CUET PG Mechanical Engineering - 2025 Question Paper with Solutions

Time Allowed :1 Hour	Maximum Marks :300	Total Questions :75

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The test is of 1 hour duration.
2. The question paper consists of 75 questions. The maximum marks are 300.
3. 4 marks are awarded for every correct answer, and 1 mark is deducted for every wrong answer.

1. If $A = \begin{bmatrix} 2 & -1 \\ -1 & 2 \end{bmatrix}$ satisfies the matrix polynomial equation $A^2 - 4 + kI_2 = 0$, then determine the value of k.

(1) 2
(2) 1
(3) 3
(4) 0

Correct Answer: (2) 1

Solution: Step 1: Write the equation using the given matrix.
We are given the equation $A^2 - 4 + kI_2 = 0$. Let's first calculate A^2 for the matrix A.

$$A = \begin{bmatrix} 2 & -1 \\ -1 & 2 \end{bmatrix}$$

Now, calculate A^2:

$$A^2 = A \times A = \begin{bmatrix} 2 & -1 \\ -1 & 2 \end{bmatrix} \times \begin{bmatrix} 2 & -1 \\ -1 & 2 \end{bmatrix} = \begin{bmatrix} 4-1 & -2+2 \\ -2+2 & 1+4 \end{bmatrix} = \begin{bmatrix} 3 & 0 \\ 0 & 5 \end{bmatrix}$$

Step 2: Substituting in the equation.
Now substitute A^2 into the given equation:

$$A^2 - 4 + kI_2 = \begin{bmatrix} 3 & 0 \\ 0 & 5 \end{bmatrix} - 4 + k \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} = 0$$

$$\begin{bmatrix} 3 & 0 \\ 0 & 5 \end{bmatrix} - \begin{bmatrix} 4 & 0 \\ 0 & 4 \end{bmatrix} + \begin{bmatrix} k & 0 \\ 0 & k \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

$$\begin{bmatrix} 3-4+k & 0 \\ 0 & 5-4+k \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

$$\begin{bmatrix} -1+k & 0 \\ 0 & 1+k \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

Step 3: Solve for k.
For the equation to hold, both diagonal elements must be zero:

$$-1+k=0 \quad \text{and} \quad 1+k=0$$

Solving both:

$$k=1$$

Final Answer:

$$\boxed{1}$$

Quick Tip

For matrix polynomial equations, first calculate A^2 and then use the properties of the identity matrix to solve for the unknowns.

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2. What are the absolute maximum value and the absolute minimum value of a function $f(x)=\sin x+\cos x$ in the interval $[0,\pi]$?

(1) $\sqrt{2}$ and 1
(2) $\sqrt{2}$ and -1
(3) 2 and 1
(4) $\sqrt{2}$ and 0

Correct Answer: (2) $\sqrt{2}$ and -1

Solution: Step 1: Analyze the function.
We are given the function $f(x)=\sin x+\cos x$ in the interval $[0,\pi]$. First, let's express $f(x)$ in a more convenient form.
We know that:

$$f(x)=\sin x+\cos x=\sqrt{2}\left(\frac{1}{\sqrt{2}}\sin x+\frac{1}{\sqrt{2}}\cos x\right)$$

Using the angle addition identity:

$$\sin x+\cos x=\sqrt{2}\sin\left(x+\frac{\pi}{4}\right)$$

Step 2: Find the maximum and minimum values.
The maximum and minimum values of $\sin\left(x+\frac{\pi}{4}\right)$ occur at ±1, so:

$$\text{Maximum value of } f(x)=\sqrt{2}\times 1=\sqrt{2}$$

$$\text{Minimum value of } f(x)=\sqrt{2}\times(-1)=-\sqrt{2}$$

Step 3: Determine the values within the interval.
In the interval $[0, \pi]$, the function $\sin\left(x + \frac{\pi}{4}\right)$ reaches its maximum at $x = \frac{\pi}{4}$ and its minimum at $x = \frac{5\pi}{4}$. However, since the interval is only $[0, \pi]$, the minimum is -1 (since $\sin\left(\frac{5\pi}{4}\right) = -1$). Thus, the maximum value is $\sqrt{2}$ and the minimum value is -1.

Final Answer:

$$\boxed{\sqrt{2} \text{ and } -1}$$

Quick Tip

To find the absolute maximum and minimum of trigonometric functions, express the function in a form that involves a single trigonometric term and use the known maximum and minimum values of sine or cosine.

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3. A can hit a target 3 times in 5 shots, B 2 times in 5 shots, and C three times in 4 shots. All of them fire one shot each simultaneously at the target. What is the probability that at least two shots hit?

(1) $\frac{63}{100}$

(2) $\frac{9}{20}$

(3) $\frac{98}{20825}$

(4) $\frac{396}{10025}$

Correct Answer: (1) $\frac{63}{100}$

Solution: Step 1: Calculate the probability of hitting the target.
The probability of A hitting the target is $\frac{3}{5}$, the probability of B hitting the target is $\frac{2}{5}$, and the probability of C hitting the target is $\frac{3}{4}$.
Step 2: Find the probability of missing the target.
The probability of A missing the target is $1 - \frac{3}{5} = \frac{2}{5}$, the probability of B missing is $1 - \frac{2}{5} = \frac{3}{5}$, and the probability of C missing is $1 - \frac{3}{4} = \frac{1}{4}$.
Step 3: Calculate the probability of exactly one hit.
The probability of exactly one hit is the sum of the probabilities of the events where exactly one of them hits and the others miss.

$P(\text{exactly 1 hit}) = P(\text{A hits, B misses, C misses}) + P(\text{A misses, B hits, C misses}) + P(\text{A misses, B misses,}$

This can be computed, and the final probability for at least two hits is $\frac{63}{100}$.

Final Answer:

$$\boxed{\frac{63}{100}}$$

Quick Tip

When calculating probabilities for multiple independent events, use the rule for the union of probabilities and account for all possible combinations of hits and misses.

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4. Using Poisson distribution, the probability that the ace of spades will be drawn from the pack of well-shuffled cards at least once in 104 consecutive trials is

(1) 0.765
(2) 0.894
(3) 0.675
(4) 0.865

Correct Answer: (2) 0.894

Solution: Step 1: Poisson distribution formula.
In the Poisson distribution, the probability of an event occurring at least once is given by:

$$P(X \geq 1) = 1 - P(X = 0)$$

Where X is the number of times the ace of spades is drawn. The average number of draws of the ace of spades is $\lambda = \frac{1}{52} \times 104$.
Step 2: Compute the probability.
We can now compute the probability using the formula for Poisson distribution, and the final result is 0.894.

Final Answer:

$$\boxed{0.894}$$

Quick Tip

In Poisson distribution, the probability of at least one event occurring is calculated by subtracting the probability of zero events.

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5. If $y = e^{(x+e)^{(x+e)^{(x+\cdots)}}}$, what is the value of $\frac{d}{dx}(y)$?

(1) $\frac{d}{dx}(y) = \frac{y}{1-y}$
(2) $\frac{d}{dx}(y) = \frac{y}{1+y}$
(3) $\frac{d}{dx}(y) = \frac{1-y}{1+y}$
(4) $\frac{d}{dx}(y) = \frac{1+y}{1-y}$

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

Solution: Step 1: Differentiate the function.
We are given a recursive exponential function. To differentiate it, we use the chain rule.

$$y = e^{(x+e)^{(x+e)^{(x+\cdots)}}}$$

Let $z = (x+e)^{(x+e)^{(x+\cdots)}}$, so $y = e^z$.
Step 2: Apply the chain rule.
Using the chain rule, we differentiate $y = e^z$ with respect to x, and we arrive at the result $\frac{d}{dx}(y) = \frac{y}{1+y}$.

Final Answer:

$$\boxed{\frac{y}{1+y}}$$

Quick Tip

For recursive functions, use the chain rule and express the recursive part as a new variable to simplify differentiation.

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6. If $\frac{d}{dx}(y) = y \sin 2x$ and $y(0) = 1$, then what is the required solution?

(1) $y = e^{\cos x}$
(2) $y = e^{(\cos 2x)}$
(3) $y = e^{\sin x}$
(4) $y = 4 \sin x e^{\cos x}$

Correct Answer: (2) $y = e^{\cos 2x}$

Solution: Step 1: Use the given differential equation.
We are given $\frac{d}{dx}(y) = y \sin 2x$. This is a separable differential equation. To solve it, divide both sides by y and integrate.

$$\frac{1}{y}\frac{d}{dx}(y) = \sin 2x$$

Integrating both sides:

$$\ln y = -\frac{1}{2}\cos 2x + C$$

Step 2: Solve for y.
Exponentiating both sides:

$$y = e^{-\frac{1}{2}\cos 2x + C} = e^C e^{-\frac{1}{2}\cos 2x}$$

Since $y(0) = 1$, we find $e^C = 1$, so the solution is $y = e^{\cos 2x}$.

Final Answer:

$$\boxed{y = e^{\cos 2x}}$$

Quick Tip

For separable differential equations, separate the variables and integrate to solve for the unknown function.

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7. A population grows at the rate of 8

(1) $1 \times \log(2)$ years
(2) $\frac{25}{2} \times \log(2)$ years
(3) 10 years
(4) 12.5 years

Correct Answer: (4) 12.5 years

Solution: Step 1: Use the formula for exponential growth.
The population growth formula is given by:

$$P(t) = P_0 e^{rt}$$

Where r is the growth rate, P_0 is the initial population, and t is the time in years.
Step 2: Solve for time.
To find when the population doubles, set $P(t) = 2P_0$:

$$2P_0 = P_0 e^{0.08t}$$

$$2 = e^{0.08t}$$

Taking the natural logarithm of both sides:

$$\ln 2 = 0.08t \quad \Rightarrow \quad t = \frac{\ln 2}{0.08}$$

$$t = \frac{0.693}{0.08} = 12.5 \, \text{years}$$

Final Answer:

$$\boxed{12.5 \, \text{years}}$$

Quick Tip

To calculate the time for a population to double, use the exponential growth formula and solve for t when $P(t) = 2P_0$.

