DEPARTMENT OF AERONAUTICAL ENGINEERING
U20AE403 – MECHANICS OF MACHINES
TWO MARKS QUESTION AND ANSWER

Unit I - KINEMATICS OF MACHINES

1. Define 'degrees of freedom'. (Nov/Dec 2016)

It is defined as the number of input parameters which must be controlled independently in order to bring the device into a particular position.

The degrees of freedom of a mechanism (n)

is given by n = 3(L-1)-2j-h

L = Number

of links j =

Number of

joints

h = Number of higher pairs.

2. What is meant by spatial mechanism? (Nov/Dec 2015)

Spatial mechanism have special geometric characteristics in that all revolute axes are parallel and perpendicular to the plane of motion and all prism axes lie in the plane of motion.

3. Classify the constrained motion. (Nov/Dec 2016)

There are three types.

1) Completely constrained motion (eg. Square bar moving in a square hole)
2) In completely constrained motion (eg. Circular shaft in a hole)
3) Successfully constrained motion (eg. Piston and cylinder)

4. What is meant by number synthesis? (Apr/May 2017)

Expressing mobility or degree of freedom of a mechanism in terms of the number of links and the number of pair connections of a given type is known as number synthesis.

5. What are the some important inversions of four chain mechanism?

1) Crank-rocker mechanism.
2) Crank-crank mechanism.
3) Rocker-rocker mechanism.

6. What is toggle position?

It is the position of a mechanism at which the mechanical advantage is infinite and the sine of angle between the coupler and driving link is zero.

7. What is pantograph? (Apr/May 2017)

Pantograph is a device which is used to reproduce a displacement exactly in an enlarged or reduced scale. It is used in drawing offices, for duplicating the drawings, maps, plans, etc. It works on the principle of 4 bar chain mechanism.

8. What are the applications of single slider crank mechanism? (Nov/Dec 2015)

1) Rotary or Grome engines.
2) Crank and slotted lever mechanism.
3) Oscillating cylinder engine.
4) Bull engine
5) Hand pump.

9. Give some examples for kinematics pairs. (Nov/Dec 2016)

1) Crank and connecting rod
2) Connecting and piston rod
3) Piston and engine cylinder.

10. What is link?

A link or an element is defined as that part of a machine which has motion relative to some other part. A link need not to be a single unit, but it may consist of several parts which are manufactured as separate units.

11. What are the different types of links?

1) Rigid link.
2) Flexible link.
3) Fluid link.

12. Write down the different types of motion. (Nov/Dec 2016)

1) Rectilinear motion.
2) Curvilinear motion.
3) Circular motion.

13. What is the difference between velocity and speed?

Velocity is defined as the rate of change of displacement of a body with respect to the time. Speed is defined as the rate of change of linear displacement of a body with respect to the time.

14. What are the different methods are used for finding the velocity?

1) Graphical method.
2) Analytical method.

15. What is a cam? (May/June 2016)

A cam is a rotating machine element which gives reciprocating or oscillating motion to another element known as follower.

16. Give some examples of cam.

1) Radial or disc cams.
2) Cylindrical or barrel cams.
3) End or face cams.
4) Wedge cams.

17. What ate the different motions of the follower?

1) Uniform motion.
2) Simple harmonic motion.
3) Uniform acceleration and retardation.
4) Cycloidal motion.

18. Define trace point. .(May/June 2016)

It is a reference point on the follower and is used to generate the pitch curve. In case of knife edge follower the knife edge represents the trace point and

the pitch curve corresponds to the cam profile.

19. Write the different types of follower.

1) Knife edge follower
2) Roller follower
3) Mushroom or flat faced follower
4) Spherical faced or curved shoe follower.

20. What is cam profile?

The surface of cam which comes into contact with follower, is known as cam profile.

Unit II - GEARS AND GEAR TRAINS

1. What is an angle of obliquity in gear? (Nov/Dec 2016)

It is the angle between the common normal to two gear teeth at the point of contact and the common tangent at the pitch point. It is also called as pressure angle.

2. What is bevel gearing? Mention its types.

When the non-parallel or intersecting but coplanar shafts connected by gears, they are called bevel gears and the arrangement is bevel gearing.

Types.

1) Skew bevel gearing
2) Spiral gearing.

3. What is meant by arc of approach? (Apr/May 15)

It is the portion of the path of contact from the beginning of the engagement to the pitch point.

4. What is meant by arc of recess?

It is the position of the path of contact from pitch point to the end of the engagement to the pitch point.

5. What is meant by Arc of contact? (Apr/May 15)

It is the path traced by a point on the pitch circle from the beginning to the end of engagement of a pair of teeth.

6. State law of gearing.

The law of gearing states that for obtaining a constant velocity ratio, at any instant of teeth the common normal at each point of contact should always pass through a pitch point, situated on the line joining the centre of rotation of the pair of mating gears.

