

DHANALAKSHMI SRINIVASAN ENGINEERING COLLEGE

(AUTONOMOUS)

(Approved by AICTE & Affiliated to Anna University, Chennai)

Accredited with 'A' Grade by NAAC, Accredited by TCS

Accredited by NBA with BME, ECE & EEE

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COURSE MATERIALS

DESIGN OF TRANSMISSION SYSTEM

Course Name	Design of transmission systems			
Year/Section/Department	III /A/ Mechanical Engineering			
Credits Details	L: 3	T: 0	P: 0	C: 3
Total Contact Hours Required	45			

Syllabus:

UNIT I/ DESIGN OF FLEXIBLE ELEMENTS	No. of Periods : 9
Design of Flat belts and pulleys - Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys– Design of Transmission chains and Sprockets	
UNIT II/ SPUR GEARS AND PARALLEL AXIS HELICAL GEARS	No. of Periods : 9
Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects – Fatigue strength- Factor of safety - Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces for helical gears	
UNIT III/ BEVEL, WORM AND CROSS HELICAL GEARS	No. of Periods : 9
Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demeritsterminology.Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.	
UNIT IV/ GEAR BOXES	No. of Periods : 9
Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications - Constant mesh gear box -Speed reducer unit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.	
UNIT V/ CAMS, CLUTCHES AND BRAKES	No. of Periods : 9
Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses. Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches-Electromagnetic clutches. Band and Block brakes - external shoe brakes – Internal expanding shoe brake	

UNIT-1 DESIGN OF FLEXIBLE ELEMENTS PART-A -

1. Give an expression for ratio of tensions in a flat belt drive.

$$\frac{T_1}{T_2} = e^{\mu\theta}$$

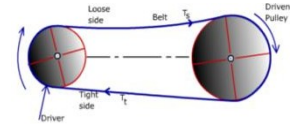
Where, T_1 =Tension in tight side in N; T_2 =Tension in slack side in N; μ =Coefficient of friction; θ =Angle of contact of driving pulley in radians.s

2. How is a V-belt specified?

Here's a typical example of its specification "C2032 IS 2494: 1964". Here the 'C' denotes the section type of the belt, '2032' represents the nominal inside length of the belt and 1964 is referred to as year of coding.. The power transmitting capacity of section 'C' type of the belt is 1 kW to 12 kW.

3. Why tight-side of the belt should be at the bottom side of the pulley?

The positions of input and output pulleys are such that the tight side of the belt must be on the bottom and slack side on the top of the pulleys.

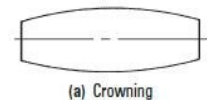


Otherwise, the angle of contact between the belt and rim of the pulley reduces, decreasing the power transmission capacity of the belt.

4. Explain the term "Crowning of pulley".

[Nov/Dec-2016, May/June 2014]

The pulley rims are tapered slightly towards the edges. This slight convexity is known as crowning. The crowning tends to keep the belt in centre on a pulley rim while in motion. These flat belts stayed centered on pulleys without any guides or flanges. The key to keeping them tracking centered on the pulleys is the use of "crowned pulleys"



5. A longer belt will last more than a shorter belt. Why?[Apr/May 2017]

The life of a belt is a function of the centre distance between the driver and driven shafts and diameter of driver and driven pulleys. The shorter the belt, the more often it will be subjected to additional bending stresses while running around the pulleys at a given speed. And also it will be destroyed quickly due to fatigue. Hence the increased centre distance and diameter of pulley will increase the belt life. Hence, a longer belt will last more than a shorter belt.

6. Mention the losses in belt drives?

[Nov/Dec

2014] The losses in a belt drive are due to: (i) Slip and creep of the belt on the pulleys (about 3%) (ii) Bending of the belt over the pulleys (about 1%) (iii) Friction in the bearings of pulley (about 1%) and (iv) Windage or air resistance to the movement of belt and pulleys (usually negligible)

7. In what ways the timing belts are superior to ordinary V-belts? [April/May 2015]

Flat belt and V-belt drives cannot provide a precise speed ratio, because slippage occurs at the sheaves. But certain applications require an exact output to input speed ratio. In such situations, timing belts are used. Since the timing belts (aka. synchronous 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.

8. Why are idler pulleys used in a belt drive?

Idler pulleys are used to take up slack, change the direction of transmission, or provide clutching action in any industry, material handling or any other mechanical purpose. But they don't provide any mechanical advantage, nor does it transmit power. One such example of its application is to improve belt drive performances as they reduce vibration by supporting a segment of belt which is prone to vibration/oscillation. They are also used in car engines for positive clutching action by running the idler pulley on the slack side of the flat-belt drive from engine to transmission.

9. Name the few materials for belt drives? [May/June 2016]

(i) Leather (ii) Fabric and cotton (iii) Rubber (iv) Balata and (v) Nylon.

10. 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 that pulley or must lie in the plane of the pulley, otherwise the belt will run off the pulley. "The centreline of the belt when it approaches a pulley must lie in the midplane of the pulley",

11. What is wipping? How it can be avoided in belt drives?

If the centre distances between two pulleys are too long then the belt begins to vibrate in a direction perpendicular to the direction of motion of belt. This phenomenon is called as wipping. Wipping can be avoided by using idler pulleys.

12. What is centrifugal effect on belts? [Nov/Dec 2015]

As the belt moves round the pulley, it would experience a centrifugal force which has a tendency to separate the belt from the pulley surface. To maintain contact between the pulley and belt, the centrifugal force produce additional tension in the belt, which is known as centrifugal tension ($T_c = mv^2$).

13. Write the advantages of V-belts over flat belts? [Nov/Dec 2017]

1. Friction is more due to groove (wedge). Thus these transmit more power. 2. Reduced angle of contact and hence more power is transmitted 3. There is no slip in a V-belt since belt runs in a groove. 4. It is compact since distance between two shaft axes is less. 5. It is more silent drive. 6. It has more speed. 7. It has more velocity ratio or reduction ratio. 8. It can be used in all orientations

i.e. horizontal, vertical or inclined installations.

14. Which side of the belt should be on the bottom side of the pulley and why? [April/May 2019]

The positions of input and output pulleys are such that the tight side of the belt must be on the bottom and slack side on the top of the pulleys. Otherwise, the angle of contact between the belt and rim of the pulley reduces, decreasing the power transmission capacity of the belt.

15. How are wire ropes designated? Give an example? [Nov/Dec 2012]

Wire ropes are designated (or specified) by the number of strands and the number of wires in each strand. Standard Wire Rope, 6x7 Class Wire Rope, Strands: 6, Wires per Strand: 7, Core: Fiber Core, Standard Grade(s): Improved Plow (IPS), Lay: Regular or Lang, Finish: Bright or Galvanized

16. What do you understand by 6 x 19 constructions in wire ropes?[Nov/Dec 2014]

A 6 x 19 wire rope means a rope is made from 6 strands with 19 wires in each strand.

17. what are the factors upon which the coefficient of friction between the belt and pulley depends? [May/June 2014, 2012]

The coefficient of friction between the belt material and pulley surface depends upon the belt material, material of the pulley surfaces, belt speed and belt slip.

18. Name the types of belts used for transmission of power? [May/June 2013, Nov/Dec 2018]

1. Flat belts 2. V-belts 3. Ribbed belts 4. Toothed or timing belts

19. List out the various stresses induced in the wire ropes? [May/June 2013, 2019]

1. Direct stress due to the weight of the load to be lifted 2. Bending stress when the rope passes over the sheave 3. Stress due to acceleration 4. Stress due to starting and stopping 5. Effective stress.

