

**Homework Assignment 2**  
**Modeling a Complete Drivetrain in Matlab**  
**Solution**

**Task 3: Interpretation of the plots**

Once you have successfully completed Tasks 1 and 2, you need to use the resulting graphs to answer the following questions:

*Question 1:* At which engine speed does the engine produce the maximum power?

From the plot on the left, below, one can see that the power output reaches a maximum around 5200RPM.

*Question 2:* When driving at 50 km/h in which gear does the engine produce the most power? Approximately how much power is that? Under which circumstances would you consider driving at 50 km/h using this gear? (Note: convert 50km/h to mph if you don't have a good sense for how fast 50 km/h is).

From the plot on the right, below, one can see that a vertical line drawn at 50 km/h would first cross the curve corresponding to 4<sup>th</sup> gear, then 3<sup>rd</sup>, 2<sup>nd</sup>, and finally first gear. First gear would therefore correspond to the largest power output. The power is approximately 120kW. Typically one would shift to a higher gear at much lower RPM. The exception may be when you really want to accelerate VERY quickly (as in a drag race), or when you want to pull a heavy load up a steep hill at 50km/h. These are unusual circumstances, though.

*Question 3:* If one would like to accelerate as quickly as possible by "flooring it," at which velocities should one shift gears? Explain. (Note we are assuming that the tires will not slip).

One should switch gears such that at each velocity the largest possible engine power is generated. As soon as the curve for first gear (in the plot on the right) dips below the curve for second gear, one should switch from first to second, and similarly for third and fourth gear. This means that one should shift at approximately the following speeds:

from first to second: 65 km/h  
from second to third: 113 km/h  
from third to fourth: 172 km/h

*Question 4:* When accelerating from 0 to 200 km/h in the fashion considered in question 3, what is the highest engine speed (in RPM) that you will reach? At which car velocity will you reach this maximum engine speed?

From the figure on the left, one can see that for engine speeds above the peak power (approx 5200RPM), the power drops with further increases in engine speed. We can reverse this statement and say that in that range of engine speeds, the speed is higher as the power gets smaller. Now, look at the figure on the right. You can see that the highest RPM in a given gear will be reached right before you switch to the next gear. The gear for which this engine speed is largest is in gear 1 because it corresponds to the lowest engine power at the point of the gear switch (that is, the point where the power curves for gear 1

and gear 2 intersect, which corresponds to 65 km/h as pointed out in the answer to Question 3). The engine power at that speed is approximately 89 kW, which according to the figure on the left would correspond to an engine speed of approximately 6100 RPM. 6100RPM is thus the highest engine speed you will reach while accelerating from 0 to 200km/h.

