MCEN 4228/5228
Modeling of Human Movement
(K): Knowledge Problem, (C): Challenge Problem, (EX): Extra Credit (for Undergrads)
HW0

1. **(K)** Describe the primary function (joint + action) of the following muscles:
    a) Biceps Brachii: ***elbow flexion***
    b) Triceps (all heads)
    c) Anterior Deltoid
    d) Posterior Deltoid
    e) Pectoralis Major
    f) Rectus Femoris
    g) Vastus Lateralis
    h) Vastus Medialis
    i) Vastus Intermedius
    j) Semitendinosus
    k) Semimembranosus
    l) Biceps femoris
    m) Gastrocnemius
    n) Soleus
    o) Tibialis Anterior
    p) Gluteus Maximus
    q) Gluteus Medius

2. **(K)** Describe a movement that takes place primarily in the (a) sagittal plane, (b) transverse plane, and (c) frontal plane. (We are looking for three movements here, one for each plane).

3. **(K)** Solve the following differential equation for x(t). You can solve it by hand or using a software of your choice.

$$\ddot{x}_m + \frac{b}{m}\dot{x}_m + \frac{k_m}{m}x_m = 0$$

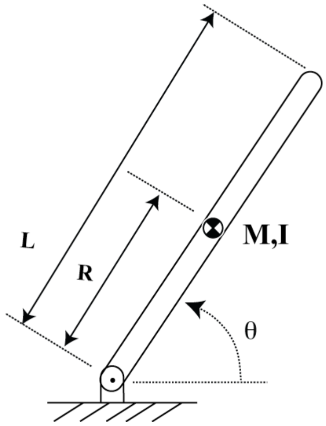
4. **(K)** Solve the following differential equation for x(t). Plot the solution.

$$\frac{dx(t)}{dt} = 5x(t) + 3, \quad where \quad x(0) = 0$$

5. **(K)** For vectors **A** and **B**, what is the *unit* vector perpendicular to vectors **A** and **B**?

A = [4, 3, 5] **B** = [-1, -5, 3]

6. **(K)** Draw a free body diagram for the inverted pendulum shown below. Assume the rod has mass M and moment of inertia I (about the center of mass).



7. **(K)** Find the equation of motion that relates the angular acceleration of the rod to the angle θ. You answer will be in terms of M (mass), I (moment of inertia), R (distance from the pin joint to the center of mass), and g (acceleration due to gravity).

8. **(C)** Describe Hooke's law, by both writing the basic equation and explaining what it means. Do you think Hooke's law can represent muscles and tendons? Why or why not?

9. **(C)** Familiarize yourself with numerically integrating differential equations in Matlab with the **ode45** function. Use **ode45** to plot the solutions (**x** vs **time**) for the differential equations in Problems 3 and 4 in this homework. Assume reasonable initial conditions and values for the parameters if needed.

   Submit one figure with the following subplots:
   a) Problem 3: x vs time
   b) Problem 4: x vs time

10. **(EX)** Examine the ballode demo in Matlab, the documentation for which is here:

    http://www.mathworks.com/help/matlab/math/ordinary-differential-equations.html?s_tid=doc_12b#f1-669698
    (or type doc ode45 and follow documentation.)

```
openExample('matlab/SimpleEventLocationABouncingBallExample')
```

The demo above is a numerical simulation of one-dimensional ball-bouncing. Now extend this simulation to two dimensions (x and y), and **plot the ball motion for several bounces, including horizontal and vertical motion versus time and versus each other.** For the horizontal motion assume that the ball slips when in contact with ground and that this slippage causes a proportional reduction in horizontal velocity. Choose an initial condition so that the ball moves to the right and show how the bouncing dies out over time with a coefficient of restitution of less than 1. You may choose your own values for coefficient of restitution and horizontal damping rate.

Submit one figure showing ball motion for several bounces with following 3 subplots:

a) horizontal motion vs. time
b) vertical motion vs. time
c) horizontal vs. vertical motion

To Submit Online:

1. ONE homework document as a .pdf: handwritten, scanned or a combination.