# ME 240: Introduction to Dynamics and Vibrations, Fall 2016

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| **Lectures** | **Section 003 - M and W 9:30-11:00 and F 9:30-10:30 in 1045 GGBL** |
| **Instructor** | Chinedum Okwudire |
| **Office** | 2656 GGB (New Addition) |
| **Phone** | (734) 647-1531 |
| **Email** | okwudire@umich.edu |
| **Office Hours** | Wed 4:30-5:30 in 2656 GGB |
| **Prerequisites** | Physics 140 is a prerequisite and Math 216 is a co-requisite |
| **Textbook (Optional)** | *Engineering Mechanics - Dynamics*, Meriam, 7th Edition (Student Value Edition), Wiley http://www.wiley.com/WileyCDA/Section/id-819551.htmln |
| **ME 240 Course Website** | Login to Canvas (http://umich.instructure.com/) |
| **Teaching Assistants** | Jeffrey Koller, jrkoller@umich.edu<br>Mehdi Sadeghpour, mehsad@umich.edu |
| **ME240 Tutoring Hrs.** | **(**ME) Findley Learning Center<br>Tuesday 2-5 Cubicle B (2520 GGB)<br>Wednesday 12:00-7:00 Room A (2528 GGB) and Room B (2520 GGB)<br>Thursday 12:00-7:00 Room A (2528 GGB) and Room B (2520 GGB) |
| **Optional Recitation Hrs.** | Friday 10:30-12:00, 1045 GGBL |
| **Lecture Video Recordings:** | https://leccap.engin.umich.edu/leccap/viewer/r/ZdiQrl (2015 Lectures) |

## Expectations

You should expect that I start and end each class on time and that I prepare the clearest possible lecture. In turn, I expect you to attend every lecture, to be on time, and to complete all of the required work in the course. I expect you to avoid side talks or any distractions during lectures. Material specific to class lectures may appear on exams. I also expect you to strictly abide by the Engineering Honor Code (http://www.engin.umich.edu/students/honorcode/) in **ALL** work related to this class. Any violations of the Code will be taken up with the Engineering Honor Council.

## Course Objectives

1. To teach planar kinematics of particles, systems of particles and rigid bodies.
2. To teach problem formulation and solution methods for the dynamic equations of motion for planar motion of rigid bodies.
3. To develop simplified, rigid body models for systems of mechanical components.
4. To introduce the concepts and uses of work and kinetic energy.
5. To teach fundamental concepts and solution strategies for mechanical vibration problems.

## Course Outcomes

1. Describe the planar motion of a particles and rigid bodies.
2. Describe planar motion of a system of connected rigid bodies including pinned, rolling and sliding connections.

3. Draw free body diagrams for particles, rigid bodies and systems of rigid bodies along with their components.
4. Apply the laws of motion to relate forces obtained from free body diagrams and accelerations from kinematics to derive the equations of motion for particles and rigid bodies in planar motion.
5. Develop simplified models and dynamic equations of motion for connected mechanical systems including rigid links, inextensible cords, sliding and rolling contact conditions, springs and masses.
6. Develop closed form solutions for single degree of freedom free and harmonically driven vibratory systems.
7. Design to avoid or achieve resonance in single degree of freedom mechanical models.
8. Understand definitions of work, potential energy and kinetic energy.
9. Learn that work and energy principles may be more appropriate for problem solution when forces are not a primary quantity of interest and to use these principles to obtain velocity, position and the work done by external forces.
10. Obtain a basic level of understanding of how to apply modern computational software for solving and animating dynamics problems.
11. Obtain numerical results for the dynamic equations of motion using algebraic manipulation, solution of differential equations or computational methods.

**Homework Assignments**

Completing homework problems and computer problems are essential parts of this course and they represent critical opportunities to learn the material. Note that excerpts of homework problems may be incorporated into quiz and exam problems. Homework will be assigned on Fridays and are due at the beginning of class on the following Friday. All homework will be counted towards your grade and late submissions will not be accepted. Two computer assignments will be assigned in tandem with weekly homework assignments. Assignments and solutions will be posted on our course website.

