ME 562 – ADVANCED DYNAMICS
PURDUE UNIVERSITY
Summer 2010

Instructor:

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TEXT:

Greenwood, D.T., Principles of Dynamics, Prentice Hall, 1988 (2nd Edition).

REFERENCE:

Huseyin, K., Vibrations and Stability of Multiple Parameter Systems, Sijthoff and Noordhoff, 1978.

LECTURE NOTES:

Copies of the MS PowerPoints used for the course will be available from the Boiler Copy Shop in Purdue Memorial Union, and at the course website.

PREREQUISITES:

Sophomore level course in dynamics covering particle kinematics and dynamics, planar kinematics and kinetics of rigid bodies; Vector calculus and matrix theory, ordinary differential equations.

GRADING:

Homework	40%
Midterm Exam	25% (in class, 50 mins)
Final Exam	35% (finals week, two hrs.)

- Homework assignments will be given every three to four lectures. Each assignment will consist of 3 or 4 problems. All problems will be collected, but only one or two will be graded. The assignments will be due three to four days from the day assigned. Exact schedule will be posted on the website. No late homework will be accepted.

- The mid-term exam will be given in-class some time between the 5th and the 6th week. The exact date will be announced at least 2 weeks in advance.

- The final exam will be given during the finals week (the 8th week of the Summer session).

ME 562 – Course Outline
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A.K.Bajaj – Instructor

Important Note: The text will be followed closely with some sections covered through *reading assignments*. The reading assignments will be given in lectures and the student will be responsible for the material assigned for reading. There will be homework problems that will cover the assigned material.

The course outline given below essentially follows the text for most part. Examples will be given in lectures to illustrate and expand on the text material and will not be restricted to the end of the chapters. A few sections will require supplementary material which will be provided as the semester progresses.

1. INTRODUCTORY CONCEPTS — Text

   1.1 Elements of Vector Analysis
   1.2 Newton's Laws of Motion
   1.3 Units
   1.4 The Basis of Newtonian Mechanics
   1.5 D'Alembert's Principle

2. KINEMATICS OF A PARTICLE — Text

   2.1 Kinematics of a particle: Position, Velocity, and Acceleration of a Point
   2.2 Angular Velocity
   2.3 Rigid Body Motion About a Fixed Point
   2.4 Time Derivative of a Unit Vector
   2.5 Velocity and Acceleration of a Particle in Several Coordinate Systems
   2.6 Simple Motions of a Point
   2.7 Velocity and Acceleration of a Point in a Rigid Body
   2.8 Vector Derivatives in a Rotating System
   2.9 Motion of a Particle in a Moving Coordinate System
   2.10 Planar Motion

3. DYNAMICS OF A PARTICLE — Text

   3.1 Direct Integration of the Equations of Motion
   3.2 Work and Energy
   3.3 Conservative Forces
   3.4 Potential Energy
   3.5 Linear Impulse and Momentum
   3.6 Angular Momentum and Angular Impulse
   3.7 Mass-Spring-Damper System
   3.8 Coulomb Friction

4. DYNAMICS OF A SYSTEM OF PARTICLES — Text

   4.1 The Equations of Motion
   4.2 Work and Kinetic Energy
   4.3 Conservation of Mechanical Energy
   4.4 Linear Impulse and Momentum
   4.5 Angular Momentum
   4.6 Angular Impulse
   4.7 Collisions
   4.8 The Rocket Problem

5. ORBITAL MECHANICS — Text

6. LAGRANGE'S EQUATIONS — Text and Supplementary Notes

6.1 Constraints and Their Classification
6.2 Possible and Virtual Displacements
6.3 Generalized Coordinates and Forces, Degrees of Freedom
6.4 Principles of Virtual Work and D'Alembert's Principle
6.5 Potential (Conservative), Gyroscopic, and Dissipative Forces
6.6 Derivation of Lagrange's Equations for Holonomic Systems
6.7 Lagrange Multipliers and Nonholonomic Systems

7. MORE ON ANALYTICAL MECHANICS — Supplementary Notes

8.1 Lagrangian, Generalized Momenta and Conservation
8.2 Ignorable Coordinates
8.3 Routh's Method for Reduction of Degrees of Freedom
8.4 Hamilton's Principle
8.5 Hamiltonian Form of Equations of Motion

8. BASIC CONCEPTS AND KINEMATICS OF RIGID BODY MOTION
Text and Supplementary Notes

7.1 Degrees of Freedom of a Rigid Body
7.2 Moments of Inertia
7.3 Matrix Notation
7.4 Kinetic Energy
7.5 Dyadic Notation
7.6 Transformation (Translation and Rotation) of Coordinates
7.8 Principal Axes
7.9 Displacement of a Rigid Body
7.10 Axes and Angle of Rotation
7.12 Finite and Infinitesimal Rotations
7.13 Euler Angles
7.14 Rigid Body Motions in a Plane

9. DYNAMICS OF A RIGID BODY — Text and Supplementary Notes

8.1 General Equations of Motion
8.2 Equations of Motion in Terms of Euler Angles
8.3 Free Motion of a Rigid Body
8.5 Motion of a Symmetric Top
8.6 Other Methods for Axially Symmetric Bodies
8.7 Impulse-Momentum and Work-Energy Principles