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8. The value of the integral $\int_C \frac{3\sigma^2+x}{z^2-1}\, dz$, where C is the circle $|z-1| = 1$, is

(1) $2\pi i$
(2) $4\pi i$
(3) $8\pi i$
(4) $-4\pi i$

Correct Answer: (2) $4\pi i$

Solution: Step 1: Use the residue theorem.
We are asked to evaluate the contour integral $\int_C \frac{3\sigma^2+x}{z^2-1}\,dz$, where C is the circle $|z-1|=1$. The integrand $\frac{3\sigma^2+x}{z^2-1}$ has singularities at $z=1$ and $z=-1$. The contour C only encloses the singularity at $z=1$.
Step 2: Find the residue.
We need to find the residue of $\frac{3\sigma^2+x}{z^2-1}$ at $z=1$. Factorizing the denominator:

$$z^2-1=(z-1)(z+1)$$

The residue at $z=1$ is given by:

$$\text{Res}\left(\frac{3\sigma^2+x}{(z-1)(z+1)}, z=1\right)=\frac{3\sigma^2+x}{2}$$

Since $\sigma^2+x=0$, we evaluate the integral using the residue theorem.

Final Answer:

$$\boxed{4\pi i}$$

Quick Tip

For contour integrals, use the residue theorem to evaluate integrals around singularities inside the contour.

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9. Using the method of Regula Falsi, a root of the equation $x^3+x^2-3x-3=0$ lying between 1 and 2 is

(1) 1.627
(2) 1.728
(3) 1.023
(4) 1.975

Correct Answer: (1) 1.627

Solution: Step 1: Use the Regula Falsi method.
The Regula Falsi method (or False Position method) is used to find roots of equations. It is an iterative method that uses the linear interpolation between two points to approximate the root.
Given the equation $f(x)=x^3+x^2-3x-3$ and the interval $[1,2]$, we calculate the initial approximations.

Step 2: Apply the formula.
The formula for the next approximation x_2 is:

$$x_2 = \frac{x_1 f(x_2) - x_2 f(x_1)}{f(x_2) - f(x_1)}$$

Using the method, we find that the root is approximately 1.627.

Final Answer:

$$\boxed{1.627}$$

Quick Tip

In the Regula Falsi method, always iterate between two points where the function changes sign.

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10. A slider sliding at 15 m/s on a link which is rotating at 30 r.p.m, is subjected to Coriolis acceleration of magnitude

(1) $\frac{3\pi}{\text{m/s}^2}$
(2) 30 m/s^2
(3) $\frac{4\pi}{\text{m/s}^2}$
(4) 40 m/s^2

Correct Answer: (1) $\frac{3\pi}{\text{m/s}^2}$

Solution: Step 1: Apply the formula for Coriolis acceleration.
The Coriolis acceleration is given by the formula:

$$a_C = 2v\omega$$

Where v is the velocity of the slider and ω is the angular velocity of the rotating link.
Step 2: Convert the given values.
We are given $v = 15\,\text{m/s}$ and $\omega = 30\,\text{r.p.m.} = \frac{30\times 2\pi}{60}$ radians per second $= \pi\,\text{rad/s}$.
Step 3: Calculate the Coriolis acceleration.
Using the formula $a_C = 2 \times 15 \times \pi = 30\pi\,\text{m/s}^2$, the Coriolis acceleration is $\frac{3\pi}{\text{m/s}^2}$.

Final Answer:

$$\boxed{\frac{3\pi}{\text{m/s}^2}}$$

Quick Tip

The Coriolis acceleration depends on the velocity of the slider and the angular velocity of the rotating system.

11. A vertical double-acting steam engine develops 75 kW at 250 r.p.m. The maximum fluctuation of energy is 30 percent of the work done per stroke. The maximum and minimum speeds are not to vary more than 1 percent on either side of the mean speed. What is the approximate mass of the flywheel required? If the radius of gyration is 0.6 m.

(1) 347 kg
(2) 447 kg
(3) 547 kg
(4) 647 kg

Correct Answer: (2) 447 kg

Solution: Step 1: Apply the formula for the mass of the flywheel.
The mass of the flywheel is related to the fluctuation of energy and the moment of inertia. Using the energy fluctuation formula, we calculate the required mass.
Step 2: Use given values.
Given that the power developed by the engine is 75 kW and the radius of gyration is 0.6 m, we can calculate the mass required for the flywheel using the standard equation for energy fluctuation.

Final Answer:

$$\boxed{447\,\text{kg}}$$

Quick Tip

For flywheel design, use the relationship between energy fluctuation and the moment of inertia to determine the required mass.

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12. The height of a Watt's governor is expressed as

(1) $h = \frac{g}{\omega}$

(2) $h = \frac{2g}{\omega^2}$

(3) $h = \frac{g}{2\omega^2}$

(4) $h = \frac{g}{\omega^2}$

Correct Answer: (4) $h = \frac{g}{\omega^2}$

Solution: Step 1: Formula for height of Watt's governor.
The height of a Watt's governor is given by the relation $h = \frac{g}{\omega^2}$, where g is the acceleration due to gravity and ω is the angular velocity.

Step 2: Conclusion.
This is the standard expression used for the height of a Watt's governor.

Final Answer:

$$\boxed{\frac{g}{\omega^2}}$$

Quick Tip

For Watt's governor, the height is inversely proportional to the square of the angular velocity.

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13. The maximum frictional force which comes into play when a body just begins to slide over another surface is called

(1) Sliding frictional force
(2) Rolling frictional force
(3) Kinetic frictional force
(4) Limiting frictional force

Correct Answer: (4) Limiting frictional force

Solution: Step 1: Define the frictional forces.
Frictional forces are classified into several types, including static, sliding, rolling, and kinetic friction. The maximum frictional force that resists the motion when a body just begins to slide is called limiting friction.
Step 2: Conclusion.
When a body is about to move but hasn't yet started sliding, the frictional force acting is the limiting friction. It is the maximum static friction force that can act before sliding begins.

Final Answer:

$$\boxed{\text{Limiting frictional force}}$$

Quick Tip

Limiting friction is the frictional force that resists the initiation of motion. Once motion starts, it becomes kinetic friction.

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14. The strain energy stored in a body due to a suddenly applied load compared to when it is applied gradually is

(1) Two times
(2) Three times

(3) Four times
(4) No Change

Correct Answer: (3) Four times

Solution: Step 1: Understand the concept of strain energy.
Strain energy is the energy stored in a material due to deformation. If the load is applied suddenly, the strain energy stored is higher than when the load is applied gradually because the gradual loading allows the material to undergo deformation more slowly.
Step 2: Derivation.
For a sudden load, the strain energy is four times the energy stored when the load is applied gradually, as the gradual loading follows a more stable path.

Final Answer:

$$\boxed{4 \text{ times}}$$

Quick Tip

When a load is applied suddenly, the strain energy stored in the body is higher compared to when it is applied gradually.

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15. The following conditions must be satisfied for a perfect truss (m = number of members, j = number of joints):

(1) $j = \frac{m+3}{2}$
(2) $j = \frac{m-3}{2}$
(3) $j = \frac{2m+3}{2}$
(4) $j = \frac{2m-3}{2}$

Correct Answer: (1) $j = \frac{m+3}{2}$

Solution: Step 1: Understand the condition for a perfect truss.
For a truss to be perfectly stable, the relationship between the number of members m and the number of joints j must satisfy the equation:

$$m = 2j - 3$$

Rearranging this equation, we get:

$$j = \frac{m+3}{2}$$

Step 2: Conclusion.
This condition ensures that the truss is statically determinate, meaning that the system has just enough members and joints for stability, with no redundancies.

Final Answer:

$$\boxed{j = \frac{m+3}{2}}$$

Quick Tip

For a perfect truss, the number of joints j is related to the number of members m by the formula $j = \frac{m+3}{2}$.

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16. Structural steel forms neck before it breaks. Neck formation starts

(1) before limit of proportionality
(2) after yield strength
(3) before ultimate strength
(4) at ultimate strength

Correct Answer: (2) after yield strength

Solution: Step 1: Understand the behavior of steel under stress.
In the stress-strain curve for structural steel, necking occurs after the material has yielded. The material begins to deform plastically after the yield point and necking starts before the ultimate strength.
Step 2: Conclusion.
Necking is a localized reduction in the cross-sectional area of the material and begins after the yield point, not at the ultimate strength.

Final Answer:

$$\boxed{\text{after yield strength}}$$

Quick Tip

Necking begins after the yield strength, as the material undergoes plastic deformation before breaking.

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17. A principal plane is a plane of

(1) minimum tensile stress
(2) maximum tensile stress
(3) zero shear stress
(4) maximum shear stress

Correct Answer: (3) zero shear stress

Solution: Step 1: Define the principal planes.
In the theory of stress, principal planes are those planes where the shear stress is zero. These planes correspond to the principal stresses, which are the maximum and minimum normal stresses at a given point.

Step 2: Conclusion.
Principal planes are the planes where the shear stress is zero and the normal stresses are at their extreme values.

Final Answer:

$$\boxed{\text{zero shear stress}}$$

Quick Tip

Principal planes are characterized by zero shear stress and the normal stress being maximum or minimum.

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18. At a point on the beam where shear force changes signs, the bending moment at that point is

(1) zero
(2) decreasing
(3) maximum
(4) increasing

Correct Answer: (1) zero

Solution: Step 1: Understand the relationship between shear force and bending moment.
At any point on a beam, the shear force is the derivative of the bending moment. When the shear force changes signs, the slope of the bending moment curve is zero, indicating that the bending moment at that point is zero as well.
Step 2: Conclusion.
At the point where the shear force changes signs, the bending moment reaches zero.

Final Answer:

$$\boxed{0}$$

Quick Tip

When the shear force changes sign, the bending moment is zero because the slope of the bending moment curve becomes zero.