20. Mention the parts of roller chains? [Nov/Dec 2012]

1. Inner (pin link or coupling link) and outer link plates (roller link) 2. Pin 3. Bushing and rollers.

21. Define co-efficient of Friction? [April/May 2018]

The coefficient of friction is the ratio of the frictional force to the force acting perpendicular to the two surfaces in contact. This coefficient is a measure of the difficulty with which the surface of one material will slide over another material. Thus, the ratio of friction F to load L is constant. This constant ratio is called the coefficient of friction and is usually symbolized μ (μ).

Mathematically, $\mu = F/L$.

22. When do you use Stepped pulley drive? [Nov/Dec 2018]

Stepped pulley is used when the speed of the driven shaft is to be changed very frequently as in case of machine tools such as lathe, drilling machine etc.

23. What is meant by “Chordal action of chain”? Also name a company that produces driving chains. [April/May 2015]

When chain passes over a sprocket, it moves as a series of chords instead of a continuous arc as in the case of a belt drive. It results in varying speed of the chain drive. This phenomenon is known as chordal action. Some of the company names producing chains are: Roto mechanical

equipments, Chennai: Monal Chains Limited, Mumbai; Innotech Engineers Ltd., New Delhi.

24. Give any three applications of chain drives. What are their limitations? or List the chain drive failures. [April/May 2011, [Nov/Dec 2017]

Chain drives are widely used in transportation industry, agricultural machinery, metal and wood working machines. Limitations :heavy height ,sudden failure, intensive wear of the links in the joints susceptibility to jerks and overloads.

25. What is the effect of chordal action in chain drives? How can you reduce that effect?

[April/May 2015] As

the chain enters and exits, it rises and falls as each pitch engages and disengages the sprockets. This movement, called chordal action, causes chain speed variations (drive roughness) that may be objectionable in some applications. These speed variations can normally be minimized by increasing the size of the sprockets. Chordal action results in a pulsating and jerk motion of a chain. In order to reduce the variation in chain speed, the number of teeth on the sprocket should be increased.

26. What do you mean by galling of roller chains? [May/June 2012]

Galling is a stick-slip phenomenon between the pin and the bushing. When the load is heavy and the speed is high, the high spots (i.e. joints) of the contacting surfaces are welded together. This phenomenon of welding is called as galling of roller chains. Use high quality, high pressure lubricants and ensure that the lubricant regime is such that the film of lubricant is constantly maintained between the surfaces.

27. Under what circumstances chain drives are preferred over V belt drives? or What are the advantages of chain drives? [May/June 2016] [April/May 2018]

The popularity of chain drives stems from their ability to transmit high torque levels in a small package, at relatively low cost, while utilizing readily available stock components. While initial costs of standard roller chain drives can be quite low, the cost of maintaining them can be substantial. The ability to create any length of chain with connecting links. The availability of a large selection of chains and sprockets.

28. What factors will affect the working conditions of chain drive? [Nov/Dec-2016]

1. Tension in the chains 2. Sizes of the pulley/gear 3. Number of pulley/gear 4. Length of the chain drive 5. Friction between chains & pulley/gear 6. Angle of contact .

29. List the advantages of wire ropes compared to chains ? [Apr/May-2017]

1. More reliable in operation 2. Silent operation even at high working speeds 3. Less danger for damage due to jerks.

UNIT-2 SPUR GEARS AND PARALLEL AXIS HELICAL GEARS PART-A -

C309.2

1. Specify the conditions based on which gear cutters are selected.

The conditions are a) the capacity of the machine size and shape of the gear b) Proper material selection c) The magnitude of production range d) the production time e) the technical experience of the machinist f) The economic viability of the machine g) the cutting forces

2. Define backlash? What factors influence backlash in gear drives? [Nov/Dec 2016]

Shortest distance between the non-contacting surfaces of the adjacent teeth is referred to as backlash. a) Module and b) pitch line velocity influence the backlash in gear drives.

3. What are the advantages of the helical gear over spur gear?

* Helical gears produce less noise than spur gears of equivalent quality because the total contact ratio is increased. * Helical gears have a greater load carrying capacity than equivalent size of spur gears. * A limited number of standard cutters are used to cut a wide variety of helical gears simply by varying the helix angle. * Smoother engagement of the gear teeth. * More teeth carry load at a given time so that they are more efficient – carry more load for a given size

4. State the law of gearing. (or) State the conditions of correct gearing (or) what conditions must be satisfied in order that a pair of spur gears may have constant velocity ratio

[May/june 2014] . [Nov/Dec 2012, April /May

2015, 2019] 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 (fixed point), situated on the line joining the centres of rotation of the pair of mating gears.

The angular velocity ratio of the gears of a gear-set must remain constant throughout the mesh.

5. What is pressure angle? [April /May 2015 & 2014, Nov/Dec 2014] It

is the angle which the line of action makes with the common tangent to pitch circles of mating gears. Simply refers to the angle through which forces are transmitted between meshing gears. Ideally 20° of pressure angle (involute system) is preferred because the tooth acting as a beam is wider at the base.

6. What are the advantages of toothed gears over the other types of transmission systems? [Nov/Dec 2018]

Advantages of gear drives over other drives, i.e. belt, rope and chain drives are a) it is very compact and need less space. b) It has a very high efficiency which is very useful in transmitting motion. c) The main advantage of gear drive is that it transmit same velocity ratio.

d) Again a good advantage is that it is a very good reliable service. e) And last is that it can be used to transmit a very large power..

7. Define module. [April/May 2011, May/June 2013, Nov/Dec 2015]

Module, m this indicates the tooth size and is the number of mm of pitch circle diameter (p.c.d.) per tooth. For gears to mesh, their modules must be equal. Gear ISO standards and design methods are now normally based on the module. EG a gear of module 3 has 16 teeth, its pitch circle diameter is: $3 \times 16 = 48$ mm. In a pair of spur gears, the module is 6 mm.

8. What are the common forms of gear tooth profile? [Apr/May 2011]

(i) Involute tooth profile and (ii) Cycloidal tooth profile.

9. What are the standard interchangeable tooth profiles?

- (i) $14\frac{1}{2}^{\circ}$ composite system (ii) $14\frac{1}{2}^{\circ}$ full depth involute system (iii) 20° full depth involute system and (iv) 20° stub involute system.

10. State some materials used for manufacturing of gears?

[May/June 2013]

Metallic gears: steel, cast iron and bronze. Non-metallic gears: wood, compressed paper and synthetic resin

11. Why is pinion made harder than gear?

[Nov/Dec 2012, 2018]

Since the teeth of pinion undergo more number of cycles than gear and hence quicker wear.

12. List out the various methods of manufacturing a gear.

1. Gear milling, 2. Gear hobbing, 3. Gear shaping, 4. Gear molding, 5. Injection molding, 6. Die casting and 7. Investment casting.

13. What are the main types of gear tooth failure?

[May/June 2013, 2012]

1. Tooth breakage (due to static and dynamic loads). 2. Tooth wear (or surface deterioration):
2. (a) Abrasion; (b) Pitting and (c) Scoring or seizure.

14. What are the assumptions made in deriving Lewis equation?

1. The effect of radial component, which induces compressive stresses, is negligible. 2. The tangential component is uniformly distributed across the full face width. 3. The tangential force is applied to the tip of a single tooth. 4. Stress concentration in the tooth fillet is negligible.

