ME 8651 DESIGN OF TRANSMISSION SYSTEMS

IMPORTANT QUESTIONS AND QUESTION BANK

UNIT-1 DESIGN IF FLEXIBLE ELEMENTS

2-Marks

1. What are the materials used for belt drive?
2. Why slip is less in the case of V-belts when compare this flat belts?
3. Give an expression for ratio of tensions in a flat belt drive?
4. How is a V-belt specified?
5. Distinguish between open drive and close drive for a belt drive. Which is better?
6. Give the advantages of chain drives over belt drives?
7. Specify the five parts of roller chain?
8. Give any three applications of chain drives?
9. What are the limitations of chain drives?
10. List out the various stresses induced in the wire ropes?

13-Marks

1. Calculate the power capacity of the leather belt of 9mm x 250mm is used to drive a CI pulley 900mm in diameter at 336rpm. If the active arc on the smaller pulley is 120o and stress in tight side is 2Mpa. The density of the leather may be taken as 980 kg/m3 and coefficient of friction of leather on CI is 0.35.

2. Design a flat belt drive for a fan running at 360rpm which is driven by a 10 KW at1440 rpm motor. The belt drive is open type and the distance between the pulley Centres is 2000 mm .The diameter of a driven pulley is 1 m

3. Design a flat belt drive to transmit 20kW at 720rpm. The centre distance is 3m and the speed ratio is 3. Diameter of rolling pulley is 1.2 m

4. Design a flat belt drive to transmit 15 KW at 480rpm from an engine to line shaft at 1200 rpm. The centre distance between the pulleys 2

5. A flat belt drive is required to transmit 12 KW from a motor running 720 rpm. The belt is 12 mm thick and has mass density of 0.001 gm/mm3. Permissible stress in the belt not to exceed 2.5 N/mm2.Diameter of driving pulley is 250 mm whereas the speed of driven pulley is 240 rpm. The two shafts are 1.25 m apart, coefficient of friction is 0.25. Determine the width of the belt.

6. Design a suitable V-belt for a centrifugal pump running at 340 rpm is to be driven by 100 KW motor at 1440 rpm. The drive is to work at least 20 hours every day?

7. Design a V-belt drive to transmit 10kW at 400 rpm. The speed ratio is 3. Centre distance between the pulleys is 600 mm and the drive is crushers

8. 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 n1 = 1000 rpm, n2 = 300 rpm and power, P = 7.5kW.
9. A truck equipped with 9.5 KW engine uses a roller chain of the final drive to the rear axle. The driving sprocket runs at 900 rpm and driven sprocket at 400 rpm with a center distance of approximately 600 mm. select a suitable the roller chain

10. A roller chain drive is used between a driver shaft running at 1440rpm and a driven shaft running approximately at 720rpm. The power transmitted is 15KW. The drive is to be used for 2 shifts/day with 8hours/shift. The center distance is approximately 1000mm and the chain tension can be adjusted by moving the motor in the rails. Design the drive.
11. A compressor is to run by a motor pulley running at 1440 rpm, speed ratio 2.5. Choose a flat belt crossed drive. Centre distances between pulley is 3.6m take belt speed as 16m/s. Load factor is 1.3 take a 5 ply, flat belt. Power to be transmitted to be 12 KW. High speed load rating is 0.0118KW/Ply/mm width at V=5 m/s .Determine the width and length of the belt.
12. At the construction site,1 ton of steel is to be lifted up to a height of 20m with the help of 2 wire ropes of 6x 19 size, nominal diameter 12mm and breaking load 78 KN. Determine the factor of safety if the sheave diameter is 56 d and if wire rope is suddenly stopped in 1 second when travelling at a speed of 1.2 m/s. What is the factor of safety if bending load is neglected?
13. A leather belt 9mm*250mm is use to drive a cast iron pulley 900 mm in diameter at 336 rpm. If the active are on the smaller pulley is 120^{o}and stress in tight side is 2 MPa, find the power capacity of the belt. The density of the leather may be taken as 980 kg/m3 and coefficient of friction of leather on cast iron is 0.35.
14. 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 respectively, for a centre distance of 3.6 m, belt speed of 20 m/s and coefficient of friction =0.3.There is a slip of 1.2% at each pulley and 5% friction loss at each shaft with 20% over load
15. Design a chain drive to actuate a compressor from 15 KW electric motor 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

