (from gradients) encode spatial location for image reconstruction.

Quick Tip

MRI signal properties:

- Amplitude \propto proton density
- Frequency \propto spatial position (via gradients)

104. The ratio of the area of the input phosphor to the area of output phosphor in the image intensifier is

1. Phosphorescence factor
2. Phosphor factor
3. Phosphor number
4. Brightness gain

Correct Answer: 4. Brightness gain

Solution:

Brightness gain = (Input phosphor area)/(Output phosphor area) \times minification gain \times flux gain. This ratio is fundamental to intensifier performance.

Quick Tip

Image intensifier gains:

- Minification gain = (Input diameter/Output diameter)²
- Flux gain = Electron acceleration gain
- Total gain 5,000-30,000

105. As the active element diameter of the ultrasonic transducer increases, the beam width _____ and therefore, lateral resolution _____.

1. Increases, improves
2. Does not change, does not change
3. Decreases, improves
4. Decreases, deteriorates

Correct Answer: 1. Increases, improves

Solution:

Larger transducer diameter reduces beam divergence (narrower beam width), improving lateral resolution as the ultrasound beam remains focused over greater depths.

Quick Tip

Transducer physics:

- Larger diameter → Less divergence → Better lateral resolution
- Higher frequency → Better axial resolution but more attenuation

106. NMR images that display T1 and T2 properties of the tissue provide very high contrasts between various soft tissues approaching whereas it is only a few percent with X-rays.

- (1) 1000%
- (2) 600%
- (3) 150%
- (4) 300%

Correct Answer: (3) 150%

Solution: Nuclear Magnetic Resonance (NMR) imaging utilizes differences in T1 (spin-lattice) and T2 (spin-spin) relaxation times to produce images with very high contrast between different soft tissues. This contrast can approach about 150

Quick Tip

MRI provides high soft tissue contrast (up to 150

107. The PET scanners constructed using a bismuth germanate detector have and than those with thallium-doped sodium iodide detector.

- (1) High resolution, high efficiency
- (2) Low resolution, high efficiency
- (3) High resolution, low efficiency
- (4) Low resolution, low efficiency

Correct Answer: (1) High resolution, high efficiency

Solution: PET scanners using bismuth germanate (BGO) detectors have higher resolution and efficiency compared to those with thallium-doped sodium iodide detectors. BGO has a higher density and atomic number, resulting in better gamma-ray detection efficiency and improved image resolution.

Quick Tip

Bismuth germanate detectors in PET scanners improve both resolution and efficiency compared to NaI(Tl) detectors.

108. The factors playing an important role in the biological interaction of tissue and ultrasound waves are

- (1) Frequency, wavelength and intensity
- (2) Time, frequency and duty cycle
- (3) Frequency, time and wavelength
- (4) Frequency, irradiation time, beam intensity and duty cycle

Correct Answer: (4) Frequency, irradiation time, beam intensity and duty cycle

Solution: The biological effects of ultrasound depend on frequency, irradiation time, beam intensity, and duty cycle. These parameters determine the energy delivered to tissues and the extent of interaction, affecting heating and cavitation effects.

Quick Tip

Key parameters affecting ultrasound tissue interaction include frequency, irradiation time, intensity, and duty cycle.

109. The filters used to reduce the unwanted X-rays exposure to the patient are made of:

- (1) Aluminium, copper
- (2) Steel, lead
- (3) Copper, aluminium
- (4) Lead, copper

Correct Answer: (1) Aluminium, copper

Solution: Aluminium and copper filters are used in X-ray machines to absorb low-energy X-rays that contribute to patient dose without improving image quality. These filters help reduce unnecessary radiation exposure.

Quick Tip

Aluminium and copper are commonly used as filters to reduce patient dose by absorbing low-energy X-rays.

110. Rad is a measure of energy while Rem is a measure of

- (1) incident, absorbed energy
- (2) absorbed, incident energy
- (3) biological damage caused, incident energy
- (4) absorbed, biological damage caused

Correct Answer: (4) absorbed, biological damage caused

Solution: Rad (radiation absorbed dose) measures the amount of energy absorbed per unit mass of tissue. Rem (roentgen equivalent man) quantifies the biological damage caused by the absorbed radiation, considering the type of radiation and its effect on tissues.

Quick Tip

Rad measures absorbed dose; Rem accounts for biological effect of the absorbed radiation.

111. SPECT cameras detect only radio-nuclides that produce a of single photons and these radio-nuclides an on-site cyclotron.

- (1) single emission, do not require
- (2) cascaded emission, require
- (3) cascaded emission, do not require
- (4) single emission, require

Correct Answer: (3) cascaded emission, do not require

Solution: SPECT cameras detect gamma rays emitted from radio-nuclides via cascaded emission of single photons. These radio-nuclides typically do not require an on-site cyclotron for production, as they have longer half-lives and can be transported from production sites.

