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ME8651 DESIGN OF TRANSMISSION SYSTEMS

2 MARKS QUESTIONS AND ANSWERS

UNIT – I

1. What are the materials used for belt drive? (JUNE 2013)

1. Leather, 2.rubber, 3.cotton, 4.fabric balata, 5.canvas, 6.hemp

2. **Why slip is less in the case of v-belts when compared with flat belts? (JUNE 2013)**

The wedging action of the v-pulley reduces the slip in the case of v-belt.

3. **What is a power drive? Mention their types.**

The power drive is a set of machine members employed to transmit power or energy produced in one machine to another machine. Their main types are (1) Mechanical, (2) Hydraulic, (3) Pneumatic and (4) Electrical drives.

4. **What is meant by mechanical drives? Classify them.**

The drives which transmit power by means of contact forces are called as mechanical drives. They can be classified based on

(a) Way of power transmission.

(i) Friction drives [E.g. Belt drives, Rope drives]

(ii) Toothed drives [Eg.. Gear drives, Chain drives]

(b) Centre distance between power shafts

(i) Long distance drives (Eg. Belt drives, chain drives, rope drives)

(ii)Short distance drives (Eg. Gear drives)

(c) Intermediate link between driving and driven members.

(i) No intermediate link (Eg. Gear drives)

(ii) With intermediate link (Eg. Belt, rope drives, chain drives)

5. **State the -Law of Belting. (JUNE 2012)**

The law of belting states that the centerline of the belt when it approaches the pulley must lie in the mid plane of that pulley which should be perpendicular to the axis of the pulley. Otherwise the belt will run off the pulley.

6. **Explain the term crowning of pulleys. (JUNE 2007,JUNE 2014)**

Pulleys are provided a -slight conical shapes (or) convex shapes in their rims surface in order to prevent the belt from running off the pulley due centrifugal force. This is known as crowning of pulley.

Usually the crowning height t may be 1/96 of pulley face width.

7. **Briefiy explains about friction and its applications.**

Friction is said to be a resisting force that is developed between two relatively -moving surfaces. For some machines, this frictional force may be an unwanted force and hence it is to be reduced to the maximum level. For some other machines Bearings brakes, clutches are the good examples.

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8. **What are the types of belts?,**

(a) Flat Belts
(b) V Belts.-(i) Multiple V belt. (ii) Ribbed Belt.
(c) Toothed or Timing
(d), Round, Belts.

9. **Indicate some merits and demerits of belt-drive. (May 2006)**

Merits

1. Belt drives are used for long distance power transmission.
2. Their operations are smooth and flexible.
3. Simple in design and their manufacturing cost is lower.

Demerits

1. They need large space.
2. Loss of power due to friction is more.

11. By what materials, belt-pulleys are made?

Belt-pulleys are made of cast-iron or steel

12. What is meant by the ply of belt?

Flat belts are.made of thin strips and laminated one over the other in order to get thick belt. These thin strips or sheets are called as plies of belt. Usually flat belts are made of 11 ply, 4 ply, 5 ply, 6 ply and 8 ply belt etc And 4 ply belt is thicker than 3 ply belt and so-on.

13. Mention the different types of joints employed for joining flat-belts. (june 2011)

(i) Cemented joints (ii) Laced joints (iii) Crest joints. (iv) Hinged joints.

14. What conditions should be followed when flat belt drive is installed?

1. The axes of power transmitting shafts should be parallel.
2. It should have, optimum center distance between the shafts'.
3. The tight-side of the drive should be at the bottom side of the pulley.

15. What is belt rating?

Flat-belts are made of different sizes such as 3 ply, 4 ply and V - belts are made of different grades such as A, B, C, D and E grade belts. Belt rating is defined as the power transmitting capacity of unit size flat belt or a particular grade single V belt.

16. Specify the application of round belt.

Round-belt is applied, in sewing machine.

17. Specify the purpose of crowning of bets. (May 2005)

To prevent slipping from pulley due to centrifugal force.

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18. What factors should be considered during the selection of a belt drive?

a) Amount of power to be transmitted. b) Peripheral and angular speeds. c) Speed ratio. A) Efficiency. e)Centre distance between shafts f) Space available. g) Working environment.

19. Explain creep in belts.

Since the tensions produced by the belt on the two sides of the pulley are not equal, the belt moves with a very negligible velocity, due to the difference of two tensions. This slow movement of the belt over the pulley is known as creep of belt and it is generally neglected.

20. How is a V-belt designated?

V-belt is designated by a grade letter followed by its inside length in code number, year of coding. For example, D 3048: IS 2494: 1964. M belts are designated by the grade letter and inside length only such D - 3048.

21. In what ways, timing belts are superior to ordinary V-belts? (June 2007, Dec 2010)

Since the timing belts possess toothed shape in their -inner side, engagement with toothed pulley will provide positive drive without, belt-slip where as in the case of ordinary V-belts, chances of slip are and hence positive drive is not possible at all times. Hence toothed belts (I timing belts) are superior to ordinary V-belts.

22. What are the types of ropes?

They are two types namely

a) Fibre ropes

b) Wire ropes.

23. In what ways wire ropes are superior to fibre ropes?

a) Wire ropes are stronger, more durable than fibre ropes.

b) Wire ropes can withstand shock loads.

c) Their efficiency is high.

d) They can be operated for Very long centre distance even upto 1000 m.

Hence wire-ropes are superior in most of occasions.

24. State the materials for belts.

Leather, cotton fabrics, rubber, animal's hair, silk, rayon,Woolen,balata etc

25. How is wire-ropes designated?

A wire-rope is designated by the number of strands and the number of wires in each strand. For example, a wire rope having six strands, and each strand containing nineteen wires can be denoted as 6 x 19rope.

26. What are the various stresses induced in wire ropes?

i. Direct tensile load due to load and self-weight of the rope.

ii. Bending stress when the rope winds round the drum.

iii. Stresses due to changes in starting and stopping etc.

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27. Write the features of a chain drive.

A chain drive is a flexible mechanical drive which may be considered to be intermediate between belt drive and gear drive in that it has features common to both, Chains are suitable for long as well as short center distance drives and give a more compact, drive than is possible with belts. Chain drives are similar to belt drives in which the chains, are operated between toothed wheels called as sprockets.

28. Mention the applications of chain drives.

Chain drives are employed in transportation machineries like motor-cycle, bi-cycles, automobiles and technological machineries, like agricultural machines, crushes etc.

