VALLIAMMAI ENGINEERING COLLEGE
DEPARTMENT OF MECHANICAL ENGINEERING

Subject code: ME 6601
Subject Name: DESIGN OF TRANSMISSION SYSTEMS

UNIT-I DESIGN OF FLEXIBLE ELEMENTS

PART-A

1	Name the types of transmission belt	BT-1
2	List the commonly used belt	BT-1
3	Define law of belting	BT-1
4	Explain the term "Crowning of Pulleys"	BT-4
5	Develop the formula for maximum tension in a belt	BT-6
6	Define slip in a flat belt drive	BT-1
7	Describe creep in a flat belt	BT-2
8	Illustrate the factors affecting coefficient of friction	BT-3
9	Illustrate the factors to be considered in design of belt drives	BT-3
10	Describe the meaning of wire designation 6x12?	BT-2
11	Describe the stresses induced in wire ropes?	BT-2
12	Explain silent chain.	BT-5
13	Classify the types of failure in chain drive.	BT-4
14	Explain the main classification of chains?	BT-4
15	Explain the chordal actions in chain drive.	BT-5
16	Integrate why odd number of teeth for sprocket is preferred.	BT-6
17	Discuss the different types of flat belt drives?	BT-2
18	List the advantage of flat belt drives.	BT-1
19	Integrate why the face of the pulley is crowned?	BT-6
20	List the factors affecting the belt life.	BT-1

PART-B

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 120^o and stress in tight side is 2Mpa,. The density of the leather may be taken as 980 kg/m^3 and coefficient of friction of leather on CI is 0.35.**(BT-3)**
2. Design a flat belt drive for a fan running at 360rpm which is driven by a 10 KW at 1440 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 1m.
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 is 2 m .The diameter of engine pulley is 600 mm.
5. A flat belt drive is required to transmit 12 KW from a motor running at 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. Centre distance is 1.2 m.
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 crusher.
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 n_1 = 1000 rpm, n_2 = 300 rpm and power, P = 7.5 kW.
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 centre distance of approximately 600 mm. select 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 centre distance is approximately 1000mm and the chain tension can be adjusted by moving the motor in the rails. Design the drive.

UNIT-II SPUR GEARS AND PARALLEL AXIS HELICAL GEARS

PART-A

1	Describe the advantage of gear drives.	BT-2
2	Define law of gearing	BT-1
3	Describe the following (i) Pressure angle (ii) Diametral pitch	BT-2
4	Define module	BT-1
5	Describe backlash.	BT-2
6	Explain undercutting in gears.	BT-5
7	Explain the interference in gears?	BT-4
8	Classify the main types of gear tooth failure?	BT-3
9	Explain the requirement of gear material.	BT-5
10	Integrate the materials commonly used for gears.	BT-6
11	Differentiate involute and cycloid profiles	BT-4
12	Integrate the common profiles used for gear tooth.	BT-6
13	Illustrate interchange ability of gears.	BT-3
14	Illustrate herringbone gear and its application.	BT-3
15	Differentiate Spur and helical gear	BT-4
16	Describe virtual number of teeth in helical gear?	BT-2
17	List the advantages of Spur Gears.	BT-1
18	List the disadvantage of Spur Gears.	BT-1
19	List the advantages of Helical Gears.	BT-1
20	List the disadvantages of Helical Gears.	BT-1

PART-B

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 20^0 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 20^0 full depth involute with 18 teeth on the pinion. Both the pinion and gear are made of steel with a maximum safe static stress of 180 N/mm^2. Assume medium shock condition.
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 720 N/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 helical gear to transmit 15 KW at 1400 rpm to the following specification. Speed reduction is 3, Pressure angle is $20^0$and helix angle is 15 degree. The material for both the gears is C45 steel. Allowable static stress is 180 N/mm^2, Surface endurance limit is 800 N/mm^2 and Young's Modulus of material is 2×10^5 N/mm^2
8. Design a helical gear for the following specification: Power - 12.5KW, Pinion speed - 1200 rpm, Gear Ratio - 3.5, Pressure angle is 20^0, helix angle is 15 degree. Gear are expected to work 6 hours/day for 10 years.
9. 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.
10. 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 25^0 may be assumed for the gears. Standard involute profile 20^0 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**

UNIT-III BEVEL, WORM AND CROSS HELICAL GEARS

PART-A

1	Give the use of bevel gears	BT-2
2	Generalize what are the various force acting on bevel gears?	BT-6
3	Explain Mitre gears.	BT-4
4	Explain crown gears.	BT-4
5	Classify the bevel gears.	BT-3
6	Define Zerol bevel gear.	BT-1
7	Show when do you prefer worm and worm wheel drive?	BT-3
8	List the advantages of worm gear drive.	BT-1
9	List the disadvantages of worm gear drive.	BT-1
10	Define the terms of worm gear drive. 1. Helix angle 2. Lead angle	BT-1
11	Describe in which gear drive self locking is available?	BT-2

12	Generalize what is irreversibility in worm gears and how is it obtained?	BT-6
13	Describe about helix angle of a herringbone gear?	BT-2
14	List the various materials used for the production of gears?	BT-1
15	Describe the various losses in the worm gear.	BT-2
16	Illustrate Hypnoid gear with example.	BT-3
17	Differentiate between the spiral bevel gears and hypnoid gears.	BT-4
18	List the materials used for the manufacture of worm and worm wheel.	BT-1
19	Explain why worm is made of harder material than worm wheel	BT-5
20	Explain " crossed helical gear drive is not used for power transmission"	BT-5

PART-B

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 is 15 Ni 2 Cr 1 Mo 15/Steel. The tooth profiles of the gears are of 20^o composite form.
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 is to work for 40 hrs/week for 3 years. Pressure angle is 20 degree.
3. Design a BEVEL gear drive to transmit 4 KW. Speed ratio = 4. Driving shaft speed 225 rpm. The drive is non-reversible. Assume a life of 25000 hours.
4. A Pair of bevel gears is to be used to transmit 14KW from a pinion rotating at 400rpm to a gear mounted on shaft running at 200rpm. The axes of the two shafts are at 90°. Design the pair of bevel gears.
5. 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 720rpm. Use Lewis and Buckingham's equation.
6. 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.
7. 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% is desired.
8. 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 45^0C. Take overall heat transfer coefficient as 10 W/m^2 ^{0}C.
9. 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.

