ED7204-INTEGRATED MECHANICAL DESIGN

Unit 1-Fundamentals and design of shafts

TWO MARKS

1. What is role of analysis in design?
2. Define endurance limit.
3. What is impact load?
4. What are the various phases of design process?
5. What are the different types of loads that can act on
6. machine components?
7. What is ISO standard?
8. What are the types of variable stresses?
9. Differentiate between repeated stress and reversed stress.
10. What are the types of fracture?
11. Distinguish between brittle fracture and ductile fracture.
12. Define stress concentration and stress concentration factor.
13. What is tolerance?
14. What are the types of fits?
15. What is clearance fit?
16. What is interference fit?
17. What is transition fit?
18. What is hole basis system?
19. What is shaft basis system?
20. What is BS?

16 Marks

1. The load on a bolt consists of an axial pull of 10KN together with a transverse shear force of 5 KN. Find the diameter of bolt required by 1) Maximum distortion energy theory. 2) Maximum principal stress theory 3) Maximum strain energy theory (16)

2. The bending stress in a machine part fluctuates between a tensile stress of 280N/mm2 and a compressive stress of 140N/mm2. What should be the minimum ultimate tensile strength of this part to carry this fluctuation indefinitely according to (i) Goodman's formula (ii) Soderberg formula Factor of safety is 1. 75. Assume that the yield point is never likely to be less than 55% of the Ultimate tensile strength or greater than 93 % of it. (16)

3. Determine the thickness of a 120mm wide uniform plate for safe continuous operation if the plate is to be subjected to a tensile load that has a maximum value of 1000N.The properties of the plate materials are as follows. Endurance limit stress is 225MPa and yield point stress is 300MPa.The factor of safety based on yield point may be taken as 1.5. (16)

4. A hot rolled bar of steel is subjected to a torsion load varyingfrom-150N-m to 450N-m. Determine the required diameter of the bar using a factor of safety of 1.7. Properties of the material may be assumed as follow. Ultimate tensile stress = 450MPa Yield stress = 300MPa 16)

5. A transmission of shaft made C45 steel subjected to a fluctuating torque varying from -100N-m to +500N-m.Also a fluctuating bending moment acts on the shaft which varies from +500N-m to -500Nm. Let the stress concentration factor be 2. The shaft is machined for a factor of safety.5.Determine the required diameter of the shaft. (16)

6. (a) A piston of a reciprocating compressor has a diameter of 60mm.The maximum pressure on the piston fall is 1.25MN/m2.Assuming the gudgeon pin passing through the small end of the connecting rod can be safely loaded in shear up to 10MN/m2, Calculate the minimum diameter of the gudgeon pin.(8)
(b) Explain with mathematical expressions. Maximum principal stress
theory and Von-Mises-Henky theory(8)

7. (a) Determine the diameter of the steel bar, which is a ductile in nature subjected to an axial load of 60KN and torsional moment of1600N-m.Use the factor of safety 2.5.E=200GPa.(8)
(b) Explain with mathematical expressions. Maximum shear theory Venant's theory and (8)

8. A steel member is subjected to a 3-D stress system and resulting principal stress are 120N/mm2 tension, 80N/mm2and 40N/mm2compression. If the proportional limit of the material in simple tension is280N/mm2 and its poison's ratio is O.3.Determine the factor of safety according to (a) Maximum principal stress theory (b) Maximum principal strain theory (c) Maximum shear stress theory.(16)

9. A bolt is subjected to a tensile load of 25KN and a shear load of 10KN.Determine the diameter of the bolt according to (a) Maximum principal stress theory (b) Maximum principal strain theory (c) Maximum shear stress theory. Assume factor of safety 2.5, Yield point stress in simple tension300N/mm2, Poisson's ratio is 0.25.(16)

10. Taking stress concentration in to account find the maximum stress induced when a tensile load of 20KN is applied to (i) Rectangular plate80mm wide and 12mm thick with a transverse hole of 16mm diameter.(ii)Stepped shaft of diameters 60mm and 30mm width a fillet radius of6mm.(16)

Unit 2 Design of Gears and Gear boxes

Two marks

1. state the merits and demerits of helical gears.
2. State any two methods of designing a helical gears.
3. State the types of helical gear .
4. Why the crossed helical gear drive not used for power transmission?
5. Mention few gear material.
6. What is a herring bone gear? Where is it used?
7. What is the advantage of helical gear over spur gear?
8. What is backlash in gears?
9. When are bevel gears preferred?
10. What is herring bone gear? Where is it used?
11. what are the generally used gear profiles?
12. Specify the significance of minimum number of teeth in pinion.
13. How does failure by pitting happen in gears?
14. Mention the merits of non metallic gears?
15. What is the effect of increasing the pressure angle in gears?
16. When do we employ crossed helical gear?
17. Mention two characteristics of hypoid gear?
18. Compare the contact between mating teeth of spur and helical gears.
19. Define factor of safety for bending and pitting.
20. What is a herring bone gear? Where is it used?

