**Department of Mechanical and Materials Engineering**
**Ph.D. Comprehensive Study Guide**
**DYNAMICS**
**February 2010**

**Textbook:** J.L. Meriam and L.G. Kraige, Engineering Mechanics (Dynamics), John Wiley & Sons Inc., Vol. 2, SI Version, Sixth Edition, ISBN 978-0-471-78703-7

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**Topics Covered:**

**Chapter 1: Introduction to Dynamics.** History, applications, definitions, units and dimensions, Newton's laws (articles 1/1 through 1/8).

**Chapter 2**: **Kinematics of Particles.** Planar motion (rectilinear, curvilinear), coordinate systems (rectangular, normal and tangential, polar), conversions between coordinate systems, 3D motion and coordinate systems (rectangular, cylindrical, spherical), free and constrained paths, relative motion between particles (articles 2/1 through 2/10).

**Chapter 3: Kinetics of Particles.** Newton's Second Law, equations of motion, work and energy, impulse and momentum (articles 3/1 through 3/10). (when I taught MECH 228 I never had time to teach articles 3/11-3/14 as I was covering Chapter 5 in details before teaching Chapters 3&4 - which was done simultaneously.

**Chapter 4: Kinetics of Systems of Particles.** Generalized Newton's Second Law, work and energy, impulse and momentum, conservation of energy and momentum, steady mass flow (articles 4/1 through 4/6).

**Chapter 5: Plane Kinematics of Rigid Bodies.** Rigid-Body assumption, motion (displacement, velocity and acceleration) in 2D using vector analysis, scalar algebra and graphical approach: translation (rectilinear and curvilinear), fixed-axis rotation, general plane motion, absolute and relative motions, instantaneous center of zero velocity, motion relative to rotating axes (articles 5/1 through 5/8).

**Chapter 6: Plane Kinetics of Rigid Bodies.** General equations of motion, translation, fixed-axis rotation, general plane motion, work and energy, impulse and momentum (articles 6/1 through 6/9 except for article 6/7).

**Chapter 7: Introduction to Three-Dimensional Dynamics of Rigid Bodies.** 3D kinematics (fixed-axis and fixed-point rotations, general motion), angular momentum for 3D rigid bodies, kinetic energy, equations of motion, simplified approach to gyroscopes (articles 7/1 through 7/10 and part of 7/11).

**Chapter 8: Vibration and Time Response.** Equation of motion and time response for: undamped and damped free vibration using free-body diagrams and work-energy method for single-degree-of-freedom systems, undamped and damped forced vibration of single

DOF systems (external harmonic vibration, base excitation, vibration measuring instruments); equivalent single DOF system of continuous elements/systems using energy equivalence (articles 8/1 through 8/6).

**Appendix B: Mass moments of Inertia.** Moments and products of inertia, parallel axis theorem, radius of gyration, composite bodies (articles B/1 and B/2).