UNIT-2 SPUR GEARS AND PARALLEL AXIS HELICAL GEARS

2-Marks

1. State law of gearing and summarize how interference can be avoided in gear.
2. Name the profiles of spur gear. List the various methods of manufacturing gears
3. Describe the following (i) Pressure angle (ii) Diametrical pitch iii) module
4. List the different types of gear mechanism
5. Describe backlash. What factors influence backlash?
6. Explain undercutting in gears
7. Why is gear tooth subjected to dynamic load?
8. Classify the main types of gear tooth failure?
9. Integrate the materials commonly used for gears.
10. Differentiate involute and cycloid profiles

13-Marks

1. Design a pair of straight spur gear drive for a stone crusher, the gears are made of C40 steel. The pinion is to transmit 30 KW at 1200 rpm. The gear ratio is 3. The gear is to work 8 hours/day 6days in a week for 3 years.
2. Design a spur gear pair to transmit 22.5KW at 900 rpm. Speed reduction ratio is 2.5. Material for pinion and wheel are C15 steel and cast iron grade 30 respectively. Take pressure angle 200 and working life of gear is 10,000 hours.
3. Design a spur gear drive required to transmit 45 KW at pinion speed of 800 rpm. The velocity ratio is 3.5:1. The teeth are 200 full depth involute with 18 teeth on the pinion. Both the pinion and gear are made of a steel with maximum safe static stress of 180 N/ mm^2
4. Design a straight spur gear drive to transmit 8KW. The pinion speed is 720rpm 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 350BHN. Ultimate strength is 720N/$mm^2$and yield strength is 360 N/mm^2.
5. Design a spur gear to transmit 2 KW at 1440 rpm. Desired speed ratio is 3. Use C45 steel for gears
6. A 37.5 kW power is transmitted at 450 rpm to a shaft running at approximately 112 rpm through a spur gear drive. The load is steady and continuous. Design the gear drive and check the design. Assume the following materials: Pinion-heat treated cast steel; Gear-High grade cast iron.
7. Design a spur gear drive for a heavy machine tool with moderateshocks. The pinion is transmitting 18KW at 1200 rpm with a gear ratio of 3.5. Design the

drive and check for elastic stress and plastic deformation. Make a sketch and label important dimensions arrived

8. Design a helical gear to transmit 15 KW at 1440 rpm to the following specification. Speed reduction is 3, Pressure angle is 200and helix angle is 15 degree. The material for both the gears is C45 steel. Allowable static stress is 180 N/mm2, Surface endurance limit is 800 N/mm2 and Young's Modulus of material is 2 x 105N/mm^2
9. Design a helical gear for the following specification: Power - 12.5KW, Pinion speed-1200 rpm, Gear Ratio - 3.5, Pressure angle is 200, helix angle is 15 degree. Gear are expected to work 6 hours/day for 10 years
10. A helical gear with 30 degree 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, pitch diameter and face width for 20 degree full depth teeth. Assume 15Ni 2Cr 1 Mo15 material for both pinion and wheel
11. A helical gear speed up drive is required to drive a centrifugal compressor running at 3000rpm. The helical gear speed up unit is driven by an electric motor running at 1000rpm. The compressor requires a nominal input power of 12.5 KW. The helix angle of 250 may be assumed for the gears. Standard involute profile 200 full depth system will be used for the gear teeth. The gear pair is required to last for at least 10,000 hrs. Design the gear drive for the following materials. Pinion: Heat treated cast steel, Gear: High grade cast iron
12. Design a pair of helical gears to transmit 37.5KW at 1750 rpm of the pinion. The drive is subjected to heavy shock loading. The speed reduction ratio is 4 and the helix angle is 150. Select suitable material and design the gears. Check for working stresses and sketch the drive
13. Design a helical gear drive to transmit the power of 14.7KW. Speed ratio 6, pinion speed 1200rpm, helix angle is 250. Select suitable materials and design the gear
14. Design a pair of spur gear to transmit 20 KW at a pinion speed of 1440 rpm. The transmission ratio is 4.Assume 15Ni2Cr1Mo15 for pinion and C45 for gears
15. A speed reducing unit using spur gear is to be designed. Power to be transmitted is 60 hp and is continuous with moderate shaft loads. The speed of the shaft are 720 rpm and 144 rpm. The centr distance is kept as small as possible. Select a suitable material and design the gears. Give the details of the gear.

UNIT-III BEVEL,WORM AND HELICAL GEARS

2-Marks

1. Under what situation bevel gears are used
2. Write a short notes on Crown gear and Miter gear?

3. Mention two characteristics of hypoid gear?
4. How bevel gears are manufactures. Summarize zero bevel gear?
5. Define back cone radius for a bevel gear?
6. Define the following term i) Cone distance ii) Face angle?
7. Show when do you prefer worm and worm wheel drive?
8. Illustrate reference angle? How is related to speed ratio of bevel gear?
9. Why is the efficiency of worm gear drive comparatively low? obtained?
10. List the materials used for the manufacture of worm and worm and wheel. Justify?

13-Marks

1. Design a pair of bevel gears to transmit 10 kW at 1440 rpm of the pinion. The velocity ratio should be about 4. Material for gear is1 5 N i 2 C r 1M o 1 5 / Steel. The tooth profiles of the gears are of 20^o
2. Design a cast iron bevel gear drive for a pillar drilling machine to transmit 1875 Watts at 800rpm to a spindle at 400 rpm. The gear to work for 40 hr/week .pressure angle is 20 degree?
3. 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 gear wheel shaft is 120 rpm. Pinion is made of steel and wheel is made of cast iron. Each gears are expected to work 2 hrs./day for 10 years
4. 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 the worm gear drive if an efficiency of at least 82% desired?
5. A steel worm running at 240 rpm receives 1.5 KW from its shaft. The speed reduction is 10:1. Design the drive so as to have an efficiency of 80%. Also determine the cooling area required, if the temperature rise is restricted to 450C. Take overall heat transfer coefficient as 10 W/m^2 °C
6. Design the worm gear drive and determine the power loss by heat generation of Hardened steel worm rotates at 1440 rpm and transmits 12 KW to a phosphor bronze gear with gear ratio of 16
7. A hardened steel WORM rotates at 1260 rpm and transmits 8 KW to a phosphor bronze gear with gear ratio of 18. Design the worm gear drive and determine the power loss by heat generation
8. Design a worm gear drive to transmit 22.5KW at a worm speed of 1440 rpm. Velocity ratio is 24:1. An efficiency of at least 85% is desired. The temperature raise should be restricted to 40 c. Determine the required cooling area
9. A hardened steel work rotates at 1440 rpm and transmit 12KW 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?

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 raise should be restricted to 40^0C. Determine the required cooling area/
11. Design a pair of right angled bevel gear to transmit 15KW at 750 rpm to another gear to run at 250 rpm. Not less than 20 teeth are to be used on either gears. The pressure angle is 20^0. Assume a gear life of 12000 hrs
12. 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 gear has 40 teeth with 5mm module. The pressure angle in the diametral plane is 20^0.Determine i) Lead angle of the worm ii) Velocity ratio iii) Centre distance. Also calculate the efficiency of worm gear drive and power lost in friction
13. 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 1° 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?
14. Design a bevel gear drive, to transmit 10 KW power at 1440 rpm. Gear ratio is 3, and life of gears 10,000 hrs. Pinion and gear are made of C45 steel at minimum number of steel teeth is 20?
15. Design a pair of bevel gears for two shafts whose axes are at right angles to transmit 10KW at 1440 rpm. The speed of gear is 20 rpm use lew is Buckingham's equations?

UNIT-IV GEAR BOXES

2-marks

1. Write notes on preferred Numbers and Give its advantages?
2. List any two methods used for changing speeds in gear box?
3. Specify the four types of gear box?
4. Which type of gear is used in constant mesh gearbox? Justify?
5. Compare sliding mesh and synchromesh gear box.?
6. Illustrate about step ratio? Name the series in which the speed of Multi speed gear are arranged?
7. Differentiate Ray diagram and structural diagram?
8. List six standard speeds starting from 18rpm with a step ratio of 1.4?
9. Sketch the kinematic layout of gears for 3 speeds between shafts.
10. Define torque converter. List its functions and appilcations?