15. What are the effects of increasing and decreasing the pressure angle in gear design?

[April/May 2015, 2017 & 2014, Nov/Dec 2014]

* Increasing the pressure angle will increase the beam and surface strengths of tooth. But gear becomes noisy. * Decreasing the pressure angle will increase the minimum number of teeth required on the pinion to avoid interference/ undercutting.

16. A helical gear has a normal pressure angle of 20 degrees, a helix angle of 45 degrees, normal module of 4mm and has 20 teeth. Find the pitch diameter? [Nov-Dec 2016]

Solution : Pitch circle diameter (d) = $(m_n \times Z) / \cos\beta$, = $(4 \times 20) / \cos 45 = 113.3 = 114\text{mm}$

17. Differentiate double helical and herringbone gears.

[Nov/Dec 2015, Apr/May 2017]

When there is groove in between the gears, then the gears are specifically known as double helical gears. When there is no groove in between the gears, then the gears are known as herringbone gears.

18. Write short notes on stub tooth system. or What is meant by stub tooth in gear drives ?

[Nov/Dec 2017] [May/June 2012]

In this system, the thickness of tooth at top surface and its root is more compared to full depth tooth

system. Also this kind of tooth possesses shorter addendum and larger pressure angle, usually 20° and thus interference problem may be eliminated. For standard stub tooth system, the tooth proportions are as Whole depth=1.8*module; Addendum=0.8*module; Dedendum=1.0*module; Working Depth=1.6*module; Clearance=0.2*module;

19. What are the advantages of helical gears? [Nov/Dec 2012]

*Transmit more power *Provide smooth and soundless operation.

20. What are the profiles of a spur gear? [May/June 2016]

Two constant velocity tooth profiles are the most commonly used in modern times: the cycloid and the involute

21. What is herringbone gear? [May/June 2016]

Herringbone gears, also called double helical gears, are gear sets designed to transmit power through parallel or, less commonly, perpendicular axes. The unique tooth structure of a herringbone gear consists of two adjoining, opposite helices that appear in the shape of the letter 'V'. Double helical gears are used in many applications such as cranes, fluid pumps and power transmission to the propulsion screws in military ships for a quieter and less vibration operation.

22. State the advantages of Herringbone gear. [April/May 2015, 2013]

Herringbone gears eliminate the existence of axial thrust load in the helical gears. Because, in herringbone gears, the thrust force of the right hand is balanced by that of the left hand helix.

23. Why is a gear tooth subjected to dynamic load? [Nov/Dec 2014]

Dynamic loads are due to (i) Inaccuracies of tooth spacing (ii) Irregularities in tooth profiles (iii) Elasticity of parts (iv) Misalignment between bearings (v) Deflection of teeth under load (vi) Dynamic unbalance of rotating masses.

24. Compare the features of spur and helical gears ? [Nov/Dec 2012]

Spur gear: Spur gears are the most common type of gear, and are also the most simple. They have straight teeth that are produced parallel to the axis of the gear. Since they have the simplest design, they are the easiest to design and manufacture, and are therefore the most economical type of gear. Spur gears are not known to be the smoothest or quietest gears, but they are highly efficient and produce a lot of power. They run well at slow to moderate speeds, but they tend to vibrate and become noisy at higher speeds

Helical gear : Helical Gears have teeth that are set on an angle to the gear axis. Since the teeth engage more gradually, they have a smoother and quieter operation than spur gears. Helical gears also have greater tooth strength and a higher load carrying capacity. Further, helical gears can transmit power between either parallel or non-parallel shafts, while spur gears can only transfer power between parallel shafts.

25. Define the various pitch in a helical gear? [May/June 2012]

1. Transverse circular pitch (P_t) 2. Normal circular pitch (P_n) 3. Axial Pitch (P_a) 4. Normal diametral pitch (P_d)

26. Specify the types of Gear failures?

[April/May

2018] The various major areas by which the gears tend to fail are 1. Shock loading failures 2. Fatigue Failures 3. Failures due to Wear 4. Failures due to Scuffing (a severe form of adhesion wear, when metal from one gear tooth transfers to another over time

27. In what ways helical gears are different from Spur gears?

[April/May

2018] The spur gears will have a zero helix angle, It is straight tooth gear used to transmit power between the shafts which are mutually parallel, there is a negligible axial thrust present between shafts. Helix angle is the angle made b/w the helices and the axis of rotation. In case of helical gear the helix angle varies between 20 to 45 degrees. It is also used for parallel shaft power transmission but a higher axial thrust may be present.

28. Define virtual no. of teeth in helical gears?

[Nov/Dec

2017,2018] The formative or equivalent number of teeth for a helical gear may be defined as the number of teeth that can be generated on the surface of a cylinder having a radius equal to the radius of curvature at a point at the tip of the minor axis of an ellipse obtained by taking a section of the gear in the normal plane. Mathematically, formative or equivalent number of teeth on a helical gear $Z_E = Z / \cos^3 \beta$

Z = Actual number of teeth on a helical gear and β = helix angle.

UNIT-3 BEVEL, WORM AND CROSS HELICAL GEARS

PART-A C309.3

1. What is virtual or formative number of teeth in bevel gears?

[Nov/Dec 2014, April/May 2017, May/June 2014]

An imaginary spur gear considered in a plane perpendicular to the tooth of the bevel gear at the larger end is known as virtual spur gear. The number of teeth z_v on this imaginary spur gear is called virtual number of teeth in bevel gears. $z_v = z / \cos \delta$ where z = actual number of teeth on the bevel gear and δ = pitch angle.

2. Why is the efficiency of worm gear drive comparatively low?

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

3. Define the following terms: (a) Cone distance (b) Face angle.

[May/June 2014]

(a) Cone distance: In bevel gears, cone distance is the length of the pitch cone element.

(b) Face angle: It is the angle subtended by the face of the tooth at the cone centre.

4. In which gear drive, self-locking is available?

[April/May 2015, 2013, 2018]

In the worm gear drive, self-locking is available.

5. Why is multistart worm more efficient than the single start one?

The efficiency of the worm depends mainly on pressure angle (also known as pitch angle of the worm). For a single start worm this pressure angle will be less. In a multistart worm, this pressure angle can be increased (of the order 45°). That's why multistart worm is more efficient.

6. What is the difference between an angular gear and a miter gear? [Nov/Dec 2015, 2017]

When the bevel gears connect two shafts whose axes intersect at an angle other than a right angle, then they are known as angular bevel gears.

When equal bevel gears (having equal teeth and equal pitch angles) connect two shafts whose axes intersect at right angle, then they are known as miter gears.

7. A pair of worm gears is designated as 2/54/10/5. Find the gear ratio.

Solution: (2/54/10/5): $(z_1/z_2/q/m_x)$ Therefore, Gear ratio, $i = z_2/z_1 = 54/2 = 27$

8. Write the conditions of self locking of worm gears in terms of lead and pressure angle in gear design. And also write the condition for over running drives? or [Apr/May 2017]

* The drive is called self-locking, if $\mu \geq \cos \alpha \cdot \tan \gamma$

* The drive is called overrunning, if $\mu < \cos \gamma \cdot \tan \gamma$

9. Why phosphor bronze is widely used for worm gears?

Phosphor bronze has high antifriction properties to resist seizure. Because in worm gear drive, the failure due to seizure is more.

10. List out the main types of failure in worm gear drive. [Nov/Dec 2012]

1. Seizure
2. Pitting and rupture.

11. In worm gear drive, only the wheel is designed. Why? [Apr/May

2011] Since always the strength of the worm is greater than the worm wheel, therefore only the worm wheel is designed.

