LUKHDHIRJI ENGINEERING COLLEGE-MORBI

Mechanical Engineering Department

(3171917)

DESIGN OF MACHINE ELEMENTS

A.Y.2022-23

ASSIGNMENTS

STUDENT NAME : _____

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BATCH : _____

(3171917) Design of Machine Elements

List of Assignments

A.Y. 2022-23

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1.	Design Considerations	CO1	PO1,PO3, PSO1				
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4.	Pressure vessels	CO2	PO1,PO2, PSO1				
5.	Rolling contact bearings	CO3	PO1,PO2, PSO1				
6.	Sliding contact bearings	CO3	PO1,PO2, PSO1				
7.	Design of gear drives(Spur, Helical, Bevel and Worm)	CO2	PO1,PO2, PSO1				
8.	Speed Gear box	CO4	PO1,PO2, PSO1				
9.	Design of Mechanisms	CO5	PO1,PO2, PO3,PSO1				

Vision:

To deliver quality engineering education for Mechanical Engineers with Professional competency, Human values and Acceptability in the society.

Mission

- To nurture engineers with basic and advance mechanical engineering concepts
- To impart Techno-Managerial skill in students to meet global engineering challenges
- To create ethical engineers who can contribute for sustainable development of society

ASSIGNMENT -1
DESIGN CONSIDERATIONS (CO-1)

1. What is standardization? State the benefits of it.
2. What are preferred numbers? Find out the numbers of R10/3 (100… 1000) derived series.
3. Specify the diameters to standardize eleven shafts from 100 to 1000 mm.
4. A manufacturer is interested in starting a business with five different models of tractors ranging from 7.5 to 75 kW capacities. Specify power capacities of the models. There is an expansion plan to further increase the number of models from five to nine to fulfill the requirement of farmers. Specify the power capacities of the additional models.
5. Explain the terminology for fits and tolerances with neat sketch.
6. What is Fits? Explain the types of different Fits with sketch?
7. What are the principles of design for manufacture and assemblies (DFMA)?
8. Explain the design consideration of castings process with sketches.
9. Write short note on aesthetic considerations in design.

ASSIGNMENT -2
DESIGN OF COUPLING (CO- 2)

1. Compare and Contrast the Clutch and Coupling.
2. Which is the weakest member of assembly in a unprotected flanged coupling? Why?
3. Draw neat sketch of Flexible coupling and list the empirical relations for the dimensions in terms of shaft diameter.
4. Classify couplings and mention an application of each type.
5. Design a cast iron protective type flange coupling to transmit 15 kW at 900 r.p.m. from an electric motor to a compressor. The service factor may be assumed as 1.35. The following permissible stresses may be used:
   - Shear stress for shaft, bolt and key material = 40 MPa
   - Crushing stress for bolt and key = 80 MPa
   - Shear stress for cast iron = 8 MPa
6. Design a protective type of cast iron flange coupling for a steel shaft transmitting 15 kW at 200 r.p.m. and having an allowable shear stress of 40 MPa. The working stress in the bolts should not exceed 30 MPa. Assume that the same material is used for shaft and key and that the crushing stress is twice the value of its shear stress. The maximum torque is 25% greater than the full load torque. The shear stress for cast iron is 14 MPa.
7. Design a bushed-pin type of flexible coupling to connect a pump shaft to a motor shaft transmitting 32 kW at 960 r.p.m. The overall torque is 20 percent more than mean torque. The material properties are as follows :
   a) The allowable shear and crushing stress for shaft and key material is 40 MPa and 80 MPa respectively.
   b) The allowable shear stress for cast iron is 15 MPa.
   c) The allowable bearing pressure for rubber bush is 0.8 N/mm2.
   d) The material of the pin is same as that of shaft and key.

ASSIGNMENT -3
SPRING (CO-2)

1. Classify springs and mention an application of each type.
2. Derive the equation for Energy Stored in Helical Springs with usual notations.
3. Discuss why the length of leafs in laminated springs are not same?
4. Show the design Considerations for a Leaf Springs.
5. Design and draw a valve spring of a petrol engine for the following operating conditions :
   Spring load when the valve is open = 400 N
   Spring load when the valve is closed = 250 N
   Maximum inside diameter of spring = 25 mm
   Length of spring when the valve is open = 40 mm
   Length of spring when valve is closed = 50 mm
   Maximum permissible shear stress = 400 MPa
6. Design a helical spring for a spring loaded safety valve for the following conditions :
   Diameter of valve seat = 65 mm
   Operating pressure = 0.7N/mm2
   Maximum pressure when the valve blows off freely = 0.75 N/mm2
   Maximum lift of the valve when the pressure rises from 0.7 to
   0.75 N/mm2 = 3.5 mm
   Maximum allowable stress = 550 MPa
   Modulus of rigidity = 84 kN/mm2
   Spring index = 6.
7. A truck spring has 12 numbers of leaves, two of which are full length leaves. The spring supports are 1.05 m apart and the central band is 85 mm wide. The central load is to be 5.4 kN with a permissible stress of 280 MPa. Determine the thickness and width of the steel spring leaves. The ratio of the total depth to the width of the spring is 3. Also determine the deflection of the spring.