13-Marks

1. Design the six speed gear box is to provide the speeds in the range of 160 to 500 rpm and transmit a power of 5 kW at 710 rpm. Draw the speed diagram and kinematics diagram. Determine the number of teeth module and face width of all gears, assuming suitable materials for the gears
2. Design a 9 speed gear box for the following data. Minimum speed: 180rpm, Maximum speed: 1800rpm. Using standard step ratio, draw the speed diagram, kinematic layout. Also find the number of each teeth on gear?
3. Design a nine speed gear box for a machine to provide speeds ranging from 100 to 1500 rpm. The input is from a motor of 5 kW at 1440 rpm. Assume any alloy steel for the gear
4. Design 12 speed gear box for a minimum speed of 160 rpm and a maximum speed of 2000 rpm. The input speed of motor is 1600 rpm. Draw the speed diagram, kinematic diagram and indicate the number of teeth on each gear
5. Design the layout of a 12 speed gear box for a milling machine having an output of speeds ranging from 100 to 1200 rpm. Power is applied to the gear box from a 5kW induction motor at 1440 rpm. Choose standard step ratio and construct the speed diagram. Decide up on the various reduction ratios and number of teeth on each gear wheel sketch the arrangement of the gear box

6. Design the headstock gear box of a lathe having nine spindle speeds ranging from 50 to 1500 rpm. The power of the machine may be taken as 6 kW and speed of the motor is 1450 rpm. Minimum number of teeth on the gear is to be 2x3. a) Draw the speed diagram b) Sketch the layout of the gear box. c) Calculate the number of teeth on all gears?
7. Draw the ray diagram and kinematic lay out of a gear box for an all geared headstock of a lathe. The maximum and minimum speeds are to be 2800 and 63 rpm respectively. The number of steps is 12 and drive is from a 3 kW electric motor running at 1440rpm?
8. The spindle of a pillar drill is to run at 12 different speeds in the range of 100 rpm and 355 rpm. Design a three stage gear box with a standard step ratio. The gear box receives 5KW from an electric motor running at 360rpm. Sketch the layout of the gear box, indicating the number of teeth on each gear. Also sketch the speed diagram?
9. Design a 16 speed gear box for the following data. Minimum speed: 100rpm, step ratio: 1.25. The input is from a 5KW, 1000rpm motor. Draw the speed diagram, kinematic diagram and indicate the number of teeth on each gear
10. A 16 speed gear box is required to furnish output speeds in the range of 100 to 560 rpm. Sketch the kinematic arrangement and draw the speed diagram

11. A sliding mesh gear box is to be used for '4' forward and '1' reverse speeds. First gear speed ratio is 5.5 and reverse speed gear ratio is 5.8. Clutch gear on clutch shaft and (constant mesh) on lay shaft has speed ratio of 2. Calculate the no of teeth on all the gears. Assume that the min no of teeth on any gear should not be less than 18. Calculate the actual gear ratios. Assume that the geometric first is 1:x:x2:x3
12. Design a nine speed gear box for a machine to provide speeds ranging from 100 rpm to 1500 rpm. The input is from a motor of 5 Kw at 1440 rpm. Assume any alloy steel for the gears
13. Design a 12 speed gear box for a lathe. The min and max speeds are 100 and 1200 rpm. Power is 5 Kw from 1440 rpm induction motor
14. A six speed gear box is required to provide output speeds in the range of 125 to 400 r.p.m. with a step ratio of 1.25 and transmit a power of 5 kW at 710 r.p.m. Draw the speed diagram and kinematics diagram. Determine the number of teeth module and face width of all gears, assuming suitable materials for the gears. Determine the length of the gear box along the axis of the gear shaft
15. Sketch the arrangements of a six speed gear box. The minimum and maximum speeds required are around 460 and 1400 rpm. Drove speed is 1440 rpm. Construct speed diagram of the gear box and obtain various reduction ratios. Use standard output speeds and standard step ratio. Calculate number of teeth in each gear and verify whether the actual output speeds are within + 2% of standard speeds?

