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Student Name: _____

Test 1: ECG 776: Adaptive Control , Fall2019

Problem 1 (5 Points) Draw two block diagrams to show the difference between a model reference adaptive control and a direct adaptive control system. Which one can you expect to be stable in general?

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Problem 2 (10 Points) Given

$$\dot{x} = A(t)x(t) + B(t)u(t), \quad x(t_0) = x_0$$
$$y(t) = C(t)x(t) + D(t)u(t)$$

show that the solution is

$$x(t) = \Phi(t, t_0)x(t_0) + \int_{t_0}^{t} \Phi(t, \tau)B(\tau)u(\tau)d\tau$$

(a) What properties should the function $\Phi(t, t_0)$ satisfy for the solution?
(b) If A, B, C, and D are constants, then what is the solution, and correspondingly what is $\Phi(t, t_0)$? Show that your solution is in fact the true solution.

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Problem 3 (5 Points) Consider the plant

$$y = \frac{s-1}{s^3}u$$

Design a closed loop control law for u as

$$u = -\frac{p(s)}{\ell(s)}y$$

so that the closed loop system is

$$(s+1)^5 y = 0$$

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Problem 4 (5 Points) Given a system

$$\dot{x} = Ax + Bu$$
$$y = Cx$$

where,

$$A = \begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix}, \quad B = \begin{pmatrix} 0 \\ 1 \end{pmatrix}, \text{ and } C = \begin{pmatrix} 1 & 1 \end{pmatrix}$$

(a) Is this system controllable, (b) observable, (c) stabilizable, (d) detectable? (e) Write the system in controllable and/or observable form if it can be done.