12. For transmitting large power, worm reduction gears are not generally preferred. Why?

In worm drive, meshing occurs with sliding action. Since sliding occurs, the amount of heat generation and power loss are quite high.

13. Under what situation, bevel gears are used? [Apr/May 2011, 2018] [May/June 2013]

Bevel gears, which are conically shaped and most often mounted on shafts that are 90 degrees apart, but can be designed to work at other angles as well and used to transmit power between two intersecting shafts.

13. What are the forces acting on bevel gear?

[May/June 2013, Nov/Dec 2018] 1. Tangential force 2. separating force. It is resolved into two components, they are axial and radial force

14. Write some applications of worm gear drive?

[Nov-Dec

2016] It is commonly used in automotive differentials, Tuning Instruments, Elevators/Lifts, Gates and Conveyor Belts

15. What are the main types of failures in worm gear drives? [Nov/Dec 2012]

1. Seizure 2. Pitting 3. Surface wear

17. What is the helical angle of worm?

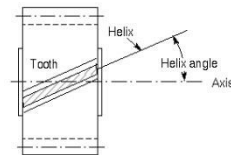
[May/June 2016]

In mechanical engineering, a helix angle is the angle between any helix and an axial line on its right, circular cylinder or cone.

Common applications are screws, helical gears, and worm gears. The helix angle references the axis of the cylinder, distinguishing it from

the lead angle, which references a line

perpendicular to the axis. Naturally, the helix angle is the geometric complement of the lead angle. The helix angle is measured in degrees.



18. what is a crown gear?

[Nov-Dec 2016, May/June 2013, 2019]

A crown gear (or a contra gear) is a gear which has teeth that project at right angles to the face of the wheel. In particular, a crown gear is a type of bevel gear where the pitch cone angle is 90 degrees.



19. How bevel gears are manufactured?

[May/June 2016]

Bevel gears can be manufactured through the gear hobbing and machining process.

20. What kind of contact is required between worm and worm wheel? How does this differ from other gears?

[Nov/Dec 2015]

Sliding contact is required between worm and worm wheel. For other gears Line contact is required for other gears.

21. What is a Zerol Bevel Gears?

[April/May

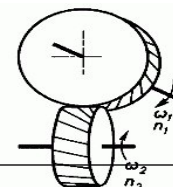
2015] Spiral bevel gears with curved teeth but with a zero degree spiral angle are known as zerol bevel gears.

22. Mention the advantages of worm gear drive?

[Nov/Dec 2014] Worm gears are used to transmit power between two non-intersecting, non-parallel shafts. Worm gears can be used for high speed reduction ratios as high as 300:1.

23. When do we employ crossed helical gear? [Nov/Dec 2012]

crossed helical gear sets are used to transmit power and motion between



non- intersecting and non-parallel axes. Both of the gears that mesh with each other are involute helical gears, and a point contact is made between them. They can stand a small change in the center distance and the shaft angle without any impairment in the accuracy of transmitting motion.

24. List the various types of Bevel gears?

[May/June 2012]

1.Straight bevel gears 2.Spiral bevel gears 3.Zerol bevel gears 3.Hypoid gears

25. What are the various losses in the worm gear drive?

[May/June

2012] Worm drives have high power losses .A disadvantage is the potential for considerable sliding action, leading to low efficiency. They produce a lot of heat.High-ratio units have a smaller gear-tooth lead

(helix) angle, which causes more surface contact between them. This higher contact causes higher friction and lower efficiency. Typical worm-gear efficiencies range from 49% for a 300:1, double- reduction ratio, up to 90% for a 5:1, single-reduction ratio. For this reason, these units are usually more suitable for low ratios.

29. What are the disadvantages of worm gear drive?

[Nov/Dec 2017] 1.Due to the friction caused by the sliding contact of the gears, worm gears have high operating temperatures and low efficiency.2. since the worm wheel is often made of bronze, which is a softer metal, the worm wheel will wear. 3. Relatively costly to fabricate.

30. What is irreversibility in worm gear?

[Nov/Dec 2018] Neglecting friction in the bearings, worm gearing is irreversible when the lead angle is equal to or less than the angle of friction. When worm gearing is self-locking or irreversible, this means that the worm-gear cannot drive the worm.

31. What is Crown and miter gear?

[Apr/May 2019]

A crown gear is a gear which has teeth that project at right angles to the face of the wheel. Miter gears are one type of bevel gears where the two rotational axes intersect.

32. Define Pitch and Lead of Worm Gear.

[Apr/May 2019]

Lead (L) – is the axial advance of a helix for one complete turn, as in the threads of cylindrical worms and teeth of helical gears.

Pitch is defined as the axial distance between adjacent threads on a helix.

UNIT-4 GEAR
BOXES PART-A -
C309.4

1. Comment on the number of gears to be used in the output shaft. [May/June 2012]

It is practiced in the gear box that output shaft is fixed with maximum of three gears.

2. Calculate standard step ratio for six speed gear box with speed ranging between 100 and 560rpm.

$$\phi = [N_{\text{Max}}/N_{\text{Min}}]^{1/n-1} = [560/100]^{1/6-1} = 1.411$$

3. Select 3 pairs of gears with total teeth for each pair 60 and speed ratios 1, 1.41, and 2.

$$z_1 + z_2 = z_3 + z_4 = z_5 + z_6 = 60; i = z_2/z_1 = 1; i = z_4/z_3 = 1.41;$$

$$i = z_6/z_5 = 2 \quad z_1 = 30; z_2 = 30; z_3 = 25; z_4 = 36; z_5 = 20;$$

$$z_6 = 40$$

4. Differentiate ray diagram and structural diagram? (or) What does the ray diagram of gear box indicates? What is a speed diagram?

[May/June 2012, Nov/Dec 2016, April/May

2018] The ray or speed diagram is a graphical representation of the drive arrangement in general form. It serves the specific values of all the transmission ratios and speed of all the shafts in the drive.

The structural diagrams are drawn from the structural formulae which is a graphical tool used to find the range ratio of transmission groups. The structural diagram gives information about the number of shafts and the number of gears on each shaft.

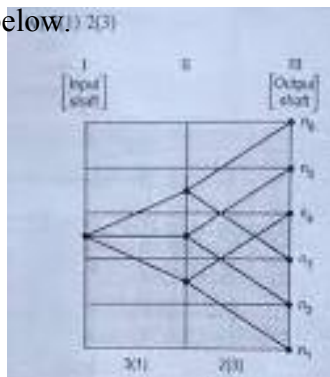
5. What is the function of spacers in a gear-box?

The function of spacers is to provide the necessary distance between the gears and the bearings.

6. Draw the ray diagram for a 6 speed gear box. [April/May 2015]

A typical ray diagram for a twelve speed gear box, for the preferred structural formula

3(1) 2(3) is shown below:



7. What are the methods of lubrication in speed reducers?

Splash or spray lubricating method and * Pressure lubrication method.

8. List any two methods used for changing speeds in gear boxes.

[Nov/Dec 2016]

1. Sliding mesh gear box and 2. Constant mesh gear box

10. What are preferred numbers?

[Apr/May 2011, 2013, Nov/Dec

2014] Name the series in which speeds of multi speed gear box are arranged. [May/June

2014] Preferred numbers are the conventionally rounded off values derived from geometric series. There are five basic series, denoted as R 5, R 10, R 20, R 40 and R 80 series.

