

O K L A H O M A   S T A T E   U N I V E R S I T Y

SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING  
SCHOOL OF MECHANICAL AND AEROSPACE ENGINEERING



**ECEN/MAE 5713 Linear Systems**  
**Spring 2012**  
**Midterm Exam #1**



**Name :** \_\_\_\_\_

**E-Mail Address:** \_\_\_\_\_

**DO ALL FOUR PROBLEMS**

**Problem 1:**

Show that if  $f(u_1 + u_2) = f(u_1) + f(u_2)$  for any  $u_1, u_2$ , then  $f(\alpha u) = \alpha f(u)$  for any rational number  $\alpha$  and for any  $u$ .

**Problem 2:**

If  $\{A, b, c, d\}$ ,  $d \neq 0$ , is a realization with  $H(s) = c(sI - A)^{-1}b + d$ , show that  $\{A - (bc/d), b/d, -c/d, 1/d\}$  is a realization for a system with transfer function  $1/H(s)$ .

**Problem 3:**

Realize the following SIMO continuous-time, time-varying system and show the state space representation, i.e.,  $\{A(t), B(t), C(t), D(t)\}$ ,

$$e^{-t} \dot{y}_2(t) + y_1(t) + \ddot{y}_2(t) + y_2(t) = \ddot{u}(t) - tu(t)$$

$$\dot{y}_1(t) + \dot{y}_2(t) + ty_1(t) = \dot{u}(t) + t^2 u(t)$$

**Problem 4:**

Determine an observable canonical form realization (in minimal order) for discrete-time system

$$ky(k+3) + \cos ky(k+2) + k^2 y(k) = e^{-k} u(k+3) + (k+1)u(k+1) + e^{-k^2} u(k).$$

Notice that gain block maybe  $k$  dependent. Show the simulation diagram and its corresponding state space representation.