BYJU'S EXAM PREP

AE/JE Foundation

Mechanical Engineering

Theory of Machines & Engineering Mechanics

Top 100 Most Expected Questions

1. Limiting force of friction is the

A. Tangent of angle between normal reaction and the resultant of normal reaction and limiting friction.

B. Ratio of limiting friction and normal reaction.

C. The friction force acting when the body is just about to move.

D. The friction force acting when the body is in motion.

Ans. C

Sol. The limiting force of friction is the friction action on the body when the body is just about to move. It is also known as maximum static friction.

2. Internal forces are not shown on a free body diagram because the internal forces are

A. Equal to zero

B. Equal and opposite and they don't affect the calculations

C. Negligibly small

D. Not important

Ans. B

Sol. Internal forces are not shown on a free body diagram because the internal forces are Equal and opposite and they don't affect the calculations.

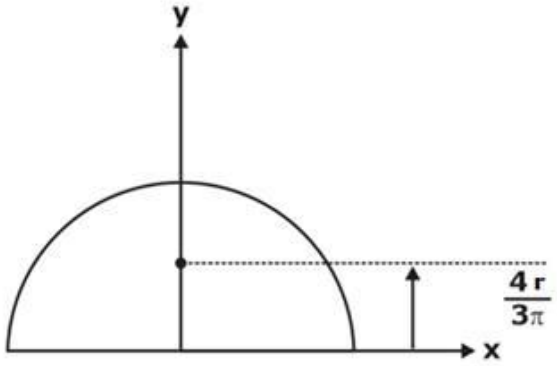
3. Distance of centroid of a semicircle of radius r from its base is

A. $\frac{4r}{3\pi}$ B. $\frac{3\pi}{4r}$

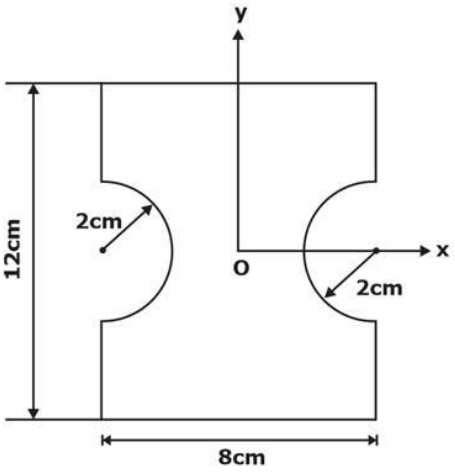
C. $\frac{4\pi}{3r}$ D. $\frac{2\pi}{3r}$

Ans. A

Sol. The distance of centroid from the base is $\frac{4r}{3\pi}$.



4. The coordinate of centroid of area is



A. (4, 6.9)
B. (0, 0)
C. (4, 6)
D. (4, 9)

Ans. B

Sol. The part is symmetric about y and x axis hence the centroid lie at origin.

5. A machine gun of mass 25 kg fires a bullet of mass 30 gram with a velocity of 250 m/s. The velocity (in m/s) with which the machine gun will recoil is ___.

A. 0.3
B. 0.15
C. 0.6
D. 0.9

Ans. A

Sol. Given

Mass of the machine gun (M) = 25 kg

Mass of the bullet (m) = 30 g = 0.03 kg

velocity of firing (v) = 250 m/s.

Let V = Velocity with which the machine gun will recoil.

We know that MV = mv

$25 \times V = 0.03 \times 250 = 7.5$

$v = 0.3$ m/s

6. Concept of virtual work can be applied to:

A. Beams

B. Lifting machines

C. framed structure

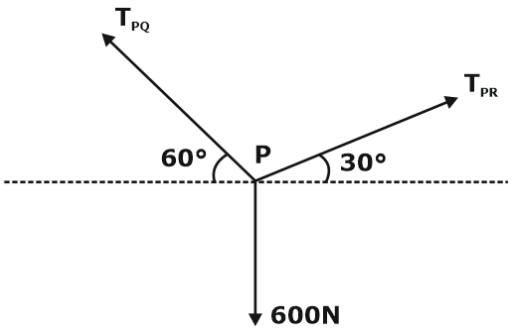
D. All of above

Ans. D

Sol. Concept of virtual work can be applied to Beams, Lifting machines, framed structure.

Concept of virtual work states that in equilibrium the **virtual work** of the forces applied to a system is zero. Newton's laws state that at equilibrium the applied forces are equal and opposite to the reaction, or constraint forces. This means the **virtual work** of the constraint forces must be zero as well.

7. If point P is in equilibrium under the action of applied forces, the value of tension T_{PQ} and T_{PR} are respectively.



A. 520, 300

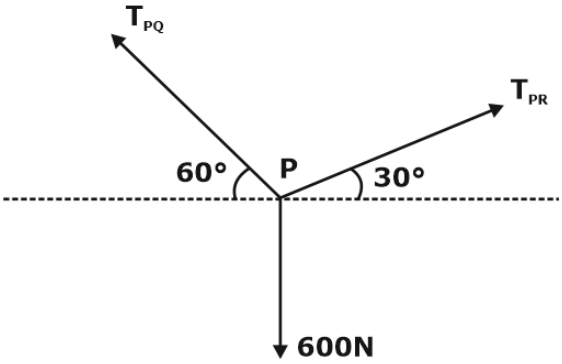
B. 300, 520

C. 250√3, 250√3

D. 250, 250√3

Ans. A

Sol.



By lami's theorem

$$\frac{T_{PQ}}{\sin 120} = \frac{T_{PR}}{\sin(90+60)} = \frac{600}{\sin(90)}$$

T_{PQ}= 519.61

T_{PR}= 300

8. Method of sections is more suitable when

A. Only reactions at the supports are desired.

B. Only forces in few of the members are desired.

C. Only forces in few of the members away from the supports are desired.

D. forces in all the members are desired.

Ans. C

Sol. Method of section becomes more useful when forces in members away from the supports need to be find.

The forces in selected members can be find directly without finding forces in all members.

9. Two steel balls of 2 kg and 4 kg mass, respectively are pressed on the two ends of a spring, all pre-placed on a smooth surface. When released, the smaller ball moves with an acceleration of 2 m/s^2. The simultaneous acceleration of the bigger ball will be :

A. 0.5 m/s^2 B. 1 m/s^2

C. $2m/s^2$ D. 4 m/s^2

Ans. B

Sol. Since two ball pressed on the two ends of a spring, hence the force exerted upon releasing the spring will be same on both.

Therefore, $F_1 = F_2 = F$

or $m_1a_1 = m_2a_2$

or $a_2 = \frac{m_1a_1}{m_2} = \frac{2 \times 2}{4} = 1$

10. For perfectly elastic bodies, the value of coefficient of restitution is

A. 1 B. 0.5 to 1

C. 0 to 0.5 D. 0

Ans. A

Sol.

Coefficient of restitution $(e) = \frac{V_2 - V_1}{u_1 - u_2}$

For perfect elastic e = 1

i.e. velocity of separation is equal to velocity of approach.

11. Concurrent force system is the system when _____.

A. Lines of action of all forces pass through a point

B. Lines of action of all forces are parallel to each other

C. Lines of action of all forces lie along same line

D. Lines of action of all forces are not parallel to each other

Ans. A

Sol. Concurrent force system is a type of system of forces in which line of action of all the forces meet at a point.

If line of action of forces lie along the same line known as collinear system of forces.

12. Identify the correct statements

1. Distance is a scaler quantity
2. Displacement is a vector quantity
3. Speed and velocity are both vector quantity
4. Acceleration is a vector quantity

A. 1, 2, 3 B. 1, 2, 4

C. 1, 3, 4 D. 2, 3, 4

Ans. B

Sol. Displacement is a vector quantity as it has both magnitude and direction.

Distance is a scaler quantity as it has only magnitude.