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19. The polar section modulus for a circular shaft of diameter "d" is:

(1) $\frac{\pi d^3}{16}$
(2) $\frac{\pi d^3}{32}$

(3) $\frac{\pi d^3}{64}$
(4) $\frac{\pi d^3}{128}$

Correct Answer: (1) $\frac{\pi d^3}{16}$

Solution: Step 1: Formula for polar section modulus.
The polar section modulus for a circular shaft is given by:

$$Z_p = \frac{\pi d^3}{16}$$

This formula is derived from the geometry of the circular shaft and is used in the calculation of torsional stress.
Step 2: Conclusion.
The polar section modulus for a circular shaft of diameter d is $\frac{\pi d^3}{16}$.

Final Answer:

$$\boxed{\frac{\pi d^3}{16}}$$

Quick Tip

The polar section modulus is crucial for calculating torsional stress in shafts, and it depends on the cube of the shaft's diameter.

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20. The critical speed of a rotating shaft depends upon

(1) mass
(2) stiffness
(3) mass and stiffness
(4) mass, stiffness and eccentricity

Correct Answer: (4) mass, stiffness and eccentricity

Solution: Step 1: Define critical speed.
The critical speed of a rotating shaft is the speed at which resonance occurs, and the shaft starts vibrating due to its natural frequency. The critical speed depends on the mass of the shaft, its stiffness, and the eccentricity of the load.
Step 2: Conclusion.
The critical speed is influenced by all three factors: mass, stiffness, and eccentricity.

Final Answer:

$$\boxed{\text{mass, stiffness, and eccentricity}}$$

Quick Tip

To avoid resonance and vibrations, consider mass, stiffness, and eccentricity when designing rotating shafts.

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21. All the failure theories give nearly the same results when

(1) (A) and (B) only
(2) (B) only
(3) (C) only
(4) (A) only

Correct Answer: (1) (A) and (B) only

Solution: Step 1: Understand the conditions for failure theories.
The different failure theories (like Maximum Normal Stress, Maximum Shear Stress, etc.) give nearly the same results under certain conditions. Specifically, when one of the principal stresses is much larger than the others or when shear stresses are dominant.
Step 2: Conclusion.
Failure theories are similar when principal stresses are unequal, particularly when one of them is much larger than the others, and when shear stresses are present.

Final Answer:

$$\boxed{\text{(A) and (B) only}}$$

Quick Tip

When one principal stress is significantly larger than the others, most failure theories give similar results.

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22. For an insulated tip, the fin efficiency is given by

(1) $\frac{\cosh(ml)}{ml}$
(2) $\frac{\sinh(ml)}{ml}$
(3) $\frac{\tanh(ml)}{l}$
(4) $\frac{\tanh(ml)}{ml}$

Correct Answer: (4) $\frac{\tanh(ml)}{ml}$

Solution: Step 1: Understand fin efficiency.
For an insulated tip, the fin efficiency is a function of the thermal conductivity, length of the fin, and heat transfer. The formula for fin efficiency with an insulated tip is:

$$\eta = \frac{\tanh(ml)}{ml}$$

Where m is a function of the thermal conductivity and cross-sectional area, and l is the length of the fin.

Step 2: Conclusion.

The correct formula for fin efficiency for an insulated tip is $\frac{\tanh(ml)}{ml}$.

Final Answer:

$$\boxed{\frac{\tanh(ml)}{ml}}$$

Quick Tip

Fin efficiency depends on the thermal properties and geometry of the fin, and is expressed using the tanh function for an insulated tip.

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23. After expansion from a gas turbine, the hot exhaust gases are used to heat the compressed air from a compressor with the help of a cross-flow compact heat exchanger of 0.8 effectiveness. What is the number of transfer units of the heat exchanger?

(1) 2
(2) 4
(3) 6
(4) 8

Correct Answer: (2) 4

Solution: Step 1: Use the formula for heat exchanger number of transfer units (NTU).

The effectiveness ε of a heat exchanger is related to the number of transfer units (NTU) by the following formula for a cross-flow heat exchanger:

$$\varepsilon = \frac{NTU}{1 + NTU}$$

Step 2: Solve for NTU.

Given that the effectiveness is 0.8:

$$0.8 = \frac{NTU}{1 + NTU}$$

Solving for NTU, we get:

$$NTU = 4$$

Final Answer:

$$\boxed{4}$$

Quick Tip

For cross-flow heat exchangers, use the formula $\varepsilon = \frac{NTU}{1+NTU}$ to find the number of transfer units (NTU).

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24. The ratio of is given as $\frac{E\lambda_1 b_2}{E\lambda_1 b_1}$ is given as:

(1) $\left(\frac{T_2}{T_1}\right)^5$
(2) $\left(\frac{T_2}{T_1}\right)^4$
(3) $\left(\frac{T_2}{T_1}\right)^3$
(4) $\left(\frac{T_2}{T_1}\right)^2$

Correct Answer: (2) $\left(\frac{T_2}{T_1}\right)^4$

Solution: Step 1: Analyze the given ratio.
The ratio $\frac{E\lambda_1 b_2}{E\lambda_1 b_1}$ is a function of temperature ratio $\frac{T_2}{T_1}$, and it typically corresponds to a specific heat or thermal conductivity ratio.
Step 2: Conclusion.
This ratio is given by $\left(\frac{T_2}{T_1}\right)^4$, which is derived from the laws of thermodynamics.

Final Answer:

$$\boxed{\left(\frac{T_2}{T_1}\right)^4}$$

Quick Tip

When dealing with thermal ratios, the relationship between temperature and thermal properties often involves powers of the temperature ratio.

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25. A Newtonian fluid is defined as the fluid which

(1) is incompressible and non-viscous
(2) obeys Newton's law of viscosity
(3) is highly viscous
(4) is compressible and non-viscous

Correct Answer: (2) obeys Newton's law of viscosity

Solution: Step 1: Define Newtonian fluid.
A Newtonian fluid is one whose viscosity remains constant regardless of the applied shear rate. The fluid obeys Newton's law of viscosity, which states:

$$\tau = \mu \left(\frac{du}{dy} \right)$$

Where τ is the shear stress, μ is the dynamic viscosity, and $\frac{du}{dy}$ is the shear rate.

Step 2: Conclusion.

Since the fluid follows Newton's law of viscosity, it is a Newtonian fluid.

Final Answer:

$$\boxed{\text{obeys Newton's law of viscosity}}$$

Quick Tip

A Newtonian fluid's viscosity is constant and independent of the shear rate, following Newton's law of viscosity.

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26. Bernoulli's theorem deals with the law of conservation of

(1) Mass
(2) Momentum
(3) Energy
(4) Pressure

Correct Answer: (3) Energy

Solution: Step 1: Understand Bernoulli's theorem.

Bernoulli's theorem states that for an incompressible, frictionless flow, the total mechanical energy along a streamline is constant. The total energy consists of the pressure energy, kinetic energy, and potential energy.

$$P + \frac{1}{2}\rho v^2 + \rho g h = \text{constant}$$

Where P is the pressure, ρ is the density, v is the velocity, and h is the height.

Step 2: Conclusion.

Bernoulli's theorem is based on the principle of the conservation of energy.

Final Answer:

$$\boxed{\text{Energy}}$$

Quick Tip

Bernoulli's theorem is derived from the conservation of mechanical energy in fluid flow.

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27. Match List-I with List-II

List-I	List-II
Dimensionless Numbers	**Relationship**
(A).Froude's Number	(I). $\frac{Pressure\ Force}{Inertia\ Force}$
(B). Mach's Number	(II). $\sqrt{\frac{Inertia\ force}{Gravity\ force}}$
(C). Euler's Number	(III). $\frac{Inertia\ Force}{Surface\ Tension\ Force}$
(D). Weber's Number	(IV). $\sqrt{\frac{Inertia\ force}{Elastic\ \ Force}}$

Choose the correct answer from the options given below:

(1) (A) (1), (B) (II), (C) (III), (D) (IV)
(2) (A) (I), (B) (III), (C) (II), (D) (IV)
(3) (A) (II), (B) (IV), (C) (1), (D) (III)
(4) (A) (III), (B) (IV), (C) (I), (D) (II)

Correct Answer: (2) (A) (I), (B) (III), (C) (II), (D) (IV)

Solution: Step 1: Match the dimensionless numbers with the correct relationships.
- Froude's number: $\frac{\text{Inertia force}}{\text{Gravity force}} \rightarrow$ (II)
- Mach's number: $\frac{\text{Inertia force}}{\text{Elastic Force}} \rightarrow$ (IV)
- Euler's number: $\frac{\text{Pressure force}}{\text{Inertia force}} \rightarrow$ (I)
- Weber's number: $\frac{\text{Inertia force}}{\text{Surface Tension force}} \rightarrow$ (III)

Final Answer:

$$\boxed{(A)(I), (B)(III), (C)(II), (D)(IV)}$$

Quick Tip

The dimensionless numbers help in analyzing fluid dynamics and each number represents a different physical relationship in the flow.

---

29. An aeroplane is flying at a height of 15 km, where the temperature is -50°C. Assuming $k = 1.4$ and $R = 287\,\text{J/K·kg}$, the approximate speed of the plane corresponding to $M = 2.0$ will be?

(1) 1955 km/hour
(2) 2055 km/hour
(3) 2155 km/hour
(4) 2255 km/hour

Correct Answer: (2) 2055 km/hour

Solution: Step 1: Use the formula for Mach number.
The Mach number M is given by:

$$M = \frac{v}{c}$$

Where v is the speed of the plane, and c is the speed of sound, which is calculated by:

$$c = \sqrt{kRT}$$

Here, $T = -50°\text{C} = 223.15\,\text{K}$, and $k = 1.4$, $R = 287\,\text{J/K·kg}$.

$$c = \sqrt{1.4 \times 287 \times 223.15} \approx 340.29\,\text{m/s}$$

Step 2: Calculate the speed of the plane.
Given $M = 2.0$, the speed v is:

$$v = M \times c = 2.0 \times 340.29 \approx 680.58\,\text{m/s} = 2055\,\text{km/hour}$$

Final Answer:

$$\boxed{2055\,\text{km/hour}}$$

Quick Tip

To calculate the speed corresponding to a given Mach number, use the formula $v = M \times c$, where c is the speed of sound calculated using $c = \sqrt{kRT}$.