7. Define normal and axial pitch in helical gears. (Nov/Dec 2017 R13)

Normal pitch is the distance between similar faces of adjacent teeth, along a helix on the pitch cylinder normal to the teeth.

Axial pitch is the distance measured parallel to the axis between similar faces of a adjacent teeth.

8. What are the methods to avoid interference? (Nov/Dec 2016)

1. The height of the teeth may be reduced.
2. The pressure angle may be increased.

9. What is the advantage when arc of recess is equal to arc of approach in a meshing gears?

When arc of recess equal to arc of approach, the work wasted by friction is minimum and efficiency of drive is maximum.

10. What do you know about tumbler gear?

Tumbler gears are those which are used in lathes for reversing the direction of rotation of driven gears.

11. Define contact ratio.

It is the ratio of the length of arc of contact to the circular pitch is known as

contact ratio. The value gives the number of pairs of teeth in contact.

12. Where will the interference occur in an involute pinion and gear are in mesh having same size of addendum?

There will be an interference between the tip of pinion and flank of gear.

13. Define interference. (Nov/Dec 2017 R13)

The phenomenon when the tip of tooth undercuts the roots on its mating gear is known as interference.

14. What you meant by non standard gear teeth?

The gear teeth obtained by modifying the standard proportions of gear teeth parameters is known as non standard gear teeth.

15. Define cycloidel tooth profile and involute tooth profile.

A cycloid is the curve traced by a point on the circumference of a circle which rolls without slipping on a fixed straight line.

Involute profile is defined as the locus of a point on a straight line which rolls without slipping on the circumference of a circle.

16. Define Backlash.

It is the difference between the tooth space and the tooth thickness along the pitch circle. Backlash = Tooth space – Tooth thickness.

17. What is gear train? (Nov/Dec 2018 R13)

Two or more gears re made to mesh with each other to transmit power from one shaft to another. Such a combination is called a gear train.

18. What are the types of gear trains?

1. Simple gear train.
2. Compound gear train.
3. Reverted gear train.
4. Epicyclic gear train.

19. Write velocity ratio in compound train of wheels? (Nov/Dec 2018 R13)

Speed of last follower- Product of teeth on drives. Speed of first driver- Product of teeth on followers.

20. Define simple gear train.

When there is only one gear on each shaft, it is called as simple gear train.

Unit III - FRICTION

1. What is dry friction?

The friction that exists between two unlubricated surfaces is known as dry friction.

2. What is greasy friction?

When the two surfaces in contact have a minute thin layer of lubricant between them, then it is called as greasy friction.

3. What is fluid friction? (Nov/Dec 2015 R13)

When the two surfaces in contact are completely separated by a lubricant, then it is called as fluid friction.

4. State the laws of dry friction.

1. The frictional force is directly proportional to the normal reaction between the surfaces.
2. The frictional force opposes the motion.
3. The frictional force is independent of the area and the shape of the contacting surfaces.

5. State the laws of fluid friction.

1. The frictional force is almost independent of load.
2. The frictional force is independent of the substances of the bearing surfaces and opposing tendency is less.
3. The frictional force reduces with increase in temperature of the lubricant.

6. What is angle of repose? (April/May 2017 R13)

The angle of repose is defined as the maximum inclination of a plane at which a body remains in equilibrium over the inclined plane by the assistance of friction only.

7. What is limiting angle of friction?

The limiting angle of friction is defined as the angle at which the resultant reaction R makes with the normal reaction.

8. Define Co-efficient of friction. (Nov/Dec 2015 R13)

It is defined as the ratio of the limiting friction to the normal reaction between two bodies. $\mu = F / Rn$

9. What is the efficiency of the inclined plane?

The efficiency of inclined plane is defined as the ratio between effort without friction and the effort with friction.

10. Why self locking screws have lesser efficiency? (April/May 2017 R13)

Self locking screws needs some friction on the thread surface of the screw and nut hence it needs higher effort to lift a body and hence automatically the efficiency decreases.

11. What are the functions of clutches? (Nov/Dec 2015 R13)

1. It supplies power to the transmission system.
2. It stops the vehicle by disconnecting the engine from transmission system.
3. It is used to change the gear and idling the engine.
4. It gives gradual increment of speed to the wheels.

12.What is the difference between cone clutch and centrifugal clutch?

Cone clutch works on the principle of friction alone. But centrifugal clutch uses principle of centrifugal force in addition with it.

13. Why friction is called as necessary evil?

Friction is the important factor in engineering and physical applications such as belt and ropes, jibs, clutches and brakes, so it is the necessary one.

If the friction exceeds certain value it will cause heat, damage and wear when applied. So it is called necessary evil.

14. What are the belt materials? (Nov/Dec 2015 R13)

1. Leather.
2. Cotton or fabric.
3. Rubber.
4. Balata.
5. Nylon.

15. Explain velocity ratio. (Nov/Dec 2015 R13)

It is defined as the ratio between velocity of the driver and follower or driven.