Speed is a scaler quantity where as velocity and acceleration are vector quantity.

13. In a perfect truss, the numbers of members should be
Where J is the number of joints.
A. 2J – 3
B. J-1
C. 2J-1
D. 3J-2

Ans. A

Sol. A perfect truss the number of member is equal to L = 2J – 3
A perfect truss is one in which the number of members is sufficient to keep it in equilibrium.

14. The principal of virtual work states that the virtual work is zero for
A. a body moving with constant linear velocity
B. a body rotating with constant angular velocity
C. a body in equilibrium
D. a body moving with constant linear acceleration

Ans. C

Sol. The principal of virtual work states that the virtual work is zero for a body in equilibrium.

15. A body of mass 10kg moving with a velocity of 2m/s is acted upon by a force of 50N for 3 seconds. The final velocity is
A. 12m/s
B. 10m/s
C. 15 m/s
D. 17 m/s

Ans. D

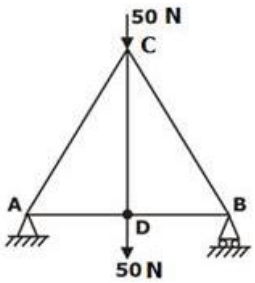
Sol. Given,
Force =50N,
v_1 = 2m/s, m = 10kg
t = 3sec

$$F = \frac{\Delta P}{\Delta t} = \frac{m(v_2 - v_1)}{T}$$

$$50 = \frac{10(v_2 - 2)}{3}$$

v_2 = 17 m/s

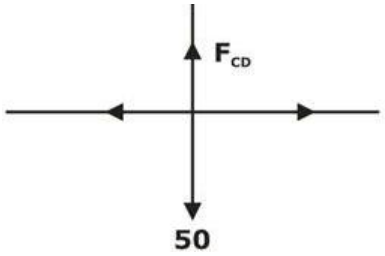
16. The force induced in vertical member CD of symmetrical plane truss is



A. 50 N (T)
B. 100 N (C)
C. 50 N (C)
D. 0 N

Ans. A

Sol. Considering the joint D.



$\Sigma F_V = 0$

F_{CD} = 50N tensile in nature

17. Two forces can be in equilibrium only if they are

(i) equal in magnitude

(ii) opposite in direction

(iii) collinear in action

A. (i) and (ii) only

B. (i) and (iii) only

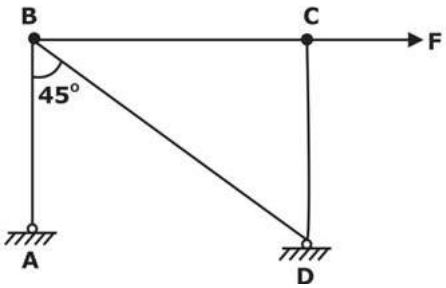
C. (ii) and (iii) only

D. (i), (ii) and (iii)

Ans. D

Sol. Forces can be in equilibrium only if they are equal in magnitude and opposite in directions and are collinear.

18. A Horizontal force F acts at the Hinge C of bars of system shown the force induced in bar CD is



A. F

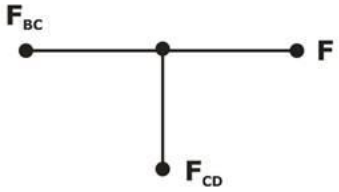
B. $\sqrt{2}$ F

C. $\frac{F}{\sqrt{2}}$

D. 0

Ans. D

Sol. Considering the joint C.



Hence CD is 3rd member between two Collinear member.

F_{CD} = 0

19. Which of the following is not true about the frictional force?

A. It is directly proportional to the normal reaction between the surfaces

B. It is dependent on the area

C. It depends upon the nature of the surfaces in contact

D. None of these

Ans. B

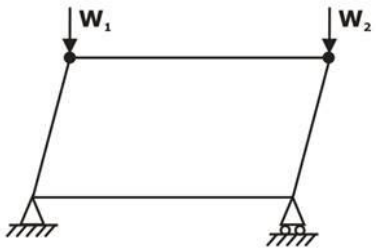
Sol. The frictional force

1. It is directly proportional to the normal reaction between the surfaces

2. It depends upon the nature of the surfaces in contact

3. frictional force is independent of the area.

20. The following truss shown is



A. Perfect truss

B. Redundant truss

C. Collapsible truss

D. None of above

Ans. C

Sol. Number of member (L) = 4

Number of joints (J) = 4

2J – 3 = 8 – 3 = 5

L < 2J – 3,

Hence it is collapsible truss.

21. There is a 10 kg block of ice. It takes 10 N to keep it moving across the floor at constant speed. The kinetic coefficient of friction, μ_k, is

A. 0 B. 0.1

C. 0.2 D. 0.3

Ans. B

Sol. Force of kinetic friction, $F_k = \mu_k mg$

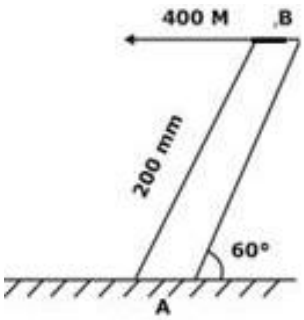
Since it is moving with constant speed

$\mu_k mg = 10$ N

$\mu_k (10 \times 9.8) = 10$ N

$$\mu_k = \frac{10}{10 \times 9.8} = 0.1$$

22. The Force of 400 N acting on the lever AB at point B can be replaced by which of the following _____.



A. A Force of 400 N at A

B. A Couple of 69.3 Nm at A

C. A Force of 400 N at A and a couple of 69.3 Nm at A.

D. A couple of 69.3 Nm at A.

Ans. C

Sol. The force 400 N can be transferred to A.

Moment About A = 400 × 0.2 sin60°

$$M_B = 400 \times 0.2 \times \frac{\sqrt{3}}{2}$$

M_B = 69.3 Nm

23. According to Newton's first law of motion, the body acted upon by a coplanar system of forces is said to be in equilibrium when

A. ΣFx = 0 B. ΣFy = 0

C. ΣM = 0 D. All of these

Ans. D

Sol. A body is said to be in equilibrium if it is in a state of rest or uniform motion. For coplanar system of forces, the scalar equations of equilibrium are:

a) ΣFx = 0

b) ΣFy = 0

c) ΣM = 0

24. Which of the following is true in context of solving truss by method of section?

A. A section can cut any number of members with maximum 3 unknown forces in members.

B. A section can cut any number of members with maximum 4 unknown forces in members.

C. A section can cut any number of members with maximum of 5 unknown forces in members.

D. All of above

Ans. A

Sol. By solving a truss problem by method of section a section can cut any number of members but the unknown forces in those members can be maximum 3. Because three equations are used.

$\Sigma f_x = 0$ $\Sigma f_y = 0$ $\Sigma M = 0$

25. A body of mass 5 kg has the displacement as function of time: $x = 0.75t^3 - 4.5t^2 + 12t$; (t = time in seconds, x = in meters). Calculate the displacement of the body at the instant when, acceleration of the body is zero.

A. 10 m
B. 12 m
C. 20 m
D. 25 m

Ans. B

Sol. $x = 0.75t^3 - 4.5t^2 + 12t$

$$V = \frac{dx}{dt} = 2.25t^2 - 9t + 12$$

$$a = \frac{dv}{dt} = \frac{d^2x}{dt^2} = 4.5t - 9$$

$a = 0 \Rightarrow 4.5t = 9$

$t = 2$

$\therefore$ At $t = 2$, $x = 0.75(2)^3 - 4.5(2)^2 + (12 \times 2) = 12$ m

26. The value of coefficient of restitution for perfectly inelastic collision

A. 0
B. 0.33
C. 0.5
D. 1

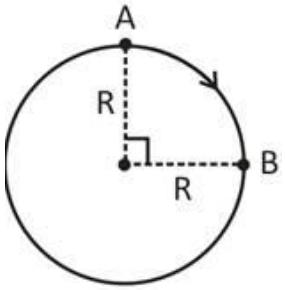
Ans. A

Sol. For a perfectly inelastic collision,

Velocity of separation = 0

Therefore, the value of coefficient of restitution is 0 for perfectly inelastic collision.