ASSIGNMENT -4
PRESSURE VESSELS (CO-2)

1. Distinguish between circumferential stress and longitudinal stress in a cylindrical shell, when subjected to in internal pressure.
2. Derive Lame's equation for thick cylinder.
3. Explain Clavarino's and Birnie's equation for pressure vessels in detail.
4. What is autofrettage ? What are the various methods used for pre- stressing the cylinder?
5. Derive the equation of interference (δ) for compound cylinder.
6. Explain various types of ends used for pressure vessels giving practical applications of each.
7. A cast iron cylinder of internal diameter 200 mm and thickness 50 mm is subjected to a pressure of 5 N/mm2. Calculate the tangential and radial stresses at the inner, middle (radius = 125 mm) and outer surfaces.
8. A seamless cylinder with a storage capacity of 0.025 m3 is subjected to an internal pressure of 20 MPa. The length of the cylinder is twice its internal diameter. The cylinder is made of plain carbon steel 20C8 (Sut = 390 N/mm2) and the factor of safety is 2.5. Determine the dimensions of the cylinder.

9. The piston rod of a hydraulic cylinder exerts an operating force of 10 kN. The friction due to piston packing and stuffing box is equivalent to 10% of the operating force. The pressure in the cylinder is 10 MPa. The cylinder is made of cast iron FG 200 and the factor of safety is 5. Determine the diameter and the thickness of the cylinder.

ASSIGNMENT -5
ROLLING CONTACT BEARINGS (CO-3)

1. Enlist different types of Rolling contact bearing. What are the applications of Sliding and rolling-contact bearing?
2. Write the advantages and disadvantages of Deep groove ball bearing and Angular contact bearing.
3. Define *L*10 life, static load and dynamic load carrying capacity of rolling-contact bearing.
4. Write the selection procedure of rolling contact bearing from manufacturer's catalogue.
5. A shaft rotating at constant speed is subjected to variable load. The bearings supporting the shaft are subjected to stationary equivalent radial load of 3 kN for 10 per cent of time, 2 kN for 20 per cent of time, 1 kN for 30 per cent of time and no load for remaining time of cycle. If the total life expected for the bearing is 20 × 106 revolutions at 95 per cent reliability, calculate dynamic load rating of the ball bearing.
6. A single-row deep groove ball bearing is subjected to a pure radial force of 3 Kn from a shaft that rotates at 600 rpm. The expected life L_{10h} of the bearing is 30 000 h. The minimum acceptable diameter of the shaft is 40 mm. Select a suitable ball bearing for this application.
7. Select a single row deep groove ball bearing for a radial load of 4000 N and an axial load of 5000 N, operating at a speed of 1600 r.p.m. for an average life of 5 years at 10 hours per day. Assume uniform and steady load.

ASSIGNMENT -6
SLIDING CONTACT BEARINGS (CO-3)

1. Differentiate hydrodynamic bearings and hydrostatic bearings.
2. Explain bearing characteristic number ($\mu N/p$) curve for hydrodynamic bearings.
3. The following data is given for a hydrostatic thrust bearing:
   thrust load = 500 kN, shaft speed = 720 rpm
   shaft diameter = 500 mm, recess diameter = 300 mm
   film thickness = 0.15 mm, viscosity of lubricant = 160 SUS
   specifi c gravity = 0.86
   Calculate
   (i) supply pressure;
   (ii) flow requirement in litres/min;
   (iii) power loss in pumping; and
   (iv) frictional power loss.
4. The following data is given for a 360° hydrodynamic bearing:
   radial load = 3.2 kN, journal speed = 1490 rpm
   journal diameter = 50 mm, bearing length = 50 mm
   radial clearance = 0.05 mm, viscosity of lubricant = 25 cP
   Assuming that the total heat generated in the bearing is carried by the total oil flow in the bearing, calculate
   (i) Coefficient of friction;
   (ii) Power lost in friction;
   (iii) Minimum oil film thickness;
   (iv) Flow requirement in 1itres/min; and
   (v) Temperature rise.