16. State the law of belting.

Law of belting states that the centre line of the belt as it approaches the pulley must lie in a plane perpendicular to the axis of the pulley or must lie in the plane of the pulley, otherwise, the belt will runoff the pulley.

17. What is slip?

The relative motion between belt and pulley due to insufficient friction is called slip.

18. What is creep? (Nov/Dec 2015 R13)

The phenomenon of sudden contraction and expansions of belt when it passes from slack side to tight side is called as creep.

19. What is centrifugal effect on belts?

During operation, as the belt passes over a pulley the centrifugal effect due to its self weight to lift the belt from the pulley surface. This reduces the normal reaction and hence the frictional resistance.

20. What is the cross belt used instead of open belt?

1. Cross belt is used where the direction of rotation of driven pulley is opposite to driving pulley.
2. Where we need more power transmission there we can use cross belt drive

Unit IV - BALANCING and MECHANISM FOR CONTROL

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 rotating masses are to be dynamically balanced? (Nov/Dec 2017 R13)**

   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 cam shafts, steam turbine rotors, engine crank shafts, and centrifugal pumps, etc.

3. **Write different types of balancing? (April/May 2017 R13)**

   a) Balancing of rotating masses
   - Static balancing
   - Dynamic balancing

   b) Balancing of reciprocating masses.

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

   (a) The resultant centrifugal force must be zero, and

   (b) The resultant couple must be zero.

5. **Whether grinding wheels are balanced or not? If so why? (April/May 2017 R13)**

   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.

6. **Whether your watch needles are properly balanced or not?**

   Yes, my watch needles are properly balanced by providing some extra projection (mass) in the opposite direction.

7. **Why is only a part of the unbalanced force due to reciprocating masses balanced by revolving mass? (Or) 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.

8. **Differentiate between the unbalanced force caused due to rotating and reciprocating masses? (Nov/Dec 2016 R13)**

   - Complete balancing of revolving mass can be possible. But fraction of reciprocating mass only balanced.
   - The unbalanced force due to reciprocating mass varies in magnitude but constant in direction. But in the case of revolving masses, the unbalanced force is constant in magnitude but varies in direction.

9. **Why are the cranks of a locomotive, with two cylinders, placed 90° to each other?**

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

10. **List the effects of partial balancing of locomotives? (Nov/Dec 2017 R13)**

    - Variation in tractive force along the line of stroke,
    - Swaying couple, and
    - Hammer blow

11. **Define tractive force?**

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

12. **Define swaying couple? (Nov/Dec 2016 R13)**

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

13. **What are different types of balancing machines?**

    - Static balancing machines,
    - Dynamic balancing machines, and
    - Universal balancing machines.

14. **What is the function of Governor?**

    The function of a governor is to maintain the speed of an engine within specified limits whenever there is a variation of load. Governors control the throttle valve and hence the fuel supply to cater the load variation on engines.

15. **How governors are classified?**

    (a).Centrifugal governors.

    - Pendulum type: Example: Wattgovernor.
    - Gravity controlled type: Example: Porter and Proell governors.
    - Spring controlled type: Example: Hartnell and Hartung governors.

(b). Inertia governors.

16. **What do you mean by 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 governoreffort.

17. **Define power of a governor? (Nov/Dec 2016 R13)**

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.

18. **What is meant by sensitiveness of a governor?**

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

19. **Define coefficient of sensitiveness?**

It is the ratio between range of speed and mean speed

20. 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.

Unit V – VIBRATION

1. **What are the different types of vibrations? (Nov/Dec 2016 R13)**
   - Free vibrations,
   - Forced vibrations, and
   - Damped vibration
2. **State the methods of finding natural frequency of a system?**
   - Equilibrium (or Newton's) method,
   - Energy method, and
   - Rayleigh method.
3. **What is meant by free vibration and forced vibrations? (April/May 2017 R13**

   Free or natural vibrations: 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 vibrations: When the body vibrates under the influence of external force, then the body is said to be under forced vibrations.

4. **What do you mean by damping and damped vibration? (Nov/Dec 2016 R13)**

   Damping: The resistance against the vibration is called damping.

   Damped vibration: When there is a reduction in amplitude over every cycle of vibration, then the motion is said to be damped vibration.
5. **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.
6. **What are the various types of damping? (April/May 2017 R13**

   (a) Viscous damping
   (b) coulomb or dry friction damping
   (c) Solid or structural damping, and
   (d) slip or interfacial damping.
7. **What is the limit beyond which damping is detrimental and why?**

   When damping factor > 1, aperiodic motion is resulted. That is, aperiodic motion means the system cannot vibrate due to over damping. Once the system is disturbed, it will take infinite time to come back to equilibrium position.
8. **Define logarithmic decrement?**

   Logarithmic 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.
9. **What is meant by critical damping? (Nov/Dec 2016 R13)**

   The system is said to be critically damped when the damping factor $\zeta = 1$. If the system is critically damped, the mass moves back very quickly to its equilibrium position within no time.
10. **Define critical or whirling or whipping speed of a shaft?**

    The speed at which resonance occurs is called critical speed of the shaft . In

other words, the speed at which the shaft runs so that the additional deflection of the shaft from the axis of rotation becomes infinite is known as critical speed.