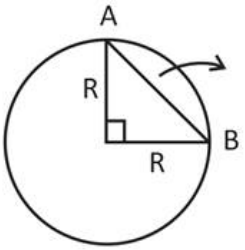
27. In a circle an ant travel from A to B as shown in figure, the displacement travelled by the ant is_____. (if radius of the circle is R)



A. $\frac{\pi R}{4}$
B. πR
C. R
D. $\sqrt{2}R$

Ans. D

Sol.



Displacement is the shortest Distance = $\sqrt{R^2 + R^2} = \sqrt{2}R$

28. Two equal forces are acting at a point with an angle of 60 ° between them. If the resultant force is equal to $60\sqrt{3}$, what is the magnitude of each force?

A. 30N
B. 50N
C. 40N
D. 60N

Ans. D

Sol. If two equal forces at a point acts an angle $\Phi=60^0$ then magnitude of resultant force is

$R = \sqrt{P^2 + P^2 + 2P^2\cos(60)}$

$60\sqrt{3} = P\sqrt{3}$

P = 60 N

Hence magnitude of each force = 60 N

29. Static friction force is

A. constant friction force
B. Variable friction force
C. Relative motion is there
D. None of these

Ans. B

Sol. Static friction force = f_s is Variable friction force.

whose value changes from zero to limiting friction.

and $0 \le f_s \le F_{limiting}$

and $F_{limiting} = \mu N$

30. In an elastic collision

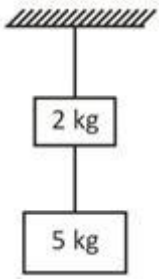
A. The initial kinetic energy is equal to the final kinetic energy
B. The final kinetic energy is less than the initial kinetic energy
C. The kinetic energy first decreases then increases
D. The kinetic energy first increases then decreases

Ans. A

Sol. In an elastic collision total energy of body remains conserved.

So initial kinetic energy is equal to the final kinetic energy.

31. Find tension in 5 kg string as shown in the figure



A. 7g
B. 6g
C. 5g
D. 2g

Ans. C

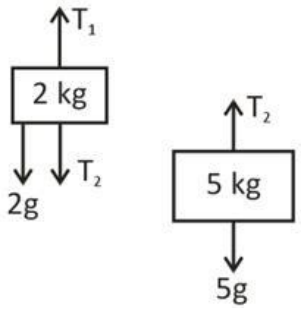
Sol. As shown in Diagram,

$T_2 = 5g$

And $T_1 = 2g + T_2$

$\therefore T_1 = 7g$

F.B.D. of 2kg and 5kg



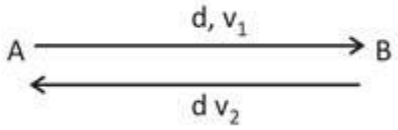
32. A man goes from A to B at V_1 speed return from B to A at V_2 speed, find Average Speed

A. $\frac{V_1V_2}{2}$ B. $\frac{V_1+V_2}{2}$

C. $\frac{2V_1V_2}{V_1+V_2}$ D. $\frac{V_1+V_2}{2V_1V_2}$

Ans. C

Sol.



$$\text{Avg. speed} = \frac{\text{Total dist}}{\text{Total time}} = \frac{2d}{t_1+t_2}$$

$$= \frac{2d}{\frac{d}{V_1}+\frac{d}{V_2}} = \frac{2V_1V_2}{V_1+V_2}$$

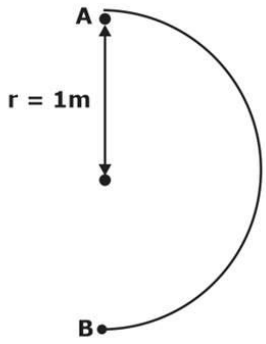
33. A body goes from point A to B on a semicircle of radius 1 m in 1 sec. The average speed & average velocity are

A. 1, π B. 2, π

C. π, 1 D. π, 2

Ans. D

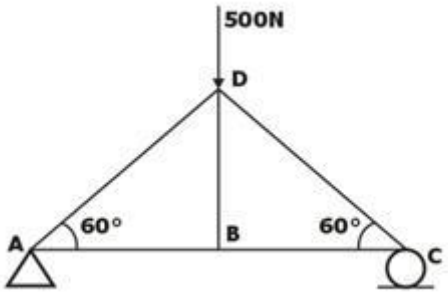
Sol.



Average speed = $\frac{\pi \times 1}{1} = \pi m/s$

Average velocity = $\frac{2}{1} = 2m/s$

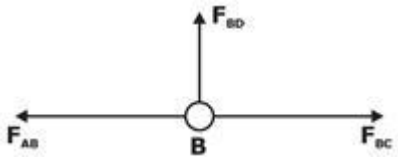
34. In the pin-jointed plane frame shown in the figure below the force in the member BD is:



A. 5000N (Tensile)
B. 5000N (Compressive)
C. 4000N(Tensile)
D. Zero

Ans. D

Sol. Balancing the forces at joint 'B'.



Adopting method of joints at junction B,

$\sum F_Y = 0$

$\Rightarrow F_{BD} = 0$

35. Centre of gravity of a triangle lies at the point of concurrence of
A. the right bisectors of the angle of the triangle
B. the median of the triangle
C. the altitude from the vertices of the opposite side
D. None of these

Ans. B

Sol. The point where the three medians of the triangle intersect. The 'center of gravity' of the triangle One of a triangle's points of concurrency.

36. A body of mass 5 kg accelerates at a constant rate of 2 m/s^2 on a smooth horizontal surface due to external force acting at 30° with horizontal. The magnitude of the force is
A. 10 N
B. 13.54 N
C. 11.54 N
D. 15 N

Ans. C

Sol. Horizontal component of the force acting at 30° = Fcos θ

And we have,

$F\cos(\theta) = m \times a$ (in the direction of horizontal surface)

$F\cos\left(30^\circ\right) = 5kg \times 2m / sec^2$

$F = 11.54N$

37. A 70 kg man pushes a 50 kg man by a force of 70 N. The 50 kg man has pushed the 70kg man with a force of magnitude

A. 50 N

B. 70 N

C. 140 N

D. 0

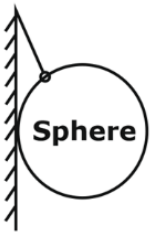
Ans. B

Sol. Given,

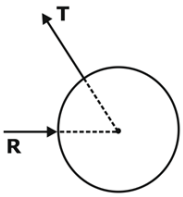
A 70 kg man pushes a 50 kg man by a force of 70 N.

According to Newton's 3rd law of motion, 50 kg man will push 70 kg man with same force but in opposite direction.

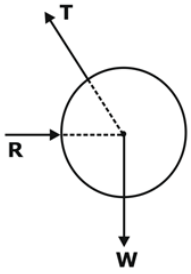
38. The correct free body diagram of sphere is (Assume smooth wall)



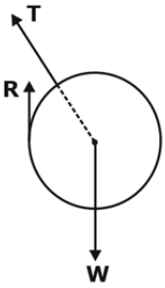
A.



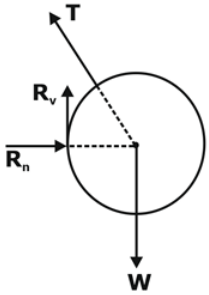
B.



C.

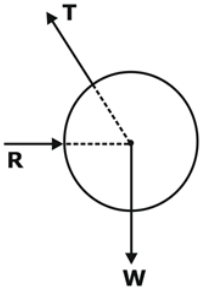


D.



