2.004 Laboratory Syllabus, Spring 2003

Experiment 1: MatLab I – basics and programming

Concepts: (1) Matrix operations, arithmatics
(2) Mathematical operations and functions
(3) Plotting and graphing
(4) Toolboxes
(5) m-files
(6) Basic programming concepts
(7) Conditional statements, loops
(8) Functions and m-files
(9) Numerical estimation of differentials and integrals

Experiment 2: Collision, long drop: kinematics and energy functions

Experiment: Measure ball drop at the balcony of lobby 7

Concepts: (1) Deduce kinematics parameters from measured trajectory
(2) Understanding impulse; deduce force interaction from momentum measurement
(3) Energy functions
(4) Measuring coefficient of restitution

Experiment 3: Pendulum motion: kinematics, reference frames and geometric constrains

Experiment: A rod pendulum suspended by two bars, w/ & w/o rotation

Concept: (1) Complex kinematics in two-dimensions
(2) Natural modes
(3) Separating linear and angular momentum
(4) Predicting the motions of different locations on a rigid body
(5) Modification of natural modes by geometric constrains

Experiment 4: Rocker: Dynamics and momentum principles

Experiment: The dynamics of a rocker

Concept: (1) Dynamics of a rocker in rolling without slipping condition
(2) Natural frequency of rockers of different geometry

Experiment 5: MatLab III: Control Toolbox

Concepts: (1) Control toolbox and interfaces
(2) Poles and zeros
(3) Root-Locus and gain
(4) Proportional, differential, and integral control implementation
(5) PI, PD, PID controls

Experiment 6: Control of 2nd order spring-mass-damper system

Experiment: Controlling the response of a spring-mass-damper system with different m & k

Concepts: (1) Linking MatLab simulation with observed system dynamics
(2) Modify dynamics by modifying m & k
(3) Examine the need to effect of changing control parameters and schemes

Experiment 7: Coupled Drive Shaft: Vibrational modes, geometric constraints, and control

Experiment: A rods driven by a second rod driven by an orthogonal rod coupled by a spring joint

Concepts: (1) Kinematics and effects of geometric constrains
(2) Effect of geometric constrains in modifying effective inertia
(3) P, PD, PI, PID control in the transient response of a 1 DOF system
(4) Linearization around a equilibrium point

Experiment 8: Spring coupled masses: 4th order system

Experiment: Spring loaded rod driving a spring coupled mass

Concept: (1) Kinematics and effects of geometric constrains
(2) Effect of the zero and tuned damping
(3) Transient responses in a 4th order system
(4) Failure of simple proportional control