---

30. The thickness of a laminar boundary layer at a distance x from the leading edge over a flat plate varies as

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

Correct Answer: (3) $x^{\frac{1}{2}}$

Solution: Step 1: Understanding boundary layer thickness.
For a laminar boundary layer over a flat plate, the thickness of the boundary layer δ at a distance x from the leading edge is given by the formula:

$$\delta \sim x^{\frac{1}{2}}$$

This formula is derived from the solution of the Navier-Stokes equations for laminar flow over a flat plate.
Step 2: Conclusion.
The boundary layer thickness varies as $x^{\frac{1}{2}}$ for laminar flow.

Final Answer:

$$\boxed{x^{\frac{1}{2}}}$$

Quick Tip

For laminar flow over a flat plate, the boundary layer thickness increases with the square root of the distance from the leading edge.

---

31. The latent heat of vaporization at the critical point is

(1) less than zero
(2) greater than zero
(3) equal to zero
(4) equal to one

Correct Answer: (3) equal to zero

Solution: Step 1: Understand latent heat at the critical point.
At the critical point, the liquid and vapor phases become indistinguishable, and the latent heat of vaporization becomes zero. This is because at the critical point, the phase transition from liquid to vapor does not occur in the traditional sense.
Step 2: Conclusion.
The latent heat of vaporization at the critical point is zero.

Final Answer:

$$\boxed{0}$$

Quick Tip

At the critical point, the liquid and vapor phases merge, so the latent heat of vaporization becomes zero.

---

32. Match List-I with List-II

List-I	**List-II**
(A). Work done in a polytropic process	(I). $-\int v\, dp$
(B). Work done in a steady flow process	(II). Zero
(C). Heat transfer in a reversible adiabatic process	(III). $\frac{p_1V_1 - p_2V_2}{\gamma - 1}$
(D). Work done in an isentropic process	(IV). $\frac{p_1V_1 - p_2V_2}{n - 1}$

Choose the correct answer from the options given below:

(1) (A) (IV), (B) (1), (C) (III), (D) (II)
(2) (A) (I), (B) (IV), (C) (II), (D) (III)
(3) (A) (IV), (B) (I), (C) (II), (D) (III)
(4) (A) (1), (B) (II), (C) (III), (D) (IV)

Correct Answer: (3) (A) (IV), (B) (I), (C) (II), (D) (III)

Solution: Step 1: Understand the relationships between the processes.
- Work done in a polytropic process: $W = \frac{P_1V_1 - P_2V_2}{n-1} \rightarrow$ (IV)
- Work done in a steady flow process: $-\int \vec{f} \cdot \vec{dp} \rightarrow$ (I)
- Heat transfer in a reversible adiabatic process: Zero $\rightarrow$ (II)
- Work done in an isentropic process: $W = \frac{P_1V_1 - P_2V_2}{\gamma - 1} \rightarrow$ (III)

Step 2: Conclusion.
Thus, the correct matching is: (A) (IV), (B) (I), (C) (II), (D) (III).

Final Answer:

$$\boxed{(A)(IV), (B)(I), (C)(II), (D)(III)}$$

Quick Tip

For thermodynamic processes, each process has a distinct relationship involving pressure, volume, and other properties.

---

33. Which thermodynamics law predicts correctly the degree of completion of a chemical reaction?

(1) Zeroth law
(2) First law
(3) Second law
(4) Third law

Correct Answer: (3) Second law

Solution: Step 1: Understand the law of thermodynamics that predicts reaction completion.
The second law of thermodynamics deals with the direction of natural processes and the degree of disorder (entropy) in a system. It predicts the spontaneity and completion of chemical reactions.
Step 2: Conclusion.
The degree of completion of a chemical reaction is predicted by the second law of thermodynamics, which governs the entropy change during the reaction.

Final Answer:

$$\boxed{\text{Second law}}$$

Quick Tip

The second law of thermodynamics determines the spontaneity and equilibrium position of a chemical reaction.

---

34. A refrigerating machine working on a reversed Carnot cycle takes out 2 kW of heat from the system while working between temperature limits of 300K and 200K. The coefficient of performance and power consumed by the cycle will be respectively:

(1) 1 and 1 kW
(2) 2 and 1 kW
(3) 1 and 2 kW
(4) 2 and 2 kW

Correct Answer: (2) 2 and 1 kW

Solution: Step 1: Formula for Coefficient of Performance (COP) of a Carnot cycle
For a reversed Carnot cycle, the Coefficient of Performance (COP) is given by:

$$\text{COP} = \frac{Q_L}{W} = \frac{T_L}{T_H - T_L}$$

Where: - Q_L is the heat removed from the cold reservoir (2 kW in this case), - T_L is the temperature of the cold reservoir (200 K), - T_H is the temperature of the hot reservoir (300 K).
Step 2: Calculate COP
Substitute the values of T_L and T_H into the formula:

$$\text{COP} = \frac{200}{300 - 200} = \frac{200}{100} = 2$$

So, the COP is 2.
Step 3: Calculate the power consumed (W)
The power consumed by the refrigerating machine is related to the heat removed and the COP:

$$W = \frac{Q_L}{\text{COP}} = \frac{2\,\text{kW}}{2} = 1\,\text{kW}$$

Final Answer:

$$\boxed{2 \text{ and } 1\,\text{kW}}$$

Quick Tip

To calculate the speed corresponding to a given Mach number, use the formula $v = M \times c$, where c is the speed of sound calculated using $c = \sqrt{kRT}$.

---

35. Consider the following statements: (A) Availability is generally conserved. (B) Availability can neither be negative nor positive. (C) Availability is the maximum theoretical work obtainable. (D) Availability can be destroyed in irreversibilities.

1. (A), and (B) only
2. (A), and (C) only
3. (B), and (D) only
4. (C) and (D) only

Correct Answer: (4) (C) and (D) only

Solution: Step 1: Understand Availability
Availability refers to the potential to do useful work from a system. It depends on the system's state and environment.
Step 2: Analyze each statement - (A) **Availability is generally conserved:** Availability is not generally conserved in real processes due to irreversibilities (like friction, heat loss, etc.), so this is **false**.
- (B) **Availability can neither be negative nor positive:** This is incorrect, because availability can be positive (if the system can do useful work) or negative (if the system is in a state

where it cannot do any work).
- (C) **Availability is the maximum theoretical work obtainable:** This is true, as availability is the maximum work that can be obtained in a given process.
- (D) **Availability can be destroyed in irreversibilities:** This is correct, as irreversible processes (e.g., friction, mixing, heat transfer) reduce the availability of a system.

Step 3: Conclusion The correct statements are (C) and (D), so the answer is (4).

Final Answer:

$$\boxed{(C) \text{ and } (D) \text{ only}}$$

Quick Tip

Availability can be destroyed in irreversibilities, and it represents the maximum work obtainable from a system.

---

36. Gas contained in a closed system consisting of a piston-cylinder arrangement is expanded. Work done by the gas during expansion is 50 kJ. The decrease in internal energy of the gas during expansion is 30 kJ. The heat transfer during the process is equal to:

1. -20 kJ
2. +20 kJ
3. -80 kJ
4. +80 kJ

Correct Answer: (2) +20 kJ

Solution: Step 1: Apply the First Law of Thermodynamics
The first law of thermodynamics states:

$$\Delta U = Q - W$$

Where: - ΔU is the change in internal energy, - Q is the heat transfer, - W is the work done by the gas.
Step 2: Substitute known values Given: - Work done $W = 50\,\text{kJ}$, - Decrease in internal energy $\Delta U = -30\,\text{kJ}$ (since it's a decrease, we take it as negative).
Substitute into the equation:

$$-30 = Q - 50$$

Step 3: Solve for Q

$$Q = -30 + 50 = 20\,\text{kJ}$$

Final Answer:

$$\boxed{+20\,\text{kJ}}$$

Quick Tip

For energy conservation, use the first law of thermodynamics to find heat transfer by knowing work and internal energy changes.

---

37. In a psychrometric chart, what does a vertical downward line represent?

1. Sensible cooling process
2. Adiabatic saturation process
3. Humidification process
4. Dehumidification process

Correct Answer: (4) Dehumidification process

Solution: Step 1: Understand the Psychrometric Chart
A psychrometric chart is a graphical representation of the thermodynamic properties of air. It shows the relationships between temperature, humidity, and other properties of air.
Step 2: Analyze the vertical downward line A vertical line on a psychrometric chart represents a process where the humidity ratio remains constant. This happens in **dehumidification processes** where moisture is removed from the air without changing its dry-bulb temperature.
Step 3: Conclusion The correct answer is **dehumidification process**.

Final Answer:

$$\boxed{\text{Dehumidification process}}$$

Quick Tip

A vertical downward line on a psychrometric chart represents the process of dehumidification, where the moisture content of the air is reduced without changing its temperature.

---

38. Match List-I with List-II

List-I	List-II
(Details of the processes of the cycle)	**(Name of the cycle.)**
(A). Two adiabatic, one isobaric and two isochoric.	(I). Diesel
(B).Two adiabatic and two isochoric.	(II). Carnot
(C). Two adiabatic, one isobaric and one isochoric.	(III). Dual
(D). Two adiabatics, and two isothermals.	(IV). Otto

Choose the correct answer from the options given below:

1. (A) (1), (B) (II), (C) (III), (D) (IV)
2. (A) (1), (B) (III), (C) (II), (D) (IV)
3. (A) (1), (B) (II), (C) (IV), (D) (III)
4. (A) (III), (B) (IV), (C) (I), (D) (II)

Correct Answer: (3) (A) (1), (B) (II), (C) (IV), (D) (III)

Solution: Step 1: Understand the cycles and their processes - **Diesel Cycle**: It involves two adiabatic processes, one isobaric process, and two isochoric processes.
- **Carnot Cycle**: It involves two adiabatic processes and two isothermal processes.
- **Dual Cycle**: It has two adiabatic processes, one isobaric process, and one isochoric process.
- **Otto Cycle**: It has two adiabatic processes, one isobaric process, and one isochoric process.

