Spring
2022

SCUPI
Sichuan University - Pittsburgh Institute

ME1015 Rigid Body Dynamics

Instructor: Jangho Yoon, Ph.D.
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Office hours: Tuesday : 02:00 PM ~ 05:00 PM
Thursday: 02:00 PM ~ 05:00 PM – By appointment only
Class time: Monday: 13:50 - 16:25
Class location: Teaching Building C, Room #506

Catalog Description: This is 3 credit hour course intended to introduce students to the motion of particles and rigid bodies. Students are expected to develop an understanding of the fundamental principles of applied kinematics for particles and rigid bodies in engineering dynamics and demonstrate an integrated understanding of engineering dynamics principles through applications involving problem solving and through creation of design solutions to engineering scenarios.

Course Objective At the end of the course, the student will be able to:

- Interpret the geometry and physical meaning of mechanical systems by drawing diagrams (free body diagrams and kinematic diagrams)
- Apply several governing methods (Newton laws, work-energy, impulse-momentum) to study mechanical systems
- Analyze and predict the kinematics and kinetics of a body using various reference frame

Prerequisites: MATH 0240 Analytic Geometry & Calculus 3
ENGR 0135 Statics & Mechanics of Materials I

Textbook: Engineering Mechanics Dynamics. 9th edition by *J. L. Meriam, L. G. Kraige, and J. N. Bolton*, John Wiley & Sons, Inc. New York, 2018.

Reference: Engineering Mechanics – Dynamics Any Edition by R. C. Hibbler, Prentice Hall.

Topics Covered:

1. Kinematics in Normal, Cylindrical & Tangential Coordinates
2. Absolute & Relative Motion
3. Kinetics: Equations of Motion
4. Principle of Work & Energy for Particles
5. Linear Impulse & Momentum
6. Angular Impulse & Momentum
7. Relative Velocity & Acceleration of Rigid Bodies
8. Moment of Inertia
9. Work and Energy for Rigid Bodies
10. Motion of a Rigid Body
11. Moments and Products of Inertia
12. Angular Momentum & Kinetic Energy

Grades

Daily Review Questions	5 %
Two Small Projects	10 % (5% each)
Two Term Exams	40 % (20% each. Scheduled tentatively on Apr. 11 and May 23)
One Final exam	45 % (Final Week)

While grades may be curved, there is no guarantee of any curve. However, a student will have to reach 50 % of the total number of possible points in order to receive a grade of D or better and to become eligible for make-up exam. If any student takes Make-Up exam, the highest grade that the student can receive is D. In the absence of a curve the grading scale is

	$A > 90\%$	$A^- > 85\%$
$B^+ > 80\%$	$B > 76\%$	$B^- > 73\%$
$C^+ > 70\%$	$C > 66\%$	$C^- > 63\%$
$D^+ > 61\%$	$D = 60\%$	$F < 60\%$

Homework, Daily Review Questions, Project and Exams

There will be homework assigned on weekly base, which will not be graded. **The answer(s) of the review question(s) must be handwritten otherwise there will be 50% penalty**. **Late submission will be accepted with 70% penalty and 100% penalty after posting solution on BB. unless an arrangement is made with the instruction well ahead of the due time, at least day before.** One lowest score will be dropped from your grade at the end of semester.

Two small projects will be assigned. One will be based upon the experiment that you design and perform. The other will be computer simulation using MatLab. The details will be given when the project is assigned.

There will be **two term exams** and **a final exam**. The final exam is comprehensive. The exams in this course will be closed book and closed note. All the necessary formulas will be given to students by the instructor.

If you miss any exam, NO make-up will be given for the missing exam *without prior* arrangement. If you have a serious conflict with an exam time, you MUST discuss it with the INSTRUCTOR well ahead of the scheduled exam day to make an appropriate arrangement. Exams missed due to unpredictable events such as a family emergency and a traffic accident will be dealt with on a case-by-case basis if the student has a proper document(s) to prove it.

Students have one week after the any graded work of any kind including exams is returned or the grad is posted on BB to bring up any questions regarding the grading discrepancy.

It is important that you show the work in an organized manner clearly showing your thought process in solving the given question. Instructor cannot give credits for the answer(s)/work(s) that is(are) not readable and/or understandable.

Make sure that you use appropriate units for all your works such as homework, project and exam, or you will **be penalized** for any missed unit or wrong unit, and **be penalized** for using excessive number of significant figures

e.g., $\pi = 3.1415926535897932385$ instead of $\pi = 3.14$

Collaboration:

Collaboration between students is strongly encouraged for better understanding of the course material. Students are allowed to discuss homework problems and projects in terms of **methodologies**, but **not the solutions** of a problem, which means that each student MUST do the actual work independently. Inappropriate collaboration (also known as cheating) includes

- Using all or parts of homework, exams or projects from this year or any previous year
- Sharing of work such as graphs, equations, calculations or any other derived material that was not presented to the class
- Talking, passing information or using inappropriate materials during an exam Anyone found to be participating in inappropriate collaboration may be immediately failed from the course.

Office Hours:

Office hours are times I have specifically set aside to be available to students. During office hours, you can come to my office; you don't need an appointment. I may be available at other times; please email to schedule a time, or simply drop by, outside these times.

Be prepared to show me what work you have done and try to avoid asking vague questions

Attendance:

On-time attendance at all class activities is expected. Attendance itself will not be graded, but the student is responsible for any material that was covered, and any changes to the exam dates and homework assignments announced in class. Make-up work will only be accepted if prior arrangement has been made or if a valid emergency excuse (e.g., meteor strike) is accompanied by appropriate documentation.

Other Policies:

Please honor the following: do not come late; do not disturb the class by having conservation with others; turn off all cell phones and electronic gadgets; do not work on any other class materials.

Those students who fail to follow these policies may be asked to leave the class.

The instructor also reserves the right to extend credit for alternative assignments, projects, or presentations and to make changes to this syllabus as needed.

All changes will be announced via Blackboard and/or announced in class.

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Class Week	Chapter	Topic
1	Ch. 1	Introduction - Basic Concepts, Newton's Law, Units
2	Ch. 2.1 ~ Ch. 2.5	Rectilinear & Curvilinear Motion in Rectangular and Normal & Tangential Coordinates
3	Ch. 2.6 ~ Ch. 2.8	Polar Coordinates, Space Curvilinear Motion and Relative Motion
4	Ch. 3.1 ~ Ch. 3.4	Kinetics - Equation of Motion and Rectilinear Motion
5	Ch. 3.5 ~ Ch. 3.7	Curvilinear Motion, Work & Kinetic Energy, and Potential Energy
6	Ch. 3.8 ~ Ch. 3.12	Impulse & Momentum and Impact
7	Ch. 4.1 ~ Ch. 4.3	Generalized Newton's Law, Work-Energy
8	**Exam I (April 11)**	
9	Ch. 4.4 ~ Ch. 4.5	Impulse-Momentum, Conservation of Energy and Momentum
10	Ch. 5.1 ~ Ch. 5.4	Rotation, Absolute Motion and Relative Velocity
11	**Labor Day**	
12	Ch. 5.5 ~ Ch. 5.6	Instantaneous Center of Velocity and Relative Acceleration
13	Ch. 6.1 ~ Ch. 6.3	Force, Mass, and Acceleration I
14	**Exam II (May 23)**	
15	Ch. 6.4 ~ Ch. 6.5	Force, Mass, and Acceleration II
16	Ch. 6.6 ~ Ch. 6.8	Work & Energy and Impulse & Momentum
17	**Final Exam**	