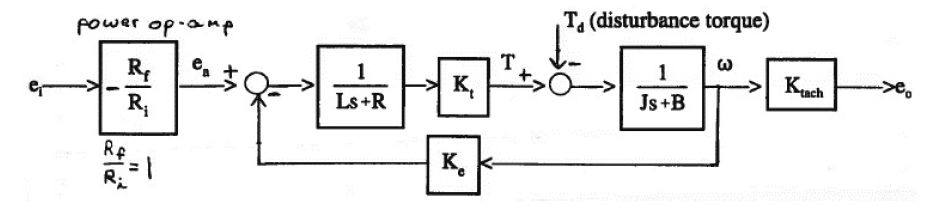
Part 3 a)

The MUT in the open-loop set-up is still connected to the back-drive motor, therefore it would experience both motor’s moment of inertia as well as damping conditions. Assuming both motors are the same, the system equations of the MUT can be derived from the following schematic:

From the circuit, Kirchhoff’s loop law:

The voltage drop is proportional to the resulting angular velocity of the mechanical system, and the current is proportional to the resulting torque by:

Using and , the mechanical system equation is:

Since the inductance is three magnitudes less than the resistance, the inductance term is neglected. Laplace transform and combine the equations:

The transfer function is then:

b) From the block diagram, when the disturbance torque is equal to the motor torque , the output velocity would be zero, and would equal to the stall torque of the motor at the input voltage.

For input voltage, , at stall torque:

Where from experimental data, from information given, for step input, and assuming and converted to the proper units:

The negative sign indicates an arbitrary direction.

c)

The gain , and the time constant , where , the values are found to be:

Which is the motor’s velocity constant .

The moment of inertia term is double the amount given on the spec sheet since the MUT also drives the back-drive motor:

Convert to the correct units:

The matches the expected value for the motor.

d) The recorded data is from the tachometer. Therefore, the motor’s gain would need to multiply by Ktach:

Solve for :

Use and to solve for :

e) Setting time from data:

Steady-State Error: