Department of Mechanical Engineering

2.010 CONTROL SYSTEMS PRINCIPLES

Laboratory Session 3
### Preparation Exercise

Laboratory Session Objectives:

(i) Construction of a velocity controller for the lab servo motor using an op-amp feedback circuit.

(ii) Measurement of the closed-loop system characteristics.

This exercise is intended to help you understand the measurements you will make.

Preparation: Before you come to the laboratory do the following exercise. Keep this on hand for reference during the lab and hand it in as part of the report. Also review the class handout *Introduction to the Operational Amplifier* and bring it to the lab for reference.

Exercise: Consider the proportional control system shown in the following figure:
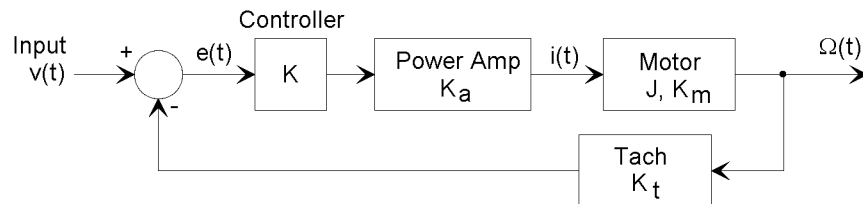
(a) Derive the transfer function relating the angular velocity Ω of the motor to the voltage input command in terms of the controller gain K, servo amp gain K_a, motor torque constant K_m, and tachometer gain K_t. Ignore nonlinearities such as Coulomb friction.

(b) Derive the closed loop time constant in terms of the controller gain K.

(c) Determine the steady-state error to a constant (step) input as a function of the controller gain K.

(d) How would you expect the steady-state error to be affected by the Coulomb friction phenomenon you observed in Lab Session 2.