Ans. B

Sol. The correct free body diagram of sphere is shown. A normal reaction from the wall is acting on sphere. Tension T is pulling the sphere and the weight W is acting downward.

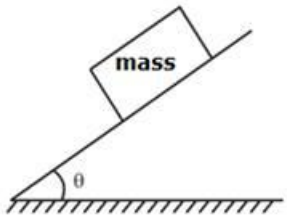


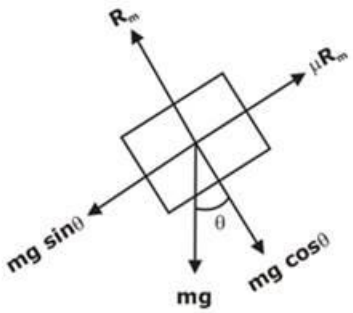
39. Block A kept on an inclined surface just begins to slide if the inclination is 30°.Block A is replaced by another block B and it is found it just begins to slide if inclination is 40° then

A. Mass of A > mass of B
B. Mass of A < mass of B
C. Mass of A = mass of B
D. All the three are possible

Ans. D

Sol.





mg sinθ = μ mg cos θ

tan θ = μ, Hence no dependence on mass.

40. The term 'virtual work' refers to

A. virtual work done by virtual forces
B. Virtual work done by actual forces
C. actual work done by virtual forces
D. None

Ans. B

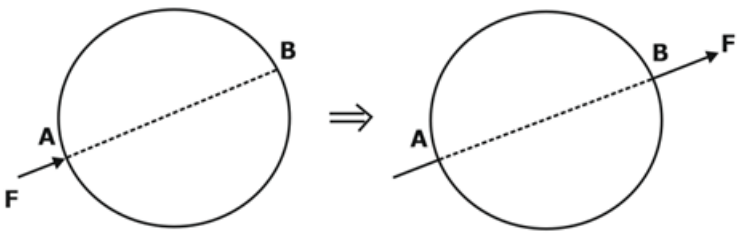
Sol. **Virtual work** is the total **work** done by the applied forces and the inertial forces of a mechanical system as it moves through a set of **virtual** displacements. When considering forces applied to a body in static equilibrium, the principle of least action requires the **virtual work** of these forces to be zero.

41. According to Principle of transmissibility of forces ,the effect of a force upon a body is

A. Maximum when it acts at the center of gravity of a body.
B. Different at different points in its line of action.
C. The same at every point in its line of action.
D. minimum when its acts at the centre of gravity of the body.

Ans. C

Sol. The Principle of transmissibility of forces states that effect of a force upon a body is same at every point in its line of action.



****

1. For a cam having simple motion described as simple harmonic motion having ascent-dwell$_1$-descent-dwell$_2$ nature, if the angle for ascent is 65º angle for descent is 85º and dwell$_1$ is 50º find the angle for dwell$_2$ in degree.

   A. 20

   B. 70

   C. 160

   D. 360

Ans. C

Sol. We know that

ascent + dwell$_1$ + descent + dwell$_2$ = 360º

65 + 85 + 50 + dwell$_2$ = 360º

dwell$_2$ = 160º

2. Which of the following equation represents forced vibration with damping?

   A. $m\ddot{x} + c\dot{x} + kx = 0$

   B. $m\ddot{x} + kx = 0$

   C. $m\ddot{x} + c\dot{x} + kx = F\sin\omega t$

   D. $m\ddot{x} + kx = F\sin\omega t$

Ans. C

Sol. The equation for the forced damping with vibration is,

$m\ddot{x} + c\dot{x} + kx = F\sin\omega t$

where

m= Mass of the system,

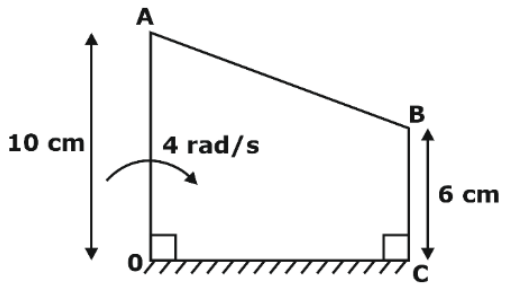
c= Coefficient of damping,

k = Stiffness of spring,

F= maximum value of unbalanced force

So, the correct option is (c).

3. For the given four bar linkage, the velocity of B with respect to A will be:



   A. 40 cm/s

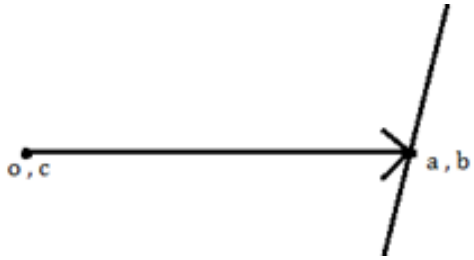
   B. -40 cm/s

   C. 0 m/s

   D. Data insufficient

Ans. C

Sol. The velocity diagram for the given configuration at this instant will be:



From, the velocity diagram we can easily say that relative velocity $\overrightarrow{V_{BA}}$ = 0 m/s.

$\because \overrightarrow{V_B} = \overrightarrow{V_A}$

So, the correct option is (c).

4. A spring controlled governor is said to be stable if controlling force (F) and the radius of rotation (r) obey the relation (where, a and b are constants):

A. F = ar
B. F = ar +b
C. F = ar – b
D. F = a/r

Ans. C

Sol. A spring controlled governer is stable when F = ar –b

When F = ar , then the governor is isochronous

When F = ar + b, then governor is unstable

5. Which of these is an approximate straight line motion mechanism?

A. Scott Russell's mechanism
B. Hart's mechanism
C. Peaucellier mechanism
D. Watt's mechanism

Ans. D

Sol. Watt's consists of three links. Two of them are of equal length whereas one is shorter. Due to the rotation motion of the longer links, the centre of the shorter link traces an approximate straight line. Out of the following mechanism, Watt's mechanism is an approximate straight line mechanism whereas the rest are exact straight line mechanisms.

6. The number of teeth on gear is 40. It is meshed with pinion of module 5 mm what is diameter of gear _____.?

A. 100 mmm
B. 200 mm
C. 400 mm
D. 50 mm

Ans. B

Sol. Since module (m) is given by:

$$\text{Module } m = \frac{\text{Diameter(D)}}{\text{No. of teeth(T)}} \Rightarrow 5 = \frac{\text{Diameter(D)}}{40}$$

Diameter = 200 mm

7. In a slider crank mechanism the crank rotates with uniform angular velocity. The angular acceleration of connecting rod will zero when the____.

A. crank is perpendicular to line of action.
B. crank is aligned with line of stroke.
C. crank is perpendicular to connecting rod.
D. Both A & B

Ans. B

Sol. We know that,

$$\alpha_{CR} = \frac{-\omega^2}{n}\sin\theta, \text{ (If } \theta = 0)$$

Then $\alpha_{CR} = 0$

8. The angular velocity of the connecting rod in a single slider crank mechanism is given by

A. ω cos(θ) B. n cos(θ) / ω

C. ω cos(θ)/n D. cos(θ) / nω

Ans. C

Sol. The angular velocity of the connecting rod in a single slider crank mechanism is given by ω cos(θ)/n

where ω = angular velocity of crank

n = Obliquity ratio

9. If first and last gear having teeth 40 and 50 respectively of a simple gear train, what will be the train value and speed ratio respectively if first gear is driving gear

A. 4/5 and 5/4 B. 3/5 and 4/5

C. 5/3 and 3/5 D. 4/5 and 3/5

Ans. A

Sol.

$$\text{Speed Ratio} = \frac{N_{driver}}{N_{driven}} = \frac{T_{driven}}{T_{driver}} = \frac{50}{40} = \frac{5}{4}$$

$$\text{Train Value} = \frac{1}{\text{speed ratio}} = \frac{4}{5}$$

10. The follower starts from rest at beginning and it comes to rest at end of stroke. During its travel the follower may follow approximately with of the following motion :

A. Uniform velocity B. SHM

C. Cycloidal D. All of these

Ans. D

Sol. The follower follows any one of these motions during its complete travel from beginning of the stroke to end of stroke. It may also follow uniform acceleration or retardation.

