Dynamics- ME 101
Guided Practice Model
By Raghu Agarwal

Topic: Kinematics of a Particle

Overview

Most of the contents of this chapter, and specifically this section of the chapter, should be familiar to the student. By completing this pre-class activity you will refresh and renew your understanding of the motion equations of a particle, how to apply them in the solution of a problem on rectilinear motion, motion of interconnected particles, and motion of pulleys in a pully system. Along with the physics course, here you will be required to apply your knowledge of derivatives, integration, and trigonometric functions. It would be helpful to have a math handbook and your physics textbook on mechanics handy.

Learning Objectives

Basic Learning Objectives: You would be responsible for learning and demonstrating your understanding of the following basic learning objectives:

- What is the relationship between displacement, velocity, and acceleration
- What are the general motion equations of a particle
- What is a rectilinear motion
- What is the difference between a single particle motion and the connected particle motion
- Explain the what is a relative motion of particles
- Be able to apply derivatives and develop motion equations

Advance Learning Objectives: The following objectives must be mastered by each student during the class activities and through the homework assignment.

- Derive the motion equation of a particle
- Derive the motion equations of particle under constant acceleration
- Derive motion equations of relative motion of particles
- Apply the above motion equations to a particle moving with a variable acceleration
- Apply the above motion equations to a particle moving with a constant acceleration
- Apply the relative motion of particles equations to relative motion of two particle moving with constant acceleration
- Apply the relative motion of particles equations to a system of pulley

Resources

Reading:

- McGraw Hill Connect: Chapter 11.2 A, B, and C
- PowerPoint Lecture Slides posted on CANVAS

Exercises (Here is an incomplete list of exercises, they will be posted after I have had some help from McGraw Hill in understanding the new e-book we are using for the course)

- Complete Quiz 1 posted on CANVAS

Turn-in Instructions

- Complete all exercises as posted on CANVAS and Connect.
- No hard-copy required, all work is completed online.

Lesson Plan: Dynamics - ME 101

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Lesson: Application of Rectilinear Motion Equations

Timeframe: Approximately 4-hours

Materials needed: Projection system for presenting PowerPoint slides

Objectives:

Basic:

1. Define position, velocity, and acceleration of a particle in rectilinear motion. The concept of position, distance traveled, velocity, and speed should be understood.

2. Write the relationship between position, velocity, and acceleration of a particle in rectilinear motion, under general conditions, and as a function of time. Solve for one of the variables if two of them are given.

3. Identify and analyze special cases of rectilinear motion (uniform motion, uniformly accelerated motion), general conditions, and as a function of time using vector notations.

Advanced:

1. *Compute the derivative of a function and compute the components of a vector in cartesian coordinates.*
2. *Describe the concept of relative motion and compute position, velocity, and acceleration of particles in (1) relative motion and in (2) dependent relative motion.*

Background to the Lesson: This course is required for all Mechanical and Civil Engineering majors. Kinetics of particles is the basis for the entire course and very important for students to understand the concepts and applications outlined in the objectives. The pre-requisites for the course are: CE 95/99 and Math 32. Dynamics is one of the most demanding courses in the College of Engineering and requires a strong background in Math 32 and Physics 50. Therefore, this course has been designated as one of the 'highest failure rate' courses in engineering. Our challenge is to make this course a bit easier to understand and more interesting for the students. Students enrolled in this course are expected to have a strong background in math and physics, and if they have some weakness, they should be prepared to review and refresh the concepts learned in Math 32 and Physics 50.

Introduction to Lesson: My Colleague, Vimal Viswanathan and I are developing some videos and looking in to other resources to make the course easier and more Interesting. Currently, there is only a limited material

available for the pre-class activity, but we are working on creating some videos that be added as they are developed. If the flipped class mode is implemented in Fall 2018, students will be required to read chapter 11.2 A, B, and C from the Connect e-book and review my PowerPoint lecture slides. Also, they will complete a reading quiz that has simple conceptual questions to prove that they have carried out the pre-class activities. The in-class activities will entail a brief discussion and review of the chapter material assigned in the pre-class activities and a more comprehensive session with individual and group exercises. The post-class activities will entail applying motion equations to constant acceleration problems.