11. What is step ratio? (or) Define progression ratio.

[Nov/Dec 2015, 2018, May/June 2014]

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.

12. What does the ray-diagram of gear box indicate?

[May/June 2012, Apr/May

2017] The ray diagram is a graphical representation of the drive arrangement in general form.

It serves to determine the specific values of all the transmission ratios and speeds of all the shafts in the drive.

13. State any three basic rules to be followed while designing a gear box. (or) Write any two principles to be followed to obtain optimum design in gear box.

[Nov/Dec 2017]

The transmission ratio (i) in a gear box is limited by $\frac{1}{4} \leq i \leq 2$. (ii) For stable operation, the speed ratio of any stage should not be greater than 8. i.e., $N_{\max}/N_{\min} \leq 8$. (iii) In all stages except in the first stage, $N_{\max} \geq N_{\text{input}} > N_{\min}$.

14. What is a speed reducer?

Speed reducer is a gear mechanism with a constant speed ratio, to reduce the angular speed of output shaft as compared with that of input shaft.

15. What are the possible arrangements to achieve 12 speeds from a gear box? [April/May 2011, May/June 2013]

The possible arrangements are: (i) 3 x 2 x 2 scheme (ii) 2 x 3 x 2 scheme and (iii) 2 x 2 x 3 scheme.

16. List out the possible arrangements to achieve 16 speed gear box.

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

17. Specify four types of gear box.

[Nov/Dec 2014]

Sliding mesh gear box, constant mesh gear box, synchromesh gearbox, planetary gearbox

18. What is multispeed gear box?

[May/June

2016] A gearbox that converts a high speed input into a number of different speed output it is

called a multi-speed gear box. Multi speed gear box has more than two gears and shafts. A multi speed gearbox reduces the speed in different stages.

19. Why geometric progression is selected for arranging the speeds in gear box?

[Apr/May

2017] When the speeds are arranged in G.P , it has the following advantages over the other progressions. 1.The speed loss is minimum 2.No.of gears to be employed is minimum 3.G.P provides a more evenrange of spindle speeds at each step. 3.The lay out is comparatively very compact. 4.G.P m/c tool spindle speeds can be selected easily from preferred numbers, Because preferred numbers are in geometric progression.

20. What is R20 series?

[May/June 2016]

In industrial design, preferred numbers (also called preferred values, preferred series or convenient numbers are standard guidelines for choosing exact product dimensions within a given set of constraints. Product developers must choose numerous lengths, distances, diameters, volumes, and other characteristic quantities. Preferred numbers represent preferences of simple numbers (such as 1, 2, and 5) and their powers of a convenient basis, usually 10. The R5, R10 and R20 series refers to the Renard 5 (first-choice sizes 60 % increments), Renard 10 (second-choice sizes 25 % increments) and Renard 20 (third-choice sizes 12 % increments) series of preferred numbers standardized in ISO3.

21. Write the significance of structural formula?

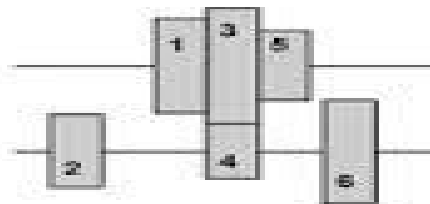
[Nov/Dec 2015] Structural

formula

is used to to find the number of speeds (n)available at the spindle and through no. Stages it can be achieved.

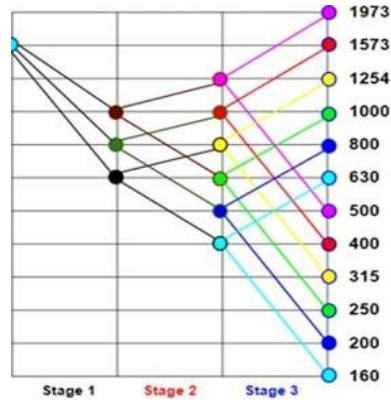
$$n = p_1 (X_1) . p_2 (X_2) . p_3 (X_3) \quad p = \text{stages in the gear box, } X = \text{Characteristic of the stage.}$$

22. Sketch the kinematics layout of gears for 3 speeds between two shafts.



23. Draw the ray diagram for 12 speed gear box?

[May/June 2013, Nov/Dec 2017]

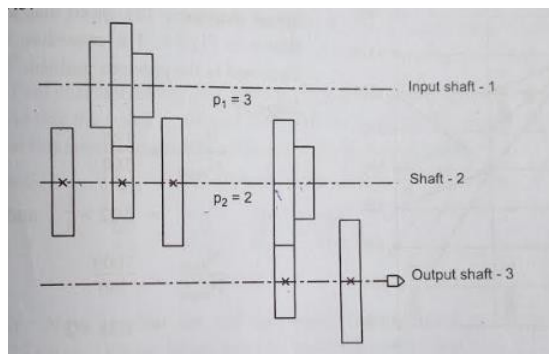


24. List four application where constant mesh gear box is used? [Nov/Dec 2012] Vehicles which use this type of gearboxes are farm trucks, motorcycles, and heavy machinery. The availability of such mechanisms like constant mesh gearbox which create less noise and are cost effective.

25. What are the conditions required for interchangeability of toothed Gears? [Nov/Dec 2012] For interchangeability of all gears, the set must have the same circular

pitch, module, diameter pitch, pressure, angle, addendum and dedendum and tooth thickness must be one half of the circular pitch.

26. Draw the kinematic layout for the 6-speed gear box. [Apr/May 2019]



27. What is a Torque Converter? [Apr/May 2019] A torque converter is a type of fluid coupling which transfers rotating power from a prime mover to a rotating driven load.

28. List out all possible arrangements to achieve 16 speed gear box. [Nov/Dec 2018]
3(1) 3(3) 2(5)

2(1) 3(2) 3(5)

3(1) 2(3) 3(5)

UNIT-5 CAM, CLUTCHES AND BRAKES

PART-A - C309.5

1. Explain the desirable properties of friction material used for the lining of brake shoes.(or)

What are the desirable properties of friction material to be used for clutches?

*A high and uniform coefficient of friction * Good resiliency * the ability to withstand high temperatures, together with good heat conductivity. * High resistance to wear, scoring and galling. Friction materials are basically composite materials made up of strands and fibre composites.

2. Why in automobiles, braking action when travelling in reverse is not as effective as when moving forward? [April/May 2015]

When an automobile moves forward, the braking force acts in the opposite direction to the direction of motion of the vehicle Whereas in reverse travelling the braking force acts in the same direction to the direction of motion of the vehicle. So it requires more braking force to apply brake.

3. Distinguish between coupling and a clutch? [Nov/Dec

2012] Couplings are used as permanent connecting elements between two power transmitting elements whereas clutches are used as temporary connecting elements. Thus periodical engagement is possible in clutch connection.

4. Classify clutches based on the coupling methods. [May/June 2014]

*Positive contact clutches * Frictional clutches * Overrunning clutches * Magnetic clutches and Fluid couplings.

5. What is fade? [May/June 2012/May/June

2013] When the brake is applied continuously over a period of time, the brake becomes overheated and the coefficient of friction drops. This results in sudden fall of efficiency of the brake. This phenomenon is known as 'fade' of 'fading'.

6. What are the effects of temperature rise in clutches ? [May/June 2013]

Because the temperature rise beyond the permissible range in brakes will cause:

(i) excessive wear (ii) distortion of the brake linings and (iii) surface cracks due to thermal stresses.