Quick Tip

SPECT uses cascaded photon emissions and radio-nuclides that don't need an on-site cyclotron.

112. The presence of noise in a medical image will generally

- (1) produce artifacts
- (2) produce blurring
- (3) reduce visibility of low contrast objects

(4) produce image distortion

Correct Answer: (3) reduce visibility of low contrast objects

Solution: Noise in medical imaging reduces the visibility of low contrast structures by masking subtle differences. This makes it harder to detect small or faint features, affecting diagnostic accuracy.

Quick Tip

Noise lowers contrast resolution by hiding low-contrast details in medical images.

113. Polymeric biomaterials are preferred due to:

- (1) hardness and stability
- (2) flexibility and stability
- (3) wear resistance applications
- (4) load bearing applications

Correct Answer: (2) flexibility and stability

Solution: Polymeric biomaterials are preferred in many biomedical applications because they offer excellent flexibility and good chemical and mechanical stability. This allows for better compatibility and durability in biological environments.

Quick Tip

Flexibility and stability make polymers ideal biomaterials for diverse medical uses.

114. The material used for neural stimulation devices is

- (1) Platinum
- (2) Stainless steel

- (3) Gold
- (4) Silver

Correct Answer: (1) Platinum

Solution: Platinum is widely used for neural stimulation devices due to its excellent biocompatibility, corrosion resistance, and electrical conductivity. It provides reliable long-term performance within the body.

Quick Tip

Platinum's biocompatibility and conductivity make it ideal for neural stimulation electrodes.

115. A material used for a blood bag should have:

- (1) flexibility and optimal porosity
- (2) optimal porosity and relative inertness
- (3) reasonable brittleness and relative inertness
- (4) chemical stability and flexibility

Correct Answer: (4) chemical stability and flexibility

Solution: Blood bag materials must be chemically stable to avoid reactions with blood and flexible enough to allow handling and storage. Flexibility also helps in preventing ruptures during use.

Quick Tip

Blood bag materials need chemical stability and flexibility for safety and durability.

116. Alumina and Zirconia are examples of bioceramics.

- (1) porous to allow tissue in growth
- (2) bioactive
- (3) resorbable
- (4) bioinert

Correct Answer: (4) bioinert

Solution: Alumina and Zirconia are classified as bioinert ceramics because they do not interact chemically with the biological environment. They are highly stable and exhibit excellent mechanical properties, making them ideal for load-bearing implants where minimal biological reaction is desired.

Quick Tip

Bioinert ceramics like Alumina and Zirconia resist biological interaction and are used in implants needing chemical stability.

117. The biomaterials are expected to mimic the functions of

- (1) Cell Organelles
- (2) Transmembrane proteins
- (3) Cytoplasm
- (4) Extracellular Matrix (ECM)

Correct Answer: (1) Cell Organelles

Solution: Biomaterials are designed to mimic the functional aspects of cell organelles to interact compatibly within biological systems. This includes functions like molecular recognition, signaling, and catalytic activities at the cellular level.

Quick Tip

Biomaterials aim to replicate cell organelle functions for better biological integration.

118. The most important aspects of biomaterial-tissue interactions are:

- (1) Biocompatibility
- (2) Bioavailability
- (3) Bioequivalence
- (4) Bioluminescence

Correct Answer: (1) Biocompatibility

Solution: Biocompatibility is crucial for biomaterials as it determines their ability to perform desired functions without causing adverse biological responses. It ensures that the material is safe and effective when implanted.

Quick Tip

Biocompatibility is key for successful biomaterial integration in tissues.

119. Biodegradation will be more for materials with

- (1) More molecular weights and high crystallinity
- (2) Low molecular weights and high crystallinity
- (3) More molecular weights and less crystallinity
- (4) Low molecular weights and less crystallinity

Correct Answer: (4) Low molecular weights and less crystallinity

Solution: Materials with low molecular weight and less crystallinity degrade faster because amorphous regions are more accessible to enzymes and hydrolytic attack, and shorter polymer chains are easier to break down.

Quick Tip

Low molecular weight and low crystallinity increase biodegradability of polymers.

120. Image formation in electron microscope is based on

- (1) Column length
- (2) Electron number
- (3) Differential scattering
- (4) Specimen size

Correct Answer: (3) Differential scattering

Solution: Electron microscopy image formation is primarily based on the differential scattering of electrons by different components of the specimen, producing contrast that reveals structural details at high resolution.

Quick Tip

Electron microscopes use differential scattering of electrons to form detailed images.