CUET PG 2026 Mechanical Engineering Question Paper with Solutions

Time Allowed :1 Hour 30 Minutes	**Maximum Marks :**300	**Total Questions :**75

General Instructions

Read the following instructions very carefully and strictly follow them:

- The Question Paper consists of 75 Multiple Choice Questions (MCQs).
- Total marks for the exam is 300.
- The total duration is 90 minutes; a, timer on the screen will display the remaining time, and the exam will automatically submit when the time reaches zero.
- For every correct answer, 4 marks (+4) will be awarded to the candidate, and a 1 mark (-1) will be deducted for every incorrect answer.
- Question papers are available in both English and Hindi.

1. Which of the following is a coarse crusher used in mechanical operations?
(A) Ball Mill
(B) Jaw Crusher
(C) Hammer Mill
(D) Fluid Energy Mill

Correct Answer: (B) Jaw Crusher

Solution:

Step 1: Understanding the Question:
The question asks us to identify the equipment used for coarse crushing, which is the initial and primary stage of size reduction for large materials.

Step 2: Detailed Explanation:
Let's analyze the function of each option:

- **Ball Mill:** This is a type of grinder used to produce fine or super-fine powders. It is used in the final stages of size reduction, not the initial coarse stage.

- **Jaw Crusher:** This is a primary crusher that reduces the size of large rocks or ore by compressing the material between a fixed jaw and a moving jaw. It is specifically designed for coarse crushing.

- **Hammer Mill:** This is typically used for intermediate or secondary crushing. It reduces the size of materials by repeated impacts from small hammers.

- **Fluid Energy Mill:** This is used for ultra-fine grinding, often producing particles in the micron or sub-micron range. It uses high-speed jets of fluid (like air or steam) to cause particles to collide with each other.

Step 3: Final Answer:
Based on the analysis, the Jaw Crusher is the equipment specifically designed for coarse crushing. Therefore, option (B) is the correct answer.

Quick Tip

Remember the typical sequence of size reduction: **Coarse Crushing** (Jaw Crusher) → **Intermediate Crushing** (Hammer Mill) → **Fine Grinding** (Ball Mill) → **Ultra-fine Grinding** (Fluid Energy Mill).

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2. Forces whose line of action passes through a common point are known as what?
(A) Parallel Forces
(B) Coplanar Forces
(C) Concurrent Forces
(D) Collinear Forces

Correct Answer: (C) Concurrent Forces

Solution:

Step 1: Understanding the Question:
The question asks for the specific term used in mechanics to describe a system of forces where all the forces' lines of action intersect at a single, common point.

Step 2: Detailed Explanation:
Let's define the terms given in the options:

- **Parallel Forces:** The lines of action of these forces are parallel to each other and never intersect.

- **Coplanar Forces:** These forces all lie within the same two-dimensional plane. Their lines of action may or may not intersect at a common point.

- **Concurrent Forces:** These are forces whose lines of action all pass through a single common point. This matches the description in the question perfectly.

- **Collinear Forces:** These are forces that act along the same straight line. They are a special case of concurrent forces.

Step 3: Final Answer:
The definition that exactly matches the condition "line of action passes through a common point" is **Concurrent Forces**. Therefore, option (C) is correct.

Quick Tip

To remember the difference:
Concurrent $\rightarrow$ Meet at a common **point**.
Collinear $\rightarrow$ Act along the same **line**.
Coplanar $\rightarrow$ Exist on the same **plane**.
Parallel $\rightarrow$ Lines of action are **parallel**.

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3. For a DC power source for arc welding with characteristics $3V + I = 240$, what voltage V yields maximum power?
(A) 20 V
(B) 30 V
(C) 40 V
(D) 60 V

Correct Answer: (C) 40 V

Solution:

Step 1: Understanding the Question:
We are given the voltage-current (V-I) characteristic of a DC power source and asked to find the voltage (V) at which the power output (P) is maximum.

Step 2: Key Formula or Approach:
The power (P) delivered by a DC source is given by the formula:

$$P = V \times I$$

To find the maximum power, we need to express P as a function of a single variable (either V or I) and then find the maximum of that function. This can be done using calculus (finding the derivative and setting it to zero) or by recognizing the function as a parabola.

Step 3: Detailed Explanation:
First, we express the current I in terms of voltage V from the given characteristic equation:

$$3V + I = 240 \implies I = 240 - 3V$$

Now, substitute this expression for I into the power equation:

$$P = V \times I = V(240 - 3V)$$
$$P(V) = 240V - 3V^2$$

This is a quadratic equation of the form $P = aV^2 + bV + c$, with $a = -3$ and $b = 240$. Since $a < 0$, the parabola opens downwards, and its vertex represents the maximum point. The voltage at the vertex is given by:

$$V = -\frac{b}{2a}$$

Substituting the values of a and b:

$$V = -\frac{240}{2(-3)} = -\frac{240}{-6} = 40\,\text{V}$$

Step 4: Final Answer:
The voltage that yields the maximum power is 40 V. Therefore, option (C) is the correct answer.

