Problem of Practices
on
Mechanical Engineering Design
Chapter-10 Helical Gears

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1. A parallel helical cast gear with 30° helix angle is required to transmit 50 HP at 2000 rpm. Find the module, pitch, diameter and width for 20° involute full depth tooth. The gear has 25 teeth. The static stress for cast steel can be taken as 1000 kg/cm^2. Use Lewis formula, assume that face width is 3 × circular pitch and from factor is 0.123.
   Any other data not supplied can be assumed suitably.
2. Explain the following terms, with the help of a neat sketch, pertaining to the Helical gears.
   (i) Axial pitch (ii) Normal circular pitch (iii) Lead (iv) Helix angle
3. A pair of gears is to be designed to transmit 4 kW at 600 rpm of the pinion to a gear rotating at 150 rpm. 20° FD involute teeth are to be used. The centre distance should be as small as possible. Only from strength considerations (Lewis equation), determine the module, face width and number of teeth on gears, assuming spur gear drive or helical gear drive.
4. Design the teeth for two herring bone gears for a single reduction speed reducer whose velocity ratio is 3.80. The speed reducer is to transmit 27 kW when the pinion turns 3000 rev/min. The helix angle should be 30° and the teeth are to be

20° stub in the plane of rotation. The length of the face of the pinion should not exceed twice the pitch diameter.

5. A 20° normal pressure angle helical pinion having 20 teeth and helix angle of 30° transmits 3kW at 30 rev/sec. The speed ratio is 4, normal module is 4 mm and the face width is 36 mm. Calculate the maximum contact stress in the tooth if the gear and pinion are made of steel.

6. A pair of helical gears are used to transmit 18 kW at 8000 rpm of the pinion. The teeth are 20° stub in diametral plane and the helix angle is 45°. The gear and the pinion have a pitch diameter of 320 mm and 80 mm respectively. Both gear and pinion are made of cast steel with a allowable static strength of 100 MPa. Suggest a suitable module and face width for the gear pair and check the strength of the design in wear. Take modulus of elasticity for cast steel as 2×10^5 MPa, and $\sigma_{es} = 618$ MPa.

7. Two helical gears are used in a speed reducer that is driven by an I.C. Engine. The rated power of the speed reducer is 75 kW at a pinion speed of 1200 rpm. The speed ratio is 3 to 1. Assuming medium shock condition and 24 hour operation, find the module, face, number of teeth in each gear and the material and heat treatment requirement if the teeth are 20° full depth in the normal plane.

8. Design a pair of helical gears of equal diameter, 20° stub tooth helical gears to transmit 40 kW with moderate shock at 1200 rpm. The two shafts are parallel and 45 cm apart. Find the module and face width of the teeth.

9. Design a pair of parallel helical gears made of 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 gear is made of steel with ultimate strength of 600 N/mm^2 and heat treated to a surface hardness of 300 BHN. The service factor and the factor of safety are 1.5 and 2 respectively.

10. A 56 kW motor running at 450 rpm is geared to a pump by means of a helical gearing. The C30 forged steel pinion on the motor shaft is 200 mm in diameter and drives a good grade cast iron gear on the pump shaft at 120 rpm. Determine the module and the face width.

11. Two precision cut forged steel helical gears have 20° full depth involute teeth. The helix angle is 23° and permissible static bending stress is 100 MPa. If gear ratio is 3 : 1, module is 3 mm, face width is 300 mm and surface endurance strength is 630 MPa; find the power transmitted and wear load and state whether the design is safe. The speed of pinion is 600 rpm.

12. A pair of helical gears used to transmit 7.5 kW at 1440 rpm of pinion has 20° involute stub teeth. Helix angle is 30°. Gear ratio is 4:1. Centre distance is 200 mm. Material for both pinion and gear is steel having safe static stress of 100 MPa and hardness of 200 BHN. Design the gears. Check the design for Dynamic and wear strength considerations.
C = Dynamic load constant = 119×10^3 N/m.
Use minimum no of teeth on pinion.

13. The following data is given for a pair of parallel helical gears made of steel:
Power transmitted = 20 kW, $n_p = 720$ rpm, $z_p = 35$, $z_g = 70$, centre distance = 285 mm, normal module = 5 mm, $b = 50$ mm, normal pressure angle = 20°, $\sigma_{ut} = 600$

N/mm^2, surface hardness number = 300 BHN, grade of machining = 6, Service factor = 1.25. Calculate:

(i) The helix angle;
(ii) Beam strength,
(iii) Wear strength,
(iv) Static load
(v) The dynamic load by Buckingham's equation.
(vi) Effective factor of safety against bending failure.