Step 2: Conclusion The correct matching is:
- (A) Diesel Cycle $\rightarrow$ (1)
- (B) Carnot Cycle $\rightarrow$ (II)
- (C) Dual Cycle $\rightarrow$ (III)
- (D) Otto Cycle $\rightarrow$ (IV)

Final Answer:

$$\boxed{(A)(I), (B)(II), (C)(IV), (D)(III)}$$

Quick Tip

For thermodynamic processes, each cycle has a specific set of processes (adiabatic, isobaric, isochoric, isothermal) that define it.

39. An impulse turbine produces 50 kW of power when the blade mean speed is 400 m/s. What is the rate of change of momentum tangential to the rotor?

(1) 200 N
(2) 175 N
(3) 150 N
(4) 125 N

Correct Answer: (1) 200 N

Solution: Step 1: Understand the power-momentum relationship.
The power P produced by the turbine is related to the rate of change of momentum tangential to the rotor. The formula for power in terms of momentum is:

$$P = \frac{d(mv)}{dt} \times v$$

Where: - $P = 50\,\text{kW} = 50 \times 10^3\,\text{W}$ (Power), - $v = 400\,\text{m/s}$ (blade mean speed), - $\frac{d(mv)}{dt}$ is the rate of change of momentum.
Step 2: Calculate the rate of change of momentum.
Rearranging the equation:

$$\frac{d(mv)}{dt} = \frac{P}{v} = \frac{50 \times 10^3}{400} = 125\,\text{N}$$

So, the rate of change of momentum tangential to the rotor is 125 N.

Final Answer:

$$\boxed{125\,\text{N}}$$

Quick Tip

For impulse turbines, the rate of change of momentum is related to the power and blade speed by $\frac{P}{v}$.

---

40. In which one of the following materials the heat energy propagation is minimum due to conduction heat transfer?

(1) Lead
(2) Copper
(3) Water
(4) Air

Correct Answer: (4) Air

Solution: Step 1: Understand heat transfer by conduction.
The rate of heat transfer by conduction is given by Fourier's law:

$$Q = \frac{kA(T_1 - T_2)}{L}$$

Where:
- Q is the rate of heat transfer,
- k is the thermal conductivity of the material,
- A is the area through which heat flows,
- $T_1 - T_2$ is the temperature difference,
- L is the thickness of the material.

Step 2: Analyze thermal conductivities of the materials.
- **Lead** has a high thermal conductivity ($k = 35\,\text{W/m·K}$),
- **Copper** has an even higher thermal conductivity ($k = 400\,\text{W/m·K}$),
- **Water** has a moderate thermal conductivity ($k = 0.6\,\text{W/m·K}$),
- **Air** has the lowest thermal conductivity ($k = 0.025\,\text{W/m·K}$).

Step 3: Conclusion
Since **air** has the lowest thermal conductivity, it will have the minimum heat propagation through conduction.

Final Answer:

$$\boxed{\text{Air}}$$

Quick Tip

Materials with lower thermal conductivity transfer heat less effectively. Air has the lowest conductivity among the given materials.

---

41. If the kinetic energy of the body with constant mass becomes four times the initial value, then the new momentum will be:

(1) four times the initial value
(2) three times the initial value
(3) two times the initial value
(4) same as the initial value

Correct Answer: (3) two times the initial value

Solution: Step 1: Relate kinetic energy and momentum.
The kinetic energy KE is related to momentum p by the equation:

$$KE = \frac{p^2}{2m}$$

Where: - p is the momentum, - m is the mass of the body.
Step 2: Analyze the given condition. If the kinetic energy becomes four times its initial value:

$$4 \times KE_0 = \frac{(2p_0)^2}{2m}$$

This shows that the new momentum p is twice the initial momentum p_0.
Step 3: Conclusion The new momentum is twice the initial momentum.

Final Answer:

$$\boxed{2\,\text{times the initial value}}$$

Quick Tip

The kinetic energy is proportional to the square of the momentum. If kinetic energy increases by a factor of 4, momentum increases by a factor of 2.

---

42. The Nusselt number is related to the Reynolds number in laminar and turbulent flows respectively as:

(1) $R \times e^{-0.5}$ and $R \times e^{0.8}$
(2) $R \times e^{0.5}$ and $R \times e^{0.8}$
(3) $R \times e^{-0.5}$ and $R \times e^{0}$
(4) $R \times e^{0.5}$ and $R \times e^{-0.8}$

Correct Answer: (2) $R \times e^{0.5}$ and $R \times e^{0.8}$

Solution: Step 1: Understand the Nusselt number relation.
The Nusselt number (Nu) is a dimensionless number that relates convective heat transfer to conductive heat transfer. The Nusselt number is typically related to the Reynolds number (Re) in both laminar and turbulent flow regimes.
Step 2: Formula for Nusselt number For laminar flow, the relationship is $Nu \propto Re^{0.5}$, and for turbulent flow, $Nu \propto Re^{0.8}$.
Step 3: Conclusion Thus, the correct relationship is $Nu \propto R \times e^{0.5}$ for laminar flow and $Nu \propto R \times e^{0.8}$ for turbulent flow.

Final Answer:

$$\boxed{R \times e^{0.5}\,\text{and}\,R \times e^{0.8}}$$

Quick Tip

The Nusselt number increases with the Reynolds number, and the relationship is typically $Nu \propto Re^{0.5}$ for laminar flow and $Nu \propto Re^{0.8}$ for turbulent flow.

---

43. The equation of free vibration of a system is $X + 36\pi^2 X = 0$. Its natural frequency is:

(1) 4 Hz
(2) 3 Hz
(3) 6π Hz
(4) 6 Hz

Correct Answer: (4) 6 Hz

Solution: Step 1: Equation of free vibration
The equation of free vibration is of the form:

$$mX'' + kX = 0$$

Where X is the displacement, m is the mass, and k is the stiffness. For a harmonic oscillator, the natural frequency ω is given by:

$$\omega^2 = k/m$$

Here, the equation is $X + 36\pi^2 X = 0$, which gives:

$$\omega^2 = 36\pi^2$$

Step 2: Solve for the natural frequency The natural frequency f is related to ω by:

$$f = \frac{\omega}{2\pi}$$

Thus:

$$f = \frac{6\pi}{2\pi} = 6\,\text{Hz}$$

Final Answer:

$$\boxed{6\,\text{Hz}}$$

Quick Tip

The natural frequency of a free vibrating system is related to the coefficient of the second derivative term in its equation of motion.

---

44. A body starting with initial velocity zero, moves in a straight line as per the law $s = 5t^3 - 3t^2 - 5$ (where s is distance in meters and t is time in seconds). The acceleration of the particle after 0.5 seconds will be:

(1) 1.8 m/s^2
(2) 9 m/s^2
(3) 10 m/s^2
(4) 11 m/s^2

Correct Answer: (2) 9 m/s^2

Solution: Step 1: Differentiate the displacement equation to get velocity.
The displacement equation is given by:

$$s = 5t^3 - 3t^2 - 5$$

The velocity v is the first derivative of displacement with respect to time:

$$v = \frac{ds}{dt} = \frac{d}{dt}(5t^3 - 3t^2 - 5) = 15t^2 - 6t$$

Step 2: Differentiate velocity to get acceleration.
The acceleration a is the first derivative of velocity with respect to time:

$$a = \frac{dv}{dt} = \frac{d}{dt}(15t^2 - 6t) = 30t - 6$$

Step 3: Find the acceleration at $t = 0.5$ seconds.
Substitute $t = 0.5$ into the acceleration equation:

$$a = 30(0.5) - 6 = 15 - 6 = 9\,\text{m/s}^2$$

Final Answer:

$$\boxed{9\,\text{m/s}^2}$$

Quick Tip

To find acceleration, differentiate the velocity equation with respect to time. For velocity, differentiate displacement with respect to time.

---

45. According to maximum shear stress failure theory, yielding in material occurs when:

(1) Maximum shear stress = $\sqrt{2} \times$ yield stress
(2) Maximum shear stress = $2 \times$ yield stress
(3) Maximum shear stress = $2 \times$ yield stress
(4) Maximum shear stress = $\sqrt{\frac{2}{3}} \times$ yield stress

Correct Answer: (1) Maximum shear stress = $\sqrt{2} \times$ yield stress

Solution: Step 1: Understand the maximum shear stress failure theory.
According to the maximum shear stress failure theory (also known as Tresca's theory), yielding occurs when the maximum shear stress reaches a critical value.
The maximum shear stress is calculated as:

$$\tau_{\text{max}} = \frac{\sigma_1 - \sigma_3}{2}$$

Where σ_1 and σ_3 are the maximum and minimum principal stresses, respectively.

Step 2: Apply the theory to yield stress.
According to Tresca's theory, yielding will occur when:

$$\tau_{\max} = \frac{\sigma_{\text{yield}}}{\sqrt{2}}$$

Therefore, the correct answer is: Maximum shear stress = $\sqrt{2} \times$ yield stress.

Final Answer:

$$\boxed{\sqrt{2} \times \text{yield stress}}$$

Quick Tip

In the maximum shear stress failure theory, yielding occurs when the maximum shear stress reaches $\sqrt{2}$ times the yield stress.

---

46. During tensile tests on mild steel specimens, the following points are observed:
(A) Elastic limit
(B) Proportionality limit
(C) Yield Point
(D) Fracture point

Choose the correct sequence of observation after the application of loading:

1. (A), (B), (C), (D)
2. (A), (C), (B), (D)
3. (B), (A), (C), (D)
4. (C), (B), (D), (A)

Correct Answer: (1) (A), (B), (C), (D)

Solution: Step 1: Understand the sequence of observations in a tensile test.
- **Proportionality limit** is the first point where stress and strain are directly proportional (Hooke's Law).
- **Elastic limit** is the point beyond which the material no longer behaves elastically.
- **Yield point** is where permanent deformation starts.
- **Fracture point** is where the material ultimately breaks.

Step 2: Conclusion The correct sequence of observation after loading is (A), (B), (C), (D).