ASSIGNMENT -7
DESIGN OF GEAR DRIVES (CO-2)

1. Explain fundamental law of gearing with necessary diagram.
2. Explain different types of gear tooth failures, causes and their possible remedies.
3. Define :
    a) Interference
    b) Undercutting
    c) Backlash
    d) Miter gear
    e) Crown gear
4. Derive the necessary equations of force analysis for Helical gear.
5. A pair of spur gears with 20° full-depth involute teeth consists of a 20 teeth pinion meshing with a 41 teeth gear. The module is 3 mm while the face width is 40 mm. The material for pinion as well as gear is steel with an ultimate tensile strength of 600 N/mm2. The gears are heattreated to a surface hardness of 400 BHN. The pinion rotates at 1450 rpm and the service factor for the application is 1.75. Assume that velocity factor accounts for the dynamic load and the factor of safety is 1.5. Determine the rated power that the gears can transmit.
6. A pair of parallel helical gears consists of a 20 teeth pinion meshing with a 100 teeth gear. The pinion rotates at 720 rpm. The normal pressure angle is 20°, while the helix angle is 25°. The face width is 40 mm and the normal module is 4 mm. The pinion as well as the gear is made of steel 4OC8 (Sut = 600 N/mm2) and heat treated to a surface hardness of 300 BHN. The service factor and the factor of safety are 1.5 and 2 respectively. Assume that the velocity factor accounts for the dynamic load and calculate the power transmitting capacity of gears.
7. A herringbone speed reducer consists of a 26 teeth pinion driving a 104 teethgear. The gears have a normal module of 2 mm. The pressure angle is 20° and the helix angle is 25°. The pinion receives 100 kW power through its shaftand rotates at 3600 rpm. The face width of each half is 35 mm. The gears are made of alloy steel 30Ni4Cr1 (Sut = 1500 N/mm2) and heat treated

to a surface hardness of 450 BHN. The service factor is 1.25. Determine the factor of safety against bending failure and against pitting failure.

8. 1 kW power at 720 rpm is supplied to the worm shaft. The number of starts for threads of the worm is four with a 50 mm pitch–circle diameter. The worm wheel has 30 teeth with 5 mm module. The normal pressure angle is 20°. Calculate the effi ciency of the worm gear drive and the power lost in friction.
9. A pair of bevel gears, with 20° pressure angle, consists of a 20 teeth pinion meshing with a 30 teeth gear. The module is 4 mm, while the face width is 20 mm. The material for the pinion and gear is steel 50C4 (Sut = 750 N/mm2). The gear teeth are lapped and ground (Class-3) and the surface hardness is 400 BHN. The pinion rotates at 500 rpm and receives 2.5 kW power from the electric motor. The starting torque of the motor is 150% of the rated torque. Determine the factor of safety against bending failure and against pitting failure.

ASSIGNMENT -8
SPEED GEAR BOX (CO-4)

1. Outline the procedure of designing multi speed gear box.
2. Why is it necessary to provide multispeed drive for a machine tool? What are the basic considerations in design of multi speed gearbox?
3. Differentiate structure diagram and speed diagram giving suitable example.
4. Give step by step procedure for the design of 8 speed drive for a lathe giving governing design equations.
5. Draw the ray and speed diagram for a nine speed gear box. State the necessary assumptions taken.
6. Draw speed ray diagram and layout for a 6 speed gear box. The output speeds are 160 rpm minimum and 1000 rpm maximum. The motor speed is 1440 rpm
7. Draw the structure and speed diagram for a gear box having operating speed range from 56 rpm to 1000 rpm. Use R4 series, with standard spindle speed. The gear box is connected to a motor driven by a pair of pulleys. Assume the motor speed to be 1440 rpm. Draw the gear box layout diagram.
8. Design a suitable speed gear box for a head stock of a lathe that has a variation of speed from 105 rpm to 690 rpm in 9 steps. The power is supplied by an electric motor of 10 kW capacity running at 1000 rpm and driving the input shaft through a V belt drive having a speed reduction of 2:1. Draw the structural diagram, speed chart and determine the number of teeth on each gear.
9. A radial drill machine using a gear box is required to give 8 stepped speeds. The motor power is 4 kW at 1440 rpm. The power from motor to the input shaft of gear box is transmitted by a V belt drive giving a speed reduction of 1:6. The minimum and maximum speeds are 70 rpm and 1800 rpm respectively. Make layout diagram of gear box. Draw ray diagram and speed chart.

ASSIGNMENT -9
DESIGN OF MECHANISMS (CO-5)

1. Discuss with neat sketch the valve gear mechanism of IC engine.
2. Explain typical hoisting system with diagram.
3. Draw the crane hook assembly diagram with name.
4. Design crane hook and derive the necessary equations.
5. Write a short note on wire ropes. (It should include advantages, constructions and lays of rope).
6. Write the selection procedure of wire ropes from manufacturer's catalogue.
7. Explain stresses of wire ropes with necessary equations.
8. Derive necessary equations for the design of valve gear mechanism for IC engine.