UNIT –I
MECHANICS
Part-A

1. **Define stress and write its unit.**
   Stress is defined as the restoring force per unit area which brings back the body to its original state from the deformed state.
   $$Stress = \frac{Restoring\ \ force}{Unit\ \ area}$$ Unit : N/m^2
2. **Define strain and write its unit.**
   Strain is defined as the ratio of change in dimension to the original dimension.
   Strain = $\frac{change\ in\ dimension}{original\ \ dimension}$ Unit : No unit.
3. **What is Hooke's law? (Jan 2019)**
   Stress is directly proportional to the strain produced, within the elastic limit.
   Stress $\propto$ strain
   E= $\frac{stress}{strain}$ N/m^2, where E is a constant called modulus of elasticity.
4. **Define Young's modulus.**
   It is defined as the ratio between the longitudinal stress to the longitudinal strain within the elastic limit.
   Y=$\frac{F/A}{l/L}$ $=\frac{FL}{Al}$ Unit: N/m^2
5. **Define bulk modulus.**
   Bulk modulus is defined as the ratio between the volume stress to volume strain within the elastic limit. K = $\frac{F/A}{v/V}$ $=\frac{FV}{Av}$ Unit: N/m^2
6. **Define rigidity modulus.**
   It is defined as the ratio between the tangential stress to the shearing strain within the elastic limit.
   $$\eta = \frac{F/A}{\theta} = \frac{F}{A\theta}$$ Unit: N/m^2
7. **What do you infer from stress- strain diagram?**
   a. Within the elastic limit, stress is directly proportional to strain.
   b. It distinguishes the elastic and plastic limit of a material.
   c. It determines the ultimate strength of the material.
   d. It helps us to distinguish the material based on the properties such as ductility and brittleness.
8. **What are the effects of hammering and annealing on elasticity of a material? (Jan 2018)**
   While being hammered or rolled, crystal grains break into smaller units resulting in increase of their elastic properties. While annealing constituent crystals are uniformly oriented and form large crystal grains, which results in decrease in their elastic properties.

9. **List any two factors affecting elastic modulus and tensile strength (Apr 2019)**

(i) Temperature (ii) Impurities (iii) Hammering, rolling and annealing (iv) Stress

10. **How do temperature and impurity in a material affect the elasticity of the material?**

(i) Effect of temperature: The rise in temperature decreases the elasticity and vice versa.Ex: carbon filament becomes plastic at higher temperature.

(ii) Effect of impurities: The addition of impurities produces variation in elastic property of the material. The increase and decrease in elasticity depends on the type of impurity added to it. Ex: when potassium is added to gold, the elastic property of the gold increases.

11. **When a wire is bent back and forth, it becomes hot. Why? (Jan 2018)**

Heat is generated due to the elastic hysteresis and frictional force. Hence it becomes hot.

12. **Define elastic limit.**

The maximum stress upto which a body can recover its original shape and size, after removing the external force is called as elastic limit.

13. **Define tensile strength. (Jan 2019)**

It is defined as the maximum stress up to which the material withstandsbefore fracture under a steady load.

Tensile strength $=\frac{maximum\ tensile\ \ load}{original\ \ cross-sectional\ \ area}$

14. **Define yield point.**

The value of stress at which the body loses its elasticity is called yield point.

15. **Define torque.**

Torque is the rotating force and is equal to the moment of the couple. Torque is the product of one of the forces forming couple and the perpendicular distance between the two opposite forces.

16. **What is a torsional pendulum?**

A circular metallic disc suspended using a thin wire executes torsional oscillations is called torsional pendulum.

17. **Define torsional stress.**

The shear stress setup in the shaft when equal and opposite torques are applied to the ends of a shaft about its axis, is called torsional stress.

18. **Define a beam.**

A beam is defined as a rod or bar of uniform cross-section whose length is very much greater than its other dimensions such as breadth and thickness.

19. **Explain neutral axis (or) how are the various filaments of a beam affected when the beam is loaded?**

When the beam is bent upwards, the middle layer of a beam remains unaltered even with the presence of load on the beam is called neutral axis. Filaments which are lying above it are elongated and those lying below it are compressed.

20. Explain bending moment of a beam.

The moment of a couple due to the elastic reaction which balances the external couple due tothe applied load is called bending moment.

21. What is uniform bending?

The beam is loaded symmetrically on both ends, the bent beam forms an arc of a circle. The radius of curvature of the bent beam is constant for given load. This type of bending is calleduniform bending.

22. What is non-uniform bending?

If the beam is loaded at its mid-point, the depression produced does not form an arc of acircle. This type of bending is called non-uniform bending.

