# Homework 2: Transmissions and Gearboxes

Due: September 11, 2014

NOTE: Use a separate piece of paper for all work except for question 1 in Section 3.

1 Block Diagrams and Interfaces (2pts)

For each terminal (arrow) on the following component blocks, specify three parameters of the interface type. Select one parameter from each of the following three categories: **1.** electrical, mechanical, or chemical, **2.** power or information, **3.**input or output. For example, a battery would be labeled as follows:
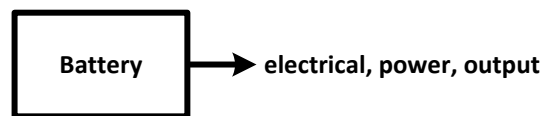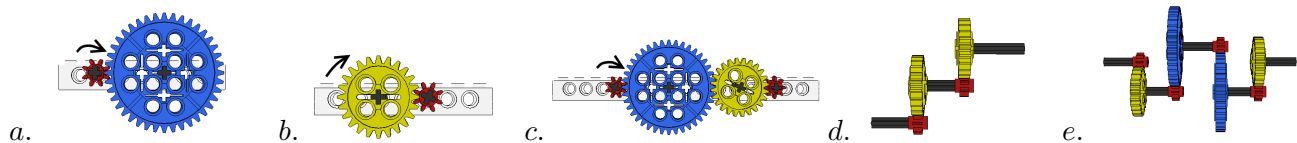

Label the remaining components in the same manner:
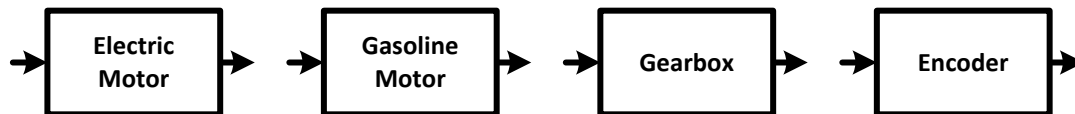
2 Gears (2.5pts)

For the questions in this section, red gears have 8 teeth, yellow gears have 24 teeth, and blue gears have 40 teeth. The input gear is the left-most gear, the output gear is the right most-gear. Compute the gear ratios for these arrangements of gears, also called *geartrains*:

a.   *b.*   *c.*   *d.*   *e.*

3 Case study: Automobile Four-Speed Manual Transmission (11.5pts)

Below is a diagram of a manual transmission from a car. Just like the bicycle transmission, it allows the driver to select different speed/torque combinations while driving. However, unlike a bicycle, the gears are always in mesh, *i.e.* there is no chain that moves from gear to gear. Instead, there are parts called *synchros* that can slide back and forth and engage with parts called *cones*. The driver uses the gear shift lever to select which synchro is engaged. Only one synchro can be engaged at a time. In the figure below, the driver has selected synchro 'b'. Answer the following questions about the manual transmission.

1. Using the worksheet on the last page of this handout, draw a line that traces the flow of power through the transmission. Start from the motor, continue through the input gears, through the engaged synchro, through the output gears and end at the wheels. (2.5pts)

2. Compute the gear ratio from the motor to the drive shaft for all five of the gears. (2.5pts)

3. Which synchro selects the highest forward gear ratio? (This is first gear) (0.5pt)

4. Which synchro selects a 1:1 ratio from the motor to the drive shaft? (0.5pt)

5. Which synchro selects the lowest gear ratio? (This is fourth gear) (0.5pt)

6. Which synchro selects a gear ratio from the motor to the drive shaft that is less than 1:1? (This is called *overdrive*, because the drive shaft turns faster than the motor. This provides better fuel economy.) (0.5pt)

7. Which synchro selects reverse? (0.5pt)

8. What is the gear ratio from the motor to the drive shaft when reverse gear is selected? (0.5pt)

For the following questions assume that the driver has selected synchro "a", the engine is turning at 1100 revolutions per minute (RPM), and the tire diameter is 0.65 meters (16" rim, 200mm wide tire, 60% aspect). Recall that the linear distance the tire travels along the ground in a single rotation is the circumference of the tire.

9. Compute the gear ratio from the motor to the rear axle. The gears that connect the drive shaft to the rear axle are called *bevel gears*. They function the same way as the *spur gears* from the previous questions, but they change the direction of rotation by 90 degrees.(1pt)

10. Compute the RPM of the rear axle. (0.5pt)

11. Compute the circumference of the tires. (0.5pt)

12. Compute the meters per minute (meters/min) that the tires move along the ground at the given RPM. (0.5pt)

13. Convert the previous answer to meters per hour, then to miles per hour.(0.5pt)

14. If the speed limit is 65mph, and the driver passes a state trooper, should she be worried?(0.5pt)

2014-09-04

a.

b.

c.

d.

e.