11. The number of links (I) which is required to form a kinematic chain can be expressed in term of the number of pairs (p) as _____.

A. I = 2p – 4 B. I = 2p – 3

C. I = 2p – 2 D. I = 2p – 5

Ans. A

Sol. A kinematic chain is an assembly of rigid bodies connected by joints to provide constrained (or desired) motion that is the mathematical model for a mechanical system.

I = 2p-4

I = the number of links

p = number of pairs

12. The static deflection of a shaft under a flywheel is 16mm. what is the critical speed (in rad/sec) (Take g = 10 m/s^2) ?

A. 50 B. 25

C. 30 D. 625

Ans. B

Sol. Given,

Static deflection = 16mm,

$$\omega_n = \sqrt{\frac{g}{\delta_{static}}}$$

$$\omega_n = \sqrt{\frac{10}{16 \times 10^{-3}}}$$

$$\omega_n = \frac{100}{4} = 25 \text{ rad / sec}$$

13. In balancing of a slider crank mechanism, The magnitude of the secondary forces is _____ than the magnitude of the primary force.

A. less than B. greater than

C. equal to D. twice of

Ans. A

Sol. In balancing of slider crank mechanism the primary force is always greater than secondary force

If the obliquity ratio n=l/r is very very greater then the effect of secondary force may be neglected and only primary forces are present.

14. For a given fractional change of speed If the displacement of the sleeve is high, then the governor is said to be____.

A. Hunting B. Isochronous

C. Sensitive D. Stable

Ans. C

Sol. A governor is said to be sensitive when it readily responds to a small change of speed The movement of the sleeve for a fractional change of speed is measure of sensitivity.

15. The instantaneous centre of a rigid thin disc rolling on a plane rigid surface is located at

A. centre of the disc

B. point of contact

C. an infinite distance on the plane surface

D. point on the circumference situated vertically opposite to the contact point

Ans. B

Sol. The instantaneous centre of a rigid thin disc rolling on a plane rigid surface is located at point of contact of the rigid disc and the plane on which it is rolling.

16. What should be the angle between the two cylinder V line engine such that all the primary and secondary forces as well as couples are perfectly balanced.

A. 30 B. 45

C. 60 D. 90

Ans. D

Sol. V line engline is the only type of engine which can be completely balanced All primary and secondary forces can be balanced when the angle between the two cylinder in vline engine is 90 degree.

17. Gyroscopic effect will be Zero in case of_____.

A. Steering during ship turns left
B. Steering during ship turns right
C. Ship during pitching
D. Ship during rolling

Ans. D

Sol. As the axes of the rolling of the ship and that of the rotor are parallel, there is no precession of the axis of spin and thus there is no gyroscopic effect.

18. In gyroscopic motion, the angular velocity of precession was found to be 5 rad/s and the angular velocity of the body was 15 rad/s. The gyroscopic acceleration will be _____.

A. 150 rad/sec^2
B. 75 rad/sec^2
C. 3 rad/sec^2
D. 20 rad/sec^2

Ans. B

Sol. ω = 15 rad/s

ω_p = 5 rad/s

The gyroscopic acceleration is given as:

$\alpha_{gyro} = \omega\omega_p = 15x5 = 75 \text{ rad} / s^2$

19. For a complete constrained motion, the degree of freedom is_____?

A. 2
B. 0
C. 1
D. 3

Ans. C

Sol. Completely constrained motion is a type of constrained motion in which relative motion between the links of a kinematic pair occurs in a definite direction by itself, irrespective of the external forces applied.

For a completely constrained constrained the degree of freedom will be 1.

20. In vibration isolation system, if $\frac{\omega}{\omega_n} < \sqrt{2}$, then for all values of damping factor, the transmissibility will always be _____

A. Greater than 1
B. Equal to 1
C. Less than 1
D. Equal to 0

Ans. A

Sol. In vibration isolation system if $\frac{\omega}{\omega_n} < \sqrt{2}$, then transmissibility ratio is greater than 1.

21. Which is correct in case of flywheel?

A. It is an inertial energy-storage device.
B. It absorbs mechanical energy and serves as reservoir.
C. It smoothen out variations in speed of shaft caused by torque fluctuations.
D. All of these

Ans. D

Sol. Flywheel is rotating mechanical device which stores rotational energy that has inertia which resist changes in rotational speed. In this the amount of energy stored is proportional to square of rotational speed. Flywheel releases stored energy by applying torque to mechanical load and decreases rotational speed.

22. The advantages of involute profile over cycloidal are given below. Which of these is NOT correct?

A. The interference is inherently absent in the involute system

B. In the involute system, the pressure angle is constant from commencement to end of engagement

C. The straight teeth of the basic rack for the involute profile admits of simple tools

D. The profile for the flank and face is a single curve in the involute system

Ans. A

Sol. In involute profile, interference is present but can be prevented by providing minimum number of teeth on pinion and gear. A slight variation in distance does not effect the velocity ratio of system is an advantageous feature of involute profile over cycloidal profile.

23. The equation of motion for a single degree of freedom system with viscous damping is

$a\ddot{x} + b\dot{x} + cx = 0$

The damping factor of the given system is:

A. $\frac{c}{2\sqrt{ab}}$ B. b

C. $\frac{b}{2\sqrt{ac}}$ D. $\sqrt{\frac{b}{2a}}$

Ans. C

Sol. Equation of motion will be :

$m\ddot{x} + c\dot{x} + kx = 0$ .....(i)

damping factor, $\zeta = \frac{c}{2\sqrt{km}}$

Comparing the given equation with equation (i), we get damping factor = $\frac{b}{2\sqrt{ac}}$

So, the correct option is (c).

24. What is the maximum acceleration of follower in a cam and follower mechanism undergoing simple harmonic motion if the cam rotational angle is φ and ω is rotation speed of cam ?

A. $\frac{h}{2} \times \left(\frac{\omega}{\phi}\right)^2$ B. $h \times \left(\frac{\pi\omega}{\phi}\right)^2$

C. $\frac{h}{2} \times \left(\frac{\pi\omega}{\phi}\right)^2$ D. None

Ans. C

Sol. For the follower with SHM, displacement is given by:

$$s = \frac{h}{2} \times \left(1 - \cos\left(\frac{\pi\omega t}{\phi}\right)\right)$$

From this maximum acceleration is found to be:

$$a_{max} = \frac{h}{2}\left(\frac{\pi\omega}{\phi}\right)^2$$

25. The number of degree of freedom of a planers linkage with 8 links and 9 simple revolute joint is.

A. 1 B. 2

C. 3 D. 4

Ans. C

Sol. Given,

Link (L)= 8 links

simple revolute joint (j) = 9,

$F = 3(L-1) - 2j - h$

higher pair(h) $= 0$

$= 3(8-1) - 2 \times 9$

= 3

26. If the elements of a kinematic pair make surface contact when in motion, then it is called_____.

A. Lower pair B. Closed pair

C. Higher pair D. Surface pair

Ans. A

Sol. If elements of a kinematic pair are in surface contact known as lower pair.

Example: piston cylinder arrangement.

If the elements of a kinematic pair make point or line contact when in motion, then it is called higher pair.