29. What are the advantages of chain drives?

1. Are having more power transmitting capacity.
2. Have higher efficiency and compact size.

3-Exert -less load on shafts since no initial tension is applied on the sprocket shafts.

4. Require easy maintenance.

30. Specify some drawbacks of chain drives.

1. The design of chain drive is more complicated. 2. The operation is noisy and production cost is high. 3. They require more accurate assembly bf shafts than for belts.

31. Indicate the types of chains.

a) Driving chains b) Hauling chains c) Loading chains.

32. What are the kinds of driving chains?

a) Amount of power to be transmitted. b) Peripheral and angular speeds.

c) Speed ratio. d) Efficiency. e) Centre distance between staffs f) Space available. g) Working environment.

33. In what way silent chain is better than ordinary driving chain? (May 2005, Nov 2009)

Silent chain drives preferred over ordinary driving chain for high power, high speed and smooth operation.

34. What are the factors upon which the coefficent of friction between the belt and pulley depends? (JUNE 2014)

a) Material of belt and pulley
b) Width of the belt
c) Type of belt cross section
d) Speed of belt etc.

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UNIT-II

1. What is pressure angle? What is the effect of increase in pressure angle? (JUNE 2014)

Pressure angle is the angle making by the line of action common- tangent to the pitch circles of mating pairs.

The increase in pressure angle results in stronger tooth, because gear tooth acts as a cantilever beam become wider , if we increase the pressure angle.

2. What condition must be satisfied in order that a pair of spur gears may have a constant velocity ratio? (Or) state law of gearing. (JUNE 2014)

At any instant of teeth the common normal at each point of contact should always pass through a pitch point of contacting teeth.

3. What is working depth of a gear tooth? (May 2005)

It is defined as the radial distance from the addendum circle to the clearance circle. It is equal to the sum of the addendum of the two meshing gears.

4. What factors influence backlash in gear drives? (May 2005)

1. Module 2. Pitch line velocity

5. Mention some applications of gear drives.

Gear drives are employed in many fields such as from smaller instruments to the heaviest and most powerful machineries,crushers etc. Some of the common applications of gears are in hoisting machineries, rolling mill, machine tools such as lathe machines, etc.

6. Why are gear drives superior to belt drives or chain drives? (Or) what are the advantages of gear drives?

1. The gear drives possess high load carrying capacity, high compact layout.
2. They can transmit power from very small values to several kilowatts.

7. How are gears classified?

Gears are classified based on

(a) Axes of gear shafts as

i) Parallel - Eg. Spur, helical, herring-bone gears.

ii) Intersecting - Eg. Bevel gears.

iii) Non-paralleland non-intersecting - Eg.- worm, gears, Skew gears.

(b) Profile of gear tooth

i) Involute gears. ii) Cycloidal gears.

(c) Position of teeth on wheel rim.

(i) Tooth parallel to axis of gear - Eg. Spur gears.

ii) Tooth inclined to axis of gear - Eg. Helical gears.

(d) Pressure angle

i) Gears with 20^0 pressure angle. ii) Gears with 14 $1/2^0$ pressure angle.

8. Illustrate the materials for making gears. (June 2009)

1. Ferrous metals such as carbon steels, alloy steels of nickel, chromium and vanadium.
2. Cast-iron of different grades.
3. Non-ferrous metals such as brass, bronze, etc.
4. Non-metals like phenolic resins, nylon, bakelite etc.

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9. What are the main types of gear tooth failures? (JUNE 2013)
a) Tooth breakage. b) Pitting of tooth surface. c) Abrasive- wears. d) Seizing of teeth etc.

10. At what occasions non-metallic gears are employed.
Non-metallic gears are employed where we require silent operation and low power transmission. For example, in instruments like pressure gauge and so on.

11. What is meant by spur-gear?
Spur-gear is the gear in which teeth are cut at the circumference of a slab called as gear-blank such that the teeth are parallel to gear-axis.

12. Define the following terms.
a) **Tip circle** or addendum circle is the circle which coincides crests or tops of all teeth.
b) **Root circle** or dedendum circle is the circle which coincides with roots or bottoms of all teeth.
c) **Pitch circle** is the imaginary circle in which the pair of gears rolls one over the other. This circle can be visible when the pair of gears fastly rotating. This will lie between tip circle and root circle.

13. How are the following terms defined?((JUNE 2013)
a) **Pressure angle** is the angle making by the line of action common- tangent to the pitch circles of mating pairs.
b) **Module m** is the ratio of pitch circle diameter to the number d of gear teeth, and is usually represented in millimetres.

14. Define the following terms. (June 2011)
a) Back lash is the difference between tooth thickness and the space into which it meshes, measured along the pitch circle.
b) Gear ratio (i) is the ratio of number of teeth of larger gear to that of smaller gear. At is also defined as the ratio of high speed to the low speed in a gear drive.
Usually, the gear ratio should always be greater than one.

15. What factors influence backlash?
The factors like errors in tooth thickness, pitch, tooth spacing, mounting misalignment, etc influence the backlash.

16. What preliminary design considerations should be, adopted, when selecting gear drive?
All kinds of gears can not be useful for all kinds of work. Hence following factors should be considered
for selecting a specific type of gear drive.
i) The amount of.power to be transmitted.
ii) Space availability.
iii) Amount of gear ratio for single step.
iv) Causes for gear failures and their preventing methods.
v) Proper material
vi) Life of gears required, usually 10,000 hours.

17. What is interference in gears? (Dec 2005)

The tip of the teeth of one gear dig into the bottom flank of mating gear. This action is called interference.

18. On what basis gear cutters are selected?

Gear cutters are selected based on the following conditions.

1) Properties of materials for work piece and tools.
2) Cost of production.
3) Structure of gears such as spur gear, helical gears and so on.
4) Module of the gear.

19. How do gears fail?

Gears may fail due to tooth breakage by overload and misalignment of shafts. a) Corrosion of teeth by improper lubricants. c) Tooth wear because of insufficient lubrication. d) Interference because of no under-cut.

20. Fill in the blanks of the following.

a) The size of gears are usually specified by their ..... b) The commonly used gear tooth-profile is.....

Answers

a) Outer diameter, module, number-ofteeth. b) Involute profile.

21. What is a herringbone gears? (Dec 2005)

Herringbone or double helical gear consists of teeth having a right and left handed helix cut on the same blank.