7. Name four materials used for lining of friction surfaces in clutches.(or) Name few commonly used friction materials. [Nov/Dec 2018]

(i) Wood(ii) Cork (iii) Leather (iv) Asbestos based friction materials and (v) Powdered metal friction materials.

8. If a multidisc clutch has 8 discs in driving shaft and 9 discs in driven shaft, then how many number of contact surfaces it will have? [April/May

2015] Given data : $n_1 = 8$; $n_2 = 9$ Solution : Number of pair of contact surface, $n = n_1 + n_2 - 1 = 8 + 9 - 1 = 16$

9. What is the function of a clutch in a transmission systems? [May/June

2016] The clutch is a mechanical device which is used to connect or disconnect the source of power at the operator's will.

10. What is the axial force required at the engagement and disengagement of cone clutch?

[May/June 2013]

For engagement : $W_e = W_n (1 + \mu \cot \alpha)$, For disengagement: $W_d = W_n (1 - \mu \cot \alpha)$.

11. What is a self-locking brake? [Apr/May 2011, May/June 2013, Nov/Dec

2012, 2018] When the frictional force is sufficient enough to apply the brake with no external force, then the brake is said to be self-locking brake.

12. What you meant by self-energizing brake? [Nov/Dec 2016, 2017 May/June 2014, 2013]

When the moment of applied force ($F \cdot l$) and the moment of the frictional force ($\mu \cdot R_N \cdot c$) are in the same direction, then frictional force helps in applying the brake. This type of brake is known as a self-energizing brake.

13. How can pressure angle be reduced in cam design? [May/June

2012] It can be reduced by increasing the cam size or by adjusting the offset. Higher the pressure angle higher the side thrust and higher the chances of jamming the translating follower in its guide ways.

14. Name different types of clutch.

*Single Plate clutch*Multi plate Clutch*Cone Clutch*Centrifugal Clutch

15. How does the function of a brake differ from that of a clutch? [April/May

2018, 2019] Clutch used to engage and disengage the engine from the transmission system when applied. Brake is used to stop the vehicle when applied due to frictional power.

16. What is the significance of pressure angle in CAM design? [May/June

2016] It is the measure of steepness of the cam profile. The angle between the direction of the follower movement and the normal to the pitch curve at any point is called pressure angle. Pressure angle varies from maximum to minimum during complete rotation.

17. Mention a few applications of Cams?

[Nov/Dec2016] Cam mechanisms are used in various areas of machine building, such as internal-combustion engines, metal-cutting machines, and machines of the food industry, in which the cam mechanism performs a programmed operation, as well as in automated machines, in which cam mechanisms perform control functions, connecting and disconnecting working parts at the proper moment. **18. Differentiate a brake and a dynamometer?** **[April /May 2017]**

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

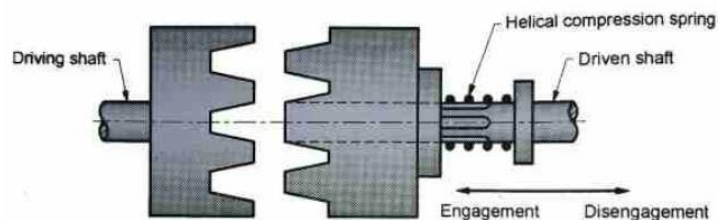
A dynamometer is a brake incorporating a device to measure the frictional resistance applied. This is used for measuring the driving forces or torque transmitted and hence the power developed by the machine.

19. Double shoe brakes are preferred than single shoe brakes. Why? **[April /May 2017]** If only one block is used for braking, then there will be side thrust on the bearing of wheel shaft. This drawback can be removed by providing two blocks on the two sides of the drum. The double shoes on the drum reduce the unbalanced force on the shaft.

20. Name the profile of cam that gives no jerk? **[Nov/Dec 2015]**

Cycloidal curve profile of cam that gives no jerk.

21. What is meant by positive clutch? **[Nov/Dec 2015]** Positive clutch is a mechanical device and type of clutch used for engage and disengage power transmission from driving shaft to driven shaft. Positive clutch is used where positive drive (torque transmit without slip) is required.



22. Differentiate between uniform pressure and uniform wear theories adopted in the design of clutches? **[Nov/Dec 2014]**

Uniform Pressure Theory:

When the mating component in clutch, bearing are new, then the contact between surfaces may be good over the whole surface. It means that the pressure over the rubbing surfaces is uniform distributed. This condition is not valid for old clutches, bearings because mating surfaces may have uneven friction. The condition assumes

that intensity of pressure is same. $P = W/A = \text{Constant}$; where, $W = \text{load}$, $A = \text{area}$

Uniform wear theory:

When clutch, bearing become old after being used for a given period, then all parts of the rubbing surfaces will not move with the same velocity. The velocity of rubbing surface increases with the distance from the axis of the rotating element. It means that wear may be different at different radii and rate of wear depends upon the intensity of pressure (P) and the velocity of rubbing surfaces (V). It is assumed that the rate of wear is proportional to the product of intensity of pressure and velocity of rubbing surfaces. This condition assumes that rate of wear is uniform; $P \cdot r = \text{Constant}$; where, $P = \text{intensity of pressure}$, $r = \text{radius of rotation}$

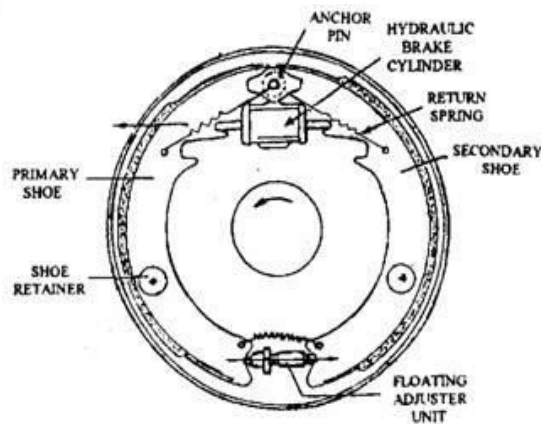
23. In a hoisting machinery, what are the different energies absorbed by a brake system?

[Nov/Dec

2014] In hoists and elevators, the potential energy and Kinetic energy released by the objects during the braking period is absorbed by the brake,

24. Sketch the internal shoe brake and name the various parts?

[May/June 2012]



25. In cone clutches semi-cone angle should be greater than 12 deg. Why? [May/June 2012]

The semi cone angle α is kept greater than a certain value to avoid self-engagement; otherwise disengagement of clutch would be difficult. This is kept around 12.5deg. if the angle is less than this value than the clutch is liable to jam in engagement

26. What are the types of brakes used in modern vehicles?

[April/May

2018] There are two kinds of service brakes, or the brakes that stop your vehicle while driving: disc and drum brakes. Additionally, almost all vehicles come with emergency brakes and anti-lock brakes.

27. Write the difference between dry and wet clutch?

[Nov/Dec 2017]

s.no	Dry clutch	Wet clutch
1	A dry clutch is a clutch which does not have oil present between the clutch plates	Physical oil is present between the plates of the clutch
2	Sound, Wear and tear is more in dry clutch	Less in wet clutch
3	Maintenance cost is high	Maintenance cost is Low
4	The life is less as compared to wet clutch	The life is high as compared to wet clutch

28. Why are Cone clutches better than disc clutches?

[Apr/May 2019]

The cone clutch transfers a higher torque than plate or disk clutches of the same size due to the wedging action and increased surface area.

