Sensors & Actuators in Mechatronics

MEAE 6960
Summer 2002

Assignment # 3
• **Problem # 1**
  
  – A load is driven at constant power under steady-state operating conditions using a separately-excited DC motor with constant supply voltages to the field and armature windings. Show that, in theory, two operating points are possible. Also show that one of the operating points is stable and the other one is unstable.
• **Problem # 2**
  - Consider the shunt-connected DC motor and the permanent-magnet DC motor. Derive the equations for the steady-state torque-speed characteristics. Sketch the corresponding characteristic curves and discuss the behavior of the motors.
• **Problem # 3**
  – In this problem you will examine the starting characteristics of the permanent-magnet DC motor as well as its dynamic response to a load change. The motor is rated at 6V, has a no-load speed of approximately 3350 rpm, and the no-load armature current is approximately 0.15 A. The motor has the following parameters:
    • \( r_A = 7 \ \Omega \)
    • \( L_{AA} = 120 \ \text{mH} \)
    • \( k_T = 2 \ \text{oz-in/A} \)
    • \( J = 150 \ \mu\text{oz-in-s}^2 \)
– With no load on the motor \((T_L = 0)\) and the motor at rest, a step input in armature voltage of 6V is applied. Plot the armature current and rotor speed vs. time.

– With the motor operating at the no-load condition, a step increase in load torque, \(T_L\), of 0.5 oz-in is applied. Plot the armature current and rotor speed vs. time.

– Use MatLab/Simulink to predict the behavior and generate the required plots. Discuss your results.