Unit: 1. FORCE ANALYSIS

1.Distinguish between space diagram and free body diagram?

A space diagram is a graphical description of the system. It generally shows the shape and size of the system, the weight, the externally applied loads, the connection and the supports of the system.

A free body diagram is a sketch of the isolated or free body which shows all the pertinent weight forces, the externally applied loads, and the reaction from its supports and connections acting upon it by the removed elements.

2. Define static force analysis?

If components of a machine accelerate, inertia is produced due to their masses. However, the magnitude of these forces are small compared to the externally applied loads. Hence inertia effect due to masses are neglected. Such an analysis is known as static force analysis.

3.What are the conditions for a body to be in static and dynamic equilibrium?

Necessary and sufficient conditions for static and dynamic equilibrium are,

1. Vector sum of all forces acting on a body is zero.
2. The vector sum of the moments of all forces acting about any arbitrary point or axis is zero.

First condition is the sufficient condition for static equilibrium together with second condition is necessary for dynamic equilibrium.

4.Define force and applied force.

Force is a pull or push, which acts on a body changes or tends to change, the state of rest or uniform motion of the body. A force is completely characterized by its point of application, its magnitude and direction.

The external force acting on a system of body from outside the system are called applied force. The applied forces are classified as active and reactive forces.

5. Which law helps to measure a force quantitatively?

Newton's second law helps us to measure a force quantitatively.

6. When will the two force member is in equilibrium?

The member under the action of two force will be in equilibrium if,

1. The two forces are of same magnitude,
2. The forces act along the same line, and
3. The forces are in opposite direction.

7. Give any three advantages of free body diagram.

1. Free body diagram assist in seeing and understanding all aspects of problem.
2. They help in planning the approach to the problem.
3. They make mathematical relations easier to the problem.

8. When will the three force member is in equilibrium?

A body or member will in be equilibrium under the action of three forces if,

1. The resultant of the forces is zero, and
2. The line of action of the forces intersect at a point.

9. Define dynamic force analysis.

When the inertia effect due to the mass of the component is also considered in addition to externally applied loads, is called as dynamic force analysis.

10. Define constraint forces.

When two or more bodies are connected together to form a group or system, the pair of action and reaction forces between any two of the connected bodies are called constraint forces.

11. Define moment of a force.

The moment of a force about a point is defined as the product of the force and the perpendicular distance from the point on the line of action of the force.

12. Define principle of moment.

Principle of moments states that the moment of a number of forces about any point is equal to the algebraic sum of the moments of all the forces of the system about the same point.

13. Differentiate between static analysis and dynamic force analysis.

If components of a machine accelerate, inertia forces are produced due to their masses. If the magnitude of these forces are small compared to the externally applied

loads, they can be neglected while analysing the mechanism. Such an analysis is known as static force analysis.

14.What do you mean by inertia.

If the inertia effect due to the mass of the component is also considered, it is called dynamic force analysis.

15.State D'Alembert's principle.

This principle states that the inertia forces and torques, acting on a body together result in statical equilibrium.

16.How you will reduce a dynamic analysis problem into an equivalent problem of static equilibrium.

By applying D'Alembert's principle to a dynamic analysis problem, we can reduce it into an equivalent problem of static equilibrium.

17.What do you mean by Equivalent offset inertia force.

Equivalent offset inertia force is the force, which can replace both inertia force and inertia torque.

18.State the principle of superposition.

The principle of superposition states that for linear systems the individual response to several disturbances or driving functions can be supported on each other to obtain the total response of the system.

19.Define piston effort.

Piston effort is defined as the net or effective force applied on the piston, along the line of stroke.

It is also known as effective driving force or net load on the gudgeon pin.

20.Define compound pendulum or torsional pendulum.

A rigid body suspended vertically at a point and oscillating with very small amplitude under the action of gravitational force is known as compound pendulum or torsional pendulum.