PART B QUESTIONS**UNIT 1**

1. A V belt drive is to transmit 45 kW in a heavy duty saw mill which works in two shifts of 8 hours each. The speed of the motor shaft is 1400 rpm with an approximate speed reduction of 3 in the machine shaft. Design the drive and calculate the average stress induced in the belt. [M/J 14]
2. A bucket elevator is to be driven by a geared motor and a roller chain drive with the information given below. Motor shaft = 3KW, Speed of motor shaft = 100 rpm, Elevator drive shaft speed = 42 rpm, Load is even. Distance bet. Centres of sprockets approximately 1.2m, period of operation is 16 hrs/day. Geared motor is mounted on an auxillary bed for centre distance adjustments. Design the chain drive [Nov-Dec 2016]
3. Design a chain drive to run (actuate) a compressor from a 15 kW electric motor running at 1000rpm, the compressor speed being 350 rpm. The compressor operates 15 hours/day. The centre distance should be approximately (minimum) 500 mm. The chain tension can be adjusted by shifting the motor. [April/May 2018]
4. A 7.5kW electric motor running at 1400rpm is used to drive the input shaft of the gearbox of a special purpose machine. Design a suitable roller chain to connect the motor shaft to the gear box shaft to give an exact speed ratio of 10 to 1. Assume the minimum centre distance between driver and driven shafts as 600 mm. [A/M 2015]
5. 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 the driven sprocket at 400 rpm with a centre distance of approximately 600 mm. select the roller chain. Select the roller chain. Number of teeth on driving sprocket can be taken at the middle of Pmax and Pmin values. [April/May 2017]
6. Design a flat belt drive to transmit 110KW for a system consisting of two pulleys of diameter 0.9m and 1.2m respectively, for a center distance of 3.6m, belt speed of 20m/s and co-efficient of friction = 0.3. There is a slip of 1.2% at each pulley and 5% friction loss at each shaft with 20% overload. [May/June 2016]

7. Select a suitable v belt and design the drive for a wet grinder. Power is available from a 0.5 kW motor running at 750 rpm. Drum speed is to be about 100 rpm . Drive is to be compact. [Nov/Dec 2015]
8. Select a wire rope for a vertical mine hoist to lift a load of 20 KN from a depth of 60 meters . A rope speed of 4 m/s is to be attained in 10 seconds.[Nov/Dec 2015]
9. A compressor is to run by a motor pulley running at 1440 rpm.Speed ratio 2.5.Choose a flat belt crossed drive.Centre distance between pulley is 3.6m.Take belt speed as 16m/s.Load factor is 1.3 . Take a 5ply flat Dunlop belt.Power to be transmitted is 12KW.High speed load rating is 0.0118KW/ply/mm.width at $V=5\text{m/s}$.Determine the width and length of the belt. [Nov/Dec 2014]
10. At the construction site 1 tonne of steel is to be lifted up to a height of 20 m with the help of 2 wire rope of 6x19 size nominal diameter 12mm and breaking load 78KN.Determine the factor of safety if the sheave diameter is 56 d and if wire rope is suddenly stopped in 1sec when travelling at a speed of 1.2m/s.What is the factor of safety if bending load is neglected.? [Nov/Dec 2014]

UNIT 2

1. Design a gear drive to transmit 22kW at 1000rpm. Speed reduction is 2.5. The centre distance between the shafts is approximately 350mm. The materials are: pinion - c45, gear wheel: CI Grade 30. Design the drive.(Use Lewis and Buckingham equations). [May/June 2013]
2. Design a pair of helical gears to transmit 10 kW at 1000 rpm of the pinion. Reduction ratio of 5 is required. [Nov/Dec 2015]
3. Design a helical gear drive to transmit the power of 14.7 KW.Speed ratio 6, pinion speed 1200 rpm, helix angle is 25 deg.Select suitable materials and design the gear? [April/May 2015]
4. A speed reducing unit using spur gear is to be defined. Power to be transmitted is 60 hp and is continuous with moderate shaft loads. The speed of the shafts are 720 rpm and 144 rpm respectively. The center distance is kept as small as possible. Select a suitable material and design the gears. Give the details of the gears. [May/June 2016]
5. A pair of helical gears is subjected to moderate shock loading is to transmit 30 KW at 1500 rpm of the pinion. The speed reduction ratio is 4 and the helix angle is 20° . The service is continuous and the teeth are 20° FD in the normal plane. For gear life of 10,000 hours, design the gear drive. [May/June 2016]
6. Design a pair of straight spur gear drive for a stone crusher, the pinion and wheel are made of C15 steel and cast iron grade 30 resply.The pinion is to transmit 22KW power at 900 rpm.The gear ratio is 2.5.Take pressure angle of 20 degrees and working life of gears as 10,000hrs. [Nov/Dec 2016]
7. Design a pair of helical gear to transmit 10KW at 1000rpm of the pinion.Reduction ratio of 5 is required.Pressure angle is 20degrees and the helix angle is 15 degrees.The material for both the gears is 40Ni2Cr1Mo28.Give the details of the drive in a tabular form. [Nov/Dec 2016]
8. Design a spur gear drive required to transmit 45 KW at pinion speed of 800 rpm velocity ratio is 3.5 :1. Teeth are 20 deg full depth involute with 18 teeth on the pinion. Both the pinion and gear are made of steel maximum safe static stress of 180 N/mm² [N/D 15]
9. Design and draw a spur gears drive transmitting 30 KW at 400 rpm to another shaft running at 1000 rpm the compressor speed being 350 rpm the minimum centre

distance is 500 mm . The compressor operates 15 hours per day. The chain tension may be adjusted by shifting the motor. [May/June 2014]

10. Design a general purpose enclosed gear train is based on parallel helical gears, specified life is 36000 hrs. Torque at driven shaft is 411 Nm. Driving shaft speed is 475 rpm. Velocity ratio is 4. It is desired to have standard centre distance?
[Nov/Dec 2017]

UNIT 3

1. Design a worm gear drive to transmit a power of 22.5 kW at a worm speed of 1440 rpm. The speed of the wheel is 60 rpm. The drive should have a minimum efficiency of 80% and above. Select suitable materials for worm and wheel and decide upon the dimensions of the drive. [May/June 2013]
2. . 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°C. Determine the required cooling area. [Nov/Dec 2017]
- 3.. Design a bevel gear drive to transmit 7 kW at 1600 rpm for the following data. Gear ratio = 3. Material for pinion and gear C45 steel, Life = 10,000 hours [April/May 2018]
4. Design a bevel gear drive to transmit 7.5 kW at 1440 rpm. Gear ratio 3. Pinion and gear are made of forged C45 steel. Life of gears 10,000 hrs. Assume surface hardened heat treatment and IS quality 6. [April /May 2017]
5. Design a worm drive for a speed reducer to transmit 15 kW at 1440 rpm of the worm shaft. The desired wheel speed is 60 rpm. Select suitable worm and wheel materials. [Nov/Dec 2012]
6. A Hardened Steel worm rotates at 1440 rpm and transmits 12 kW to a phosphor bronze gear. the speed of the worm wheel should be 60 ± 3 % rpm. Design a worm gear drive if an efficiency of at least 82 % is desired. [N/D 2014, 2016]
7. Design a bevel gear drive to transmit 3.5 kW. Speed ratio = 4. Driving shaft speed = 200 rpm. The drive is non-reversible. Pinion is of steel and wheel of C.I. Assume a life of 25,000 hours. [May/June 2016]
8. Design a worm gear drive to transmit 20 kW at 1440 rpm speed of worm wheel is 60 rpm. [May/June 2016]
9. Design a bevel gear drive to transmit 20 HP from a worm at 1440 rpm to the worm wheel. Assume the bronze is sand chill cast. The speed of the wheel should be 40 ± 2 % rpm, initial sliding velocity can be assumed as 3 m/s and efficiency as 80%. [April /May 2017]
10. Design a straight bevel gear drive between two shafts at right angles to each other. Speed of the pinion shaft is 360 rpm and the speed of the gear wheel shaft is 120 rpm. Pinion is of steel and wheel of cast iron. Each gear is expected to work 2 hours/day for 10 years. The drive transmits 9.37 kW. [Nov/Dec 2015]