All homework assignments are to be completed on your own. You are allowed to consult with other students during the conceptualization of a problem but all written work, whether in scrap or final form, are to be generated by you working alone. You are also not allowed to possess, look at, use, or in any way derive advantage from the existence of solutions, whether these solutions were former students' work product or copies of solutions that had been made available by any instructor or publisher. Violation of this policy will initiate an action to be filed with the Dean's office and the College of Engineering's Honor Council. If you have any questions about this policy, do not hesitate to contact me.

**Optional Recitations and Homework Assignment Make up**

Every week, you will be given the chance to sign up for optional recitation hours where supplementary examples will be provided to specifically address topics that you and your classmates struggled with in the just-graded homework assignment. If you attend the recitation, you will be given the chance to redo and re-submit all or part of your homework assignment to make up 75% of your homework assignment grade.

**Quizzes and iClickers**

In-class quizzes will be given on a regular basis to test students' understanding of the course material. iClickers will be used for the quizzes, as well as for other course-related activities. Please visit: http://showcase.itcs.umich.edu/remotes/ for more information on how and where to purchase an iClicker, if you do not already have one. Also remember to **register your iClicker** by visiting the course website and clicking on iClicker Registration on the left pane.

**Examinations**

There will be two (in-class) midterm examinations and one final exam as highlighted in the course outline below. Please **mark these dates in your calendar now** as no make-up exams will be given except in the case of documented emergency.

Additionally, there will be two (in-class) mock midterm exams (also highlighted in the course outline).The mock midterm exams are optional but you may use your grades from each mock exam to make up 50% of your grade in the corresponding midterm exam. For instance, if you scored 100% in mock midterm exam #1 and then scored 50% in midterm #1, your adjusted score for midterm 1 will become: 0.5*100% + 0.5*50% = 75%.

For every exam, you may bring a basic scientific calculator and one letter-sized sheet of notes (two for the final exam). No other electronic or communication equipment is allowed.

**Grading**

**Historically, the average grade in ME240 is a B-**. This term your grade will be calculated with the following percentages:

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| Homework and Computer Assignments | 15% |
| Quizzes | 10% |
| Midterm Exam #1 + Optional Mock Midterm Exam #1 | 22% |
| Midterm Exam #2 + Optional Mock Midterm Exam #2 | 23% |
| Final Examination | 30% |
| **Total** | **100%** |

**Bonus for Participation**

Your active participation in course-related activities is not a requirement but is highly encouraged. Students who actively participate not only improve their understanding of the course material but also directly or indirectly help other students to learn. Therefore, a bonus of up to **a maximum of 4%** is available for this class. The bonus grade will consist of two components.

**(1) Instructor's Bonus (up to 2%):** This component will be assigned by the instructor to students who are particularly active in class by, for instance, asking very good questions, making very insightful comments and/or helping out with in-class activities.

**(2) Survey Completion Bonus (up to 2%):** This bonus will be given to students for completing two sets of surveys that provide feedback on the effectiveness of this small class.

**Note:** The 4% bonus will only be applied up to the maximum grade of the course. For example, if a student scores a total of 98% from the other components of the course, the maximum bonus that can be assigned to him/her is 2%.