11. **Define torsional vibration?**

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

12. **Differentiate between transverse and torsional vibration?**

- In transverse vibrations, the particles of the shaft move approximately perpendicular to the axis of the shaft. But in torsional vibrations, the particles of the shaft move in a circle about the axis of the shaft.
- Due to transverse vibrations, tensile a nd compressive stresses are induced.
- Dueto torsional vibrations, torsional shearstressesare induced in the shaft.

13. **Define torsional equivalent shaft? (Nov/Dec 2016 R13)**

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

14. **What is meant by harmonic forcing?**

The term harmonic refers to a spring-mass system with viscous damping, excited byasinusoidal harmonic force.

$$F = F_0 \sin\omega t$$

15. **What is vibration isolation?**

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

16. **Specify the importance of vibration isolation?**

When an unbalanced machine is installed on the foundation, it produces vibration in the foundation. So, in order to prevent these vibrations or to minimize the transmission of forces to the foundation, vibration isolation is important.

17. **What are the methods of isolating the vibration?**

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

18. **Give Examples of forced vibrations.**

- Ringing of electrical bell
- The vibrations of air compressors, internal combustion engines, machine tools andvarious other machinery.

19. **What are the types of external excitation?**

- Periodic forces
- Impulsive forces and
- Random forces.

20. **What are the types of isolation?**

- Isolation of force
- Isolation of motion

DEPARTMENT OF AERONAUTICAL ENGINEERING

U20AE403 – MECHANICS OF MACHINES

PART B

Unit I - KINEMATICS OF MACHINES

Inversion of mechanism

1. Describe with neat sketch, the mechanisms obtained by the inversions of single slider crank mechanism. **June/July 2021**

2. Explain the inversion of four bar mechanism with neat sketch?

3. Explain the crank and slotted link mechanism with neat sketch? **June/July 2021**

Velocity and Acceleration diagram

4. In a four bar linkage ABCD, AD is fixed and is 120 mm long. The crank AB is 30 mm long and rotates at 100 rpm in clockwise direction while the link CD is 60 mm oscillates about D. BC and AD are of equal length. Find angular velocity of the link CD when the angle BAD is 60°. **[p.no 2.1,pg.no-2.9]**

5. ABCD is a four bar chain with link AD fixed. The lengths of the links are AB = 62.5 mm; BC = 175 mm; CD = 112.5 mm; and AD = 200 mm. The crank AB rotates at Roll # rad/s clockwise. Draw the velocity and acceleration diagram when angle BAD = 60° and B and C lie on the same side of AD. Find the angular velocity and angular acceleration of links BC and CD. **[p.no 2.10,pg.no-2.34]**

Cam profile

6. A cam operating a knife-edged follower has the following data :
(a) Follower moves outwards through 40 mm during 60° of cam rotation.
(b) Follower dwells for the next 45°.
(c) Follower returns to its original position during next 90°.
(d) Follower dwells for the rest of the rotation.
The displacement of the follower is to take place with uniform velocity during both the outward and return strokes. The least radius of the cam is 50 mm. Draw the profile of the cam when
1. The axis of the follower passes through the cam axis, and
2. The axis of the follower is offset 18 mm towards right from the cam axis **[p.no 3.1,pg.no-3.37]**

7. A cam is to be designed for a knife edge follower with the following data:

1. Follower lift is 40 mm with simple harmonic motion. During 90° of cam rotation
2. Dwell for the next 30°.
3. The follower returns to its original position with simple harmonic motion. During the next 60° of cam rotation,
4. Dwell during the remaining 180°.

Draw the profile of the cam when
The line of stroke of the follower passes through the axis of the cam shaft, The radius of the base circle of the cam is 40 mm

(a) Draw the displacement diagram

(b) Draw the profile of the cam

(c) Determine the maximum velocity and acceleration of the follower during its ascent and descent, if the cam rotates at 200 r.p.m.in clockwise direction. **Nov/Dec2019 [p.no 3.3,pg.no-3.43]**

8. A cam rotating clockwise with a uniform speed is to give the roller follower of 20 mm diameter with the following motion :

(a) Follower to move outwards through a distance of 30 mm during 120° of cam rotation ;

(b) Follower to dwell for 60° of cam rotation ;

(c) Follower to return to its initial position during 90° of cam rotation ; and

(d) Follower to dwell for the remaining 90° of cam rotation.

The minimum radius of the cam is 45 mm and the displacement of the follower is to take place with simple harmonic motion on both the outward and return strokes. Draw the cam profile.