UNIT 4

1. Design a 9 speed gear box for a milling m/ with speeds ranging from 56 to 900 rpm. The o/p speed 720 rpm. Make a neat sketch of the gear box. Indicate the no. of teeth on all the gears and their speeds. Assuming the gears and shafts are made of C45 steel, calculate module, centre distance of the spindle. [April /May 2017]

2. In a machine tool application, 12 different speeds are required from 125 rpm to 450 rpm in the output shaft. The motor speed is 630 rpm. (1) Determine the 12 standard speeds in G.P. (2) Draw the ray diagram. (3) Sketch the kinematic layout. (4) Determine the number of teeth on the gears to be used.
[May/June 2013]
3. Design the layout of 12 speed gear box for a milling machine having an output of speeds ranging from 25 to 600 rpm. Power is applied to the gear box from 2.25 kW induction motor at 1440 rpm. Construct the speed diagram using standard speed ratio. Calculate the no. of teeth on each gear and sketch the arrangement of the gear box. [Apr/May 2013, Nov/Dec 2016]
4. Design a 12 speed gear box for a lathe. The minimum and maximum speeds are 100 and 1200 rpm. Power is 5 kW from 1440 rpm induction motor. Construct the speed diagram using a standard speed ratio. Calculate the number of teeth in each gear wheel and sketch the arrangement of the gear box. [April/May 2015] [April/May 2018]
5. The spindle of a pillar is to run at 12 different speeds in the range of 100 to 355 rpm. Design the gear box. Sketch the layout of the gear box indicating the number of teeth on each gear. Minimum no. of teeth on a gear is 25. Also calculate the percentage deviation of the obtainable speeds from the calculated ones. [April/May 2017] [Nov/Dec 2017]
6. A gear box is to be designed to provide 18 speeds for the spindle of a milling machine. The max. & min. speeds of the spindle are to be around 650 rpm & 35 rpm respectively. Find the speed ratios which will give the desired speeds and draw the structural diagram and kinematic arrangement of the drive.
[Nov/Dec 2015]
7. A sixteen Speed Gear box is Required to Furnish output speeds in the range of 100 rpm to 560 rpm. Sketch the Kinematic arrangement and draw the speed diagram.
[Nov/Dec 2014]
8. A six speed gearbox is required to provide output speeds in the range of 125 to 400 rpm, with a step ratio of 1.25 and transmit a power of 5 kW at 710 rpm. Draw the speed diagram and kinematic diagram. Determine the number of teeth module and face width of all gears, assuming materials for gears. Determine the length of the gear box along the axis of the gear shaft.
[May/June 2016]
9. Draw the kinematic diagram and speed diagram of the head stock gear box of a turret lathe having arrangement for spindle speeds, ranging from 31.5 rpm to 1050 rpm. Calculate the number of teeth on each gear. Minimum number of teeth on a gear is 25. Also calculate the percentage deviation of the obtainable speeds from the calculated ones. [May/June 2016]
10. Sketch the arrangement of a six speed gear box for a minimum speed of 460 rpm and a maximum speed of 1400 rpm. Draw the speed diagram and kinematic arrangement showing number of teeth in all gears. Check whether all the speeds obtained through the selected gears are within $\pm 2\%$ of standard speeds. The drive is from an electric motor giving 2.25 kW at 1440 rpm.
[Nov/Dec 2016]

UNIT 5

1. A plate clutch with maximum diameter 60 mm has maximum lining pressure of 0.35 MPa. The power to be transmitted at 400 rpm is 135 kW and $\mu = 0.3$. Find inside

diameter and spring force required to engage the clutch. Springs with spring index 6 and material spring steel with safe shear stress 600 MPa are used. Find the wire diameter if 6 springs are used. [Nov/Dec 2014]

2. A single disk clutch having one pair of contacting surfaces is required to transmit 10 kW at 720 rpm under normal operating conditions. Due to space limitations, the outer diameter should be limited to 250 mm. The coefficient of friction is 0.25 and the permissible intensity of pressure is 0.5 N/mm². Use (a) uniform pressure theory and (b) uniform wear theory and determine the clutch dimensions.

[April/May 2018]

3. A power of 20 kW is to be transmitted through a cone clutch at 500 rpm. For uniform wear condition, find the main dimensions of clutch and shaft. Also determine the axial force required to engage the clutch. Assume coefficient of friction as 0.25, the maximum normal pressure on the friction surface is not to exceed 0.08 MPa and take the design stress for the shaft material as 40 MPa.

[April/May 2015]

4. A differential band brake is operated by a lever of length 500 mm. The brake drum has a diameter of 500 mm and the maximum torque on the drum is 1000 Nm. The band brake embraces 2/3rd of the circumference. One end of the band is attached to a pin 100 mm from the fulcrum and the other end of the band is attached to a pin 80 mm from the fulcrum and on the other side of it when operating force is also acting. Coefficient of friction 0.3, find the operating force. Design the steel band, shaft and key. The permissible stresses may be taken as 70 MPa in tension, 50 MPa in shear and 20 MPa in bearing. The bearing pressure for the brake lining should not exceed 0.2 N/mm². Nov/Dec 2014

5. 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.

[May 2013]

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

[April/May 2015]

7. A multiplate clutch with both sides effective transmits 30 kW at 360 rpm. Inner and outer radii of the clutch discs are 100 mm and 200 mm respectively. The effective co-efficient of friction is 0.25. An axial load of 600 N is applied. Assuming uniform wear conditions, find the number of discs required and the maximum intensity of pressure applied.

[May/June 2016]

8. A 50 kg wheel, 0.5 m in diameter turning at 150 rpm in stationary bearings is brought to rest by pressing a brake shoe radially against the rim with a force of 100 N. If the radius of gyration of wheel is 0.2 m, how many revolutions will the wheel make before coming to rest? Assume that the co-efficient of friction between shoe and the rim has the steady value of 0.25.

[May/June 2016]

9. A multiplate clutch, steel on bronze is to transmit 6 kW power at 750 rpm. The inner radius of contact surface is 4 cm and outer radius is 7 cm. The clutch plates operate in oil, so the co-efficient of friction is 0.1. The average pressure is 0.35 N/mm². Determine (i) the total number of steel and bronze friction discs (ii) actual axial force required (iii) actual average pressure (iv) actual maximum pressure.

[Nov/Dec 2016]

10. A multi disc clutch, steel on bronze is to transmit 20KW at 1440 rpm. The clutch is to be operated in oil with the coefficient of friction 0.08 and average pressure 0.3MPa. Space limitations permits only 230mm as outside diameter of the clutch. Assuming uniform pressure, determine (i) size of the clutch, if the ratio of the mean radius to face width is 3 (ii) actual axial force required (iii) actual average pressure. The ratio of R_i/R_0 can be chosen between 0.5 to 0.75 suitably and logically.
[Apr/May 2017]