## Course Outline

| Date | Topic | Reading | Homework |
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| 9/7 | Review Syllabus, Particle Kinematics | 2/1, 2/2 | |
| 9/9 | Particle Kinematics | 2/3, 2/4 | **Hw. 1 Assigned** |
| 9/12 | Particle Kinematics | 2/5 | |
| 9/14 | Particle Kinematics | 2/6, 2/7 | |
| 9/16 | Particle Kinetics: Newton's Laws | 3/1, 3/2, 3/3 | **Hw. 1 Due, Hw. 2 Assigned** |
| 9/19 | Particle Kinetics: Newton's Laws | 3/4, 3/5 | |
| 9/21 | Particle Kinetics: Newton's Laws | 3/4, 3/5 | |
| **9/23** | **Mock Midterm Exam #1 on Particle Kinematics (in class, optional)*** | | |
| | Particle Kinetics: Newton's Laws | 3/4, 3/5 | **Hw. 3 Assigned** |
| 9/26 | Particle Kinetics: Work and Energy | 3/6 | **Hw. 2 Due** |
| 9/28 | Particle Kinetics: Work and Energy | 3/6, 3/7 | |
| 9/30 | Particle Kinetics: Work and Energy | 3/7 | **Hw. 3 Due, Hw. 4 Assigned** |
| 10/3 | Particle Kinetics: Impulse and Momentum | 3/8 | |
| 10/5 | Particle Kinetics: Impulse and Momentum | 3/9 | |
| 10/7 | Particle Kinetics: Impulse and Momentum | 3/12 | **Hw. 4 Due, CA 1 Assigned** |
| 10/10 | Rigid Body Kinematics | 5/1, 5/2 | |
| 10/12 | Rigid Body Kinematics | 5/4 | |
| **10/14** | **Midterm Exam #1 on Particle Dynamics (in class)*** | | **Hw. 5 Assigned** |
| 10/17 | Fall Study Break | | |
| 10/19 | Rigid Body Kinematics | 5/5 | |
| 10/21 | Rigid Body Kinematics | 5/6 | **Hw. 5, due, Hw. 6 Assigned** |
| 10/24 | Rigid Body Kinematics | 5/7 | |
| 10/26 | Rigid Body Kinematics | 5/7 | |
| 10/28 | Rigid Body Kinetics: Newton's Laws | 6/1, App B. | **CA 1 Due, Hw. 6 Due, Hw. 7 Assigned** |
| 10/31 | Rigid Body Kinetics: Newton's Laws | 6/2, 6/3 | |
| 11/2 | Rigid Body Kinetics: Newton's Laws | 6/4 | |
| **11/4** | **Mock Midterm Exam #2 on Rigid Body Kinematics (in class, optional)*** | | |
| | Rigid Body Kinetics: Newton's Laws | 6/5 | **Hw. 8 Assigned** |
| 11/7 | Rigid Body Kinetics: Newton's Laws | 6/5 | **Hw. 7 Due** |
| 11/9 | Rigid Body Kinetics: Work and Energy | 6/6 | |
| 11/11 | Rigid Body Kinetics: Work and Energy | 6/6 | **Hw. 8 Due, Hw.9 Assigned** |
| 11/14 | Rigid Body Kinetics: Work and Energy | 6/6 | |
| 11/16 | Rigid Body Kinetics: Impulse and Momentum | 6/8 | |
| 11/18 | Rigid Body Kinetics: Impulse and Momentum | 6/8 | **Hw. 9 Due, CA 2 Assigned** |
| **11/21** | **Midterm Exam #2 on Rigid Body Dynamics (in class)** | | |
| 11/23 | Rigid Body Kinetics: Impulse and Momentum | 6/8 | **Hw. 10 Assigned** |
| 11/25 | Thanksgiving Break | | |
| 11/28 | Mechanical Vibrations | 8/1, 8/2, 8/4 | |
| 11/30 | Mechanical Vibrations | 8/2 – 8/5 | |
| 12/2 | Mechanical Vibrations | 8/2 – 8/5 | **Hw. 10 Due & CA 2 Due, Hw. 11 Assigned** |

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| 12/5 | Mechanical Vibrations | 8/2 – 8/5 | |
| 12/7 | Mechanical Vibrations | 8/2 – 8/5 | |
| 12/9 | Mechanical Vibrations | 8/2 – 8/5 | Hw. 11 Due |

12/12 Course Review

**Final Examination Monday, December 19, 1:30 pm-3:30 pm – Comprehensive (all topics)**

* Friday class is from 9:30-11:00 on marked dates because of exams. Extra 30 minutes is already included in your ME 240 schedules