University of California

**Department of Mechanical Engineering**

ME C232/EE C220 Advanced Dynamic Systems and Control I

Fall 2017

Final Examination December 14 (Th) 8-11 AM in Room .Open Reader, Open Notes

READ ALL PROBLEMS FIRST, AND START WITH THE PROBLEM EASIEST FOR YOU.

[1] Consider a linear quadratic regulator problem defined by

1. The optimal closed loop system has a pair of complex eigenvalues, . By making us of the return difference equality, obtain and .
2. Draw the root locus of the optimal closed loop poles for . You should make the departure angle from open loop poles and the angles of asymptotes ( reasonably accurate.

[2] Consider a linear quadratic regulator problem defined by

Draw the root locus of the optimal closed loop system.

[3] Consider a free system described by

Show that the eigenvalues of *A* satisfy if and only if for any given positive definite matrix *Q*, the matrix equation,

has a unique symmetric solution , and is positive definite.

[4] Consider a system described by

1. Find the condition(s) for controllability.
2. Obtain the solution matrix. Note that may or may not be equal to or .
3. Obtain the conditions for asymptotic stability of the free system. Obtain the condition for limited stability (stability in the sense of Lyapunov). Obtain the condition for instability.

[5] A linear discrete time system is described by

The system output measurement is available every other sampling instance only: i.e. *y*(0), *y*(2), *y*(4),…. are available. Thus, the output equation is

1. Design the closed loop observer for estimation of *x*(*k*).
2. Is it possible to assign arbitrary eigenvalues to the observer? You can assume that is an observable pair. If your answer is no, give a counter example; I suggest that you examine a simple observable second order system.