Quick Tip

For any linear V-I characteristic like $aV + bI = C$, maximum power occurs when the voltage is half the open-circuit voltage (V_{oc}).
Here, V_{oc} is the voltage when $I = 0$: $3V_{oc} + 0 = 240 \implies V_{oc} = 80$ V.
Voltage for maximum power is $V_{mp} = \frac{V_{oc}}{2} = \frac{80}{2} = 40$ V. This is a very fast shortcut.

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4. The polar section modulus for a circular shaft of diameter d is given by which formula?

(A) $\frac{\pi d^3}{16}$
(B) $\frac{\pi d^3}{32}$
(C) $\frac{\pi d^4}{32}$
(D) $\frac{\pi d^4}{16}$

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

Solution:

Step 1: Understanding the Question:
The question asks for the mathematical formula for the polar section modulus, denoted as Z_p, for a solid circular shaft of diameter d. This property is crucial in analyzing shafts under torsion.

Step 2: Key Formula or Approach:
The polar section modulus (Z_p) is defined as the ratio of the polar moment of inertia (J) to the distance from the center to the outermost fiber (R), which is the radius.

$$Z_p = \frac{J}{R}$$

For a solid circular shaft of diameter d, the polar moment of inertia is:

$$J = \frac{\pi d^4}{32}$$

And the radius is:

$$R = \frac{d}{2}$$

Step 3: Detailed Explanation:
We substitute the formulas for J and R into the definition of Z_p:

$$Z_p = \frac{\left(\frac{\pi d^4}{32}\right)}{\left(\frac{d}{2}\right)}$$

To simplify this expression, we multiply the numerator by the reciprocal of the denominator:

$$Z_p = \frac{\pi d^4}{32} \times \frac{2}{d}$$
$$Z_p = \frac{2\pi d^4}{32d} = \frac{\pi d^3}{16}$$

Step 4: Final Answer:

The correct formula for the polar section modulus of a solid circular shaft is $\frac{\pi d^3}{16}$. Therefore, option (A) is correct.

Quick Tip

Don't confuse Polar Moment of Inertia (J) with Polar Section Modulus (Z_p).
Inertia (J) relates to stiffness and has units of length^4 (d^4). Formula: $\frac{\pi d^4}{32}$.
Section Modulus (Z_p) relates to strength and has units of length^3 (d^3). Formula: $\frac{\pi d^3}{16}$.

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5. What is the natural frequency of a free vibration system defined by the equation $\ddot{X} + 36\pi^2 X = 0$?

(A) 3 Hz
(B) 6 Hz
(C) 12 Hz
(D) 18 Hz

Correct Answer: (A) 3 Hz

Solution:

Step 1: Understanding the Question:
We are given the differential equation for an undamped free vibration system and asked to calculate its natural frequency (f) in Hertz (Hz).

Step 2: Key Formula or Approach:
The standard equation of motion for a simple harmonic oscillator (free vibration system) is:

$$\ddot{X} + \omega_n^2 X = 0$$

where ω_n is the natural angular frequency in radians per second (rad/s).
The natural frequency f in Hertz is related to ω_n by:

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

Step 3: Detailed Explanation:
We compare the given equation with the standard form:
Given equation: $\ddot{X} + 36\pi^2 X = 0$
Standard form: $\ddot{X} + \omega_n^2 X = 0$
By comparing the coefficients of X, we get:

$$\omega_n^2 = 36\pi^2$$

Taking the square root of both sides gives the natural angular frequency:

$$\omega_n = \sqrt{36\pi^2} = 6\pi \text{ rad/s}$$

Now, we convert the angular frequency ω_n to natural frequency f:

$$f = \frac{\omega_n}{2\pi} = \frac{6\pi}{2\pi} = 3 \text{ Hz}$$

Note: The provided answer key in the source code seems to indicate 6 Hz, but the calculation correctly yields 3 Hz, which corresponds to option (A). We will proceed with the mathematically correct answer.

Step 4: Final Answer:
The natural frequency of the system is 3 Hz. Therefore, option (A) is the correct answer.

Quick Tip

In the equation $\ddot{X} + kX = 0$, the term k is always equal to ω_n^2.
To find f, first find $\omega_n = \sqrt{k}$, then calculate $f = \omega_n/(2\pi)$.
Be careful if π is already part of the constant, as it often simplifies the final calculation.

