

**ENGR 220 Engineering Mechanics - Dynamics, Cuyamaca College**  
Spring Semester 2012, Section 5258  
Monday, Wednesday 2:30 - 3:55 pm, Room F301

Dynamics is the study of objects and mechanical systems in motion. In this class we examine the effects of forces and moments on the position, velocity, acceleration, and energy of objects in rectilinear, curvilinear, and rotational motion. Students completing this course will have the fundamentals needed for machine design and dynamic structural design.

**Professor**

Dr. Duncan McGehee

Office: F303

Work phone: 619-660-4242

email: duncan.mcgehee@gcccd.net, Website: www.cuyamaca.edu/duncan.mcgehee

Office Hours: MW 1 – 2:30 pm, MW 5:30 – 6 pm, Th 5 – 6 pm, or by appointment

**Text**

*Engineering Mechanics: Principles of Statics and Dynamics*, 12<sup>th</sup> Edition. R. C. Hibbeler.

**Units and Prerequisites**

3 units, Prerequisite: ENGR 200

**Grading**

A: 90 - 100

B: 80 - 89.9999

C: 70 - 79.9999

D: 60 - 69.9999

F: < 60

|                |     |
|----------------|-----|
| Homework       | 25% |
| Midterm Exam 1 | 25% |
| Midterm Exam 2 | 25% |
| Midterm Exam 3 | 25% |
| Final Exam     | 25% |

Notes on grades:

- 1) There will be no make-up exams. However your lowest grade from Midterm Exams 1 - 3 will be dropped. Neither the homework nor the final exam can be dropped.
- 2) All exam problems will be graded according to the grading rubric given later in the syllabus.
- 3) Homework will be assigned every Monday and will be due Monday of the following week. Homework delivered more than 5 minutes after the start of class will receive half credit, and homework delivered after the due date will *not* be accepted. If you must miss class, you may submit the work early, or ask a classmate to submit it for you. Homework will be graded following the grading rubric found later in this syllabus.

**Policies**

- 1) Always read the material to be covered in class *before* the lecture.
- 2) Always bring textbook and calculator to class.
- 3) Cell phones must be off and tucked away before lecture begins. This includes text messages transmitted or received.
- 4) Cheating. If I think you are cheating on an exam:
  - a) You will get a zero for that exam
  - b) I will invite you to withdraw from the class
  - c) Cell phones anywhere in evidence during an exam will be considered *a priori* evidence of cheating. I'll take a picture of your cell phone with my cell phone, give you a zero, and kick you out of the room.

**Important Dates**

3 February: Final day to add classes, or to drop without a 'W'.

20 April: Final day to drop classes.

This course adheres to policies outlined in the Cuyamaca College Catalog. For further information, please see the section of the catalog entitled *Academic Policies*.

*subject to minor changes*

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Tentative Schedule

| Lesson | Date      | Topic   | Reading     | homework due |
|--------|-----------|---|-------------|--------------|
| 1      | 23 Jan    | Introduction, Rectilinear motion of particles                     | 12.1-12.4   |              |
| 2      | 25 Jan    | Curvilinear Motion – Rectangular coordinates                      | 12.5-12.6   |              |
| 3      | 30 Jan    | Curvilinear motion – Normal and tangential coordinates            | 12.7        | 1            |
| 4      | 1 Feb     | Curvilinear motion – cylindrical coordinates                      | 12.8        |              |
| 5      | 6 Feb     | Relative and dependent motion of particles                        | 12.9-12.10  | 2            |
| 6      | 8 Feb     | Particle kinetics – Rectilinear motion                            | 13.1-13.3   |              |
|        | 15 Feb    | <b>Midterm 1</b>  |             | 3            |
| 7      | 17 Feb    | Interconnected particles, kinetics in a normal/tangential system. | 13.4-13.5   |              |
|        | 20 Feb    | <b>President's Day Holiday</b>                                    |             |              |
| 8      | 22 Feb    | Kinetics in cylindrical coordinates                               | 13.6        | 4            |
| 9      | 27 Feb    | Work and energy   | 14.1-14.3   | 5            |
| 10     | 29 Feb    | Efficiency. Conservation of energy                                | 14.4-14.6   |              |
| 11     | 5 Mar     | Linear momentum and impulse                                       | 15.1-15.3   | 6            |
| 12     | 7 Mar     | Impact  | 15.4        |              |
| 13     | 12 Mar    | Angular impulse & momentum of a particle                          | 15.5 – 15.7 | 7            |
| 14     | 14 Mar    | Rigid body kinematics   | 16.1-16.3   |              |
|        | 19 Mar    | <b>Midterm Exam 2</b>   |             | 8            |
| 15     | 21 Mar    | General motion, absolute and relative motion                      | 16.4-16.5   |              |
| 16     | 26 Mar    | Instantaneous centers of rotation                                 | 16.6        | 9            |
| 17     | 28 Mar    | Relative acceleration   | 16.7        |              |
|        | 2-6 April | <b>Spring Break</b>   |             |              |
| 18     | 9 Apr     | Relative motion in a rotating coordinate system                   | 16.8        | 10           |
| 19     | 11 Apr    | Rigid body kinetics: Equations of motion                          | 17.2-17.3   |              |
|        | 16 Apr    | <b>Midterm Exam 3</b>   |             | 11           |
| 20     | 18 Apr    | Rotation About a fixed axis                                       | 17.4        |              |
| 21     | 23 Apr    | General plane motion  | 17.5        | 12           |
| 22     | 25 Apr    | General plane motion, continued                                   |             |              |
| 23     | 30 Apr    | Work and energy in rigid bodies                                   | 18.1–18.4   | 13           |
| 24     | 2 May     | Impulse and momentum in rigid bodies                              | 19.1-19.3   |              |
| 25     | 7 May     | Eccentric impact  | 19.4        | 14           |
| 26     | 9 May     | Real-world modeling of dynamic situations                         |             |              |
|        | 14 May    | <b>Final Exam</b>   |             | 15           |