10. 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.

UNIT-IV GEAR BOXES

PART-A

1	Formulate the ray diagram for a six speed gear box.	BT-6
2	Define step ratio	BT-1
3	Where do we use speed reducers?	BT-1
4	Demonstrate the general structural diagram of gear box.	BT-3
5	Describe about preferred numbers in gearbox design.	BT-2
6	Distinguish between structural diagram and ray diagram.	BT-2
7	List the function of structural diagram.	BT-1
8	Give number of possible arrangements to achieve 12 speeds from a gear box	BT-2
9	Give number of possible arrangements to achieve 9 speeds from a gear box	BT-2
10	Explain multi speed gear box	BT-4
11	List the use of gear box in machine tool	BT-1
12	Explain the basic rules to be followed for optimum gear box design.	BT-4
13	Explain the possible arrangements to achieve 18 speeds from a gear box	BT-5
14	Summarize the number of preferred numbers used for design gearbox.	BT-5
15	Explain what the ray diagram of gear box indicates.	BT-4
16	Formulate the general structural formula for gear box design.	BT-6
17	List the application of speed reducer.	BT-1
18	Define gear box.	BT-1
19	Classify the types of speed reducer unit.	BT-3
20	Illustrate ray diagram for a six speed gear box.	BT-3

PART-B

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 teeth on each 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 upon 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 23. 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. Select speeds for an 18 speeds GEAR BOX for a minimum speed of 35 rpm and maximum speed 650 rpm. Draw speed diagram and a kinematic arrangement of the gear box showing the number of teeth in all the gears.

9. 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.

10. 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.

UNIT-V CAM, CLUTCHES AND BRAKES

PART-A

1	Define CAM.	BT-1
2	List the types of CAMs.	BT-1
3	Define trace point in CAM.	BT-1
4	Describe stroke in CAM.	BT-2
5	Integrate the importance of pressure angle in CAM design.	BT-6
6	Explain the term undercutting in CAM	BT-4
7	Explain the function of a clutch	BT-4
8	Name four materials used for lining of friction surfaces in clutches.	BT-1
9	Integrate the desirable properties of lining materials frictional surface.	BT-6
10	Describe the important properties of friction material to be used for clutches	BT-2
11	Explain self-locking brakes	BT-5
12	Explain self – energizing brake	BT-5
13	Classify the different types of brakes	BT-3
14	List few properties of brake friction materials.	BT-1
15	Differentiate clutch and brake.	BT-2
16	Classify the different types of followers	BT-3
17	Describe jerk or pulse in CAM.	BT-2
18	Explain the term" fading of brakes"	BT-4
19	Classify the types of clutch.	BT-3
20	List the advantages and applications of multi-plate clutch.	BT-1

PART-B

1. A single plate sketch, effective on both sides, is required to transmit 25 KW 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/mm^2. 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 $\mu = 0.3$. 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 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/mm^2. Assuming the uniform wear theory, calculate (i) the required operating force, and (ii) power transmitting capacity at 750 rpm.

4. A plate clutch has 3 discs on the driving shaft and 2 discs on the drive shaft, providing 4 pairs of contact surfaces. The OD of contact surface is 240mm and ID is 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 13KN/m and each of contact surfaces have worn away by1.25mm, find the power that can be transmitted, assuming uniform wear.

5. 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.

6. 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.

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

8. A 360 mm radius Brake drum contacts a single shoe as shown in figure -1and resists a torque of 250 Nm at 500 rpm. The co-efficient of friction is 0.3. Determine
(i) The normal reaction on the shoe,
(ii) The force to be applied at the lever end for counter clockwise rotation of the drum if e= 0(iii) The force to be applied at the lever end for clockwise rotation of the drum if e= 42 mm (iv) The force to be applied at the lever end for counter clockwise rotation of the drum if e = 42 mm.

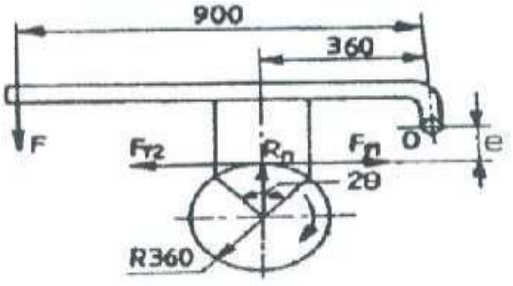

FIG-1

9. 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?

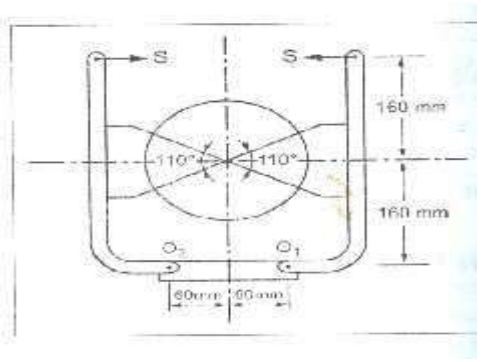

FIG-2

10. 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 centre= 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.