22. What stresses are induced in gear tooth?

1. Surface compressive stress.
2. Bending stress.

23. What is meant by a corrected gear?

In normal gear, there may be an undercut between base circle and root circle which weakens the teeth.

This undercutting can be avoided by making some modifications on the gear profile. This modification is addendum modification or profile correction or profile shift. The gear, which has this correction, is called as corrected gear.

24. Write short notes on backlash of gears. (DEC 2009)

Backlash can be defined as the play between a mating pair of gear assembled condition.

25. What are the effects of little backlash and. excessive backlash on gears?

Too little backlash may lead to over loading, overheating and ultimately seizure resulting eventual failure of the system. On the excessive backlash may cause, non uniform - transmission of *motion.*

26. Define form factor?

Form factor is a constant, employed in the design of *gear* which, design the shape and the number of teeth.

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27. Why dedendum Value is more than addendum value?

In order to get clearance between the teeth of one gear and bottom surface of mating gear so as to avoid interference, dedendum is having more value than addendum.

28. Specify the machine tools used for producing spur gears.

(i) Milling machine (ii) hear hobber (iii) gear shaper (iv) gear planner

29. What is a helical gear?

A helical gear is a cylindrical gear similar to spur-gear except that the teeth are cut at an angle, known as helix angle to the axis of the gear shaft, whereas in spur-gear, teeth are cut parallel to the axis.

30. In what ways helical gears are differed from spur gears.

S.No	Spur gear	Helical gear
1	Teeth are cut parallel to the axis.	Teeth are cut inclined to the axis.
2	Gradual engagement is obtained.	Simultaneously engaged.
3	Rough and noisy operation.	Smooth and silent operation.
4	Less power is transmitted.	More power can be transmitted.

31. What are the advantages of helical gears? (Dec 2005, JUNE 2009, MAY 2011))

i) Transmit more power. ii) Provide smooth and soundless operation. iii) Used for high speed and high velocity ratio processes.

32. What is helix angle?

Helix angle -is the angle between the axis of the gear and the through tooth face.

33. What is working depth of a gear-tooth? (june 2010)

Working depth of gear is the radial distance between addendum circle and clearance circle. It is equal to two times, the addendum value.

34. Write any two applications of a skew gear-drive. (or) Where do we, use skew gears?

The skew gears or crossed helical gears are employed in instruments, distributor drive of automobile engine etc, where small loads are applied.

UNIT-III

1. What is a bevel gear?

Bevel gear is the type of gear for which the teeth are cut on conical surface. The structure of bevel gear is similar to uniformly truncated frustum of a cone.

2. When do we use bevel gears? (June-2009, Dec-2012)

When the power is to be transmitted in an angular, direction, i.e., between the shafts whose axes intersecting at an angle, bevel gears are employed.

3. What is a crown gear? (Dec-2016)

A crown gear is a type of bevel gear whose shaft angle is 90 degree and angle of pinion is not equal to the pitch angle of gear.

4. What is the specific feature of Mitre gear? (Nov 2011, Dec-2013)

Mitre gear is the special type of crown gear in which the **shaft angle is** 90^0 and the pitch angles of pinion and gear are equal and each angle to 45^0.

5. Define the following terms. (June-2014)

a) Cone distance or pitch cone radius.

b) Face angle.

a) Cone distance or pitch cone radius is the slant length of pitch cone, i.e., distance between the apex and the extreme point of tooth of bevel gear.

b) Face angle is the angle subtended by the face of the teeth at the cone centre. It is equal to the pitch angle plus addendum angle. It is also called as tip angle.

6. In which gear-drive, self-locking is available? (Dec-2009)

Self locking is available in worm-gear drive.

7. When do we use worm-gears? (June-2013)

When we require to transmit power between nonparallel and non-intersecting shafts and very high velocity ratio of about 100 worm gears can be employed. Also worm-gears provide self-locking facility.

8. Write some applications of worm gear drive. (Dec-2016)

Worm gear, drive find wide applications like milling machine indexing head, table fan, and steering rod of automobile and so on.

9. What are the merits and demerits of worm gear drive?

Merits

1) Used for very high velocity ratio of about 100

2) Smooth and noiseless operation.

3) Self-locking facility is available.

Demerits

1) Low efficiency.

2) More heat will be produced and hence this drive can be operated inside an oil reservoir or extra cooling fan is required in order to dissipate the heat from the drive.

3) Low power transmission.

10. What are commonly used materials for worm and worm wheel? (May-2011)

Worm: steel, case hardened steel, hardened molybdenum steel

Worm wheel: cast iron, phosphor bronze.

11. What is helical angle of worm? (June-2016)

It's the angle between the tangent to the thread helix on the pitch cylinder and axis of the worm.

$\beta = 90^0 - \gamma$

12. When do we use skew helical gears? (May-2005, June-2009)

Skew gears are used to connect the transmit motion between two non parallel and non intersecting shafts.

13. Differentiate a straight bevel gear and a spiral bevel gear. (May-2010)

When teeth formed on the cones are straight, the gears are known as straight bevel and when inclined, they are known as spiral or helical bevel.

14. What is zerol bevel gear? (May-2015)

Spiral bevel gear with curved teeth but with a zero degree spiral angle is knows as zero bevel gear.

15. What are the forces acting on a bevel gear? (May-2011, June-2013)

1. Tangential force
2. Axial force
3. Radial force.

16. For bevel gears, define 'back cone distance'. (May 2005)

Back cone distance is the length of the back cone. Back cone is an imaginary cone, perpendicular to the pitch cone at the end of the tooth.

17. Which type of gears is used in automobile differential unit?

Hypoid bevel gear

18. What is virtual number of teeth in bevel gears? (June-2014, May-2014)

It is the number of teeth in the imaginary spur gear considered in a plane perpendicular to the tooth at larger end of bevel gear.

$Zv=Z/\cos\delta$ Z- actual number of teeth in bevel gear. δ- Pitch angle

19. In worm gear drive, only the wheel is designed. Why? (May-2011)

Since always the strength of the worm is greater than the worm wheel, therefore only the worm is designed.

20. Usually worm is made of hard material and worm gear is made of softer material-justify. (June-2009)

A material strength is set so that an amount of wear of the worm becomes larger than that of the worm wheel.

21. Why is the efficiency of a worm gear drive comparatively low? (June-2007)

The efficiency of worm gear drive is lower because of power loss due to friction caused by sliding.