16 Marks

1. A helical gears subjected to heavy shock load is to transmit 37.5kw at 1750rpm of the pinion. The speed reduction ratio is 4 and helix angle is15°. The service is continue 8 hours per week for 3 years. select suitable material for pinion and wheel.

2. A motor shaft rotating at 1500 rpm has to transmit 15kw to a low speed shaft with a speed reduction is 3:1. Both the gear and pinion are made of C45 steel. design a spur gear drive to suit the above conditions.

3. In a spur gear drive for a stone crusher, the gears are made of C40 steel. The pinion is transmitting 30 KW at 1200 rpm. The gear ratio is 3. Gear is to work 8 hours per day, six days a week and for 3 years. Design the drive.

4. A helical gears with 30˚ helix angle has to transmit 35 KW at 1500 rpm with a speed reduction ratio 2.5. If the pinion has 24 teeth. Assume 15 Ni 2 Cr 1 Mo 15 material for both pinion and wheel.

5. In a spur gear drive for a rock crusher, the gears are made of case hardened alloy steel. The pinion is transmitting 18 KW at 1200 rpm with a gear ratio of 3.5. The gear is to work 8 hrs/day for 3 years. Design the drive.

6. Design a of helical gears to transmit 10 kw at 1000 rpm of the pinion. Reduction ratio of 5 is required. The gear is to work 8 hrs/day for 5 years. Design the drive. select suitable material for pinion and wheel.

7. Design a bevel gear drive to transmit 10 KW at 1440 rpm. Gear ratio is 3, material for pinion and gear is C45 steel. Minimum number of teeth is to be 20.

8. Design a straight spur gear drive to transmit 8 kW. The pinion speed is 720 rpm and the speed ratio is 2. select suitable material for pinion and wheel.

9. Design a bevel gear for two shafts whose axis are at right angles. The power transmitted is 25 kW. The speed of the pinion is 300 rpm and of the gear is 120 rpm. The service is continue 8 hours per week for 3 years. select suitable material for pinion and wheel.

10. A 10 kW motor running at 1200 rpm drives a compressor at 780 rpm through a 900 bevel gearing arrangement. The pinion has 30 teeth. The pressure angle of the teeth is 200. Both the pinion and gear are made of heat treated cast iron grade 35. Determine the cone distance, average module and face width of the gears

11. The spindle of a piller drill is to run at 12 different speeds in the range of 70 rpm and 325 rpm. Design a three stage gear box with a standard step ratio. The gear box receives 4 Kw from an electric motor running at 330rpm.Design the gear box as per this arrangement 2×2×3.

12. Design the layout of 12 speed gear box for a milling machine having an output of speeds ranging from 180 to 2000rpm. Power is supplied to the gear box by 6Kw induction motor at 1440 rpm. Follow the Arrangement 2×2×3.

Unit 3 Brakes and Clutches

Two marks

1. Classify the types of brakes
2. What is shoe brake?
3. What is drum brake?
4. What is coefficient of friction?
5. What is braking torque?
6. What is angle of contact?
7. What is self-locking?
8. What is double shoe brake?
9. What is band brake?
10. Differentiate a brake and a dynamometer.
11. Differentiate a brake and a clutch.
12. What is the function of a clutch?
13. Name a few commonly used friction materials.
14. Differentiate a dry and wet operations of a clutch.
15. What is service factor?
16. Differentiate cone and centrifugal clutch.
17. Differentiate disc and cone clutch.
18. What are the materials used for internal expansion in clutches?
19. What is semi cone angle?
20. What is block brake?

16 Marks

1. A single plate clutch is used for an engine that develops a maximum torque of 120 N-m. Assume a factor of safety of 1.5 to account for slippage at full engine torque. The permissible intensity of pressure is 350 kpa and the coefficient of friction is 0.35. Calculate the inner and outer diameters of the friction lining and the axial force to be exerted by the springs to engage the clutch.

2. Derive an expression for the braking torque considering a single shoe rake: Explain self – locking and self- energizing brakes. 27. A multi – disc clutch has three discs on the driving shaft and two on the driven shaft is to be designed for a machine tool, driven by an electric motor of 22 kw running at 1440 rpm. The inside diameter of the contact surface is 130mm. The maximum pressure between the surfaces is limited to 0/N/mm2. Design the clutch. Take $\mu = 0.3$; n1 = 3; n2 = 2.

