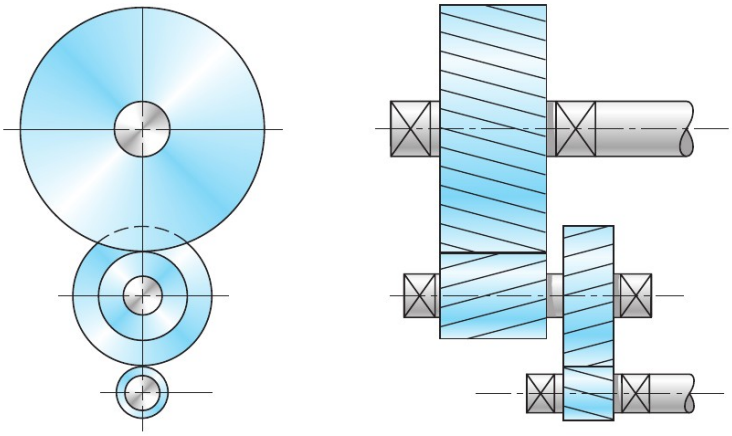
ME423 – Tutorial 8/ HW 8 – Due 22nd November

You have to submit all the problems by 11.00 pm, 22/11/2024 [Moodle].

1. As a rough guideline a reduction ratio (speed ratio, gear ratio) of pair of gears should not exceed 10:1. Note reduction ratio = number of teeth on the driven gear/number of teeth of the driver gear. To obtain higher reduction ratios, one uses a compounded gear train. A two-stage compounded gear train is shown below:

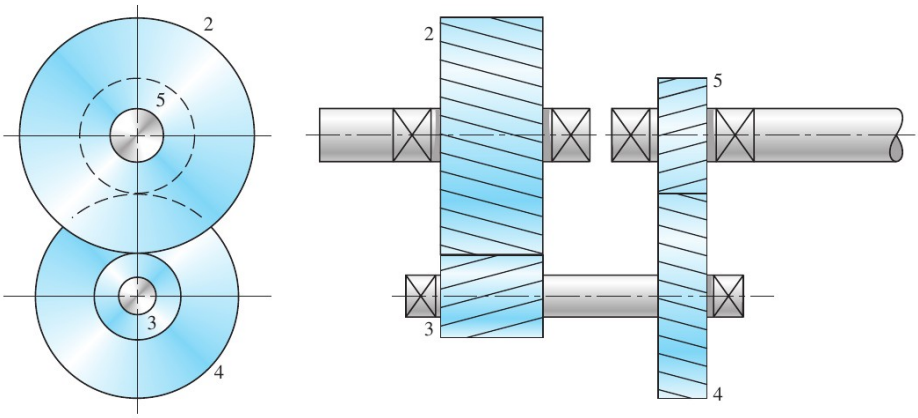


a. Select the appropriate number of teeth (20^o pressure angle) of the a two-stage compounded gear train to obtain a reduction ratio of 30:1 ($\pm 1\%$). Assume that in each stage a reduction of approximately $\sqrt{30}$ is desired. Also, assume that the number of teeth on the pinion is 16. Note that the minimum number of teeth on a pinion to avoid interference for given speed ratio and pressure angle is

$$N_p = \frac{2}{(1+2m_G)\sin^2\phi}\left(m_G + \sqrt{m_G^2 + (1+2m_G)\sin^2\phi}\right),\ m_G = N_G/N_P$$

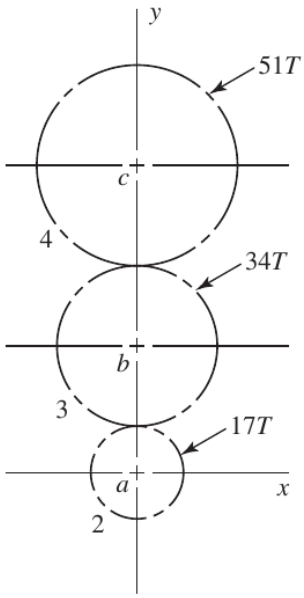
b. Select the appropriate number of teeth of the a two-stage compounded gear train to obtain an **exact** reduction ratio of 30:1.

2. It is sometimes desirable for the input shaft and the output shaft of a two-stage compound gear train to be in-line, as shown in Figure. This configuration is called a **compound reverted gear train**. This requires the distances between the shafts to be the same for both stages of the train.



Select the appropriate number of teeth of a compound reverted gear train to obtain an **exact** reduction ratio of 30:1.