1. The line of stroke of the follower passes through the cam shaft, and
2. The line of stroke of the follower is offset 15 mm from the cam axis

[p.no 3.8,pg.no-3.54]

9. It is required to set out the profile of a cam to give the following motion to the reciprocating follower with a flat mushroom contact face :

(i) Follower to have a stroke of 20 mm during 120° of cam rotation ;

(ii) Follower to dwell for 30° of cam rotation ;

(iii) Follower to return to its initial position during 120° of cam rotation ; and

(iv) Follower to dwell for remaining 90° of cam rotation.

The minimum radius of the cam is 25 mm. The out stroke of the follower is performed with simple harmonic motion and the return stroke with equal uniform acceleration and retardation. Draw the profile of the cam. **June/July 2021 [p.no 3.19,pg.no-3.73]**

10. Explain kinematics links, its types and kinematic pairs with its types based on the relative motion between the links **Apr/May2019 [pg.no-1.2, 1.7]**

Unit II - GEARS AND GEAR TRAINS

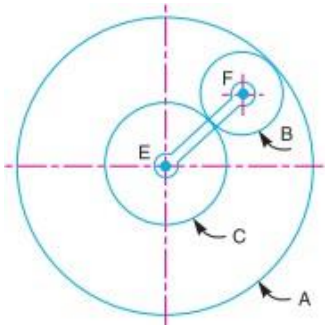
Gear problems

1. A pinion having 30 teeth drives a gear having 80 teeth. The profile of the gears is involute with 20° pressure angle, 12 mm module and 10 mm addendum. Find the length of path of contact, arc of contact and the contact ratio.**(RS Khurmi p.no 12.3)**
2. Two involute gears of 20° pressure angle are in mesh. The number of teeth on pinion is 20 and the gear ratio is 2. If the pitch expressed in module is 5 mm and the pitch line speed is
   1.2 m/s, assuming addendum as standard and equal to one module, find: 1. The angle turned through by pinion when one pair of teeth is in mesh ; and 2. The maximum velocity of sliding. **(RS Khurmi p.no 12.4)**
3. A pinion of 20 involute teeth and 125 mm pitch circle diameter drives a rack. The addendum of both pinion and rack is 6.25 mm. What is the least pressure angle which can be used to avoid interference ? With this pressure angle, find the length of the arc of contact and the minimum number of teeth in contact at a time. **(RS Khurmi p.no 12.14)**
4. A pair of involute spur gears with 16° pressure angle and pitch of module 6 mm is in mesh. The number of teeth on pinion is 16 and its rotational speed is 240 r.p.m. When the gear ratio is 1.75, find in order that the interference is just avoided ; 1. the addenda on pinion and gear wheel ; 2. The length of path of contact ; and 3. the maximum velocity of sliding of teeth on either side of the pitch point. **(RS Khurmi p.no 12.11)**
5. Two mating gears have 20 and 40 involute teeth of module 10 mm and 20° pressure angle. The addendum on each wheel is to be made of such a length that the line of contact on each side of the pitch point has half the maximum possible length. Determine the addendum height for each gear wheel, length of the path of contact, arc of contact and contact ratio. **(RS Khurmi p.no 12.8)**
6. Explain i)Law of Toothed Gearing ii) Involute Gearing

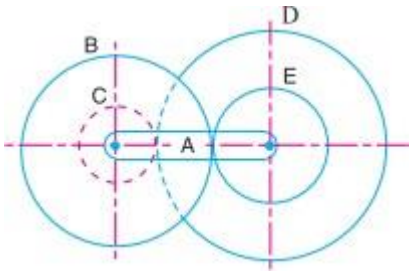
GEAR TRAIN PROBLEMS

7. Draw and explain the different types of gear trains, stating one practical application for each type.
(Nov/Dec 2016 R13) (Nov/Dec 2018 R13)

8. An epicyclic gear consists of three gears A, B and C as shown in Fig. 13.10. The gear A has 72 internal teeth and gear C has 32 external teeth. The gear B meshes with both A and C and is carried on an arm EF which rotates about the centre of A at 18 r.p.m.. If the gear A is fixed, determine the speed of gears B and C (RS Khurmi p.no 13.6)

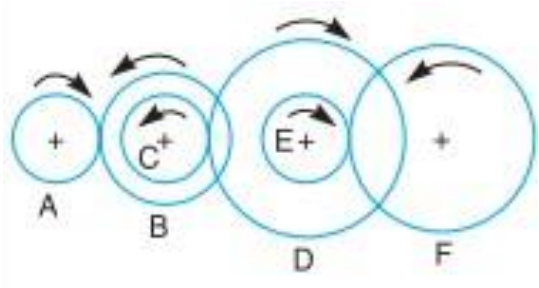


9. In a reverted epicyclic gear train, the arm A carries two gears B and C and a compound gear D - E. The gear B meshes with gear E and the gear C meshes with gear D. The number of teeth on gears B, C and D are 75, 30 and 90 respectively. Find the speed and direction of gear C when gear B is fixed and the arm A makes 100 r.p.m. clockwise. **(RS Khurmi p.no 13.5)**