27. What will be the pitch line velocity if spur gear having 30 teeth and module 2 mm rotates are 400 rpm _____.

A. 328 mm/sec B. 428 mm/sec

C. 528 mm/sec D. 1256 mm/sec

Ans. D

Sol. Pitch line velocity (V_p) = r ×ω

$$V_p = \frac{mT}{2} \times \frac{2\pi N}{60}$$

$$V_p = \frac{2 \times 30}{2} \times \frac{2\pi \times 400}{60}$$

= 1256.63 mm/sec

28. A governor has a displacement of sleeve 5 cm and force required to raise the sleeve is 7.66 N. So the work done at the sleeve of the governor is _____.

A. 38.3 N-cm
B. 0.656 N-cm
C. 1.532 N-cm
D. 50.42 N-cm

Ans. A

Sol. Given:

Displacement of sleeve = 5 cm

Effort = 7.66 N

Work done on governor:

Power = effort × displacement

Power (P) = 5 × 7.66 = 38.3 N-cm

29. Coriolis component of acceleration depends upon

A. Angular velocity of the link
B. Acceleration of the slider
C. Angular velocity of link and velocity of the slider
D. Both angular velocity of link and acceleration of the slider

Ans. C

Sol. Coriolis component of acceleration is given by: $a_C = 2V\omega$,

Where, V = velocity of slider, ω = Angular velocity of link

So, this is related to velocity of the slider and the angular velocity of the link.

30. Which of the following is the type of pendulum governor?

A. Hartnellgovernor
B. Proell governor
C. Porter governor
D. Watt governor

Ans. D

Sol. Watt governor is a pendulum governor which is simplest and gravity controlled form of the centrifugal governor.

It consist of fly balls attached to sleeves and engine driven the spindle through bevel gears.

31. Which of the following is not correct for involute gears?

A. The path of contact of two gears during mesh is along a straight line.
B. Slight change of centre distance does not affect line of action.
C. Pressure angle remains constant
D. Interference is inherently absent.

Ans. D

Sol. In case of an involute profile, the common normal at the point of contact always passes through the pitch point P and maintains a constant inclination α with the common tangent to the two pitch circles. The angle α is called the pressure angle. Therefore, the pressure angle remains constant in involute tooth.

Straight line is also referred to as the line of action or line of engagement. This line of action corresponds in principle to the rolling line for the construction of the involute tooth flanks.

In involute profile of a gear, slight shift in center distance does not affect the velocity ratio.

32. What are the parameters that need to be balanced for a static balancing of a rotating masses. Assume all masses to be rigid in nature.

A. only masses
B. only forces
C. both masses and forces
D. both forces and couple

Ans. B

Sol. For static balancing only forces needs to be balance.

For dynamic balancing both forces and couple need to be balance.

33. Which one of the following is a higher pair?

A. Belt and pulley
B. Turning pair
C. Screw pair
D. Sliding pair

Ans. A

Sol. **Lower pair.** If the joint by which two members are connected has surface contact, the pair is known as lower pair. Eg. pin joints, shaft rotating in bush, slider in slider crank mechanism.

(b) Higher pair. If the contact between the pairing elements takes place at a point or along a line, such as in a ball bearing or between two gear teeth in contact, it is known as a higher pair.

In Belt and pulley due to multiple point contact they formed higher pair.

Sliding, turning and screw pair will have lower pair.

34. The mass of sleeve in a porter governor is 24 kg and that of ball is 4kg. If the minimum speed of governor is 300 rpm, then height at min speed is _____ mm.

A. 69.61mm
B. 73.2mm
C. 74.3mm
D. 64.6mm

Ans. A

Sol. For the Porter governor:

Height: $h = \frac{895}{N^2}\left(\frac{m+M}{M}\right) = \frac{895}{(300)^2} \times \frac{28}{4}$

h = 69.61mm

35. A body of mass 20 kg is suspended from a spring which deflects 20 mm under this load. Calculate the frequency of free vibrations (in Hz) _____.

A. 3.5
B. 5
C. 6
D. 7

Ans. A

Sol. Given: Mass (m) = 20 kg

Deflection of spring: Δ = 20 mm

Frequency of free vibrations is given by:

$$f = \frac{1}{2\pi}\sqrt{\frac{g}{\Delta}}$$

On substituting the values:

$$f = \frac{1}{2\pi}\sqrt{\frac{9.81}{20 \times 10^{-3}}} = 3.52\text{Hz}$$

36. In a locomotive, the ratio of the connecting rod length to the crank radius is kept very large in order to_____.

A. Minimize the effect of primary forces
B. Minimize the effect of secondary forces
C. Have perfect balancing
D. Start the locomotive conveniently

Ans. B

Sol. Primary unbalanced force,

$F_p = m\omega^2 r\cos\theta$

Secondary unbalanced force,

$\left(m \cdot \omega^2 \cdot r \times \frac{\cos 2\theta}{n}\right)$

As $n = \left(\frac{l}{r}\right) \uparrow,\ F_s \downarrow$

So, in a locomotive, the ratio of the connecting rod length to the crank radius is kept very large in order to minimize the effect of secondary forces.

37. If the speed of the engine varies between 80 rpm and 100 rpm in a cycle of operation, then the coefficient of fluctuation of speed will be

A. 1/9
B. 9
C. 2/9
D. 4.5

Ans. C

Sol. Coefficient of fluctuation of speed is given as

$$C_s = \frac{\text{Range of speed}}{\text{Mean speed}} = \frac{100-80}{\left(\frac{180}{2}\right)} = \frac{20}{90} = \frac{2}{9}$$

38. In a governor the controlling force curve shows a relationship between_____.

A. controlling force and speed of rotation
B. controlling force and radius of rotation
C. controlling force and height of sleeve lift
D. controlling force and mass of governor ball

Ans. B

Sol. Controlling force curve is plotted between controlling force of y-axis and radius of roation at x-axis.

39. The ratio of $\frac{\omega}{\omega_n}$ for which the transmitted force is equal to the exciting force under no damping conditions___?

A. $\frac{1}{\sqrt{2}}$
B. $\sqrt{2}$
C. 2
D. 1/2

Ans. B

Sol. We know that,

$$\text{Transmissibility } (\in) = \frac{1+\left(2\zeta\frac{\omega}{\omega_n}\right)^2}{\sqrt{\left(1-\left(\frac{\omega}{\omega_n}\right)^2\right)+\left(2\zeta\frac{\omega}{\omega_n}\right)^2}}$$

$\epsilon = 1$ when $\frac{\omega}{\omega_n} = \sqrt{2}$ or 0

Under no damping ζ = 0

The transmitted force is equal to the exciting force when $\frac{\omega}{\omega_n} = \sqrt{2}$

So, the correct option is (b).

40. For an isochronous governor, the controlling force at a radius of 50 mm is 250 N. The controlling force at 75 mm radius will be:

A. 375 N

B. 350 N

C. 325 N

D. Insufficient data

Ans. A

Sol. For an isochronous governor:

$F \propto r$

$\frac{F_2}{F_1} = \frac{r_2}{r_1}$

$\frac{F_2}{250} = \frac{75}{50}$

$F_2 = 375N$

41. Total number of instantaneous canters of rotation for a mechanism having six links is_____.

A. 3 B. 15

C. 5 D. 6

Ans. B

Sol. Given

Link (n) =6

Total numbers of instantaneous canters of rotation = $\frac{n(n-1)}{2}$

$= \frac{6\times5}{2} = 15$

42. Mechanical advantage of a mechanism is ratio of the

A. Output torque to the input torque B. Output power to the input power

C. Input power to the output power D. Efficiency of mechanism to the input power

Ans. A

Sol. Mechanical advantage of a mechanism is the ratio of the output force or torque to the input force or torque.

$$\text{M.A.} = \frac{T_{output}}{T_{input}}$$

$$\text{Efficiency} = \frac{P_{out}}{P_{in}}$$

So, the correct option is (a).