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6. Which translatory joint in a robot configuration is known as a sliding joint?
(A) Revolute Joint
(B) Prismatic Joint
(C) Cylindrical Joint
(D) Spherical Joint

Correct Answer: (B) Prismatic Joint

Solution:

Step 1: Understanding the Question:
The question asks to identify the specific type of robotic joint that provides translatory (linear) motion, which is commonly referred to as a sliding joint.

Step 2: Detailed Explanation:
Let's examine the types of motion allowed by each joint:

- **Revolute Joint (R-joint):** This joint allows only rotational motion about one axis, like a hinge on a door. It provides 1 degree of freedom (rotational).

- **Prismatic Joint (P-joint):** This joint allows only linear or translatory motion along one axis. The two links connected by this joint slide with respect to each other. This is precisely what is meant by a "sliding joint". It provides 1 degree of freedom (translational).

- **Cylindrical Joint (C-joint):** This joint allows both rotational motion about an axis and translational motion along that same axis. It provides 2 degrees of freedom.

- **Spherical Joint (S-joint):** Also known as a ball-and-socket joint, this allows purely rotational motion about three perpendicular axes, like a human shoulder joint. It provides 3 degrees of freedom (rotational).

Step 3: Final Answer:
The joint that corresponds to a sliding or translatory motion is the Prismatic Joint. Therefore, option (B) is the correct answer.

Quick Tip

Associate the joint names with their motion:
Prismatic → **P**iston-like linear sliding.
Revolute → **R**evolving or rotating.
Think of the shape: A prism has straight edges, suggesting linear motion.

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7. A ball is thrown vertically upward with a velocity of 5 m/s; if it takes 10 sec for the upward journey, how long does the downward journey take?
(A) 5 s
(B) 10 s
(C) 15 s
(D) 20 s

Correct Answer: (B) 10 s

Solution:

Step 1: Understanding the Question:
We are asked to find the time taken for a ball to fall back to its starting point (downward journey), given the time it took for its upward journey.

Step 2: Key Formula or Approach:
The key principle here is the symmetry of motion under constant gravitational acceleration, assuming air resistance is negligible. For an object thrown vertically upwards from a certain point, the time it takes to reach its maximum height (time of ascent) is equal to the time it takes to fall from that maximum height back to the original starting point (time of descent).
Time of Ascent = Time of Descent

Step 3: Detailed Explanation:
The problem states that the time for the upward journey (time of ascent) is 10 seconds.
Given: $t_{upward} = 10\,\text{s}$.
Based on the principle of symmetry of motion:
$t_{downward} = t_{upward}$
Therefore, $t_{downward} = 10\,\text{s}$.
The initial velocity of 5 m/s is extra information. Note that this information is inconsistent with the time of flight (using $g \approx 10\,\text{m/s}^2$, time to peak height would be $t = v/g = 5/10 = 0.5$ s), but we must follow the primary information given, which is the 10 s journey time.

Step 4: Final Answer:
The downward journey will take the same amount of time as the upward journey, which is 10 seconds. Therefore, option (B) is correct.

Quick Tip

In vertical projectile motion problems (without air resistance), always remember the symmetry:
Time of ascent = Time of descent.
Speed at any height during ascent = Speed at the same height during descent.
Be cautious of extra or inconsistent data in questions; focus on the core principle being tested.

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8. What is the stress developed when a steel rod of radius 10 mm is stretched by a 100 kN force?
(A) 159 MPa
(B) 318 MPa
(C) 100 MPa
(D) 200 MPa

Correct Answer: (B) 318 MPa

Solution:

Step 1: Understanding the Question:
We need to calculate the tensile stress (σ) in a circular steel rod when a known tensile force (F) is applied to it. We are given the rod's radius (r).

Step 2: Key Formula or Approach:
Stress is defined as the force acting per unit of cross-sectional area. The formula is:

$$\sigma = \frac{F}{A}$$

For a circular rod, the cross-sectional area A is given by:

$$A = \pi r^2$$

Step 3: Detailed Explanation:
First, we list the given values and convert them to consistent units (SI units: Newtons and meters).
Force, $F = 100\,\text{kN} = 100 \times 10^3\,\text{N}$.
Radius, $r = 10\,\text{mm} = 10 \times 10^{-3}\,\text{m} = 0.01\,\text{m}$.
Next, we calculate the cross-sectional area A:

$$A = \pi r^2 = \pi(0.01\,\text{m})^2 = \pi(1 \times 10^{-4}\,\text{m}^2)$$

Now, we can calculate the stress σ:

$$\sigma = \frac{F}{A} = \frac{100 \times 10^3\,\text{N}}{\pi \times 10^{-4}\,\text{m}^2} = \frac{10^5}{\pi \times 10^{-4}}\,\text{Pa}$$

$$\sigma = \frac{10^9}{\pi}\,\text{Pa} \approx 318.3 \times 10^6\,\text{Pa}$$

Since $1\,\text{MPa} = 10^6\,\text{Pa}$, the stress is:

$$\sigma \approx 318.3\,\text{MPa}$$

Step 4: Final Answer:
The calculated stress is approximately 318 MPa, which matches option (B).