10. The gearing of a machine tool is shown in Fig. 13.3. The motor shaft is connected to gear A and rotates at 975 r.p.m. The gear wheels B, C, D and E are fixed to parallel shafts rotating together. The final gear F is fixed on the output shaft. What is the speed of gear F ? The number of teeth on each gear are as given below : **(RS Khurmi p.no 13.1)**

Gear	A	B	C	D	E	F
No. of teeth	20	50	25	75	26	65



Unit III – FRICTION

1. A screw jack has a square thread of mean diameter 6cm and pitch 0.8cm. the coefficient of friction at the screw thread is 0.09. A load of 3kN is to be lifted through 12cm. Determine the torque required and the work done in lifting the load through 12cm. Find the efficiency of the jack also. **(Nov/Dec 2015 R13)**
2. The pitch of 50mm mean diameter threaded screw of a screw jack is 12.5mm. The coefficient of friction between the screw and the nut is 0.13. Determine the torque required on the screw to raise a load of 25kN, assuming the load to rotate with the screw. Determine the ratio of the torque to raise the load to the torque required to lower the load and also the efficiency of the machine. **(Nov/Dec 2016 R13)**
3. The lead screw of a lathe has acme threads of 50mm outside diameter and 10mm pitch. The included angle of thread is 29 . It drives a tool carriage and exerts an axial pressure of 2500N. A collar bearing with outside diameter 100mm and inside diameter 50mm is provided to take up the thrust. If the lead screw rotates at 30rpm, find the efficiency and the power required to drive the screw. The coefficient of friction for screw threads is 0.15 and for the collar is 0.12. **(April/May 2017 R13)**
4. Two parallel shafts 6m apart are to be connected by a belt running over pulleys of diameters 60cm and 40cm respectively. Determine the exact and approximate lengths of the belt required: (i) if the belt is open (ii) if the belt is crossed. (Nov/Dec 2015 R13)
5. Two pulleys, one 450mm diameter and the other 200mm diameter are on parallel shafts 1.95 apart and are connected by a crossed belt. Find the length of the belt required and the angle of contact between the belt and each pulley. What power can be transmitted by the belt when the larger pulley rotates at 200rev/min, if the maximum permissible tension in the belt is 1kN, and the coefficient of friction between the belt and pulley is 0.25?**(Nov/Dec 2016 R13)**
6. A leather belt is required to transmit 9kW from the pulley 1.2m in diameter running at 200 rpm. The angle of contact is spread over 11/24 of the circumference and the coefficient of friction between the belt and the pulley rim is 0.3. if the safe working stress for the belt is 1.4MN/m^2, the density of the leather is 1000kg/m^3, and the thickness of belt is 10mm, determine the width of the belt taking the centrifugal tension into account. **(Nov/Dec 2017 R13)**
7. The following data refer to an open belt drive: Diameter of larger pulley=400mm; diameter of smaller pulley=250mm; Distance between two pulleys= 2m; Coefficient of friction between smaller pulley surface and belt=0.4; Maximum tension when the belt is on the point of slipping=1200N. Find the power transmitted at speed of 10m/s. It is desired to increase the power. Which of the following two methods you will select?

i) Increasing the initial tension in the belt by 10 percent.
ii) Increasing the coefficient of friction between smaller pulley surface and belt by 10 percent by the application of suitable dressing on the belt.
iii) Find, also the percentage increase in power possible in each case

8. An open belt drive connects two pulleys 1.2m and 0.5m diameter on parallel shafts 3.6m apart. The belt has a mass of 1kg/m length and the maximum tension in it is not to exceed 2kN. The

   1.2m pulley, which is the driver, runs at 200rpm. Due to the belt slip on one of the pulleys, the

velocity of the driven shaft is only 450rpm. If the coefficient of friction between the belt and the pulley is 0.3, find: (i) Torque on each of the two shafts. (ii) Power transmitted, (iii) Power lost in friction, and (iv) Efficiency of the drive.

