330:148 (g) Machine Design

Class work 1: Force, Work and Power (Ch 2)

August 20, 2007

Answers for the problems are given.

1. Calculate the amount of torque in a shaft transmitting 750 W of power while rotating at 183 rad/s. [4.10 N-m]
2. Calculate the amount of torque in a shaft transmitting 1.0 hp of power while rotating at 1750 rpm. (36.0145 in-lb)
3. A 1-in. diameter shaft is keyed to a 6-in dia pulley and transmits 4 hp. The keyed assembly rotates at 1725 rpm. What is the tangential force at the key and at the edge of the pulley? What is the peripheral speed of the pulley in ft/min? (Ans. 292 lb, 48.7 lb, 2710 fpm)

4. The elevator system shown in Figure 2.4 has a combined weight for the car and occupants of 1,000 pounds (ignore forces to accelerate the car and occupants):

   a. What is the force in the cable? (1000 lb)
   b. To raise the car 150 feet, how much work is done? (150,000 ft-lb)
   c. If it took 10 seconds to travel this distance, what power was required in ft-lb/sec, hp, and kilowatts? (15,000 ft-lb/s, 27.3 hp, 20.3 kW)
   d. If the effective diameter of the cable drum is 18 inches, determine the torque in the input shaft. (9,000 in-lb)
   e. What is the rotational speed of this shaft? (191 rpm)
   f. Calculate the power to turn this shaft, and compare this power to that determined in part c. (27.3 hp)

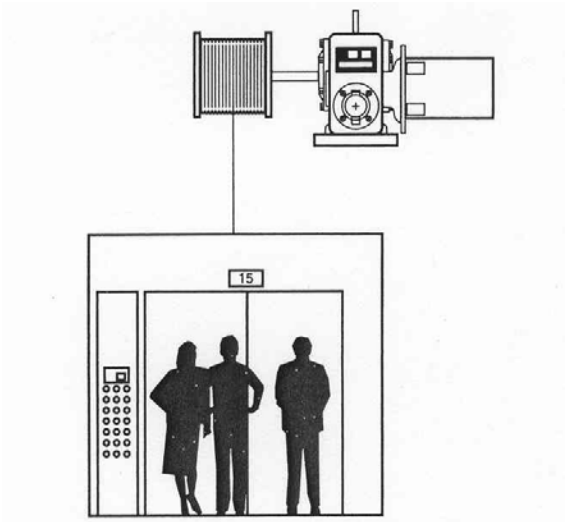

FIGURE 2.4 Elevator for Problems 1 through 4.

5. If we now include in problem 4 an acceleration of 16 ft/ sec^2 for the first two seconds of travel for the elevator car, determine:

a. The force in the cable during the first two seconds. (1,497 lb)
b. The distance traveled during that period. (32 ft)
c. The power required during the acceleration period. (43.5 hp)
d. Compare this result to the power calculated in problem 4. (60% more)

6. If a 3,000-pound automobile has a combined wind resistance and frictional losses of 200 pounds at a speed of 50 mph:

a. Calculate the power required to maintain this speed on a level road. (26.7 hp)
b. If it takes three seconds to accelerate to 60 mph from 50 mph, calculate the power to do this (ignore frictional loss). (67 hp)
c. Assuming the frictional losses stay the same during this period, what is the total power? (93.7 hp)

7. A large truck has an overall range of gear ratios that includes the transmission and differential of 12 to 1 through 3 to 1. If the engine torque is 350 ft-lb and the wheels have an effective diameter of 36 in.:

a. What force can be applied to the road at these two ratios? (700 lb)
b. If the truck weighs 40,000 pounds, ignoring any friction, what is the maximum rate of acceleration on a flat road? (2.3 ft/s^2)