Procedure [Time needed, include additional steps if needed].

Pre-Class Individual Space Activities and Resources: Outline the major steps for the preparatory activities and be sure to tie the steps to the basic learning objectives you have noted above. Note resources required for learner preparation.

Steps	**Purpose**	**Estimated Time**	**Learning Objective**
Step 1: Read Chapter 11,2 A: Uniform Rectilinear motion	Introduce students to the constant velocity motion	5-minutes	Basic #1
Step 2: Read Chapter 2 B: Uniformly accelerated motion	Learn and explore the equations of the constant acceleration motion	15-minutes	Basic #2
Step 3: Read Chapter 11.2 C: Motion of several particles	Introduce the motion equations for connected particles	15-minutes	Basic #3
Step 4: Review the lecture slides posted on CANVAS	Expose and prepare students for the in-class activities	10-minutes	Basic #3
Step 5: Complete the Reading Quiz online on CANVAS	Reinforce the learning objectives in Basic #1, 2, and 3	5-minutes	Basic - All

In-Class Group Space Activities and Resources. Outline the major steps for the in-class activities and be sure to tie the steps to the advanced learning objectives you have noted above. Also note any resources needed/developed to provide effective active learning activities within class.

Steps	Purpose	Estimated Time	Learning Objective
Step 1: Discuss the pre-class activities and answer any question formed during the activity	Clarify and re-enforce the Basic learning objectives	10-minutes	Basic - All
Step 2: Derive and explain the motion equations	Introduce the displacement, velocity and acceleration relationship	15-minutes	Advanced #1
Step 3: Short quiz (4-5) questions) based on step 2 activity	Assess students learning and provide immediate feedback	10-minutes	Advanced #1
Step 4: Have students work in small groups on a pulley problem	Cooperative learning with instructor help	15-minutes	Advanced #2
Step 5: Go over the difficult and confusing concepts that arise during the activity	Clarify any confusion, provide opportunity to ask questions	20-minutes	Advanced #1,2

Post-Class Individual Space Activities and Resources. Outline the major steps for the post-class activities and be sure to tie the steps to the advanced learning objectives you have noted above. Also note any resources learners will need to complete any post-class activities assigned after the group space activities.

Steps	Purpose	Estimated Time	Learning Objective
Step 1: Apply the rectilinear motion equations to a particle in motion. Problems will be assigned on Connect	Learn and demonstrate the application of rectilinear motion	20-minutes	Advanced #21
Step 2: Apply the rectilinear motion equations to a system of pulleys	Learn and demonstrate the application of rectilinear motion equations to a system of pulleys	20-minutes	Advanced #2

Evaluation:

Analysis. In this section, note what you think will work, and what challenges you think you may face in implementation.
Currently, I have been using the pre-class activities that entails reading the material, which will be covered in the class the following day. After the reading, students take a simple 9-10 question online simple quiz on the reading material. This pre-class activity rewards them with a 5% bonus grades, which amounts to a half letter grade bonus for them.

I am not sure if I can convert my entire class to a flipped class model, but I hope to utilize many of the flipped class concepts learned in the recent workshop this summer to my Fall 2018 classes. The concerns that prevents me from converting to an all-out flipped class model are:

- Currently, I do not have adequate resources for pre-class activities.
- We have switched to a new computer-based text. I have been working with the publisher to get familiar with its features. It will take some time to feel comfortable using the software and be able to assign the pre-class activities.
- I am concerned that not all students will be participating in the pre-class activities and could get lost in the in-class activities
- Since this is my first experience with the Flipped Class model, I am not sure how can I implement it effectively, without hurting students' learning.

Connections to Future Lessons. In this section, note how you think this lesson plan connects to your next topics in the course.
This lesson introduces the fundamental of mechanics that will be utilized throughout the course.