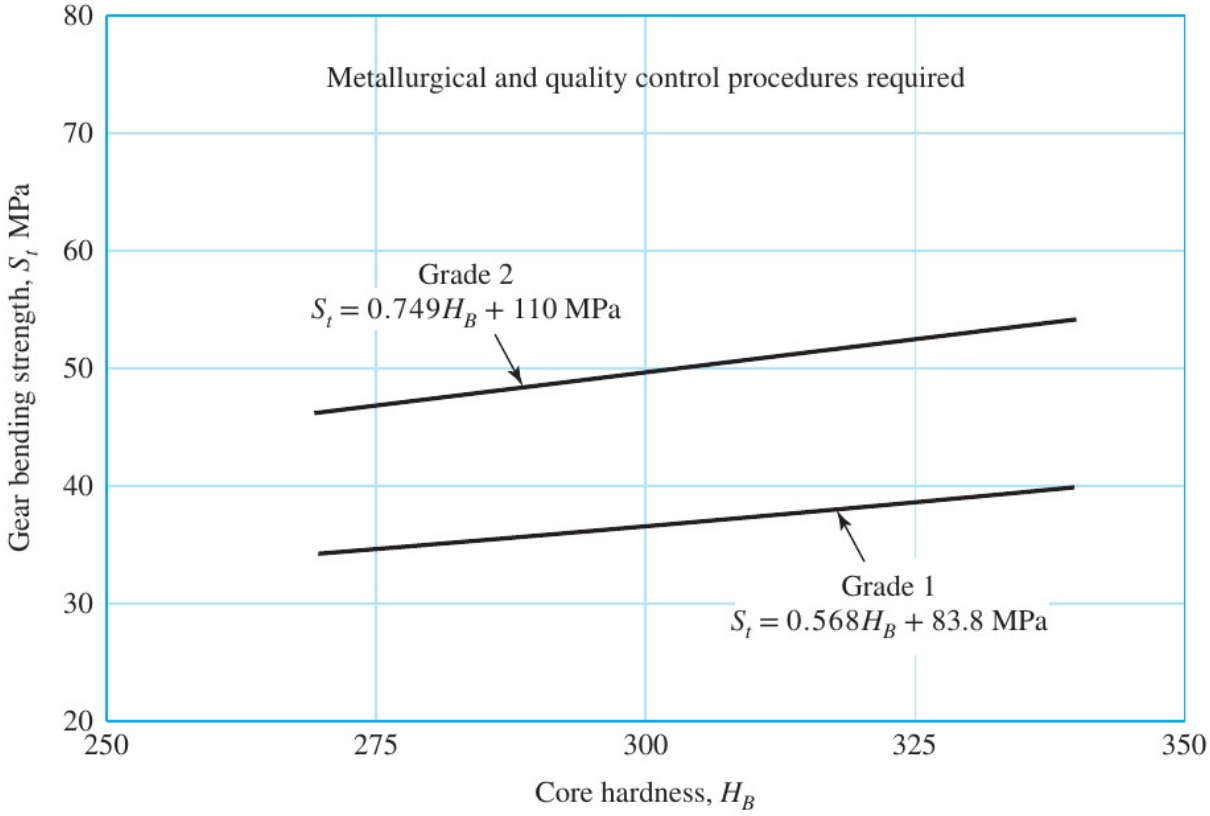
3. Shaft a in the figure has a power input of 75 kW at a speed of 1000 rev/min in the counterclockwise direction. The gears have a module of 5 mm and a 20° pressure angle. Gear 3 is an idler.



(a) Find the force F_{3b} that gear 3 exerts against shaft b.
(b) Find the torque T_{4c} that gear 4 exerts on shaft c.

4. A 17-tooth 20° pressure angle spur pinion rotates at 1800 rev/min and transmits 2980 watts to a 52-tooth disk gear. The module is 2.5 mm, the face width 38 mm, and the quality standard is No. 6. The pinion is a grade 1 steel with a hardness of 240 Brinell tooth surface and through-hardened core. The gear is steel, through-hardened also, grade 1 material, with a Brinell hardness of 200, tooth surface and core. Assume $J_P = 0.30$, $J_G = 0.40$, $I = 0.121$, $(K_S)_P = (K_S)_G = 1$,$C_H = 1$, $(C_f)_P = (C_g)_G = 1$. The loading is smooth because of motor and load. Assume a pinion life of 10^8 cycles and a reliability of 0.90.
(a) Find the factor of safety of the gears in bending.
(b) Find the factor of safety of the gears in wear.

Estimate the uncorrected bending fatigue strength using the following figure



Estimate the uncorrected surface-fatigue strength using the following figure: