Note: Students are encouraged to work together and discuss the problems. However, each student must arrive at her/his own final answers. Show all your work. Simply copied homework will result in zero.

1. (10 points) During the game against the Washington Redskins last Sunday Eli Manning threw a football in a tight spiral. (a) If the ball spun at a rate of 530 rpm, what was its angular velocity in rad/s? (b) If it spun for 1.8 seconds before it was caught by Odell Beckham Jr., how many radians did it rotate in total and how many revolutions did it rotate in total? Assume there was no air resistance.

2. (10 points) Now let’s consider more realistic situation, in which there was air resistance. So, the ball slowed down and spun slower (350 rpm) when it was caught by Odell. (a) What was the angular acceleration? (b) In this case, how many revolutions did the ball make?

3. (10 points) What force must Alex Morgan, an outstanding player in the U.S. women’s soccer team, in the figure below exert on the floor with her hands in order to do a pushup?

4. (10 points) Mariano Rivera, who is considered the best closer in the history of MLB, threw his last pitch (a 89 mph 2-seam fast ball) in his career to Yunel Escobar of Tampa Bay Rays, which Escobar popped up for an easy out. If the ball was spinning at 1,800 rpm when it left Mariano’s hand, and it took 0.05 s for him to spin it, (a) compute the torque Mariano applied to the ball, and (b) compute the force Mariano applied to the ball’s surface. The mass and radius of the baseball is 147 g and 3.7 cm. 
(Hint: You will need to use the information on the moment of inertia formula sheet handed out during the class.)

5. (10 points) Odell (in Prob. 1) was tackled by two Redskins players simultaneously when he received the ball from Eli. If one player hit him at the knee at a 90 degree angle with a 950 N force, and the other hit him at the shoulder at a 45 degree angle with a 1100 N force as shown in the figure. What is the total torque about his center of mass (CoM) applied to Odell by these players?