UNIT IV

1. What purpose does the housing of gear-box serve? (June-2012)

Gear-box -housing or casing is used as container inside which, the gears, shafts, bearings and other components are "mounted.' Also it prevents the entry of dust inside the housing and reduces noise of operation. That is, the housing Safe-guard the inner components.

2. What is the function of spacers in a gear-box? (Or) What spacers are as applied to a gear-box? (Dec-2009)

Spacers are sleeve like components, which are mounted, in shafts in-between gears and bearings or one gear and another gear in order to maintain the distance between them so as to avoid interruption between them

.

3. Fill in the blanks of the following. (June-2009)

(a) The number of gears employed in a gear-box is kept to the minimum by arranging the speed of the spindle is ..... series.

(b) In a gear- box, for a set of gears, if the centre distance and module are same, then the sum of teeth of engaging pair will be .....

Answers

a) Geometric series.

b) Equal.

4. What is a speed diagram? (or) what is ray diagram?

Speed diagram is the graphical representation of different speeds of output shaft, motor shaft and intermediate shafts.

5. For what purpose we are using gear-box?

Since the gear-box is provided with number of gears of different size arranged is different forms, we can get number of output speeds by operated motor at single speed.

6. Name the types of speed reducers.

a) Single reduction speed reduces.

b) Multi reduction speed reducers.

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7. What does the ray-diagram of gear-box indicate? (Dec-2010)

The ray-diagram or kinematic arrangement of a gear box indicates arrangement of various gears in various shafts of the gear box in order to obtain the different output speeds from the single speed of the motor.

8. What is step ratio? Or define Progression ratio. (May-2010, Dec-2015)

When the spindle speeds are arranged in geometric progression, then the ratio between the two adjacent speeds is known as step ratio or progression ratio.

9. What are the possible arrangements to achieve12 speeds from a gear box? (Dec-2013)

(i) 3 x 2 x 2 scheme
(ii) 2 x 3 x 2 scheme
(iii) 2 x 2 x 3 scheme

10. What are the possible arrangements to achieve16 speeds from a gear box? (Dec-2010)

(i) 4 x 2 x 2 scheme
(ii) 2 x 4 x 2 scheme
(iii) 2 x 2 x 4 scheme

11. Differentiate ray diagram and structural diagram. (Dec-2016)

- The ray diagram is a graphical representation of the structural formula.
- The structural diagram is a kinematic layout that shows the arrangement of gears in a gear box.

12. List any two methods used for changing speed in gear boxes. (Dec-2016)

Sliding mesh gear box
Constant mesh gear box and
Synchromesh gear box.

13. Specify four types of gear boxes. (Dec-2014)

Sliding mesh gear box
Constant mesh gear box and
Synchromesh gear box.
Epicyclic gear box.

14. Select 3 pairs of gears with total teeth for each pair 60 and speed ratios 1, 1.4, and 2. (Dec-2012)

Z_1=30, Z_2=30 then

Z_1=20, Z_2=40 then

Z_1=25, Z_2=35 then

15. What are preferred numbers? (Dec-2014)

Preferred numbers are the conveniently rounded off values derived from geometric series. There are five basic series, denoted as R5, R10, R20, R40, and R80 series.

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16. State any three basic rules to be followed while designing a gear box. (Dec-2013)

- The tranismission ratio (i) in a gear box limited by $\leq i \leq 2$,

  In otherwords and

- For stable operation ,the speed ratio at any stage should not be greater than 8.

  $\frac{Nmax}{Nmin} \leq 8$

- In all stages except in the first stage, Nmax ≥ Ninput ≥Nmin.
- The sum of teeth mating gears in a given stage must be the same for same module in a sliding gear set.
- The minimum number of teeth on smallest gear in drives should be greater than or equal to 17.
- The minimum difference between the numbers of teeth of adjacent gears must be 4.
- Gear box should be minimum possible size. Both radial as well as axial dimensions should be as small as possible.

17. Name the series in which speeds are arranged in multispeed gear boxes. (June-2011)

Basic series are R5, R10, R20 and R40.

18. Which type of gear is used in constant mesh gear box? Justify. (Dec-2009)

Helical gears are used in constant mesh gear boxes to provide quieter and smooth operation.

19. Where are multispeed gear boxes employed? (June-2009)

Multi speed gear boxes where employed wherever the variable spindle speeds are necessary.

UNIT – V

1. Classify cam based on a shape? (June-2009)

(i) Wedge cam
(ii) Radial cams
(iii) Spiral cams
(iv) Drum cams
(v) Spherical cams

2. Classification of follower? (June-2011)

(i) According to follower shape
(ii) According to motion of follower

3. Define pitch point in cam. (Dec-2013)

Pitch point is a point on the pitch curve at which the pressure angle is maximum.

4. Define base circle and pitch circle with respect to cam. (Dec-2010)

Base circle is the smallest circle that can be drawn tangential to cam profile from the centre of rotation of cam.

Pitch circle is the circle passing through the pitch point and concentric with the base circle.

5. What is angle Angle of ascend? (May-2006)

The angle of rotation of the cam from the position when the follower begins to rise till it reaches its highest points. It is denoted by θ

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6. What is radial or disc cams? (Dec-2007)

In radial cams the follower reciprocates or oscillates in a direction perpendicular to the cam axis . The cams are all radial rams. In actual practice, radial cams are widely used due to their simplicity and compactness.

7. What is classification of followers according to follower shape?

(i) Knife edge follower
(ii) Roller follower
(iii) Mushroom or flat faced follower and
(iv) Spherical faced or curved shoe follower

8. What are the motions of the follower? (June-2012)

The follower can have any of the following four types of motions

(i) Uniform velocity
(ii) Simple harmonic motion
(iii) Uniform acceleration and retardation
(iv) cycloidal motion.

9. Mention a few applications of cam. (Dec-2016)

1. Closing and opening of inlet and exhaust valve operating in IC engine.
2. Automobile steering gear boxes.
3. Capstan and turret lathe indexing mechanisms.

10. What is dwell?

The zero displacement or the absence of motion of the follower during the motion of the cam is called dwell.

11. What is the significance of pressure angle in cam design? (June-2016)

The pressure angle is very important in cam design as it represents steepness of the cam profile. If the pressure angle is too large, a reciprocating follower will jam in its bearings.