43. The motion between piston and cylinder in steam engine is a

A. Completely constrained motion

B. Incomplete constrained motion

C. Successfully constrained motion

D. None of the above

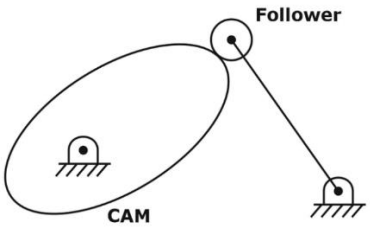
Ans. C

Sol. In completely constrained motion, the motion between a pair limited to a definite direction irrespective of the direction of force applied.

In incomplete constrained motion, the motion between a pair can take place in more than one direction.

InSuccessfully constrained motion, the motion is made to completely constrain.

44. Find DOF of the given cam and follower mechanism:



A. 1 B. 2

C. 3 D. 0

Ans. A

Sol. Number of links, n = 4

Number of lower pairs, j = 3

Number of higher pairs, h = 1

DOF = 3(n - 1) -2j -h = 3(4 – 1) -2×3 – 1 = 2

Redundant motion = 1 (between CAM and Follower)

So, Final DOF= 2-1 = 1

45. Suggest the gearing arrangement for a stirrer to run at 36 rpm being driven by a motor running at 1440 rpm.

A. Helical gear B. Differential gear

C. Spur gear D. Worm gear

Ans. D

Sol. A worm drive is a gear arrangement in which a worm (which is a gear in the form of a screw) meshes with a worm gear (which is similar in appearance to a spur gear). The two elements are also called the worm screw and worm wheel.

Here, $\frac{N_1}{N_2} = \frac{1440}{36} = 40$

A worm drive are used for high velocity speed ratio so the correct option is (D)

46. In a single slider crank mechanism, obliquity ratio is given by

A. length of connecting rod crank radius

B. crank radius/length of connecting rod

C. length of connecting rod/2

D. length of connecting rod/crank radius

Ans. D

Sol. In a single slider crank mechanism, obliquity ratio is given by length of connecting rod/crank radius.

47. The Whitworth quick return mechanism is formed in a slider-crank chain when the_____.

A. Coupler link is fixed

B. Longest link is fixed

C. Slider is fixed

D. Smallest link is fixed

Ans. D

Sol. Whitworth quick return mechanism used for rotary to rotary transmission.
So in whitworth quick return mechanism smallest link crank is fixed.

48. In case of dynamic analysis of single slider crank chain, the correct expression for force acting along the connecting rod is given by_____.
where F is the piston effort and β is the angle made by the connecting rod with the line of sliding of the slider.

A. F cos β

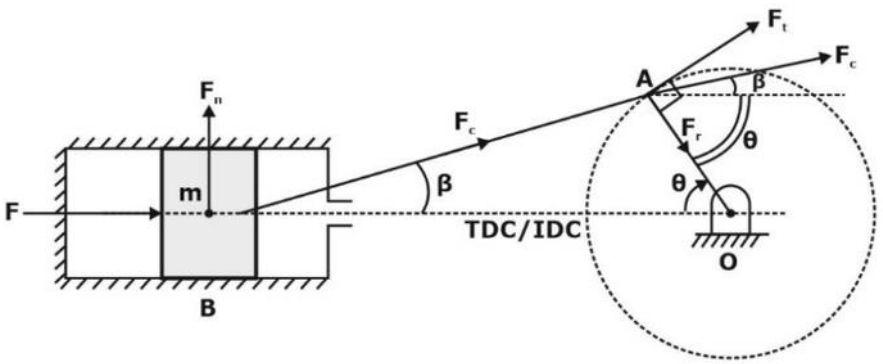
B. F / cos β

C. F / sin β

D. F sin β

Ans. B

Sol. In case of dynamic analysis of single slider crank chain, the correct expression for force acting along the connecting rod is given by:



$F_C \cos\beta = F$

$F_c = \frac{F}{\cos\beta}$

49. For a damped vibration system, the frequency(ω_d) of the system is given by Where, ω is natural frequency.

A. $\omega\sqrt{\zeta^2-1}$ B. $\omega\sqrt{1-\zeta^2}$

C. $\omega\sqrt{1-\zeta}$ D. $\omega\sqrt{1-2\zeta}$

Ans. B

Sol. The frequency of the damped system is given by,

$\omega_d = \omega\sqrt{1-\zeta^2}$

ω_d = damped vibration frequency of the system

So, the correct option is (b)

50. The critical speed depends on _____.

A. mass B. stiffness

C. mass and stiffness D. mass, stiffness and eccentricity

Ans. C

Sol. The critical speed depends upon mass, stiffness not eccentricity.

Hence (C) is correct.

NOTE: the critical speed does not depend on the eccentricity.

51. A rotating mass having moment of inertia of 30 kg-m^2 rotates at 800 rpm and is travelling in a curve of 170 metre radius at a speed of 240 km/hr. Find the precessional angular velocity(rad/s)_____.

A. 0.392 B. 83.77

C. 0.23 D. 0.0392

Ans. A

Sol. Given,

moment of inertia = 30 kg-m^2 ,

Curve radius =170 m,

Speed = 240 km/hr

$V = \frac{240\times 5}{18} = 66.67\frac{m}{s}$

$\omega_p = \frac{V}{r} = \frac{66.67}{170} = 0.392\frac{rad}{s}$

52. Which one of the following in-line engines working on four-stroke cycle is completely balanced inherently_____?

A. 2 cylinder engine B. 3 cylinder engine

C. 4 cylinder engine D. 6 cylinder engine

Ans. D

Sol. For 6 cylinder in-line engines working on four-stroke cycle, the force and couple polygon is closed and hence it is inherently balanced engine for primary and secondary forces and couples.

4-Cylinder Inline Engine → Not Completely balanced

6-Cylinder Inline Engine → Completely balanced

53. Which of the following gear profile is used to eliminate axial thrust while designing gears having constant velocity ratio.

A. helical gear
B. spur gear
C. herringbone gear
D. Both B and C

Ans. D

Sol. Spur gears having no axial thrust and herringbone gears are deisgn in such a way that axial thrust are there but they are eliminated due to gear design. Hence option D is correct

54. The pair that is formed by the lead screw of a lathe with nut is known as

A. Rolling pair
B. Sliding pair
C. Screw pair
D. Turning pair

Ans. C

Sol. When the nature of contact between the element of a pair is such that one element can turn abut the other by screw threads, the pair is known as a screw pair. The lead screw of a lathe with nut is an example of screw pair.

55. The equation of vibration as a system is $\ddot{x}+36\pi^2x=0$. Its natural frequency is____

A. 46 Hz
B. 3п Hz
C. 3 Hz
D. 6п Hz

Ans. C

Sol. Given,

$\ddot{x}+36\pi^2x=0$

Compare with

$m\ddot{x}+\omega_n^2x=0$

$\omega_n=\sqrt{\frac{k}{m}}=6\pi$

$\omega_n=2\pi f_n$

$f_n=3$

56. Oldham's coupling is used to connect two shafts which are_____.

A. parallel
B. intersecting
C. co-axial
D. perpendicular

Ans. A

Sol. Oldham's coupling is used to connect two shafts which are parallel and have lateral misalignment.

57. Two links have angular velocity of 20 rad/s and 15 rad/s both in opposite directions. If the radius of the pin at O is 10mm, O is point where two links are connected, determine the rubbing velocity at the joint____?