21.What are the requirements of an equivalent dynamical system?

a. The mass of the rigid body must be equal to the sum of masses of two concentrated masses, i.e., $m_1+m_2=m$.

b. The centre of gravity of the two masses must coincide with the centre of gravity of the rigid body. I.e., $m_1 . l_1 = m_2 . l_2$

c. The sum of mass moment of inertia of two masses about their centre of gravity is equal to the mass moment of inertia of the rigid body.

i.e., $l_1 . l_2 = (k_G)^2$.

22.What is meant by turning moment diagram or crank effort diagram?

It is the graphical representation of the turning or crank effort for various position of the crank,

In turning moment diagram, the turning moment is taken as the ordinate (Y – Axis), and crank angle as abscissa (X – Axis).

23.Differentiate the functions of Flywheel and Governor.

S.No	Flywheel	Governor
1.	The function of flywheel is to reduce the fluctuations of speed during a cycle above and below the mean value for constant load from prime mover.	Its function is to control the mean speed over a period for output load variations.
2.	Its works continuously from cycle to cycle.	It works continuously, i.e., only when there is change in the load.
3.	It has no influence on mean speed of the prime mover.	It has no influence over cyclic speed fluctuations.

24.Define inertia torque.

The inertia torque is an imaginary torque, which when applied upon the rigid body, brings it in equilibrium position. It is equal to the accelerating couple in magnitude but opposite in direction.

25.What is meant by maximum fluctuation of speed?

The difference between the maximum and minimum speeds during a cycle is called maximum fluctuation of speed.

26.Define fluctuations of energy.

The variations of energy above and below the mean resisting torque line are called fluctuations of energy.

27.Define coefficient of fluctuation of energy.

It is the ratio between the maximum fluctuation of energy to the work done per cycle.

28.Define coefficient of fluctuation of speed.

The ratio of the maximum fluctuation of speed to the mean speed is called the coefficient of fluctuation speed.

29.Why flywheels are needed in forging and pressing operations?

In both forging and pressing operations, flywheels are required to control the variations in speed during each cycle of an engine. The function of a flywheel is to store energy during the period when the supply of energy is more than the requirement, and to give away the same when the requirement of energy is more than the supply.

29.What is cam Dynamics?

Cam dynamics is the study of cam follower system with considering the dynamic forces and torques developed in it.

30.What is elastic cam Analysis?

If the members of a cam system are elastic and their speed is very high, then the analysis of such a cam system is known as analysis of elastic cam system.

31.Define unbalance and spring surge.

A disc cam produces unbalance because its mass is not symmetrical with the axis of rotation. It is called as unbalance.

Spring surge: It means vibration of the retaining spring.

32.What is the purpose of force analysis?

In the design of machines and mechanisms, it is essential to choose proper sizes for machine components. Improper selection may lead to early failure due to poor strength or excessive strength leading to increase in cost, size weight etc.

33. Define inertia torque.

A force of a couple which acts in the direction opposite to that of accelerating couple and resists any change in angular velocity is inertia torque.

34. Define crankpin effort.

Crankpin effort is the net force or effort applied at the crankpin perpendicular to the crank, giving the required turning moment on the crankshaft.

35. What is meant by correction couple?

It is a dynamically equivalent system. If the two masses are placed orbitrarily, an error in torque is introduced. To make the system dynamically equivalent, a couple should be applied. This couple is called correction couple. It is always positioned and has the direction same as that of the angular acceleration.

36. Define compound pendulum.

A rigid body suspended vertically, which oscillates with small amplitudes under the action of gravity, is known as a torsional or compound pendulum.

37. What are bearing loads?

Various forces acting upon the bearing account for bearing loads. In a reciprocating engine, it is essential to know the forces acting on piston pin and crankpin, for proper design and selection of bearings.

38. Why negative loops are formed in turning moment diagrams?

When flywheel losses energy, negative loops are formed in turning moment diagram. This indicates more energy is being taken from flywheel than produced.