3. A single plate clutch, both sides being effective, is required to connect a machine shaft to a driver shaft which runs at 500 rpm. The moment of inertia of the rotating parts of the machine is

l kgm2. The inner and outer radii of the friction discs are 50 mm and 100 mm respectively. Assuming uniform pressure of 0.1 N/mm2 and coefficient of friction of 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, during clutch slip and the energy supplied to the machine during engagement.

4. Determine the capacity and the main dimensions of a double block brake for the following data: The brake sheave is mounted on the drum shaft. The hoist with its load weights 45 kN and moves downwards with a velocity of 1.15 m/s. The pitch diameter of the hoist drum is 1.25m. The hoist must be stopped with in a distance of 3.25 m. The kinetic energy of the drum may be neglected.

5. An automotive type internal-expanding double shoe brake as shown in fig. The face width of the friction lining is 40mm and the intensity of normal pressure is limited to 1 N/mm2. The coefficient of friction is 0.32. The angle Θ1 is can be assumed to be zero. Calculate (i) the actuating force P, and (ii) the torque-absorbing capacity of the brake.

6. 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 t 0.3 N/mm2.Assuming the uniform wear theory, calculate (i) the required operating force, and (ii) power transmitting capacity at 750 rpm. (16)

7. A leather faced conical clutch has cone angle of 30°.The pressure between the contact surfaces is limited to .35N/mm2and the breath of the conical surface is not to exceed 1/3 of the mean radius. Find the dimensions of the contact surface to transmit 22Kw at 2000 rpm .Also calculate the force required to engage the clutch. .Take μ =0.15. (16)

8.A single plate clutch, both side being effective is required to connect a machine shaft to a driveshaft which runs at 500rpm .The moment of inertia of the rotating parts of the machine is 1Kgm2.Theinner and the outer radii of the friction discs are 50mm&100mm respectively Assuming uniform pressure of 0.1N/mm2and 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.(16)

9. In an automotive type internal – expanding double – shoe brake he face width of the friction lining is 40 mm and the intensity of normal pressure is limited to 1 N/mm2 . The coefficient of friction is 0.32. The angle φ1 can be assumed to be zero. Calculate (i) the actuating force P, and (ii) the torque – absorbing capacity of the brake. (16)

10.A leather faced conical clutch has cone angle of 300.The pressure between the contact surfaces is limited to .35N/mm2 and the breath of the conical surface is not to exceed 1/3 of the mean radius. Find the dimensions of the contact surface to transmit 22Kw at 2000 rpm .Also calculate the force required to engage the clutch. .Take μ =0.15 . (16)

Unit 4 Integrated design

2 marks

1. What is integrated design?
2.What are the advantages of integrated design?
3.What are the factors to be considered in Integrated design?
4.What are ID components required in a escalator?
5. What are ID components required in a elevator?
6.List out the components of a crane.
7. What are ID components required in a valve gear mechanism?
8.What are problems encountered in ID?
9.How is speed reduction in gear mechanism fixed?
10.What are the problems encountered in ID of kinematic arrangement?

50 marks

1.The drive arrangement for tiller crane has spur gear in between belt drive and rope drum. The crane is to be used in open wells for removing rock and debris. The lifting is provide by 7kw two speed electrical motor running at 720 rpm. The power is to be transmitted to the rope drum through belt drive and a two stage spur gear reduction unit. The speed reduction in the belt drive is 2, while over all speed reduction is 16. Design the required components.

2. The back gear mechanism of a lathe is to have a speed reduction from cone pulley to the spindle of 8:1 with a centre distance 200 mm approximately. The gears used are 20° full depth involute spur gears. The drive is obtained from a 25cm pulley 45cm on cross section which carries a 3 stepped cone pulley 35cm, 25 cm and 15 cm dia respectively. The safe working stress for shaft and key material is 42Mpa in shear. The safe tension per cm width of the belt is 200N. Ratio of tension is 3.Safe stress is 35Mpa. Design the spindle, belt, gear, shaft and bearing.

3.Design a 12 speed gear box for a lathe spindle rotating at a speed ranging from 200 rpm to 1250 rpm. Assume all are spur gears. Design the kinematic arrangement , gear, gear box and layout.

4.Design the various components of the valve gear mechanism for a horizontal diesel engine for the following data, Bore=140mm, Stroke 270 mm, power 8.25 KW , Speed 475 rpm max GP 3.5 N/mm2. valve opens 33 degree before ODC and 1 degree after IDC. The length of rocker arm is 150mm and included angle is 160 . Weight of valve is 3N.

5.Design a 9 speed gear box for a lathe spindle rotating at a speed ranging from 300 rpm to 1550 rpm. Assume all are spur gears. Design the kinematic arrangement , gear, gear box and layout.