446.204A Dynamics
Fall 2016
Syllabus

Introduction: This course is an introduction to the dynamics of rigid bodies and multibody systems. The practical goals are to enable students to derive the equations of motion for rigid multibody systems such as robots, vehicles, spacecraft, and other mechanical devices, and to extract qualitative and quantitative information about such systems. The material also serves as a foundation for upper level courses in advanced dynamics and vibration, robotics, biomechanics, and control.

Lectures: Lectures will be held Tuesdays and Thursdays from 11:00 AM-12:30PM, in lecture hall 301-204.

Discussion Section: In addition to the lectures, students are expected to attend a one-hour discussion section each week. Discussion groups, consisting of approximately 20 students each, will be organized and run by the teaching assistants on a weekly basis, with the goal of reviewing the lecture material, solving practice problems, and giving the students an opportunity to ask questions. Discussion sections will meet on Thursdays and Fridays in the late afternoon; the meeting times and locations will be announced at a later date. **Attendance in the discussion sections is mandatory**.

Course Instructor: The instructor for the course is Frank Chongwoo Park. His office is located in Building 301, Room 1515. He can be reached at 880-7133, or by email at *fcp@snu.ac.kr*. The instructor will be available for questions and discussion after each lecture; other times can be arranged by appointment.

Teaching Assistants: The teaching assistants for the course will be announced later on the first day of class. TA offices are located in the Robotics Laboratory, Building 302, Room 413. The main lab telephone number is 880-7149. Office hours maintained by each TA will be announced at a later date.

Course Webpage: A course webpage will be maintained at *http://etl.snu.ac.kr*. All lecture notes, homework assignments, solutions, and announcements will be made available on the course webpage. A monitored course discussion board will also be available. Personal communications with the teaching assistants should be conducted by email rather than through this course discussion board.

Course Text: The course text will be *Vector Mechanics for Engineers: Dynamics* (11th Edition) by F. Beer, E. Johnston, and P. Cornwell. Supplemental lecture notes will be distributed throughout the course as required.

Grading: The grading for the course will be based on weekly problem sets (5%), two exams (25%), a final exam (40%), and participation in discussion sections (5%). The weights are approximate,

and may be adjusted accordingly at the discretion of the instructor. Tentative dates for the exams are October 16 (exam 1), November 20 (exam 2), December 9 (final). Exams will be held in the evenings, and will be closed book, closed notes.

Prerequisites: Students should have a solid understanding of the classical physics of particles and ordinary differential equations as taught in a first year class. Students are also expected to have an understanding of statics as covered in an introductory course on the mechanics of solids, and vector calculus and matrix algebra as covered in an introductory engineering mathematics course.

Lecture Topics:

- **September 1 (Th)**: Motivational examples, fixed and moving frames in particle kinematics
- **September 6 (Tu)**: Velocity and acceleration analysis using moving frames (no discussion this week) [Problem Set 1 available]
- **September 8 (Th)**: Velocity and acceleration analysis of multibody systems
- **September 13 (Tu)**: Particle dynamics—Newton's second law for a particle [Problem Set 1 due in discussion; Problem Set 2 available]
- **September 15 (Th)**: No lecture (HOLIDAY)
- **September 20 (Tu)**: Particle dynamics—angular momentum of a particle in motion, motion under a central force. [Problem Set 2 due; Problem Set 3 available]
- **September 22 (Th)**: Particle dynamics—principle of work and energy
- **September 27 (Tu)**: Particle dynamics—impulse and momentum [Problem Set 3 due; Problem Set 4 available]
- **September 29 (Th)**: Particle dynamics—examples and case studies
- **October 4 (Tu)**: Systems of particles—equations of motion [Problem Set 4 due; Problem Set 5 available]
- **October 6 (Th)**: Systems of particles—work and kinetic energy
- **October 11 (Tu)**: Dynamics of a rigid body—the inertia tensor [Problem Set 5 due; Problem Set 6 available]
- **October 13 (Th)**: Dynamics of a rigid body—equations of motion for a single rigid body
- **October 18 (Tu)**: EXAM 1 (7-9 PM, closed book, closed notes) (No discussion this week)
- **October 20 (Th)**: Dynamics of rigid bodies—energy and momentum methods
- **October 25 (Tu)**: Dynamics of multibody systems [Problem Set 6 due; Problem Set 7 available]
- **October 27 (Th)**: Lagrangian dynamics—motivational examples, kinematics of multibody systems, degrees of freedom, generalized coordinates
- **November 1 (Tu)**: Lagrangian dynamics—variational calculus [Problem Set 7 due; Problem Set 8 available]

- **November 3 (Th)**: Lagrangian dynamics—generalized forces, derivation of equations of motion
- **November 8 (Tu)**: Lagrangian dynamics—case studies [Problem Set 8 due; Problem Set 9 available]
- **November 10 (Th)**: Lagrangian dynamics—case studies
- **November 15 (Tu)**: Linearization of the dynamics [Problem Set 9 due; Problem Set 10 available]
- **November 17 (Th)**: Linear differential equations
- **November 22 (Tu)**: EXAM 2 (7-9 PM, closed book, closed notes) (No discussion this week)
- **November 24 (Th)**: Stability analysis
- **November 29 (Tu)**: Vibration analysis [Problem Set 10 due; Problem Set 11 available]
- **December 1 (Th)**: Control of multibody systems
- **December 6 (Tu)**: Review session [Problem Set 11 due]
- **December 8 (Th)**: FINAL EXAM (6-9 PM, closed book, closed notes)