UNIT-V CAMS, CLUTCHES AND BRAKES

2-Marks

1. Mention a few applications of cams and state its advantages?
2. List the significance of pressure angle in cam design?
3. Define Jerk. Name the profile of the cam that gives no Jerk?
4. Define pitch point in a cam?
5. Name four profiles normally used in cams?
6. List the function of a clutch in a transmission system?
7. Name the factors upon which the torque capacity of a clutch depends?
8. Specify the desirable properties of friction materials to be used for clutches?
9. Give examples of axial and radial friction clutches?
10. If a multidisc clutch has 6 discs in the driving shaft and 7 disc in the driven shaft, then how many number of contact surfaces it will have?

13-Marks

1. A single plate sketch, effective on both sides, is required to transmit 25KW at 3000 rpm. Determine the outer and inner diameter of frictional surfaces if the coefficient of friction is 0.25, ratio of diameter is 1.25 and the maximum pressure is not to exceed

0.1 N/mm2. Determine (i) the face width required and (ii) the axial spring force necessary to engage the clutch?

2. A plate clutch with maximum diameter 60mm has maximum lining pressure of 0.35 MPa. The power to be transmitted at 400 rpm is 135 KW and μ =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 diameters if 6 spring are used?
3. A multi disk clutch consists of five steel plates and four bronze plates. The inner and outer diameters of friction disks are 75mm and 150mm respectively. The coefficient of friction is 0.1 and the intensity of pressure is limited to 0.3. N/mm2. Assuming the uniform wear theory, calculate (i) The required operating force, and (ii) Power transmitting capacity at 750 rpm?
4. A multi disc wet clutch is to be designed for a machine tool driven by an electric motor of 12.5 KW running at 1440 rpm. Space restrictions limit the outside disc diameter to 100mm. Determine the appropriate value of inside diameter, total number of discs and clamping force?
5. An engine developing 45kW at 1000 rpm id fitted with a cone clutch built inside the fly wheel. The cone has a face angle of 12.5 degree and a maximum mean diameter of 500 mm. The coefficient of friction is 0.2. The normal pressure on the clutch face is not exceeded 0.1N/mm 2. Determine (i) The face width required (ii) the axial spring force necessary to engage the clutch?
6. A single block brake, the diameter of drum is 250mm and the angle o surface of contect the coefficient of friction is 0.35 contact is 90o, the operating force of 700N is applied at the end of lever which is at 250mm from the center of the brake block. Determine the torque that may be transmitted. Fulcrum is at 200mm from the center of brake block with an offset of 50mm ?
7. The layout of a double block brake is shown in figure -2. The brake is rated at 250N-m at 650rpm. The drum diameter is 250mm.assuming the co-efficient of friction as 0.3 and for conditions of service a pV value of 1000 (Kpa) m/s may be assumed. Determine (i) The spring force “S” required to set the brake (ii) Width of shoes (iii) Which shoe will have greater rate of wear?
8. An internal expanding shoe brake has the following dimensions: Diameter of the drum = 300 mm, distance between the fulcrum centers = 80 mm, distance of fulcrum centers and that of cam axis, both from the drum center=100 mm, distance of the line of action of braking force from the cam axis = 90 mm, distance between the points where the cam acts on the two brake shoes = 30 mm. Each shoe subtends an angle of 90° at the drum Centre. If the braking force is 750 N and the coefficient of friction is 0.3, find the braking torque on the drum. Assume the reaction between the brake shoes and the drum passes through the point bisects the contact angle. Also assume that forces exerted by the cam ends on the two shoes are equal?
9. Design a differential band for a winch lifting a load of 20 KN through a steel wire rope wound around a barrel of 600 mm dm. The brake drum, keyed to barrel shaft is 800 mm diameter and the angle of lap of the band over the drum is about 240 degree. Operating arms of the brake are 50 mm and 250 mm. The length of operating level is 1.6m?

10. An automobile engine has an output of 80 Kw at 3000 rpm. The mean diameter of the clutch is 200 mm with a permissible pressure of 0.2 N/mm2. Friction lining is of asbestos with μ = 0.22. What should be the inner diameter of the disc? Take both sides of plates with friction lining as effective. There are 8 springs and axial deflection in spring is limited to 10 mm. Given G = 80 KN/mm2. Spring index may be taken as 6.
11. 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
12. A radial cam rotates at 1200 rpm with the follower rising 20mm with SHM in1500of the cam rotation .The roller is 32mm in diameter and the prime circle is 80mm in diameter. Check whether undercutting will occur
13. 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 exceed 1/3 of 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 =0.1