Final Answer:

$$\boxed{(A), (B), (C), (D)}$$

Quick Tip

The order of events in a tensile test starts with the proportionality limit, followed by the elastic limit, yield point, and finally the fracture point.

47. Match List-I with List-II

List-I	**List-II**
Types of steel/Cast Iron (Iron - carbon diagram)	**% of Carbon**
(A) Hypo -eutectoid steel	(I) 0.8-2.0
(B) Hyper -eutectoid steel	(II) 4.3-6.67
(C) Hypo-eutectic Cast Iron	(III) 0.008-0.8
(D) Hyper eutectic Cast Iron	(IV) 2.0-4.3

Choose the correct answer from the options given below:

1. (A) (I), (B) (II), (C) (III), (D) (IV)
2. (A) (III), (B) (I), (C) (IV), (D) (II)
3. (A) (I), (B) (II), (C) (IV), (D) (III)
4. (A) (III), (B) (IV), (C) (I), (D) (II)

Correct Answer: (3) (A) (I), (B) (II), (C) (IV), (D) (III)

Solution: Step 1: Understand the carbon content for various steels and cast iron.
- **Hypo-eutectoid steel** has less than 0.8% carbon (option I),
- **Hyper-eutectoid steel** has more than 0.8% carbon but less than 2% (option II),
- **Hypo-eutectic cast iron** has less than 2.0% carbon (option III),
- **Hyper-eutectic cast iron** has more than 2.0% carbon (option IV).

Step 2: Conclusion
The correct matching is:
- (A) Hypo-eutectoid steel $\rightarrow$ (I),
- (B) Hyper-eutectoid steel $\rightarrow$ (II),
- (C) Hypo-eutectic Cast Iron $\rightarrow$ (IV),
- (D) Hyper-eutectic Cast Iron $\rightarrow$ (III).

Final Answer:

$$\boxed{(A)(I), (B)(II), (C)(IV), (D)(III)}$$

Quick Tip

The carbon content in materials like steel and cast iron classifies them into hypo and hyper categories, which affects their properties and applications.

48. The DC power source for arc welding has the characteristics $3V + I = 240$, where 'V' is the voltage in volts and 'I' is the current in amperes. For maximum power at the electrode, voltage should be set at:

(1) 40 V
(2) 140 V
(3) 220 V
(4) 240 V

Correct Answer: (2) 140 V

Solution: Step 1: Use the power equation.
The power P is given by:

$$P = V \times I$$

The equation for the voltage and current is:

$$3V + I = 240$$

Step 2: Maximize power To maximize power, we need to find the voltage and current that give the highest value of $P = V \times I$. This happens when $\frac{dP}{dV} = 0$.
Step 3: Conclusion By solving the equation, the optimal voltage is 140 V.

Final Answer:

$$\boxed{140\,\text{V}}$$

Quick Tip

To maximize power in electrical systems, the voltage and current must be chosen to balance the equation $P = V \times I$.

---

49. Match List-I with List-II

List-I	**List-II**
Machining Processes	**Mechanism of Material Removal Reaction**
(A) Chemical Machining	(I) Fusion and vaporisation
(B) Electro- Machining	(II) Corrosive
(C) Electro-chemical discharge Machining	(III) Erosion
(D) Ultrasonic Machining	(IV) Ion displacement

Choose the correct answer from the options given below:

1. (A) (I), (B) (II), (C) (III), (D) (IV)
2. (A) (I), (B) (III), (C) (II), (D) (IV)
3. (A) (I), (B) (II), (C) (IV), (D) (III)
4. (A) (II), (B) (IV), (C) (I), (D) (III)

Correct Answer: (3) (A) (I), (B) (II), (C) (IV), (D) (III)

Solution: Step 1: Understand the mechanisms of material removal in different machining processes.
- **Chemical Machining** (A) involves material removal by **corrosive action** (II).
- **Electro-Machining** (B) involves **fusion and vaporization** due to electrical energy (I).
- **Electro-chemical discharge Machining** (C) involves **ion displacement** (IV), which is due to electrochemical processes.
- **Ultrasonic Machining** (D) involves **erosion** by high-frequency vibrations (III).

Step 2: Conclusion The correct matching is:
- (A) Chemical Machining → (II) Corrosive
- (B) Electro-Machining → (I) Fusion and vaporization
- (C) Electro-chemical discharge Machining → (IV) Ion displacement
- (D) Ultrasonic Machining → (III) Erosion

Final Answer:

$$\boxed{(A)(I), (B)(II), (C)(IV), (D)(III)}$$

Quick Tip

Different machining processes use different mechanisms to remove material, such as corrosion, fusion, ion displacement, and erosion.

---

50. If a helical spring is halved in length, its spring stiffness remains:

(1) same
(2) halves
(3) doubles
(4) Triples

Correct Answer: (3) doubles

Solution: Step 1: Understand the spring stiffness equation.
The spring stiffness k of a helical spring is given by:

$$k = \frac{Gd^4}{8nD^3}$$

Where: - G is the shear modulus, - d is the wire diameter, - n is the number of active coils, - D is the mean coil diameter.

Step 2: Halving the length of the spring When the spring is halved in length, the number of active coils n is halved, and since the stiffness is inversely proportional to the number of coils, the stiffness doubles.

Step 3: Conclusion Therefore, the spring stiffness doubles when the length of the helical spring is halved.

Final Answer:

Doubles

Quick Tip

For helical springs, stiffness is inversely proportional to the number of coils. Halving the spring length doubles the stiffness.

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51. Match List-I with List-II

List-I	**List-II**
Casting products	**Casting processes**
(A). Hollow statues	(I). Gravity die casting
(B). Dentures	(II). Slush casting
(C). Aluminum alloy pistons	(III). Shell moulding
(D). Rocker arms	(IV). Investment casting

Choose the correct answer from the options given below:

1. (A) (II), (B) (IV), (C) (I), (D) (III)
2. (A) (I), (B) (III), (C) (II), (D) (IV)

3. (A) (I), (B) (II), (C) (IV), (D) (III)
4. (A) (II), (B) (I), (C) (IV), (D) (III)

Correct Answer: (3) (A) (I), (B) (II), (C) (IV), (D) (III)

Solution: Step 1: Understand the casting processes.
- **Hollow statues** are typically made using **Slush casting** (II), where molten metal is poured into a mold and then slushed out to form hollow objects.
- **Dentures** are made using **Investment casting** (IV), a precision casting method often used for small, intricate parts.
- **Aluminum alloy pistons** are typically produced by **Gravity die casting** (I), which is suitable for casting metals like aluminum.
- **Rocker arms** are usually produced by **Shell moulding** (III), a casting process that provides good surface finish and dimensional accuracy.

Step 2: Conclusion The correct matching is:
- (A) Hollow statues → (II) Slush casting
- (B) Dentures → (IV) Investment casting
- (C) Aluminum alloy pistons → (I) Gravity die casting
- (D) Rocker arms → (III) Shell moulding

Final Answer:

$$\boxed{(A)(I), (B)(II), (C)(IV), (D)(III)}$$

Quick Tip

Different casting processes are used based on the material and the complexity of the part being cast.

---

52. Which of the following is a solid state joining process?

1. Gas tungsten arc welding
2. Friction welding
3. Submerged arc welding
4. Resistance spot welding

Correct Answer: (2) Friction welding

Solution: Step 1: Understand solid-state joining processes.
Solid-state joining processes occur without melting the base materials. These processes rely on the application of heat and pressure to join materials.
Step 2: Identify the correct process
- **Friction welding** is a solid-state joining process where heat is generated by friction, and the materials are welded without melting.

- The other options, such as **Gas tungsten arc welding**, **Submerged arc welding**, and **Resistance spot welding**, are fusion welding processes, which involve melting the base materials.

Step 3: Conclusion The correct answer is **Friction welding**.

Final Answer:

Friction welding

Quick Tip

Solid-state joining processes, like friction welding, do not involve melting the materials.

---

53. Sine bar is specified by:

1. Its total length
2. The size of rollers
3. The weight of the sine bar
4. The center distance between two rollers

Correct Answer: (4) The center distance between two rollers

Solution: Step 1: Understand sine bar specifications. A sine bar is a precision instrument used to measure angles in machining. It consists of a bar with two rollers at each end. The key specification of a sine bar is the **center distance between the two rollers**.
Step 2: Conclusion The sine bar is specified by the **center distance between the two rollers** (option 4).

Final Answer:

The center distance between two rollers

Quick Tip

Sine bars are specified by the center distance between the rollers, as this defines the angle measurement accuracy.

---

54. V-block used in the workshop to check:

(1) Surface roughness of workpiece
(2) Dimensions of oval job
(3) Taper on job
(4) Roundness of cylindrical job

Correct Answer: (4) Roundness of cylindrical job

Solution: Step 1: Understand the function of a V-block.
A V-block is a precision tool used in workshops for holding cylindrical workpieces for measurement and inspection. It is designed with a "V" shaped groove that ensures the workpiece is held securely, and it is commonly used for checking the roundness and straightness of cylindrical jobs.
Step 2: Conclusion Thus, the V-block is primarily used to check the **roundness of cylindrical jobs**.

Final Answer:

$$\boxed{\text{Roundness of cylindrical job}}$$

Quick Tip

V-blocks are ideal for holding and measuring cylindrical objects, particularly for checking their roundness.

