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2.004 Dynamics and Control II
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MASSACHUSETTS INSTITUTE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

2.004 Dynamics and Control II

Lab Session 1: Lab Familiarization¹

Preparation:

- Problem Set 1 was designed to help you review the theory for this lab session. You should have completed the exercises, and bring them to the lab.
- The handout "Description of Laboratory Rotational Plant" describes the experimental plant for this session.
- You should read this handout thoroughly before the first lab session.

Purpose of the Lab:

This first lab session will introduce you to the 2.004 lab, and familiarize you with the laboratory equipment and software tools that you will be using throughout the term. You will then use these tools to study the frictional characteristics of the rotational plant that you will be using in future weeks.

Preliminary Tasks:

1. You will work in groups of two. The lab instructors will organize you into pairs, and assign you to lab stations.
2. Each group will be assigned a 2.004 computer account on the ME domain. You should log-on to your account and set a password. Your home directory will appear as drive z:. You will be able to log on to your account, and access your files, from any computer within the ME domain.
3. Your lab instructor will spend some time describing the equipment and software that will be using throughout the term. This will include the function generator, and the data acquisition hardware and software. The first series of experiments in the lab will be concerned with the design and implementation of velocity and position controllers for the rotational flywheel system. You will have a chance to explore this equipment.
4. You will learn how to use the "Chart Recorder" virtual instrument (VI), including how to capture data, select regions of interest from a data record, print the chart, and save it as a MATLAB ".m" file, or as an Excel ".xls" file for subsequent analysis. Appendix B describes the basic operation of the Chart Recorder. You will practice using the recorder with the function generator, and save and examine some data in both MATLAB and Excel. Your instructor will help you here.

¹February 5, 2008

Today's Experiment:

Your task for this first session is to study the frictional characteristics of the motor, gear train, and bearings in the flywheel system, and to estimate numerical values for the frictional coefficients. You will study the effects of the eddy-current damping by placing magnets under the rim of the copper flywheel. There will be four separate cases: no eddy-current damping magnet, and one, two and three magnets in place. You will monitor and record the “spin-down” characteristic of the flywheel in each case.

In *Problem Set 1* you were asked to determine the angular velocity of a rotating mass as it spins down under coulomb or viscous friction. You will observe both friction characteristics here. You should be able to distinguish between them directly from the recorded data.

Procedure: You will monitor the angular velocity profile using the ETach electronic tachometer that is attached to the rotary encoder on the flywheel shaft. It produces an analog voltage v_o proportional to the shaft speed Ω

$$v_o = K_t \Omega$$

where the tachometer constant K_t is 0.016 volts/rpm.

For each of the four cases you should

- (a) Spin the flywheel by hand, and record the angular velocity decay $\Omega(t)$, using the computer-based Chart Recorder Virtual Instrument (VI) - see Appendix B. (Remember to convert the Chart Recorder output to angular velocity.)
- (b) Save a relevant section of your data to a MATLAB file. (see Appendix B)
- (c) By observing the nature of the data records, you should decide for each case whether the friction is predominantly, viscous or coulomb in nature. If you were unable to solve the relevant parts of Problem Set 1, your lab instructor will help you here.
- (d) Estimate the appropriate frictional coefficient using your results from Problem Set 1. You will need the numerical value of the moment of inertia J . If, in a given case, you decide that the friction is predominately viscous, you should estimate the value of time-constant of the decay (see Appendix A) and use that value to calculate the viscous coefficient B . If you decide the friction is coulomb in nature, estimate the value of the friction coefficient T_c using several data points.

Your Report:

As well as handing in Problem Set 1 (individual) at the end of the lab, you should also hand in a brief report of your group's work. You should include printed graphs of the data you recorded, and show the values you found for the frictional parameters, and the methods you used to estimate the coefficients.