Quick Tip

A useful shortcut for stress calculations is to remember that $1\,\text{MPa} = 1\,\text{N/mm}^2$.
You can keep the force in Newtons ($100,000\,\text{N}$) and the dimensions in mm.
Area $A = \pi r^2 = \pi(10\,\text{mm})^2 = 100\pi\,\text{mm}^2$.
Stress $\sigma = \frac{100{,}000\,\text{N}}{100\pi\,\text{mm}^2} = \frac{1000}{\pi}\,\text{N/mm}^2 \approx 318\,\text{MPa}$. This avoids dealing with powers of 10.

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9. Which mechanical drive is specifically used to impart a reciprocating or oscillatory motion to another body in contact?
(A) Gear Drive
(B) Belt Drive
(C) Cam and Follower
(D) Chain Drive

Correct Answer: (C) Cam and Follower

Solution:

Step 1: Understanding the Question:
The question asks to identify a mechanism whose primary function is to convert motion (typically rotational) into a repeating back-and-forth linear motion (reciprocating) or a back-and-forth pivoting motion (oscillatory).

Step 2: Detailed Explanation:
Let's analyze the function of each drive system:

- **Gear Drive:** Transmits rotational motion and torque between shafts, usually with a change in speed. The output motion is also rotational.

- **Belt Drive:** Transmits rotational motion between parallel shafts using a belt and pulleys. The output motion is rotational.

- **Cam and Follower:** This mechanism consists of a shaped component (the cam) that rotates, and another component (the follower) that is in contact with the cam's surface. As the cam rotates, its non-circular profile pushes the follower, causing it to move in a prescribed reciprocating or oscillatory pattern. This exactly matches the question's description. A classic example is the camshaft in an engine opening and closing valves.

- **Chain Drive:** Similar to a belt drive, it transmits rotational motion and torque between shafts, but uses a chain and sprockets for positive, non-slip transmission. The output motion is rotational.

Step 3: Final Answer:
The Cam and Follower mechanism is specifically designed to convert rotary motion into reciprocating or oscillatory motion. Therefore, option (C) is the correct answer.

Quick Tip

The key to this question is **motion conversion**.
Gear, Belt, and Chain drives are for **motion transmission** (usually rotary to rotary).
A Cam and Follower is for **motion transformation** (rotary to reciprocating/oscillatory).
Remember the camshaft in a car engine as the prime example.

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10. When a ball mill rotates at a speed higher than the critical speed, what happens to its efficiency?
(A) It increases continuously
(B) It remains constant
(C) It decreases
(D) It becomes maximum

Correct Answer: (C) It decreases

Solution:

Step 1: Understanding the Question:
The question asks about the effect on the grinding efficiency of a ball mill when its rotational speed exceeds a specific threshold known as the "critical speed".

Step 2: Key Formula or Approach:
The concept of critical speed (N_c) is central here. It is the theoretical rotational speed at which the centrifugal force acting on the outermost layer of grinding balls exactly balances the force of gravity. At this speed, the balls are just about to be pinned to the inner wall of the mill.

Step 3: Detailed Explanation:
The grinding action in a ball mill primarily occurs from the impact and attrition of balls (the grinding media) as they are lifted by the rotating mill and then cascade or cataracting down onto the material being ground.

- **Below Critical Speed:** The balls are lifted and then tumble down, causing effective grinding. The efficiency is highest at a certain percentage (typically 65-75%) of the critical speed.

- **At Critical Speed:** The outermost balls are theoretically carried around in a full circle, clinging to the wall.

- **Above Critical Speed:** When the speed is higher than critical, the centrifugal force significantly outweighs gravity. This causes all the balls to be pinned against the inner lining of the mill, a phenomenon called "centrifuging". The balls rotate with the mill but do not fall. As a result, there is no tumbling, no impact, and virtually no grinding action.

Step 4: Final Answer:
Since the grinding action ceases when the speed is higher than the critical speed, the efficiency of the ball mill drops drastically and essentially decreases to near zero. Therefore, option (C) is correct.

Quick Tip

Think of it like a bucket of water you swing in a circle over your head.
Too slow: Water spills (analogous to inefficient cascading).
Just right: Water stays in (analogous to optimal speed).
Too fast (above critical): Water is firmly pressed against the bottom (analogous to centrifuging, where balls stick to the wall and don't grind).
Therefore, **Speed ¿ Critical Speed** $\implies$ **Centrifuging** $\implies$ **No grinding** $\implies$ **Efficiency decreases**.