12. Name the profile of cam that gives no jerk. (Dec-2015)

Circle arc cam gives no jerk. Because the derivatives of acceleration of cam is zero.

i,e $Jerk = \frac{d^3\theta}{dt^3} = 0$

13. Name four profiles normally used in cams. (June-2009)

1. Spherical profile
2. Helical profile
3. Conical profile
4. Circular profile

14. What factors should be considered when designing friction clutches? Or what are the desirable properties of friction material to be used for clutches. (Dec-2005, Dec- 2009)

(a)The friction materials for the clutch should have high coefficient of friction
(b) They should not be affected by moisture and oil.
(c) May be light in weight.
(d) Dissipate heat quickly.

15. Name four materials used for lining of friction surfaces in clutches. (May-2005, Dec- 2010)

1. Wood 2. Leather3. Asbestos based friction materials 4. Powdered metal friction materials.

16. What is the function of clutch in a transmission system? (June-2016)

Clutch is machine component used as temporary coupling and is used mainly in automobiles for engaging and disengaging the driving shaft where periodical engagement is required.

17. What is meant by positive clutch? (Dec-2015)

Which transmits power from driving shaft to the driven shaft by jaws or teeth is called positive clutch.No slipping is there.

18. By what means, power is transmitted by clutches?

In clutches, power transmission is achieved through

(a) Interlocking (b) Friction (c) Wedging

19. Why are cone clutches better than disc clutches? (May-2012)

Since the cone discs are having large frictional areas and they can transmit a larger torque than disc clutches with, the same diameter and actuating force and hence cone clutches are preferred over disk clutches. But usually cone clutches are mainly used in low peripheral applications.

20. Why should the generated heat be dissipated in clutch operation? (May-2010)

In order to save the friction plates and materials from melting by the heat produced during operation, the generated heat should be dissipated.

21. Name the two theories applied for the design of friction clutches.

1. Uniform Pressure theory
2. Uniform wear theory

22. In what ways, the clutches are different from brakes? (Dec-2012, Dec-2013)

The clutch used to engage the driving and driven members and keep them moving (i.e., rotating) together, whereas brakes are employed to stop a moving member or reduce its speed.

23. What is the function of brake?

Brake is mechanical device by means of which motion of a body is retarded for slowing down or to bring it to rest, by applying artificial frictional resistance.

24. Give examples of radial and axial brakes.

Radial brakes: band brakes, block brakes, and internal expanding rim

Axial brakes: cone brakes and disc brakes.

25. What are the types of brake lining?

1. Organic liningSemi-metallic lining
2. Metallic lining

26. What is a self locking brake? (June-2013)

When the frictional force is sufficient enough to apply the brake with no external forces, then the brake is said to be self locking brake.

27. What you meant by self energizing brake? (Dec-2005, May-2011, Dec-2009, June-2014, Dec-2016)

When the moment of applied force and moment of frictional force are in the same direction, then the frictional force helps in applying the brake. This type of brake is known as self energizing brake.

28. Two blocks diametrically opposite to each other are used in a block brake. Why? (Dec- 2009)

If only one block is used for braking, then there will be side thrust on the bearings of wheel shaft. This drawback can be removed by providing two blocks on the two sides of the drum diametrically opposite.

29. If a multidisc clutch has 6 discs in driving shaft and 7 discs in driven shaft, then how many number of contact surfaces it will have? (May-2015)

Number of discs in driving shaft (n_1) = 6

Number of discs in driven shaft (n_2) = 7

Number of contact surfaces (n) = n_1+n_2-1= 6+7-1=12

PART-B

UNIT-I

1. Design a V-belt drive to the following specifications:

Power to be transmitted	: 75kw
Speed of the driving wheel	: 1440 rpm
Speed of driven wheel	: 400 rpm
Diameter of driving wheel	: 300 mm
Centre distance	: 2500 mm
Service	: 16 hours/day.

2. A v-belt drive is to transmit 45kw in a heavy duty saw mill which works in two shifts of 8 hours each. The speed of motor shaft is 1400 rpm with the approximate speed reduction of 3 in the machine shaft. Design the drive and calculate the average stress induced in the belt.

3. Design a chain drive to actuate a compressor from 10kW electric motor. The speed of the motor shaft is 960 rpm and the compressor speed being 350 rpm. The minimum centre distance is 0.5 m. The compressor operates 8 hours/day.

4. Design a V belt drive to transmit 50 KW at 1440 rpm from an electric motor to a textile machine running 24 hours a day. The speed of the machine shaft is 480 rpm.

5. A blower is to run at 600 rpm. Power to the blower is available from a motor rated 8kW at 1500 rpm. Design a chain drive for the system if the centre distance is to be 800mm.

6. A crane is lifting a load of 18kN through a wire rope and a hook. The weight of the hook is 10kN. The load is lifted with an acceleration of $1m/s^2$. Calculate the diameter of the wire rope. The rope drum diameter is taken as 30 times the diameter of the rope. Take factor of safety as 6 and young's modulus for the wire rope as 0.8×10^5 N/mm^2. The ultimate stress of the wire rope may be taken as 1800 N/mm^2.the cross sectional area of the wire rope may be taken as 0.38 times the square of the rope wire diameter.

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7. A V- belt drive is to transmit 15kW to a compressor. The motor runs at 1150 rpm and the compressor is to run at 400 rpm. Determine1. Belt specifications 2.Number of belts.

8. It is required to select a flat belt drive for a fan running at 360rpm.which is driven by a 10kw, 1440rpm motor. The belt drive is open type and space available for a center distance of 2m approximately. The diameter of a driven pulley is 1000mm.

9. Design a belt drive to transmit20kw at 720rpm aluminium rolling machine, the speed ratio being 3. The distance between the pulley is3m.diameter of rolling machine pulley is 1.2m.

10. A truck equipped with a 9.5 kw engine uses a roller chain as the final drive to the rear axle.The driving sprocket runs at 900 rpm and driven sprocket at 400rpm with center distance of approximately 600mm.Select the roller chain.

11. Design a chain drive to actuate a compressor from a 12 kW electric motor at 900 rpm, the compressor begins 250 rpm. Minimum centre distance should be 500 mm, the chain tension may be adjusted by shifting the motor on rails. The compressor is to work 8 hour/day.

12. A 15 kW squirrel cage motor, 1250 r.p.m. is driving a centrifugal pump at 550 r.p.m. The centrifugal pump is located at 700 mm form the motor. Design a chain drive.

13. A crane is lifting a load of 25 KN through a wire rope and a hook. The weight of the hook etc. is 15kN. The load is to be lifted with an acceleration of 1m/sec^2. Design the rope drive.