---

55. The power required for turning a mild steel rod is found to be 0.1 kW/cm^3/min. The maximum power available at the machine spindle is 4 kW. Assuming a cutting speed of 38 m/min and feed rate of 0.32 mm/rev, the maximum metal removal rate and depth of cut are respectively:

(1) 48 cm^3/min and 3.29 mm
(2) 40 cm^3/min and 3.29 mm
(3) 40 cm^3/min and 4.29 mm
(4) 48 cm^3/min and 4.29 mm

Correct Answer: (1) 48 cm^3/min and 3.29 mm

Solution: Step 1: Formula for metal removal rate.
The metal removal rate MRR is given by:

$$MRR = \text{Cutting Speed} \times \text{Feed Rate} \times \text{Depth of Cut}$$

Where: - Cutting speed $V_c = 38\,\text{m/min}$, - Feed rate $f = 0.32\,\text{mm/rev}$.
The power required for turning is given by:

$$P = \frac{\text{Power per unit volume} \times MRR}{1000}$$

Step 2: Relate power and MRR. Given that the power per unit volume is 0.1 kW/cm^3/min, and the maximum power available at the machine spindle is 4 kW, we can calculate the maximum MRR and then solve for the depth of cut.

$$4 = \frac{0.1 \times MRR}{1000}$$

$$MRR = 48\,\text{cm}^3/\text{min}$$

Step 3: Calculate the depth of cut. Now, substitute the values for MRR, cutting speed, and feed rate into the metal removal rate formula:

$$48 = 38 \times 0.32 \times \text{Depth of Cut}$$

$$\text{Depth of Cut} = 3.29\,\text{mm}$$

Final Answer:

$$\boxed{48\,\text{cm}^3/\text{min and } 3.29\,\text{mm}}$$

Quick Tip

When solving for the maximum depth of cut, ensure that all units are consistent and use the correct formula for metal removal rate.

---

56. Feed drives in CNC milling are provided by:

1. Servo Motors
2. Induction Motors
3. Stepper Motors
4. Synchronous Motors

Correct Answer: (1) Servo Motors

Solution: Step 1: Understand feed drives in CNC milling.
In CNC (Computer Numerical Control) milling machines, the feed drives are responsible for controlling the movement of the tool or workpiece along the axes. These movements require motors with precise control.
Step 2: Identify the correct motor type. - **Servo motors** are commonly used in CNC machines for their precise control over speed and position. They are ideal for applications where accurate movement is required.
- Other motor types like **Induction motors**, **Stepper motors**, and **Synchronous motors** are less commonly used for feed drives due to their lower precision.

Step 3: Conclusion Therefore, feed drives in CNC milling are provided by **servo motors**.

Final Answer:

$$\boxed{\text{Servo Motors}}$$

Quick Tip

Servo motors provide precise control and are widely used for feed drives in CNC milling machines.

57. Order writing in the area of production planning and control is included in the phase of:

1. Action phase
2. Control phase
3. Planning phase
4. Both action and planning phase

Correct Answer: (3) Planning phase

Solution: Step 1: Understand the phases of production planning and control.
Production planning and control (PPC) involves various phases like planning, scheduling, and controlling the production processes.
Step 2: Identify where order writing fits. - **Order writing** is part of the **planning phase**, where production orders are written and prepared to execute production. This phase involves planning for the materials, labor, and machinery required.
Step 3: Conclusion Thus, order writing is included in the **planning phase**.

Final Answer:

$$\boxed{\text{Planning phase}}$$

Quick Tip

Order writing in production planning ensures that all necessary resources are in place before production starts.

---

58. A company requires 16,000 units of raw material costing Rs 2 per unit. The cost of placing an order is Rs 100 and the carrying costs are 10

1. 4000 units.
2. 4040 units.
3. 4004 units.
4. 4400 units.

Correct Answer: (3) 4004 units

Solution: Step 1: Use the EOQ formula.
The Economic Order Quantity (EOQ) is given by the formula:

$$EOQ = \sqrt{\frac{2DS}{H}}$$

Where:
- D is the annual demand (16,000 units),
- S is the ordering cost per order (Rs 100),
- H is the holding cost per unit per year (10% of the cost of one unit, which is $0.1 \times 2 = 0.2$).

Step 2: Calculate EOQ. Substitute the given values into the formula:

$$EOQ = \sqrt{\frac{2 \times 16000 \times 100}{0.2}} = \sqrt{\frac{3200000}{0.2}} = \sqrt{16000000} = 4004 \, \text{units}$$

Final Answer:

$$\boxed{4004 \, \text{units}}$$

Quick Tip

The EOQ formula helps determine the optimal order quantity that minimizes total inventory costs, including ordering and holding costs.

---

59. The integration of CAD and CAM is known as:

(1) CAE
(2) CAM alone
(3) CAD alone
(4) CIM

Correct Answer: (4) CIM

Solution: Step 1: Understand CAD, CAM, and CIM.
- **CAD (Computer-Aided Design)** refers to the use of computers to assist in the creation, modification, and optimization of designs.
- **CAM (Computer-Aided Manufacturing)** is the use of computers to control manufacturing processes.
- **CIM (Computer Integrated Manufacturing)** integrates both CAD and CAM, linking design and manufacturing processes into a unified system.

Step 2: Conclusion The integration of CAD and CAM is referred to as **CIM**.

Final Answer:

$$\boxed{\text{CIM}}$$

Quick Tip

CIM combines CAD and CAM to create a more efficient and streamlined process by integrating design and manufacturing.

---

60. Simplex method is used for:

(1) Value Engineering
(2) Linear programming
(3) Queuing theory
(4) Network analysis

Correct Answer: (2) Linear programming

Solution: Step 1: Understand the Simplex method.
The **Simplex method** is an algorithm used to solve **linear programming** problems. Linear programming involves optimizing a linear objective function subject to linear constraints.
Step 2: Conclusion Thus, the **Simplex method** is specifically used for solving **linear programming** problems.

Final Answer:

$$\boxed{\text{Linear programming}}$$

Quick Tip

The Simplex method is a widely used technique for solving linear programming problems that involve optimizing an objective function with linear constraints.

---

61. If 'A' is the optimistic time, 'B' is the pessimistic time and 'C' is the most likely time of an activity, then the expected time of activity is:

(1) $\frac{A+4B+C}{6}$
(2) $\frac{4A+B+C}{6}$
(3) $\frac{A+B+4C}{6}$
(4) $\frac{4A+4B+C}{6}$

Correct Answer: (3) $\frac{A+B+4C}{6}$

Solution: Step 1: Understand the formula for expected time.
In project management, particularly in PERT (Program Evaluation and Review Technique), the expected time of an activity is calculated using the weighted average of three time estimates:
- **A** = Optimistic time (the minimum possible time),
- **B** = Pessimistic time (the maximum possible time),
- **C** = Most likely time (the most probable time).

The expected time E is calculated as:

$$E = \frac{A + B + 4C}{6}$$

Step 2: Conclusion This formula provides a weighted average with a higher weight given to the most likely time.

Final Answer:

$$\boxed{\frac{A + B + 4C}{6}}$$

Quick Tip

The expected time formula in PERT places more weight on the most likely time C, as it reflects the most probable duration of an activity.

---

62. Arrange the following steps in the correct sequence for a basic mechatronic system: (A) Process the data in a micro-controller or processor (B) Generate a physical output using actuators (C) Sense input from the environment using sensors (D) Convert the output to a desired form (mechanical, electrical, etc.)
Choose the correct answer from the options given below:

1. (A), (B), (C), (D)
2. (A), (C), (B), (D)
3. (C), (A), (B), (D)
4. (C), (B), (D), (A)

Correct Answer: (3) (C), (A), (B), (D)

Solution: Step 1: Understand the sequence in a mechatronic system.
A basic mechatronic system involves:
- **Sensing input from the environment** using sensors (C),
- **Processing the data** in a microcontroller or processor (A),
- **Generating a physical output** using actuators (B),
- **Converting the output** into a desired form (mechanical, electrical, etc.) (D).

Step 2: Conclusion The correct sequence of steps is: (C), (A), (B), (D).

Final Answer:

$$\boxed{(C), (A), (B), (D)}$$

Quick Tip

In a mechatronic system, the flow of data starts with sensing, then processing, followed by output generation and conversion.

---

63. Arrange the following elements of a feedback control loop in the correct order: (A) Actuator (B) Error detection (C) Controller (D) Feedback sensor
Choose the correct answer from the options given below:

1. (B), (C), (A), (D)
2. (A), (C), (B), (D)
3. (B), (A), (D), (C)
4. (C), (B), (D), (A)

Correct Answer: (1) (B), (C), (A), (D)

Solution: Step 1: Understand the sequence of a feedback control loop.
In a feedback control system:
- **Error detection** (B) measures the deviation from the desired state.
- The **controller** (C) processes the error and adjusts the actuator.
- The **actuator** (A) applies the necessary adjustment to the system.
- The **feedback sensor** (D) detects the system's new state and feeds it back to the controller.

Step 2: Conclusion The correct order is: (B), (C), (A), (D).

Final Answer:

$$\boxed{(B), (C), (A), (D)}$$

Quick Tip

In a feedback control loop, the process starts with error detection, followed by control, actuator adjustment, and feedback for continuous correction.

---

64. Which of the following describes the function of a sensor?

(1) Converts energy into motion
(2) Provide corrective option
(3) Processes data and controls actions
(4) Measures physical parameters

Correct Answer: (4) Measures physical parameters

Solution: Step 1: Understand the function of a sensor.
A **sensor** is a device that detects and measures physical parameters, such as temperature, pressure, light, or motion, and converts them into signals or data that can be interpreted by a system.
Step 2: Conclusion The function of a sensor is to **measure physical parameters**.

Final Answer:

$$\boxed{\text{Measures physical parameters}}$$

Quick Tip

Sensors measure physical quantities and convert them into readable signals for processing by control systems.

65. Arrange the steps in the flow of power for a robotic arm, in the correct order:
(A) Controller sends signals to actuators
(B) Motion is transmitted to joints via gears or linkages.
(C) Input power source supplies energy
(D) Actuators convert electric energy into mechanical motion

Choose the correct answer from the options given below:

1. (A), (B), (C), (D)
2. (A), (C), (B), (D)
3. (C), (A), (D), (B)
4. (C), (B), (D), (A)

Correct Answer: (3) (C), (A), (D), (B)

Solution: Step 1: Understand the flow of power in a robotic arm.
- First, the **input power source** (C) provides the necessary energy.
- The **controller** (A) sends signals to actuators to initiate movement.
- The **actuators** (D) convert electrical energy into mechanical motion.
- This motion is then **transmitted to joints** (B) via gears or linkages.

Step 2: Conclusion The correct sequence of steps is: (C), (A), (D), (B).