23. Define angular displacement, angular velocity and angular acceleration.

The angle described by a rigid body from its rest position in a given time is called angular displacement θ.

The rate of change of angular displacement is called angular velocity.

$\omega = d\theta/dt$.

The rate of change of angular velocity is called angular acceleration.$\alpha = d\omega/dt$

24. Define torque.

The movement of applied force about the axis of rotation is called Torque.$\tau = \bar{r} \times \bar{F}$

25. What is the relationship between linear velocity and angular velocity ?

Linear Velocity $\bar{v} = r\,\omega$

Where ω is the angular velocity

26. What is the relationship between linear acceleration and angular acceleration?

Linear acceleration $\bar{a} = r\,\alpha$

Where α is the angular acceleration.

27. Give the equation for center of mass for continuous distribution of mass.

$X = \int x\,dm \,/ \int dm$

28. Define centre of mass .

Considering a given object there is one point in it which behaves as though the entire mass of the system were concentrated there and all the external forces were acting at this point this is called the center of marks of the system.

29. What is rigid body?

A rigid body is defined as that body which does not undergo any change in shape or volume when external forces are applied on it.

30. What is rotational motion ?

A rigid body is said to have pure rotational motion if every particle of the body moves in a circle the center of which lies on a straight line called the axis of rotation.

31. Define moment of inertia of a body .

Moment of inertia of a body if its inability to change by itself its state of rest or rotational motion about its axis.

32. What is moment of inertia of a particle ?

The moment of inertia of a particle about an axis is defined as the product of mass of the particle and square of the distance of the particle from the axis of rotation.

33. What are the theorems of moment of inertia?

There are two important theorems which help to find the moment of inertia of a body about some other access if moment of inertia about any symmetrical axis of the body is given these are called parallel axis theorem and perpendicular axis theorem.

34. What is parallel axis theorem?

The moment of inertia of a body about any axis is equal to the sum of its moment of inertia about a parallel axis passing through its center of gravity of a body and the product of its mass of the body with the square of the distance between the two axis.

35. What is perpendicular axis theorem?

Perpendicular axis theorem states that the moment of inertia of a plane lamina about an axis perpendicular to its plane is equal to the sum of moments of inertia of the plane lamina about any two mutually perpendicular axis in its own plane and intersecting each other at the point where the perpendicular axis passes through it.

36. What is angular momentum ?

The moment of linear momentum is known as angular momentum.

37. State the Newtons first law for rotational motion.

An object continues in its state of rest or uniform rotation with a constant angular velocity until it is acted upon by a non-zero net torque.

38. Prove that the rotational kinetic energy is conserved in the torque free motion of arigid body.

Rotational K.E = $\frac{1}{2} I w^2$

For torque free motion, angular velocity is constant. Moment of inertia is time independent parameter so rotational K.E is conserved, if torque is not present.

39. State the law of conservation of angular momentum.

If net external torque does not act on the body, the angular momentum of the body will be a constant.

$\tau_{net} = 0 \rightarrow \frac{dL}{dt} = 0$

Therefore L is a constant.

40. What is torsional pendulum ?

A circular metallic disc suspended using a thin wire that executes torsional oscillations is called torsional pendulum.

41. What are the uses of torsional pendulum ?

Torsional pendulum is used to determine

1. Rigidity modulus of the wire

2. Moment of inertia of the disc

3. Moment of inertia of an irregular body

Part-B

1. Describe with necessary theory, the method to determine the young's modulus of thematerial of a rectangular bar by uniform bending.
2. Derive an expression for moment of inertia of a torsional pendulum.
3. Explain with necessary theory, the determination of Young's modulus of elasticity of thematerial of a beam, supported at its ends and loaded in the middle.(10 marks)
4. Derive an expression for Moment of Inertia of a solid sphere about a diameter and tangent.
5. State and prove Parallel and Perpendicular axis theorem.
6. Derive an expression for moment of inertia of a diatomic molecule and explain the rotational energy states of it.
7. Explain stress-strain diagram for an elastic material with the help of a diagram.(8 marks)
8. Explain the factors affecting elasticity of a material.(8 marks)
9. Derive an expression for moment of inertia of a thin circular disc, i) About an axis through its center and perpendicular to its plane ii.About a diameter.
10. Derive an expression for moment of inertia of a uniform rod, i) About an axis through its center and perpendicular to its length of the rod. ii. About an

axis through its end and perpendicular to its length of the rod.

11. Derive an expression for the internal bending moment of a beam in terms of radius of curvature.(8 marks)