14. Design a V-belt drive and calculate the actual belt tension and average stress for the following data. Driven pulley diameter, D= 500 mm, driver pulley diameter, d=150 mm, center distance c=925 mm, speed N_1 = 1000 rpm, N_2 = 300 rpm and power, P = 7.5 kW.

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15. A V-belt drive is to transmit 50kw in a heavy duty saw mill which works in two shifts of 8 hours each. The speed of the motor shaft is 1440 rpm with an approximate speed reduction of 2 in the machine shaft. The peripheral speed of the belt should not exceed 24m/s.design the drive.

16. Select a wire rope for a vertical mine hoist to lift 10,000 KN of coal from a depth of 750m in each 8 hours shift. Assume a two compartment shaft with hoisting skips in balance. Assume rope velocity 750 m/min, acceleration and deceleration periods of each 10 sec. and rest periods of each 10 sec for discharging and loading. Assume skip weight to be half of that of the load.

17. Design a flat belt drive to transmit 110 kW for a system consisting of two pulleys of diameters 0.9 m and 1.2 m for a centre distance of 3.6m, belt speed of 20 m/s and coefficient of friction is 0.3. there is a slip of 1.2% at each pulley and 5% friction loss at each shaft with 20% overload**.**

18. Design a chain drive to actuate a compressor from 15kw electric motor running at 1000 rpm, the compressor speed being 350 rpm. The minimum centre distance is 500mm.the compressor operates 15 hours per day .the chain tension may be adjusted by shifting the motor.

UNIT-II

1. Design a straight spur gear drive. Transmitted power 8kw.pinion speed 764 rpm. Speed ratio is 2.The gears are to be made of C45 steel. Life is to be 10,000hours.
2. Design a pair of helical gears to transmit 10kW power at a speed reduction ratio of 5. The input shaft rotates at 1000 rpm. Give the details of the drive in tabular form.

3. A motor shaft rotating at 1440 rpm has to transmit 15kW to a low speed shaft rotating at 500 rpm. The teeth are 20° involute with 25 teeth on the pinion. Both the pinion and gear are made of Cast Iron with a maximum safe stress of 56 MPa. A safe stress of 35 MPa may be taken for the shaft on which gear is mounted. Design and sketch the spur gear to suit the above conditions. The starting torque may be assumed as 1.25 time sthe running torque**.**
4. A helical gear speed reducer is to be designed. The rated power of the speed reducer is 75kW at a pinion speed of 1200 rpm. The speed ratio is 3:1. For medium shock conditions and 24 hours operation, determine the module, face width and number of teeth on each gear. The teeth are 20° FD . Assume suitable material.

5. A pair of helical gears subjected to moderate shock loading is to transmit 30 kW at 1500rpm of the pinion. The speed reduction ratio is 4 and the helix angle is 20° FD in normal plane. For the gear life of 10000 hours design the gear drive.

6. A pinion with 25 teeth and rotating at 1200rpm drives a gear which rotates at 200rpm and module is 4mm.calculate the center distance between the gears.

7. A helical gear with 300 helix angle has to transmit 35kW at 1500 rpm. With a speed reduction ratio 2.5. If the pinion has 24 teeth, determine the necessary module for 200 full depths the teeth. Assume 15Ni 2Cr 1 Mo 15 material for both pinion and wheel.

8. Design a spur gear drive required to transmit 45 Kw at pinion speed of 800 rpm. The velocity ratio 3.5:1. The teeth are 20 full depths involute with 18 teeth on the pinion. Both the pinion gear are made of steel with a maximum safe static stress of 180N / mm^2

9. Design a pair of helical gears to transmit 30kW power at a speed reduction ratio of 4:1. The input shaft rotates at 2000 rpm. Take helix and pressure angles equal to 25^0 and 20^0 respectively. The number of teeth on the pinion may be taken as 30.

10. Design a straight spur gear drive to transmit 8 kW. The pinion speed is 720 rpm and the speed ratio is 2. Both the gears are made of the same surface hardened carbon steel with 55RC and core hardness less than 350 BHN. Ultimate strength is 720 N/mm^2 and yield strength is 360 N/ mm^2.

11. A motor shaft rotating at 1500 rpm has to transmit 15kW to a low speed shaft with a speed reduction of 3:1. Assume starting torque to be 25% higher than the running torque. The teeth are 20^0 involutes with 25 teeth on the pinion. Both the pinion and gear are made of C45 steel. Design a spur gear drive to suit the above conditions and check for compressive and bending stresses and plastic deformations. Also sketch the spur gear drive**.**

12. An electric motor is to be connected to a reciprocating pump through a gear pair. The gears are overhanging in their shafts. Motor speed = 1440 rpm. Speed reduction ratio = 5. Motor power = 36.8 kW. The gears are to have 20^0 pressure angles. Design a spur gear drive.

13. A pair of helical gears subjected to moderate shock loading is to transmit 37.5kW at 1750 r.p.m. of the pinion. The speed reduction ratio is 4.25 and the helix angle is 15^0. The service is continuous and the teeth are 20^0 FD in the normal plane. Design the gears, assuming a life of 10,000 hours.

14..A compressor running at 300 rpm is driven by a15 Kw, 1200 rpm motor through a 14½ ^{0} full depth spur gears .The centre distance is 375 mm .The motor pinion is to be of C30 forged steel hardened and tempered, and the driven gear is to be of cast iron. Assuming medium shock condition, design the gear drive.

15. Design a spur gear drive required to transmit 15 Kw at pinion speed of 1400 rpm to a low speed shaft rotating at 500 rpm. The teeth are 20 degree full depth involute with 25 teeth on the pinion. Both the pinion and gear are made of CI with a maximum safe static stress of 56 N/mm^2.

16. A helical gear drive with the helix angle of 30 degree required to transmit 15 Kw at pinion speed of 10000 rpm. The velocity ratio 4:1. The teeth are 20 degree full depth involute with 25 teeth on the pinion. Both the pinion gear is made of hardened steel with a maximum safe static stress of 100N / mm^2. The face width may be taken as 14 times the module. Find the module and face width.

17. Design a gear drive to transmit 22kw at 1000 rpm. Speed reduction is 2.5.The centre distance between the shaft is approximately 350mm. the materials are pinion – C45, gear wheel-CI grade 30.design the drive. (Use lewis and Buckingham equations

18. Design and draw a spur gear drive transmitting 30kw at 400 rpm. To another shaft running approximately at 1000 rpm. the load is steady and continuous. The material for the pinion is cast steel and for gear is cast iron. take module as 10mm.Also check the design for dynamic load and wear.