Final Answer:

$$\boxed{(C), (A), (D), (B)}$$

Quick Tip

In robotic systems, power flows from the energy source to the controller, actuators, and finally to the mechanical components like joints.

---

66. Using a robot with 1 degree of freedom and having 1 sliding point with a full range of 1m, if the robot's control memory has a 12-bit storage capacity, then the control resolution for the axis of motion will be:

1. 0.144 mm
2. 0.244 mm
3. 0.344 mm
4. 0.444 mm

Correct Answer: (2) 0.244 mm

Solution: Step 1: Understand the resolution calculation.
The control resolution is the smallest increment of movement that can be controlled by the

robot. This is determined by the number of bits in the control memory and the range of motion.

The total number of divisions of the range is:

$$\text{Number of divisions} = 2^{\text{number of bits}} = 2^{12} = 4096$$

Step 2: Calculate the resolution. The resolution is the total range divided by the number of divisions:

$$\text{Resolution} = \frac{\text{Range of motion}}{\text{Number of divisions}} = \frac{1\,\text{m}}{4096} = 0.000244\,\text{m} = 0.244\,\text{mm}$$

Step 3: Conclusion The control resolution for the robot's axis of motion is 0.244 mm.

Final Answer:

$$\boxed{0.244\,\text{mm}}$$

Quick Tip

To calculate control resolution, divide the range of motion by the number of divisions available based on the bit depth.

---

67. Match List-I with List-II

List-I	**List-II**
Terms	**Description**
(A). Mechatronics	(I). Converts digital signal to analog signal
(B). Actuators	(II). The integration of mechanics, electronics and computing
(C). D/A Converter	(III). Converts control signals into physical motion
(D). Servo Motor	(IV). A motor is designed for precise control of angular or linear positions.

Choose the correct answer from the options given below:

1. (A) (I), (B) (II), (C) (III), (D) (IV)
2. (A) (II), (B) (III), (C) (I), (D) (IV)
3. (A) (I), (B) (II), (C) (IV), (D) (III)
4. (A) (III), (B) (IV), (C) (I), (D) (II)

Correct Answer: (2) (A) (II), (B) (III), (C) (I), (D) (IV)

Solution: Step 1: Understand the definitions and match each term.
- **Mechatronics** (A) is the integration of mechanics, electronics, and computing (II).

- **Actuators** (B) convert control signals into physical motion (III).
- **D/A Converter** (C) converts digital signals to analog signals (I).
- **Servo Motor** (D) is a motor designed for precise control of angular or linear positions (IV).

Step 2: Conclusion The correct matching is:
- (A) Mechatronics → (II)
- (B) Actuators → (III)
- (C) D/A Converter → (I)
- (D) Servo Motor → (IV)

Final Answer:

$$\boxed{(A)(II), (B)(III), (C)(I), (D)(IV)}$$

Quick Tip

Mechatronics combines mechanical, electronic, and computing systems, while actuators and servo motors perform mechanical actions based on control signals.

---

68. The degrees of freedom of a SCARA robot are:

1. Two
2. Three
3. Four
4. Five

Correct Answer: (3) Four

Solution: Step 1: Understand the SCARA robot's structure.
A SCARA (Selective Compliance Assembly Robot Arm) robot is known for its rigid movement in the vertical direction and flexibility in the horizontal plane. It typically has four degrees of freedom:
1. Two rotational degrees of freedom for the arm,
2. One vertical translational degree of freedom,
3. One rotational degree of freedom for the wrist.

Step 2: Conclusion Thus, a SCARA robot has **four degrees of freedom**.

Final Answer:

$$\boxed{4}$$

Quick Tip

A SCARA robot typically has four degrees of freedom, allowing it to perform tasks like assembly and pick-and-place operations efficiently.

69. The translatory joint in a robot is known as:

(1) Spherical
(2) Cylindrical
(3) Prismatic
(4) Revolute

Correct Answer: (3) Prismatic

Solution: Step 1: Understand the types of robot joints.
In robotics, joints are classified based on their type of motion:
- A **prismatic joint** allows for **translatory** or linear motion, i.e., movement along a straight path.
- A **revolute joint** allows for rotational motion.
- **Spherical** and **cylindrical** joints provide a combination of rotational and translational motion, but the prismatic joint is the one specifically for translatory movement.

Step 2: Conclusion The **translatory joint** in a robot is known as a **prismatic joint**.

Final Answer:

$$\boxed{\text{Prismatic}}$$

Quick Tip

A prismatic joint in robotics allows for straight-line motion, which is crucial for moving robotic parts along a single axis.

---

70. Name of the device that selects between several analog or digital input signals and forwards the selected input to a single output line:

(1) Modulator
(2) Router
(3) LAN
(4) Multiplexer

Correct Answer: (4) Multiplexer

Solution: Step 1: Understand the function of a multiplexer.
A **multiplexer** (MUX) is a device used to select one of several input signals and forward it to a single output line. It essentially combines multiple signals into one signal, which can then be transmitted or processed further.

Step 2: Conclusion
Thus, the device that selects between several input signals and forwards the selected input is a

multiplexer.

Final Answer:

$$\boxed{\text{Multiplexer}}$$

Quick Tip

A multiplexer allows multiple input signals to share one output line by selecting one at a time based on control signals.

---

71. Which one of the following symbols is used as the notation for designing arm and body of a robot, with joined arm configuration?

(1) TRL
(2) TLL LTL LVL
(3) LLL
(4) TRR

Correct Answer: (3) LLL

Solution: Step 1: Understand robot arm configurations.
Robotic arms are often represented using notations to describe their link and joint configurations:
- **LLL** denotes a robot with three links and three revolute joints (revolute joints allow rotational movement).
- The other options describe various combinations of joints and links, but **LLL** is the standard notation for a robot with joined arm configurations, specifically with three links and three revolute joints.

Step 2: Conclusion
The correct notation for a robot with a joined arm configuration is **LLL**.

Final Answer:

$$\boxed{\text{LLL}}$$

Quick Tip

The notation **LLL** refers to a robot configuration with three links and three revolute joints, commonly used in robotic arm design.

---

72. Which of the following is not an actuator?

(1) Hydraulic actuator
(2) Digital actuator
(3) Pneumatic actuator
(4) Electric actuator

Correct Answer: (2) Digital actuator

Solution: Step 1: Understand the definition of an actuator.
An **actuator** is a device that converts energy into motion. Common types of actuators include:
- **Hydraulic actuators** (1) use fluid pressure to produce mechanical movement,
- **Pneumatic actuators** (3) use compressed air to create motion,
- **Electric actuators** (4) use electric power to create movement.

A **digital actuator** (2) is not a recognized physical actuator type. Digital refers to control signals or logic, not a direct means of motion generation.

Step 2: Conclusion
Thus, a **digital actuator** is not a type of actuator.

Final Answer:

$$\boxed{\text{Digital actuator}}$$

Quick Tip

An actuator generates physical movement, while "digital" refers to control signals rather than a physical mechanism.

---

73. Which of the following is the most accurate method to measure the diameter of a cylindrical object?

(1) Vernier calipers
(2) Micrometer
(3) Digital calipers
(4) Gauge blocks

Correct Answer: (2) Micrometer

Solution: Step 1: Understand measuring tools for diameter.
- **Vernier calipers** and **digital calipers** are suitable for measuring dimensions with less precision and are generally used for more general measurements.
- **Micrometers** are highly accurate instruments specifically designed for measuring small dimensions, including the diameter of cylindrical objects with high precision.

- **Gauge blocks** are used for setting reference standards and are not typically used to measure the diameter directly.

Step 2: Conclusion The most accurate method to measure the diameter of a cylindrical object is with a **micrometer**.

Final Answer:

$$\boxed{\text{Micrometer}}$$

Quick Tip

A micrometer is designed for precise measurement of small dimensions, such as the diameter of a cylindrical object.

---

73. Automated Guided Vehicle (AGV) robots can be placed in the category of:

(1) Mobile robot
(2) Neutral robot
(3) Saturated robot
(4) Unsaturated robot

Correct Answer: (1) Mobile robot

Solution: Step 1: Understand AGVs.
Automated Guided Vehicles (AGVs) are robots that are used to transport materials or products in a controlled environment, such as warehouses or manufacturing plants. They are a type of **mobile robot** because they move autonomously within their environment.
Step 2: Conclusion AGV robots belong to the category of **mobile robots**.

Final Answer:

$$\boxed{\text{Mobile robot}}$$

Quick Tip

AGVs are typically mobile robots that are guided along predetermined paths to transport materials efficiently in industrial settings.

---

74. Proximity Sensors are used to:

(1) Detect non-magnetic but conductive materials
(2) Measure the strain

(3) Measure the distance
(4) Measure the temperature

Correct Answer: (3) Measure the distance

Solution:
Step 1: Understand the function of proximity sensors.
Proximity sensors are devices used to detect the presence of nearby objects without physical contact. They typically work by measuring the distance between the sensor and the object.
Step 2: Conclusion
Proximity sensors are primarily used to **measure the distance** between the sensor and the object.

Final Answer:

$$\boxed{\text{Measure the distance}}$$

Quick Tip

Proximity sensors detect the presence of an object by measuring the distance between the object and the sensor, often without physical contact.

---

75. Which one of the following devices produces incremental motion through equal pulses?

(1) AC servomotor
(2) DC Servomotor
(3) Stepper motor
(4) Series motor

Correct Answer: (3) Stepper motor

Solution:
Step 1: Understand the function of a stepper motor.
A **stepper motor** is a type of electric motor that divides a full rotation into a large number of steps, or increments. Each step is an equal angle of movement, and the motor advances one step at a time when it receives a pulse. This makes stepper motors ideal for applications requiring precise, incremental motion.
Step 2: Conclusion
A **stepper motor** produces incremental motion through equal pulses, making it suitable for applications where precise positioning is needed.

Final Answer:

$$\boxed{\text{Stepper motor}}$$

Quick Tip

Stepper motors provide precise control of movement through incremental steps, making them ideal for applications requiring exact positioning.