A. 0.35 m/s
B. 0.30 m/s
C. 0.20 m/s
D. 0.05 m/s

Ans. A

Sol. Given,

Angular velocity of 1st link = 20 rad/s

Angular velocity of 2nd link =15 rad/s

Rubbing velocity v = $(\omega_1 + \omega_2)r$

= (20 + 15) 10

v = 350mm/s = 0.35 m/s

58. For slider crank mechanism the velocity & acceleration of piston at inner dead centre will be_____ respectively.

A. 0 & 0 B. 0 & $r\omega^2$

C. 0 & < $r\omega^2$ D. 0 & > $r\omega^2$

Ans. D

Sol. We know that,

$$V_p = r\omega\left[\sin\theta + \frac{\sin 2\theta}{2n}\right]$$

At inner dead centre θ = 0°

∴ $V_p = 0$

$$a_p = r\omega^2\left[\cos\theta + \frac{\cos 2\theta}{n}\right]$$

$$a_p = r\omega^2\left[1 + \frac{1}{n}\right]$$

∴ $a_p > r\omega^2$

59. The module of a gear 1(10 teeth) is 5 mm, meshing with gear 2 has 20 teeth. Find the distance between centers of the mating gears?

A. 30 mm B. 40 mm

C. 50 mm D. 75 mm

Ans. D

Sol. As the module is the same for both gears:

Gear 1:

$$m = \frac{d}{T_1} \Rightarrow d = mT_1$$

d = 5×10 = 50 mm

Gear 2:

$D = mT_2 = 5 \times 20 = 100\text{mm}$

Thus: R = 50 mm and r = 25 mm

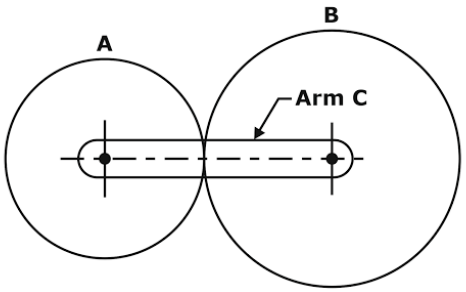
Hence the distance between centers of the gear is:

$$C = R + r = m\left(\frac{d}{T_1} + \frac{D}{T_2}\right)$$

C = 25 + 50

= 75 mm

60. For the given epicyclic gear train if the Gear B is fixed and arm C makes 10 revolutions, the number of revolutions made by gear A will be ____. Teeth on gear A and B are 25 and 100 respectively.



A. 0
B. 10
C. 30
D. 50

Ans. D

Sol. Making the tabular table.

Revolutions of Arm C	Revolutions of Gear A	Revolutions of Gear B
0	x	$-x \times \frac{T_A}{T_B}$
y	Y +x	$y - x \times \frac{T_A}{T_B}$

Teeth on gear A: $T_A = 25$

Teeth on gear B: $T_B = 100$

Speed of arm (y) = 10 revolutions

Speed of gear B = 0

$$y - x\frac{T_A}{T_B} = 0$$

$$10 = x \times \frac{25}{100}$$

x = 40 revolution

Hence speed of gear A = x + y = 50 revolutions

61. A flywheel of moment of inertia 9.8 kg m^2 fluctuates by 30 rpm, if the fluctuation in the speed is not to exceed ±3%, Then the mean angular speed of the flywheel is. Take ΔE = 3 kJ

A. 82.66 rad/sec
B. 54.12 rad/sec
C. 71.42 rad/sec
D. 41.124 rad/sec

Ans. C

Sol. Given: $C_s = 0.06$

Change in KE:

$\Delta E = I\omega_{mean}^2 C_s$

$3000 = 9.8 \times \omega_{mean}^2 \times 0.06$

$\omega_{mean} = 71.42$ rad/sec

62. In an elliptical trammel, which point surely does a circular motion _____?

A. Mid-point of the link connecting two blocks

B. No point

C. Points closed to the mid-point.

D. All points on the link.

Ans. A

Sol. Mid point is at equidistant from both prismatic joint of elliptical trammel. So major and minor axis of ellipse form by mid point will be equal, i.e. circle.

63. A system in which amplitude of vibration decreases exponentially over the time, such system is an example of_____.

A. Critically Damped system

B. Overdamped System

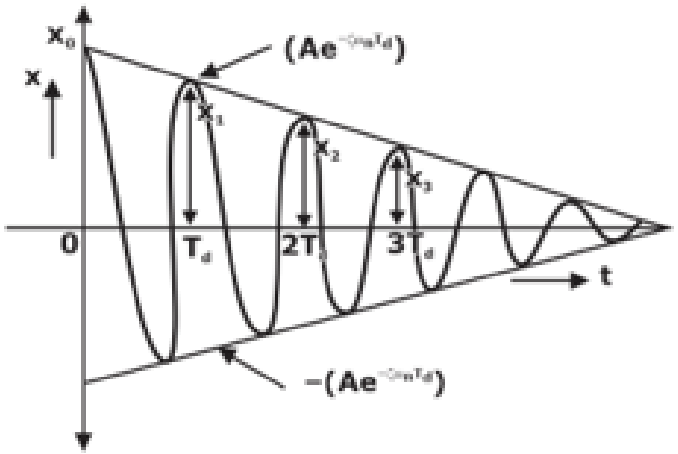
C. Under-Damped System

D. Coulamb Damped System

Ans. C

Sol. A system in which amplitude of vibration decreases exponentially over the time, such system is an example of under-Damped system.

Variation of amplitude of vibration (x) over the time (t) is shown below



64. The gear train in which the axes of the first and the last gear in the train coincide, is called a:

A. Simple gear train

B. Reverted gear train

C. Epicyclic gear train

D. Compound gear train

Ans. B

Sol. In reverted gear train axis of first gear and last gear coincides.

Ex. Wrist watch.

65. In balancing of reciprocating masses, the secondary forces are

A. Of twice the frequency of primary forces

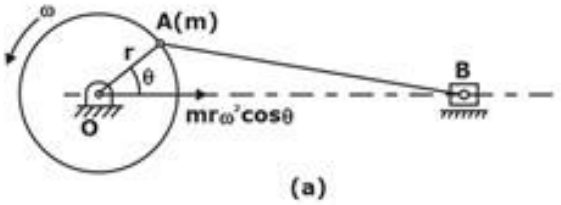
B. Of four the frequency of primary forces

C. Of same frequency as of primary forces

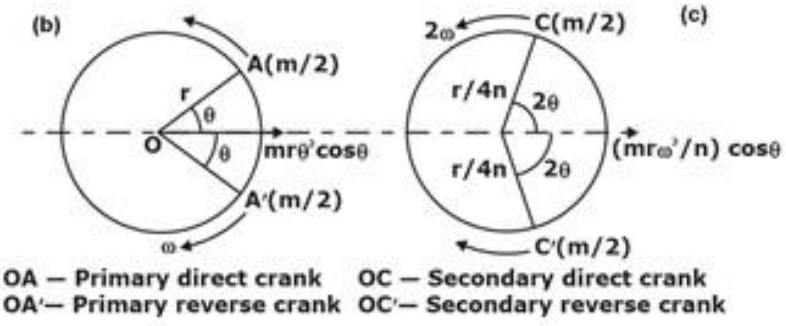
D. None of the above

Ans. A

Sol. A mass m/2, placed at the end of secondary crank of length r/4n at angle 2θ and rotating at an angular velocity 2ω in the given direction.



(a)



So, angular velocity (ω) of secondary forces are twice than that of primary.

66. A toy car is made by a group of students for analyzing the effect of various forces in running a car. The car works with help of a slider crank mechanism fitted inside the toy car. The crank moves with a constant angular velocity of 10 rad/s and the crank radius is 60 mm. If the mass of the slider is 0.2 kg due to which wheel tends to leave the surface then find the hammer blow acting on the car.

A. 6 N
B. 1.2 N
C. 2.2 N
D. 6.9 N

Ans. B

Sol. Given

radius(r)=60 mm

mass (m)=0.2 kg

Angular Velocity(ω)=10 rad/s

Hammer blow is the maximum primary unbalanced force acting on the car in vertical direction

$$\text{Hammer Blow} = mr\omega^2$$

$$\text{Hammer Blow} = 0.2 \times 0.06 \times 100$$

$$\text{Hammer Blow} = 1.2\text{N}$$

****