39. What does float or jump of a follower mean?

The stored energy in a camshaft due to wind – up phenomenon, which occurs because of variations in torque, gets released at the end of follower rise. The results in under variation of velocity and acceleration of the follower. This phenomenon is called 'jump' or 'float'.

40. State any two possible causes for wind – up.

The causes for wind – up are,

a. Shaft being flexible.
b. Follower operating at very high speeds.

UNIT: 2. BALANCING

1.Write the importance of balancing.

If the moving part of a machine are not balanced completely then the inertia forces are set up which may cause excessive noise, vibration, wear and tear of the system. So balancing of machine is necessary.

2.Why balancing of dynamic force is necessary?

If dynamic forces are not balanced, they will cause worse effects such as wear and tear on bearings and excessive vibrations on machines. It is very common in camshafts, steam turbine rotors, engine crankshafts, and centrifugal pumps, etc.

3.Define static balancing.

A system of rotating masses is said to be in static balance if the combined mass centre of the system lies on the axis of rotation.

4.State the condition for static balancing.

The net dynamic force acting on the shaft is equal to zero. This requires that the line of action of their centrifugal forces must be same.

5.Write the condition for complete balancing.

a. The resultant centrifugal force must be zero.
b. The resultant couple must be zero.

6.Differentiate clearly the static and dynamic balancing.

S.No	Static Balancing	Dynamic Balancing
1.	The dynamic forces as a result of the unbalanced masses are balanced by introducing balancing masses in the plane of rotation or different planes. The net dynamic force acting on the shaft is made zero.	The arrangement made in static balancing gives rise to a couple which tends to rock the shaft in bearing. Dynamic balancing considers the net couple as well as net dynamic force to do complete balancing.
2.	It deals only with balancing of dynamic forces.	It deals with balancing of dynamic force and balancing of couple due to dynamic force.

7.Define Dalby's method of balancing masses.

Dalby's method is used for balancing of several masses rotating in different planes. In this method several forces acting on several planes are transferred to a single reference planes.

8.Whether grinding wheels are balanced or not? If so why?

Yes, the grinding wheels are properly balanced by inserting some low-density materials. If not the required surface finish won't be attained and the vibration will cause much noise.

9.What is dynamic balancing?

A system of rotating masses is in dynamic balance when there does not exist any resultant centrifugal force as well as resultant couple.

10.What are the different types of balancing machines?

a. Static balancing machines.

b. Dynamic balancing machines.

c. Universal balancing machines.

11.State the conditions for complete balance of several masses revolving in different planes of a shaft.

a. The resultant centrifugal force must be zero

b. The resultant couple must be zero.

12.List the effects of partial balancing of locomotives.

d. Variation in tractive force along the line of stroke.

e. Swaying couple.

f. Hammer blow.

13.Can a single cylinder engine be fully balanced? Why?

No, a single cylinder engine cannot be fully balanced.

Because the unbalanced forces due to reciprocating masses remains constant in direction but varies in magnitude.

14.What are the effects of hammer blow and swaying g couple?

The effect of hammer blow is to cause the variation in pressure between the wheel and rail, such that vehicle vibrates vigorously.

The effect of swaying couple is to make the leading wheels sway from side to side.

15.Define hammer blow with respect to locomotives.

The maximum magnitude of the unbalanced force along the perpendicular to the line of stroke is known as hammer blow.

16.Define swaying couple.

The unbalanced forces acting at a distance between the line of stroke of two cylinders, constitute a couple in the horizontal direction. This couple is known as swaying couple.

17.Why rotating masses are to be dynamically balanced?

If the rotating masses are not dynamically balanced, the unbalanced dynamic forces will cause worse effects such as wear and tear on bearings and excessive vibrations on machines. It is very common in camshaft, steam turbine rotors, centrifugal pumps, etc.

18.Why complete balancing is not possible in reciprocating engine?