9. A pulley is driven by a flat belt running at a speed of 600m/min. The coefficient of friction between the pulley and the belt is 0.3 and the angle of lap is 160 . If the maximum tension in the belt is 700N; find the power transmitted by a belt. **(April/May 2017 R13)**
10. A compressor requiring 90kw is to run at about 250rpm. The drive is by V belts from an electric motor running at 750rpm. The diameter of the pulley on the compressor shaft must not be greater than 1 meter while the center distance between the pulleys is limited to 1.75 meter. The belt speed should not exceed 1600m/min. determine the number of V-belts required to transmit the power if each belt has a cross sectional area of 375mm^2, density 1000kg/m^3 and an allowable tensile stress of 2.5 MPa. The groove angle of the pulley is 35^o. The coefficient of friction between the belt and the pulley is 0.25

Unit IV - BALANCING and MECHANISM FOR CONTROL

1. A, B, C and D are four masses carried by a rotating shaft at radii 100mm, 150mm, 150mm and 200mm respectively. The planes in which the masses rotate are spaced at 500mm apart and the magnitude of the masses B, C and D are 9kg, 5kg and 4kg respectively. Find the required mass A and the relative angular settings of the four masses so that the shaft shall be in complete balance.
2. A, B, C and D are four masses carried by a rotating shaft at radii 100mm, 125mm, 200mm and 150mm respectively. The planes in which the masses rotate are spaced at 600mm apart and the magnitude of the masses B, C and D are 10kg, 5kg and 4kg respectively. Find the required mass A and the relative angular settings of the four masses so that the shaft shall be in complete balance. **(April/May 2017 R13)**
3. Four masses m1, m2, m3, and m4 are 200kg, 300kg, 240kg and 260kg respectively. The corresponding radii of rotation are 0.2m, 0.15m, 0.25m and 0.3m respectively and the angles between successive masses are 45^o, 75^o and 135^o. Find the position and magnitude of the balance mass required, if its radius of rotation is 0.2m. **(Nov/Dec 2016 R13)**
4. A shaft is rotating at a uniform angular speed. Four masses m1, m2, m3, and m4 of magnitudes 300kg, 450kg, 360kg and 390kg respectively are attached to the shaft. The masses are rotating on the same plane. The corresponding radii of rotation are 200mm, 150mm, 250mm and 300mm respectively. The angles made by these masses with horizontal are 0^o, 45^o, 120^o and 255^o respectively. If the system is to be balanced, find

(i) The magnitude of the balancing mass and

(ii) The angular position of the balancing mass if its radius of rotation is 200mm.

5. The following data refer to a single cylinder vertical reciprocating engine Mass of reciprocating parts=40kg
   Mass of revolving parts=30kg at 180mm radius
   Speed=150m
   m rpm
   Stroke=350rp
   m
   If 60% of the reciprocating mass and all the revolving mass are to be balanced, determine

(i)The balance mass required at a radius of 320mm

(ii)The unbalanced force when the crank has turned 45° from the top dead center.

6. A single cylinder horizontal engine runs at 120rpm. The length of stroke is 400 mm. the mass of the revolving parts assumed concentrated at the crank pin is 100kg and mass of the reciprocating parts is 150kg. Determine the magnitude of the balancing mass required to be placed opposite to the crank at a radius of 150mm which is equivalent to all the revolving and $2/3^{rd}$ of the reciprocating masses. If the crank turns 30° from the inner dead center, find the magnitude of the unbalanced force due to the balancing mass.
7. A four cylinder vertical engine has cranks 300mm long. The planes of rotation of the first, third and fourth cranks are 750mm, 1050mm and 1650 respectively from that of the second crank and their reciprocating masses are 150kg, 400kg, 250kg respectively. Find:
   (i) The mass of the reciprocating parts for the second cylinder and
   (ii) The relative angular positions of the cranks in order that the engine may be in complete primary balance. **(April/May 2017 R13)**
8. A leather belt is required to transmit 7.5 kW from a pulley 1.2 m in diameter, running at 250 r.p.m. The angle embraced is 165° and the coefficient of friction between the belt and the pulley is 0.3. If the safe working stress for the leather belt is 1.5 MPa, density of leather 1 Mg/m^3 and thickness of belt 10 mm, determine the width of the belt taking centrifugal tension into account. **(Nov/Dec 2017 R13)**

9. An open flat belt drive connects two parallel shafts 1.2 metres apart. The driving and the driven shafts rotate at 350 r.p.m. and 140 r.p.m. respectively and the driven pulley is 400 mm in diameter. The belt is 5 mm thick and 80 mm wide. The coefficient of friction between the belt and pulley is 0.3 and the maximum permissible tension in the belting is 1.4 MN/m2. Determine:1. diameter of the driving pulley, 2. maximum power that may be transmitted by the belting, and 3. required initial belt tension. **(Nov/Dec 2017 R13)**

10. A belt drive consists of two V-belts in parallel, on grooved pulleys of the same size. The angle of the groove is 30°. The cross-sectional area of each belt is 750 mm2 and μ. =

0.12. The density of the belt material is 1.2 Mg/m3 and the maximum safe stress in the material is 7 MPa. Calculate the power that can be transmitted between pulleys 300 mm diameter rotating at 1500 r.p.m. Find also the shaft speed in r.p.m. at which the power transmitted would be maximum.