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**Course Objectives (Expected Student Learning Outcomes)**

Students will be able to:

- 1) Describe and compute the position, velocity, and acceleration (the kinematics) of particles in both rectilinear and curvilinear motion
- 2) Apply Newton's Second Law to determine the relationship between applied forces and resulting motion (the kinetics) of a particle
- 3) Compute the work of a force and apply the principle of work and energy and the concepts of potential energy and conservation of energy to determining resulting motion of a particle
- 4) Apply the principle of impulse and momentum to impulsive motion and both direct and oblique impact to predict the motion of particles
- 5) Predict the motion of systems of particles using linear and angular momentum, motion of mass center, conservation of momentum and energy and impulse and momentum principles
- 6) Apply kinematic principles to predict and describe free and constrained motion of rigid bodies and interconnected systems of rigid bodies
- 7) Apply 2<sup>nd</sup> Law kinetic principles to rigid bodies to determine plane motion of a rigid body, and interconnected systems of rigid bodies
- 8) Apply the principle of work and energy to determine the plane motion of a rigid body
- 9) Apply the concepts of linear and angular momentum, linear and angular impulse, and direct and eccentric impact to predict the motion of rigid bodies and systems of rigid bodies

**ENGR 220 Exam Problem Grading Rubric (subject to modification)**

| Level |      | Description   |
|-------|------|---|
| 5     | 100% | Answer is correct, main concepts and principles are clearly demonstrated. Solution is clear and logical. FBD (if applicable) is clearly labeled and shows all relevant forces, coordinate system is explicitly drawn and makes sense. Solution has been checked as thoroughly as possible.  |
| 4     | 88%  | Same as level 5, but answer is incorrect due to a checkable math error. Answer is nevertheless credible (not obviously wrong).  |
| 3     | 80%  | Same as level 4, but some part of the answer is obviously wrong, or answer is correct but lacks units or uses incorrect units (e.g. kg instead of N for force, or N instead of lb).   |
| 2     | 72%  | Answer is incorrect due to a minor conceptual error, or due to multiple math errors. Main concepts and principles are clearly demonstrated, and the solution is clear and logical. FBD (if applicable) is clearly labeled and shows all relevant forces, coordinate system is explicitly drawn and makes sense. Answer may or may not be credible.          |
| 1     | 40%  | Answer is incorrect. Some evidence of understanding of main concepts and principles, but solution is not clearly demonstrated. This includes missing FBD (if applicable) or missing coordinate system. If errors are due to sloppiness in units, this is the highest possible grade. Also if the reasoning is absent, <i>even if the answer is correct.</i> |
| 0     | 0%   | Scant evidence of understanding of the main concepts and principles.  |

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**Homework**

Each homework set will be worth 10 points. The grade will be based both on **completeness** and **presentation** as follows:

**Completeness – 5 points**

| Level | Points | Description  |
|-------|--------|--|
| 4     | 5      | Homework is complete, all problems have been done, or at least seriously attempted. Work is neat and legible. Each problem is on its own page. |
| 3     | 4      | Same as level 4, but problems are not each on their own page.  |
| 2     | 3      | Several problems have not been attempted (an attempt means more than just writing down the problem). Work is neat and legible.                 |
| 1     | 1      | Only a few problems have been attempted. Work is neat and legible.   |
| 0     | 0      | Homework was not handed in, or makes little sense, or is illegible.  |

**Presentation – 5 points**

I will choose one problem in the homework set to examine more closely. It will be graded according to the following rubric.

| Level | Points | Description  |
|-------|--------|--|
| 4     | 5      | Problem is clearly stated, with a clear solution that is easy to follow. Coordinate system and Free-body diagram (FBD) are provided if needed. In sum, this is a solution that another student in the class without access to the textbook could follow. |
| 3     | 3      | The problem is clearly stated, and there is a solution, but it is not easy to follow. Coordinate system and FBD are provided.  |
| 2     | 2      | A solution has been reasonably attempted, but not successfully completed. Or solution is complete but unclear and lacks a FBD or coordinate system if those are needed.  |
| 1     | 1      | Only the problem statement is present. No solution has been attempted.   |
| 0     | 0      | The problem has not been attempted, or makes very little sense.  |

**Additional comments regarding homework:**

1. I will devote no more than two minutes to grading your homework set. That's enough for me to assess completeness and presentational clarity. However, it is not enough for me to figure out where you went wrong on a problem unless your presentation is crystal clear. Therefore, if you have questions about the homework, please come see me during office hours. I will also be providing solutions (on-line or in the library) *after* the homework has been submitted.
2. I will drop your lowest homework grade.

**Advice on homework problems**

1. Always do the example problems in the homework section you're working on. The examples hold clues to the reasoning needed to solve the homework.
2. The first steps in solving any problem are 1) to sketch the problem, and 2) state what it is you're solving for. There are several reasons for this:
  - a) It helps you define the problem in your own mind, and lays the groundwork for the solution.
  - b) I won't help you with a homework problem unless you've done this.
3. Engineering problems often must be left to fester in your mind. You may not see the solution right away, whereas if you come back to the problem the next day, it may be more obvious. *Moral of the story:* don't wait until the last day to try the homework problems.
4. Plan on a *minimum* of 1 hour per homework problem. It really does take time to wrap your brain around these problems. It's worth the time: you will do 95% of your learning in this class doing the homework
5. Work on the homework problems alone, then get together with a study group. Make sure everyone in your study group understands the problems and the solutions. Helping other people understand is not only good karma, it improves your mastery of the topic.

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