Balancing of reciprocating masses is done by introducing the balancing mass opposite to the crank. The vertical component of the dynamic force of this balancing mass gives rise to "Hammer blow". In order to reduce the hammer blow, a part of the reciprocating mass is balanced. Hence complete balancing is not possible in reciprocating engines.

19.What are the various causes of balancing of revolving masses?

g. Balancing of single rotating mass by a single mass rotating in the same plane.
h. Balancing of single rotating mass by two masses rotating in different planes.
i. Balancing of several rotating masses in a single plane.
j. Balancing of several rotating masses in different planes.

20.Why the cranks of a locomotive are generally at right angles to one another?

In order to facilitate the starting of locomotive in any position (i.e., in order to have uniformly in turning moment) the cranks of a locomotive are generally at 90 degree to one another.

21.Define tractive force.

The resultant unbalanced force due to the two cylinders along the line of stroke, is known as tractive force.

22. What are in-line engines?

Multi-cylinder engines with the cylinder centre lines in the same plane and on the same side of the centre line of the crank shaft, are known as in-line engine.

23. What are the conditions to be satisfied for complete balance of in-line engine?

k. The algebraic sum of the primary and secondary forces must be zero.

l. The algebraic sum of the couples due to primary and secondary forces must be zero.

24. Why radial engines are preferred?

In radial engines the connecting rods are connected to a common crank and hence the plane of rotation of the various cranks is same, therefore there are no unbalanced primary or secondary couples. Hence radial engines are preferred.

25. Mention any two practical examples of balancing.

The two practical examples of balancing are watch needles and automobile wheels.

26. What do you understand by the term partial balancing?

In a reciprocating engine, the provision of rotating counter mass results in only a partial balance, as one vertical component of rotating mass remains unchecked. This is called partial balancing.

27. What is an inside cylinder engine?

If the cylinders of a twin – cylinder are placed between the planes of driving wheels, then the engine is called inside cylinder engine.

28. What are inline engines?

Multi – cylinder engines with cylinder centre lines in the same plane and on the same side of the centre line of the crankshaft are called in – line engines.

29. What are V – engines?

They are radial engines with a common crank, in which the cylinders are symmetrically arranged.

30. What do you understand by field balancing?

Field balancing is used to rebalance the large, high speed rotors owing to the deformations brought on by shipping or high operating temperatures.

31. What do you mean by the terms 'shaking force' and shaking moment'?

Shaking forces are the forces transmitted to the foundation or frame of a machine owing to the inertia of the moving parts. The variation of these forces tends to 'shake' or vibrate the machine causing shaking forces and shaking moments.

32. What kind of balancing is needed for turbine rotors or motor armatures?

In the case of longer machine elements like turbine rotors and armatures, the couples resulting from unbalanced centrifugal forces will tend to turn the rotor end to end. Hence dynamic balancing is needed.

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UNIT-III

FREE VIBRATION

1. What are the causes of vibration?

   The causes of vibration are unbalanced forces, elastic nature of the system, self-excitations, winds and earthquakes.

2. How will you classify vibration?

   1. Free vibrations
      i. Longitudinal vibration
      ii. Transverse vibration
      iii. Torsional vibration
   2. Forced vibration
   3. Damped vibration

3. What is meant by free vibration and forced vibration?

   Free vibration: When no external force acts on the body, after giving it an initial displacement, then the body is said to be under free or natural vibrations.

   Forced Vibration: When the body vibrates under the influence of external force, then the body is said to be under forced vibrations.

4. Define resonance.

   When the frequency of external force is equal to the natural frequency of a vibrating body, the amplitude of vibration becomes excessively large. This phenomenon is known as resonance.

5. Define steady state and transient vibrations.

   In ideal systems, the free vibration continue indefinitely as there is no damping. Such vibration is termed as steady state vibration.