UNIT-III

1. Design a bevel gear drive to transmit 10kw power at 1440 rpm. Gear ratio is 3, and life of gears 10000 hrs. Pinion and gear made of C45 steel and minimum number of teeth is 20.

2. A 25 kW motor running at 1200 rpm drives a compressor at 780 rpm through a 90° bevel gearing arrangement. The pinion has 30 teeth, The pressure angle of the teeth is 20° Both the pinion and gear are made of heat treated cast iron grade 35. Determine the cone distance,average module and face width of the gear.

3. A 2 kW power is applied to a worm shaft at 720 rpm. The worm is of quadruple start type with 50mm as PCD. The worm gear has 40 teeth with 5mm module. The pressure angle in the diametral plane is 20°. Determine i) Lead angle of the worm ii) velocity ratio iii) Centre distance. Also calculate the efficiency of the worm gear drive and power lost in friction.

4. A 10 kW motor running at 1200 rpm drives a compressor at 780 rpm through a 90^0 bevel gearing arrangement. The pinion has 30 teeth. The pressure angle of the teeth is 20^0. Both the pinion and gear are made of heat treated cast iron grade 35. Determine the cone distance, average module and face width of the gears.

5. Design a pair of bevel gears for two shafts whose axes are at right angles. The power transmitted is 25kW. The speed of the pinion is 300 rpm and the gear is 120 rpm.

6. A 2 kW power is applied to a worm shaft at 720 rpm. The worm is of quadruple start with 50mm as pitch circle diameter. The worm is of quadruple start type with 50mm as pitch circle diameter. The worm gear has 40 teeth with 5mm module. The pressure angle in the diametral plane is 20^0. Determine (i) the lead angle of the worm, (ii) velocity ratio, and (ii) centre distance. Also, calculate efficiency of the worm gear drive, and power lost in friction.

7. A pair of straight tooth bevel gears has a velocity ratio of 4/3. The pitch diameter of the pinion is 150 mm. The face width is 50mm. The pinion rotates at 240 rev/min. The teeth are 5mm module, 14.5^0 involutes. If 6 kW is transmitted, determine (i) the tangential force at the Mean radius (ii) the pinion thrust force (iii) the gear thrust force. Draw the free body diagrams indicating the forces.

8. Design a worm gear drive with a standard centre distance to transmit 7.5 kW from a worm rotating at 1440 rpm to a worm wheel at 20 rpm.

9. Design the teeth of a pair of bevel gears to transmit 18.75 kW at 600 rpm of the Pinion. The velocity ratio should be about 3 and the pinion should have about 20 teeth which are full depth 20^0 involutes. Find the module, face width, diameter of the gears and pitch core angle for both gears.

10. Design a worm gear drive to transmit 22.5 kW at a worm speed of 1440 rpm. Velocity ratio is 24:1. An efficiency of at least 85% is desired. The temperature rise should be restricted to 40^0 C. Determine the required cooling area.

11. Design a bevel gear drive to transmit 7 kW with the following specifications: speed ratio = 4; driving shaft speed = 1600 r.p.m.; material for pinion and gear is C45 steel and life 10000 hours**.**

12. Design a pair of bevel gears for two shafts whose axes are at right angles. The power transmitted is 25kW. The speed of the pinion is 300 rpm and the gear is 120 rpm.

13. Design a worm gear drive to transmit 22.5 kW at a worm speed of 1440 rpm. Velocity ratio is 24:1. An efficiency of at least 85% is desired. The temperature rise should be restricted to 400 C. Determine the required cooling area .

14. Design a worm and gear speed reducer to transmit 22 kW at a speed of 1440 rpm. The desired velocity ratio is 24:1. An efficiency of atleast 85% is desired. Assume that the worm is made of hardened steel and gear of phosphor bronze. Take the centre distance as 100mm.

15. A 2kw power is applied to a worm shaft at 720mm.the worm is of quadruple start with 50mm as pitch circle diameter. The worm gear has 40 teeth with 5mm module. The pressure angle in the diametral plane is 200. Determine (i) the lead angle of the worm (ii) velocity ratio and (iii) centre distance. Also calculate efficiency o f worm gear drive, and power lost in friction.

UNIT-IV

1. The maximum and minimum speeds of nine speed gear box are to be 600 rpm and 100 rpm. The drive is from an electric motor giving 5.5 kW at 1440 rpm. Draw the kinematic layout diagram and the speed diagram.determine the number of teeth on all gears.

2. The maximum and minimum speeds of 9 speed gear box are to be 1800 rpm and 280 rpm. The drive is from an electric motor giving 3 kW at 1440 rpm. Design the gear box. Construct the speed diagram and sketch the arrangement of gear box.

3. Design a 12 speed gear box for a head stock of a lathe. The maximum and minimum speeds are 1200 rpm and 100 rpm respectively. The drive is from a electric motor giving 5 kW at 1440 rpm. Draw the kinematic layout diagram and the speed diagram.determine the number of teeth on all gears.

4. Design a 12 speed gear box for a head stock of a lathe. The maximum and minimum speeds are 600 rpm and 25 rpm respectively. The drive is from a electric motor giving 2.25 kW at 1440 rpm. Construct the speed diagram and sketch the arrangement of gear box**.**

5. Sketch the arrangement of a six speed gear box. The minimum and maximum speeds required are around 460 and 1400 rpm. Drive speed is 1440 rpm. Construct the speed diagram of the gear box and obtain various reduction ratio. Use standard output speeds and standard step ratio. Calculate the number of teeth in each gear and verify the actual output speeds are within +2% of standard speeds.

6. Design the layout of a 12 speed gear box for a milling machine having an output of speeds ranging from 180 to 2000 rpm. Power is applied to gear box from a 6 kW induction motor at 1440 rpm. Choose standard step ratio and construct the speed diagram. Decide upon the various reduction ratios and number of teeth on each gear wheel. Sketch the arrangement of the gear box.

7. In a drilling machine, 12 different speeds in the range of 100 rpm and 355 rpm are required. Design a three stage gear box with a standard step ratio. Sketch the layout of the gear box, indicating the number of teeth on each gear. The gear receives 5kw from an electric motor running at 360rpm.sketch also the speed diagram.

8. Design a gear drive to give 18 speeds for a spindle of a milling machine. The drive is from an electric motor of 3.75 kw at 1440 rpm. Maximum and minimum speeds of the spindle are to be around 650 and 35 rpm respectively.

