HW # 8 - GEAR FORCES

1. A spur pinion of 3 in. pitch diameter drives a 9 in. gear. The pinion shaft has 600 in-lb of torque applied, and the pressure angle is 20°. Determine the tangential force, the separating or radial force, and the gear torque. (*Ans.* F_t = 400 lb, F_r = 146 lb, M_t (gear) = 1800 in-lb).

2. The helical gear train shown in Fig .1 below transmits 10 hp from gear C to gear A at 900 rpm of gear C. The overall velocity ratio is 2. Calculate the total radial load on the shaft of gear B. and the total thrust load in the shaft of gear B. What are the tangential and separating forces between A and B and between B and C?
   Ans. Total radial load on shaft of gear B = 127 lb.
   Resultant thrust force = 0.
   Tangential force between A and B is the same as between B and C: 140 lb.
   Separating force between A and B is the same as between B and c: 51 lb.

3. An 18 pitch helical pinion with 20° stub teeth , helix angle of 23°, pitch diameter of 3 in ., and face width of 1 in. transmits 20 hp at 10,000 rpm . If the pressure angle is measured in the plane of rotation, determine the tangential force, the separating force component, and the axial or thrust force.
   Ans. 84 lb, 30 .6 lb, 35 .6 lb

4. Refer to Fig.2 below. Gear A receives 6 hp at 500 rpm through its shaft and rotates counterclockwise. Gear B is an idler and gear c is the driven gear. The teeth are 20° full depth form. (a) What is the torque on the shaft of each gear? (b) What is the tangential force for which each gear must be designed? (c) What force is applied to the idler shaft as a result of the gear tooth loads?
   Ans. (a) *MtA* = 756 in-lb, M t B = 0, *Mtc* = 864 in-lb (b) 173 lb (same for each gear) (c) 156 lb

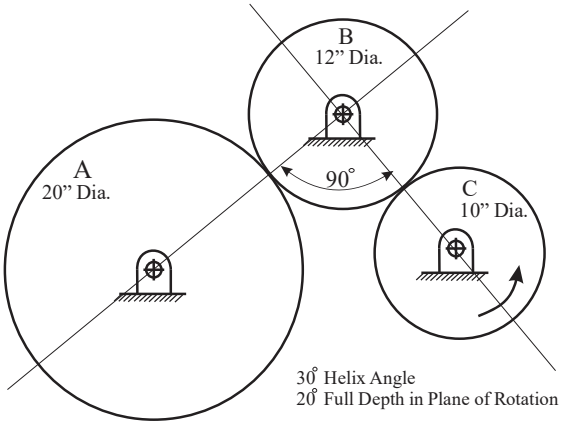

Fig. 1

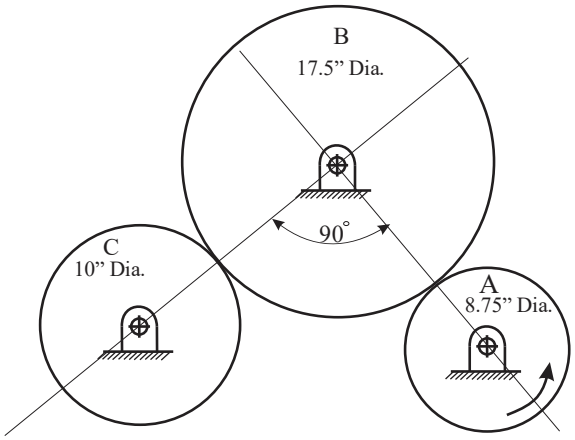

Fig. 2

5. A 20° full depth straight tooth bevel gear has a pitch of 3, a face width of 3.75 in., a pitch diameter of 12.0 in., and a cone pitch angle of 37.5°. If the torque on the gear is 6500 in-lb, what is the axial component, or thrust component, of the tooth force? What is the mean diameter of the gear? What is the tangential force at the mean radius?
   Ans. 297 lb, 4.86 in, 1340 lb.

6. A 30 tooth bevel gear meshes with a 60 tooth bevel gear with straight teeth. The angle between shafts is 90°. The torque on the pinion is 400 in-lb and the mean radius of the pinion is 2 in. The pressure angle is 20°. Determine the pinion thrust force. *Ans.* 32.6 lb

7. A pair of straight tooth bevel gears connects a pair of shafts at 90°. The velocity ratio is 3 to 1. What is the cone pitch angle of each gear? *Ans.* 18.4° for pinion, 71.6° for gear.

8. A spiral bevel pinion with a left hand spiral rotates clockwise (looking toward the apex of the pitch cone) and transmits 4 hp at 1200 rpm to a mating gear (Case III of spiral bevel gear forces). The mean diameter of the pinion is 3.00 in. The pressure angle ϕ_n measured in the plane perpendicular to a tooth is 20°, the spiral angle is 20°, and the velocity ratio is 2 to 1. Determine (a) the pitch angle of the pinion , (b) the tangential force F_t at the mean radius, (c) the pinion thrust force F_p, (d) the gear thrust force F_g.

   Ans. (a) $\beta = 26.55°$ (c) $F_p = +70$ lb (directed as shown in figure of Case III)

   (b) $F_t = 140$ lb (d) $F_g = +25.8$ lb (directed as shown in figure of Case III)

9. A worm rotating at 1150 rpm drives a worm gear. The velocity ratio is 15 to 1. The worm is double threaded and has a pitch diameter of 3 .000 in. The circular pitch of the worm gear is $1\frac{1}{8}$ in. (The axial pitch of the worm is also $1\frac{1}{8}$ in. with the lead being $2\frac{1}{4}$ in., since the worm is double threaded.) The worm has left hand threads, as shown in Case III of worm gear forces, and rotates clockwise as indicated. The normal pressure angle is 14.5° and the coefficient of friction is 0.2. If 10 hp is supplied to the worm , determine (a) the tangential force on the worm, (b) the tangential force on the gear, (c) the separating force, (d) the efficiency, (The directions are as shown in Case III.)

   Ans. (a) 365 lb , (b) 778 lb, (c) 218 lb, (d) 50.8%