   In real systems, the amplitude of vibration decays continuously because of natural damping and vanishes finally. Such vibration in real system is called transient vibration.

6. What is the equivalent spring stiffness?

   Equivalent spring stiffness is the measure of overall spring stiffness of any system having more than one spring connected in series or parallel.

   For springs in series:

$$1/S_{eqv} = 1/S_1 + 1/S_2 + \ldots\ldots\ldots + 1/S_n$$

For springs in parallel:

$$S_{eqv} = S_1 + S_2 + \ldots\ldots\ldots\ldots + S_n$$

7. List out the various method of finding the natural frequency of free longitudinal vibrations.
   1. Energy method
   2. Equilibrium method
   3. Rayleigh's method

8. Define longitudinal vibration.

When the particles of the shaft or disc moves parallel to the axis of the shaft, then the vibrations are known as longitudinal vibrations.

9. Define transverse vibrations.

When then particle of the shaft or disc move approximately perpendicular to the axis of the shaft, then the vibrations are known as transverse vibrations.

10. Define Torsional vibration.

When the particles of the shaft or disc move in a circle about the axis of the shaft, then the vibrations are known as Torsional vibrations.

11. Define degree of freedom.

The minimum number of independent coordinate required to specify the motion of a system at any instant is known as degree of freedom of the system.

12. Define simple harmonic motion.

The motion of a body to and from about a fixed point is called simple harmonic motion. The motion is periodic and its acceleration is always directed towards the mean position and is proportional to its distance from mean position. For example, the motion of a simple pendulum follows the SHM.

13. Define damping and viscous damping.

The damping can be defined as the resistance offered by a body to the motion of a vibratory system.

The damping provided by fluid resistance is known as viscous damping.

14. What are the types of damping?

    1. Viscous damping
    2. Coulomb or dry friction damping
    3. Solid or structural damping
    4. Slip or interfacial damping

15. Define damping coefficient.

    The damping force per unit velocity is known as damping coefficient.

16. What is amplitude reduction factor?

    The amplitude reduction factor is the ratio of any two successive amplitudes on the same side of the mean position.

17. Define critical speed.

    Critical or whirling or whipping speed is the speed at which the shaft tends to vibrate violently in the transverse direction. In other words, the speed at which resonance occurs are known as the critical speed.

18. What are the causes of the critical speeds?

    1. Eccentric mountings like gears, flywheels, pulleys, etc.
    2. Bending of the shaft due to its own weight,
    3. Non – uniform distribution of rotor material.

19. What is the principle of Rayleigh's method of finding natural frequency of vibration?

    The principle of Rayleigh's method is "The maximum kinetic energy at the mean position is equal to the maximum potential energy at the extreme position".

20. Distinguish between critical damping and large damping.

    If system is critically damped, the mass moves back very quickly to its equilibrium position within no time. Whereas in large damping, the mass moves slowly to the equilibrium position.

21. What are the factors that affect the critical speed of a shaft?

    1. The eccentricity of the C.G of the rotating masses from the axis of rotation of the shaft.
    2. Diameter of the disc.
    3. Span of the shaft.
    4. Types of supports connections at its ends.

22. Define damping ratio.

It is defined as the ratio of actual damping coefficient to the critical damping coefficient.

23. Define logarithmic ~~coefficient~~. decrement.

Logarithmic ~~coefficient~~ decrement is defined as the natural logarithm of the amplitude reduction factor. The amplitude reduction factor is the ratio of any two successive amplitudes on the same side of the mean position.

24. What is meant by critical damping?

The system is said to be critically damped when the damping factor $\zeta=1$. In other words, the critical damping is said to occur when frequency of damped vibration (f_d) is zero, i.e., the motion is a periodic

25. Define damping factor and resonance.

Damping factor: It is the ratio of actual damping coefficient(c) to the critical damping coefficient (c_c).