Unit V – VIBRATION

1. Find the frequency of the transverse vibrations of a shaft which is simply supported at its ends and is of 40mm in diameter and 2.5 m in length. The shaft carries three point loads of masses 30kg, 70kg and 45kg at 0.5m, 1m and 1.7m respectively from the left support. The young's modulus for the material of the shaft is 200GPa. Neglect the weight of the shaft. **(Nov/Dec 2016 R13)**
2. Derive the equations of motions and hence the natural frequency of longitudinal free vibrations of spring mass system by
   (i) Equilibrium Method
   (ii) Energy Method
   (iii) Rayleigh's Method
3. A shaft of 100mm diameter and 1 meter long is fixed at one end and other carries a flywheel of mass 1 tonne. Taking young's modulus for the shaft material as 200GN/m^2, find the natural frequency of longitudinal and transverse vibrations.

4. A shaft of length 1.25m is 75mm indiameter for the first 275mm of its length, 125mm in diameter for the next 500mm length, 87.5mm in diameter for the next 375mm length and 175mm in diameter for the remaining 100mm of its length. The shaft carries two rotors at two ends. The mass moment of inertia of the first rotor is 75kgm^2 where as of the second rotor is 50kgm^2. Find the frequency of natural torsional vibrations of the system. The modulus of the rigidity of the shaft material may be taken as 80 GN/m^2. **(Nov/Dec 2016 R13)**
5. A shaft 1.5m long supported in flexible bearings at the ends carries two wheels each of 50kg mass. One wheel is situated at the center of the shaft and the other at a distance of 375mm from the center towards left. The shaft is hollow of external diameter 75mm and internal diameter 40mm. the density of the shaft material is 7700kg/m^3 and its modulus of elasticity is 200 GN/m^2. Find the lowest whirling speed of the shaft, taking into a account the mass of the shaft. **(April/May 2017 R13)**

6. 6. An aeroplane makes a complete half circle of 50 metres radius, towards left, when flying at 200 km per hr. The rotary engine and the propeller of the plane has a mass of 400 kg and a radius of gyration of 0.3 m. The engine rotates at 2400 r.p.m.

clockwise when viewed from the rear. Find the gyroscopic couple on the aircraft and state its effect on it.

7. A shaft 1.5 m long, supported in flexible bearings at the ends carries two wheels each of 50 kg mass. One wheel is situated at the centre of the shaft and the other at a distance of 375 mm from the centre towards left. The shaft is hollow of external diameter 75 mm and internal diameter 40 mm. The density of the shaft material is 7700 kg/m^3 and its modulus of elasticity is 200 GN/m^3. Find the lowest whirling speed of the shaft, taking into account the mass of the shaft. **(April/May 2017 R13)**

8. The measurements on a mechanical vibrating system show that it has a mass of 8 kg and that the springs can be combined to give an equivalent spring of stiffness 5.4 N/mm. If the vibrating system have a dashpot attached which exerts a force of 40 N when the mass has a velocity of 1 m/s, find : 1. critical damping coefficient, 2. damping factor, 3. Logarithmic decrement, and 4. ratio of two consecutive amplitudes.

9. A machine of mass 75 kg is mounted on springs and is fitted with a dashpot to damp out vibrations. There are three springs each of stiffness 10 N/mm and it is found that the amplitude of vibration diminishes from 38.4 mm to 6.4 mm in two complete oscillations. Assuming that the damping force varies as the velocity, determine : 1. the resistance of the dashpot at unit velocity ; 2. the ratio of the frequency of the damped vibration to the frequency of the undamped vibration ; and 3. the periodic time of the damped vibration. **(Nov/Dec 2016 R13)**

10. A single cylinder vertical petrol engine of total mass 300 kg is mounted upon a steel chassis frame and causes a vertical static deflection of 2 mm. The reciprocating parts of the engine has a mass of 20 kg and move through a vertical stroke of 150 mm with simple harmonic motion. A dashpot is provided whose damping resistance is directly proportional to the velocity and amounts to 1.5 kN per metre per second. Considering that the steady state of vibration is reached; determine : 1. the amplitude of forced vibrations, when the driving shaft of the engine rotates at 480 r.p.m., and 2. the speed of the driving shaft at which resonance will occur.

11. A machine part of mass 2 kg vibrates in a viscous medium. Determine the damping coefficient when a harmonic exciting force of 25 N results in resonant amplitude of 12.5 mm with a period of 0.2 second. If the system is excited by a harmonic force of frequency 4 Hz what will be the percentage increase in the amplitude of vibration when damper is removed as compared with that with damping.

12. The mass of an electric motor is 120 kg and it runs at 1500 r.p.m. The armature mass is 35 kg and its C.G. lies 0.5 mm from the axis of rotation. The motor is mounted on five springs of negligible damping so that the force transmitted is one-eleventh of the impressed force. Assume that the mass of the motor is equally

distributed among the five springs. Determine: 1. stiffness of each spring; 2. dynamic force transmitted to the base at the operating speed; and 3. natural frequency of the system. **(Nov/Dec 2016 R13)**