9. Draw the ray diagram and kinematic layout of a gear box for an all geared headstock of a lathe. The maximum and minimum, speeds are to be 600 and 23 rpm respectively. Number of steps is 12 and drive is from a 3000w electric motor running at 1440 rpm. (JUNE 2014)

UNIT-V

1. A Plate clutch with maximum diameter of 60cm has maximum lining pressure of 350kPa. The power to be transmitted at 400rpm is 135kw and μ is 0.3. Find inside diameter and spring force required to engage the clutch. Springs with spring index 6 and material of the spring is steel with safe shear stress 600MPa are used. Find the diameters if 6 springs are used.

2. A multi disk clutch consists of 5 steel plates and 4 bronze plates. The inner and outer diameter of the friction disks are 75mmand 150 mm respectively. The coefficient of friction is 0.1 and the intensity of pressure is limited to 0.3 MPa. Assuming the uniform wear theory calculate i) Required operating force ii) Power transmitting capacity at 750 rpm.

3. Determine the maximum braking torque for a band brake and block brake having 12 blocks each of which subtends an angle of 16° at the centre. The brake is applied to a rotating drum of diameter 600mm. The blocks are 75mm thick. The two ends of the band are attached to pins on the opposite sides of the brake fulcrum at distances 40 mm and 150 mm from the fulcrum. A force of 250 N is applied at a distance of 900 mm from the fulcrum.

4. In a single block brake, the diameter of the drum is 250 mm and that of angle of contact is 90°. The operating force is 700 N is applied at the end of the lever which is at 250mm from the centre of the brake block. The coefficient of friction between the drum and the lining is 0.35. Determine the torque that may be transmitted. Fulcrum is at 200 mm from the centre of the brake block with an offset of 50mm from the surface of contact.

5. A single plate clutch, both side being effective is required to connect a machine shaft to a driver shaft which runs at 500rpm .The moment of inertia of the rotating parts of the machine is 1Kgm^2.The inner and the outer radii of the friction discs are 50mm&100mm respectively .Assuming uniform pressure of 0.1N/mm^2 and μ =0.25 , determine the time taken for the machine to reach full speed when the clutch is suddenly engaged . Also determine the power transmitted by the clutch, the energy dissipated during the clutch slip and the energy supplied to the machine during engagement.

6. In an automotive type internal – expanding double – shoe brake the face width of the friction lining is 40 mm and the intensity of normal pressure is limited to 1 N/mm^2. The coefficient of friction is 0.32. The angle φ_1 can be assumed to be zero. Calculate (i) the actuating force P, and (ii) the torque – absorbing capacity of the brake.

7. A leather faced conical clutch has cone angle of 30^0.The pressure between the contact surfaces is limited to .35N/mm^2 and the breath of the conical surface is not to exceed 1/3 of the mean radius. Find the dimensions of the contact surface to transmit 22Kw at 2000 rpm .Also calculate the force required to engage the clutch. .Take μ =0.15.

8. Draw the displace time, velocity time and the acceleration time curves for the follower in order to satisfy the following conditions (1) Stroke of the follower 25mm (2) Outstroke takes place with SHM during 900 of cam rotation (3) Return stroke takes with SHM during 750 of cam rotation (4) Cam rotates with a uniform speed of 800 rpm.

9. A radial cam rotates at 1200 rpm with the follower rising 20mm with SHM in150^{0}of the cam rotation. The roller is 32mm in diameter and the prime circle is 80mm in diameter. Check whether undercutting will occur.

10. A multi – disk clutch has 3 disks on the driving shaft and two on the driven shaft. The inner and outer diameters of friction disks are 120mm and 240mm respectively. The coefficient of friction is 0.3 and find the maximum axial intensity of pressure between the discs for transmitting 25 kW at 1575 rpm .Assuming the uniform wear theory.

11. A single plate clutch transmits 25 kW at 900 rpm. The max. Pressure intensity between the plates is 85 kN/m^2. The ratio of radii is 1.25. Both the sides of the plate are effective and the coefficient of friction is .25. Determine (i) the diameter of the plate (ii) the axial force to engage the clutch. Assuming the uniform wear theory.

12. A plate clutch has 3 discs on the driving shaft, providing 4 pairs of contact surfaces the outside diameter of the contact surfaces is 240mm and inside diameter 120mm.assuming uniform pressure and $\mu = 0.3$, find the total spring load for pressing the plates together to transmit 25kw at 1575 rpm. If there are 6 springs each of stiffness 13 kN/m and each of the contact surfaces have worn away by 1.25 mm, find the maximum power that can be transmitted, assuming uniform wear.

13. Find the torque that a two surface, dry disc clutch can transmit if the outside and inside lining diameters are 120mm and 70mm respectively, and the applied axial force is 10kw.assume uniform wear and $\mu = 0.4$.is the pressure on the lining acceptable? What lining material would be suitable?

14. Design a differential band brake for a winch lifting a load of 20KN through a steel wire rope wound around a barrel of 600mm diameter. The brake drum, keyed to the barrel shaft, is of 800mm diameter and the angle of lap of the band over the drum is about 240^0.operating arm of the brake are 50mm and 250mm. The length of the operating lever is 1.6m

15. An automobile single plate clutch consists of two pairs of contacting surfaces. The inner and outer radii of friction plates are 120 mm and 250 mm respectively. the coefficient of friction is 0.25 and the total axial force is 15kN.calculate the power transmitting capacity of the clutch plate at 500 rpm using (i) uniform wear theory and (ii) uniform pressure theory.

16. Describe with the help of a neat sketch the design procedure of an internal expanding shoe brake. Also deduce the expression for the braking torque.

17. A friction clutch is required to transmit 25 kW at 2000 rpm. It is to be of single plate disc type with both sides. The pressure is exerted by means of springs and limited to 70KPa. If the maximum possible outer diameter of the clutch plate is 300mm,find the required inner diameter of the clutch plate and the total force exerted by the springs. Assume wear to be uniform and coefficient of friction as 0.3.

18. A hydraulically operated clutch is to be designed for an automatic lathe. Determine the number of plates and operating force required for the clutch to transmit 35Nm.the clutch is to be designed to slip under 300% of rated torsional moment to be protect the gears and other part of the drive. The limits for the diameter of frictional surface due to space limitation are 100 mm and 62.5 mm. This clutch is to operate in an oily atmosphere.