

# ECE504 Homework Assignment Number 1

Due by 8:45pm on 15-Sep-2009

Tips: Make sure your reasoning and work are clear to receive full credit for each problem.

1. 10 points. Given a pendulum of length  $L$  and a point mass  $M$  with input  $u(t)$  as the force applied tangential to the direction of the motion of the mass shown in Figure 1,

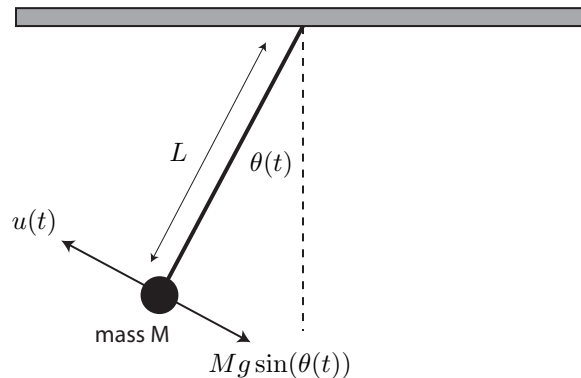


Figure 1: A pendulum.

- (a) 2 points. Write an exact input/output differential equation using  $\theta(t)$  as the output. Hint: The *moment of inertia* here is  $I = ML^2$ .
- (b) 2 points. Classify this system:
- Memoryless, lumped, or distributed
  - Causal or noncausal
  - Linear or nonlinear
  - Time varying or time invariant
- (c) 2 points. Write a linear approximation of the input/output differential equation from part (a) assuming  $\theta(t)$  is small.
- (d) 2 points. Find the impulse response and transfer function of the system in part (c).
- (e) 2 points. Use Matlab to find the step and frequency responses of the system in part (c). Type “help control” in Matlab to see your options.
2. 2 points. Chen 2.3.
3. 3 points. Chen 2.10.