Gear Speed and Torque Problems

Gear Trains

Exercise 4.2 Calculating Gear Train Speed and Torque Ratios

Objective

At the conclusion of this exercise, you will be able to do the following:

1. Interpret a schematic drawing of a gear train.
2. Calculate the gear ratio for a simple and compound gear train.
3. Interpret a gear ratio as indicating either a speed-increasing or speed-reducing gear train.
4. Identify the relationships between the input and output of a gear train.
5. Calculate the rotational speed of an output gear shaft.
6. Calculate the torque of an output gear shaft.

Procedure

Read the section on gears in Chapter 4 in your textbook. Complete the following problems.

TIP SHEET

The gear ratio (GR), speed ratio (SR), and torque ratio (TR) of a gear train should be expressed in a ratio format, not as a fraction. For example, a speed-increasing gear train would be expressed as 1:*n* and a speed-reducing gear train would be expressed as *n*:1 (in each case, *n* represents a number greater than 1). When you calculate the gear ratio of a compound gear train, you should never return a value for *n* that is less than 1. An erroneous ratio, such as 1:0.75, may indicate that you have inadvertently used the reciprocal value of one of the mating gear sets in your calculations.

Problem 4.1 The gears on shafts A, B, C, and D are 30-, 10-, 20-, and 40-tooth, respectively.

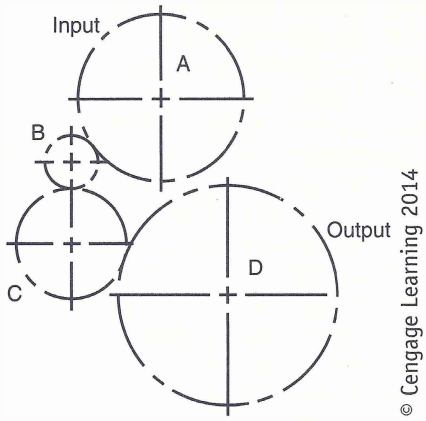

FIGURE 4-5 *A gear train schematic.*

1. Does the schematic drawing in Figure 4-5 represent a simple or compound gear train? How can you tell?

2. What is the gear ratio for this gear train? Does it represent a speed increase or decrease?

3. If the gear on shaft A is turning in a clockwise direction, in what direction will the gear on shaft D rotate?

4. Label the direction of rotation of each of the gears in the gear train with a curved arrow (for example, ↻ or ↺).

Problem 4.2 The gears on shafts A, Z, and D are 30-, 40/10-, and 40-tooth, respectively.

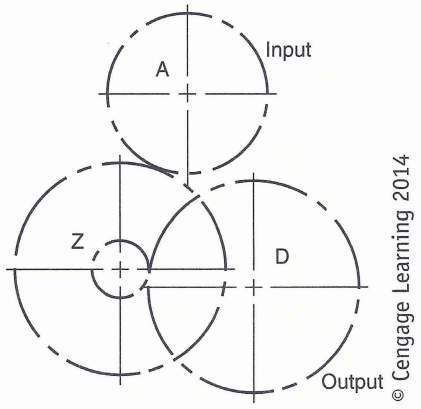

FIGURE 4-6 *A gear train schematic.*

1. Does the schematic drawing in Figure 4-6 represent a simple or compound gear train? How can you tell?

2. What is the gear ratio for this gear train? Does it represent a speed increase or decrease?

3. If the gear on shaft A is turning in a clockwise direction, in what direction will the gear on shaft D rotate?

4. Label the direction of rotation of each of the gears in the gear train with a curved arrow (for example, ↻ or ↺).

Problem 4.3 An electric motor is connected to the input shaft on the compound gear train shown in Figure 4-7. The motor spins at 5,000 RPM and generates 20 lbf·ft of torque. The gears on shafts A, B_1, B_2, C_1, C_2, and D are 10-, 40-, 20-, 40-, 30-, and 20-tooth, respectively.

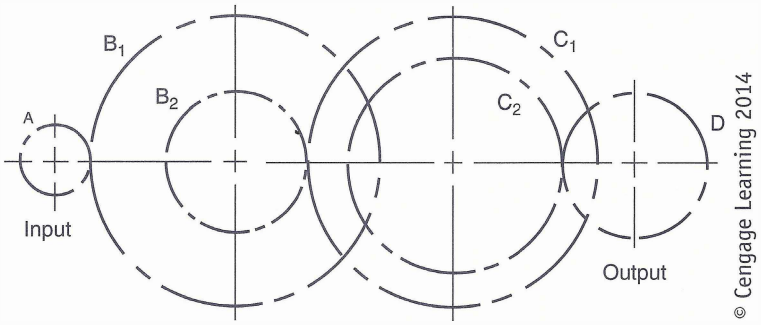

FIGURE 4-7 *A different gear train schematic.*

1. What is the gear ratio for this gear train? Does it represent a speed increase or decrease?

2. What is the rotational speed of the output gear shaft?

3. What is the torque value on the output gear shaft?

Problem 4.4 An electric motor is connected to the input shaft on the compound gear train shown in Figure 4-8. The output gear spins at 140.58 RPM and generates 106.7 lbf·ft of torque. The gears on shafts A, B_1, B_2, C_1, C_2, and D are 10-, 40-, 30-, 40-, 20-, and 40-tooth, respectively.

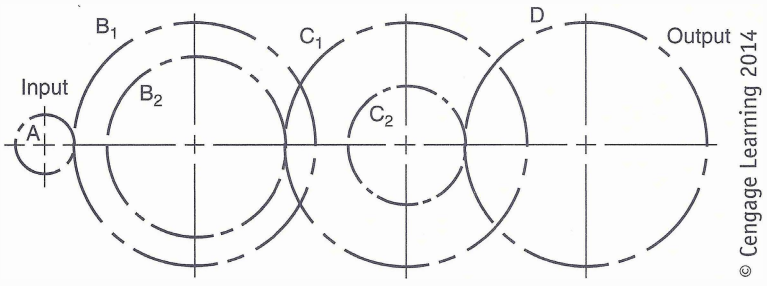

FIGURE 4-8 *Another gear train schematic.*

1. What is the gear ratio for this gear train? Does it represent a speed increase or decrease?

2. What is the rotational speed of the electric motor?

3. How much torque is the electric motor exerting on the input shaft?