Resonance: When the frequency of external force is equal to the natural frequency of a vibration body, the amplitude of vibration become excessively large. This phenomenon is known as resonance

26. Define frequency, cycle, period, and free vibration.

Frequency: It is the number of cycles described in on second.

Cycle: It is define as the mention completed during one time period.

Period: It is the time interval after which the motion is repeated itself.

Free vibrations: if the period motion continues after the cause of original disturbance (i.e., initial displacement) is removed, then the body is said to be under free vibration.

27. 'Vibration can have desirable effects'. Justify.

Though vibration is mainly known for its undesirable effects like unwanted noise and wear, sometimes it is used to design a machine with a specific application. Vibratory conveyor and cell phones are examples in support of this statement.

28. Write short notes on Holzer method?

Holzer method is used to find the natural frequency of multi - rotor system. It is a trial and error method applicable to the systems executing both free and forced vibrations.

28. Differentiate torsional vibration from transverse vibration.

S.No	Aspect	Torsional vibration	Transverse vibration
a)	Direction of motion	The particle move in circles about the axis of the shaft	Perpendicular to the axis of the shaft.
b)	Nature of stresses induced	Torsional shear stresses	Tensile and compression stresses.

UNIT IV

FORCED VIBRATION

1.Define transmissibility.

Transmissibility may be defined as the ratio of the force transmitted (F_T) to the force applied (F_O) on the system.

Transmissibility ratio, $\varepsilon = F_T / F_O$

2.What is meant by harmonic forcing?

The term harmonic forcing refers to a spring-mass system with viscous damping, excited by a sinusoidal harmonic force $F=F_0 \sin\omega t$.

3. What is vibration isolation?

The term vibration isolation refers to the prevention or minimization of vibration and their transmission due to the unbalanced machines.

The vibration isolating devices such as spring and dampers energy themselves and allow only fraction of it to the foundation.

4. Give some examples of forced vibration.

a. Ringing of electric bell ~~where the vibration is by means of electrical means (i.e., electric supply is an external force).~~

b. The vibrations of air compressors, internal combustion engines, machine tools, various other machinery.

5.Briefly explain elastic suspension.

When machine components are suspended from elastic members, the vibrational force produced by the machine components will not be transmitted to the foundation. This is called as elastic suspension.

6.Specify any two industrial applications where the transmissibility effects of vibration are important.

1.All machine tools.

2.All turbo machines.

7.What are the methods of isolating the vibration?

a. High-speed engines/machines mounted on foundation and supports cause vibrations of excessive amplitude because of the unbalanced forces. It can be minimized by providing "Spring – Damper", etc.

b. The materials used for vibration isolation are rubber, felt cork, etc. These are placed between the foundation and vibrating body.

8.Define frequency response curve and phase frequency response curve.

A curve between magnification factor and frequency ratio is known as frequency response curve.

A curve between phase angle and frequency ratio is known as phase frequency response curve.

9.Explain types of isolation.

Isolation of forces: Vibrations produced in unbalanced machines should be isolated from the foundation so that the adjoining structure is not set into vibrations. This type of isolation is known as force isolation.

Isolation of Motions: The unbalanced machines are isolated from their foundations so that there should not be any damage either to the machines or the foundations. This type of isolation is known as motion isolation.

10.Define force transmissibility.

Force transmissibility is defined as the ratio of the force transmitted to the force applied on the system.

11.Define motion or amplitude transmissibility.

It is defined as the ratio of absolute amplitude of the mass to the base excitation amplitude.

12.What is magnification factor?

The ratio of the maximum displacement of the forced vibration to the static deflection under the static force is known as magnification factor.

13. Differentiate between transverse and Torsional vibration.

1.In transverse vibrations, the particles of the shaft move approximately perpendicular to the axis of the shaft. But in Torsional vibrations, the particle of the shaft moves in a circle about the axis of the shaft.

2. Due to transverse vibrations, tensile and compressive stresses are induced. Due to Torsional vibrations, Torsional shear stresses are induced in the shaft.

14. Define node in Torsional vibration.

Node is the point or the section of the shaft at which amplitude of the Torsional vibration is zero. At nodes, the shaft remains unaffected by the vibration.

15. Define Torsional equivalent shaft.

A shaft having variable diameter for different length can be theoretically replaced by an equivalent shaft of uniform diameter such that they have the same total of twist when equal opposing torques are applied at their ends. Such a theoretically replaced shaft is known as torsionally equivalent shaft.

16. Explain Holzer method.

1.This method is used to find the natural frequency of multi – rotor system.

2.It is a trail and error method.

3.It can be applied for both free and forced vibration.

4.This method can also be applied for the systems having linear and angular motions.

17. What are the conditions to be satisfied for an equivalent system to that of geared system in torsional vibrations?

1.The kinetic energy of the equivalent system must be equal to the kinetic energy of the original system.

2. The strain energy of the equivalent system must be equal to the strain energy of the original system.

18. How will you treat the inertia of gears while calculating the frequency of torsional vibrations of geared system?

When the inertia of the gearing is taken into consideration then an additional rotor is introduced to the equivalent system and the system becomes a three-rotor system.

19. Define transmissibility ratio or isolation factor.

When a machine is mounted on springs and dampers or dashpots, the force applied will be transmitted to the foundation. Transmissibility ratio represents the ratio of force transmitted to the applied force.

20.Give some practical examples of forced vibration.

a. IC engines and machine tools

b. Electric bell

21. When stops are used in a vibrating system?

In a Vibrating system, when the frequency ratio varies from zero to higher values, dampers should be used. Instead, stops may be used to limit the resonance amplitude. This is done, because the amplification factor is infinity at resonance.

22. Name some of materials used for vibration isolation.

Rubber, felt or cork and metal springs are used for vibration isolation.

UNIT – V

MECHANISMS FOR CONTROL

Governors

1. What is the function of a governor? How does it differ from that of a flywheel?

The function of a governor is to control the mean speed over a period for output load variations.

The function of flywheel is reduce the fluctuation of speed during a cycle above the mean value for constant load prime mover.

2. State the function of flywheel and governor in an engine.

The function of a flywheel is to reduce the fluctuation of speed caused by the fluctuation of the engine turning moment during each of operation.

The function of a governor is to regulate the mean speed of an engine, when there are variations in the load.

3. What is meant by sensitivity of a governor?

A governor is said to be sensitive, when it really responds to a small change of speed. Mathematically, the sensitiveness is defined as the ratio of the mean speed to the difference between the maximum and minimum speeds.

4. What is the effect of friction on the governors?

The effect of friction on the governors is to increase the range of speed, governor effort, and minimum speeds.

5. What is the effect of fraction on the governors?

The effect of friction on the governors is to increase the range of speed, governor effort, and power of the governor.

6.How governors are classified?

Governors are classified into two broad categories as:

1.Certrifugal governors

a. Pendulum type; Example: Watt governor

b. Gravity controlled type: Example: Porter and Proell governors.

c. Spring controlled type: Example: Hartnell and Hartung governors.

2.Inertia governors

7. What is the principle of working of centrifugal pump?

The centrifugal governor are based on balancing of centrifugal force on the rotating balls by an equal and opposite radial force.

9. What is the principle of inertia governors?

In inertia governors, the balls are so arranged that the inertia forces caused by an angular acceleration or retardation of the shaft tend to alter their positions.

10. What is equilibrium speed?

The speeds at the governor balls arms, sleeve, etc., are in complete equilibrium and there is no upward or downward movement of the sleeve on the spindle is known as equilibrium speed.

11. Explain controlling force.

An equal and opposite force to the centrifugal force acting radially inwards (i.e., centrifugal force) is termed as controlling force of a governor.

12. Explain the governor effort?

The mean force acting on the sleeve for a given percentage change of speed for lift of the sleeve is known as the governor effort.

13. Define power of governor.

The power of a governor is the work done at the sleeve for a given percentage change of speed. It is the product of the mean value of the effort and the distance through which the sleeve moves.

Power = Mean effort X Lift of sleeve

14. Define coefficient of sensitiveness?

It is the ratio between range of speed and mean speed.

Coefficient of sensitiveness = Range of speed / Mean speed

15. What is meant by hunting?

The phenomenon of continuous fluctuation of the engine speed above and below the mean speed is termed as hunting. This occurs in over sensitive governors.

16. Explain the term stability of governor?

A governor is said to be stable if there is only one radius of rotation for all equilibrium speeds of the balls within the working range. If the equilibrium speed increases the radius of governor ball must also increase.

17. Explain isochronism.

A governor with zero range of speed is known as an isochronous governor. Actually the isochronism is the stage of infinite sensitivity. I.e., when the equilibrium speed is constant for all radii of rotation of the balls within the working range, the governor is said to be in isochronism. This means that the range of speed $(N_2 - N_1) = 0$.

18. What is controlling force diagram?

When the graph is drawn between the controlling force as ordinate and radius of rotation of the balls as abscissa, the graph so obtained is called as controlling force diagram.

19. What are the uses of controlling force diagram?

Controlling force diagram is used to examine the stability and sensitiveness of the governor and also shows the effect of friction on governors performance.

20. What is gyroscopic torque?

Whenever a rotating body changes its axis of rotation, torque is applied on the rotating body. This torque is known as gyroscopic torque.

21. Define windup. What is the remedy for camshaft windup?

Twisting effect produced in the camshaft during the raise of heavy load follower is called as windup.

Can windup can be prevented by mounting the flywheel as close as possible to be cam.

22.Define gyroscopic couple.

If a body having moment of inertia I and rotating about its own axis at ω rad/sec is caused to run at ω_p rad/sec about an axis perpendicular to axis of spin, then it experiences a gyroscopic couple of magnitude $(I\text{-}\omega\text{-}\omega_p)$ in the axis which is perpendicular to both the axis of spin and axis of precession.

23. Give the applications of gyroscopic principle.

a. In instrument or toy known as gyroscope.
b. In ships in order to minimize the rolling and pitching effects of waves,.
c. In aero - planes, monorail cars, gyrocompasses, etc.

24. Define steering, pitching and rolling.

Steering is the turning of a complete ship in a curve towards left or right, while it moves forward.

Pitching is the movement of a complete ship up and down in a vertical plane about transverse axis.

Rolling is the movement of a ship in a linear fashion.

25. Why there is no effect of the gyroscopic couple acting on the body of a ship during rolling?

We know that, for the effect of gyroscopic couple to occur, the axis of precession should always be perpendicular to the axis of spin. In case of rolling of a ship, the axis of precession is always parallel to the axis of spin for all positions. Hence there is no effect of the gyroscopic couple acting on the body of the ship during rolling.

26. Discuss the effect of the gyroscopic couple on a two-wheeled vehicle when taking a turn.

The gyroscopic couple will act over the vehicle outwards. The tendency of this couple is to over turn the vehicle in outward direction.

27. What is meant by automatic controls?

The automatic control system, also called, as self-activated system is a very accurate and effective means to perform desired function by the system in which the human operator is replaced by a device. These systems given higher outputs of more constant quality and with increase safety.

28.How automatic controls are classified?

The automatic control system can be classified as:

1. Open –loop or unmonitored control system,
2. Closed-loop or monitored control system,
3. Continuous control system, and
4. Discontinuous control system.

29. Define the term system?

A system is an assembly of components and linkages designed to fulfill some particular function.

30. Differentiate the terms command and response.

Command: The result of the act of adjustment, i.e., closing a valve, moving a lever, etc., is known as command.

Response: The subsequent result of the system to the command is known as response.