COURSE DESCRIPTION
Subject includes kinematics of particles and rigid bodies, plane motion of particles and rigid bodies, moments of inertia, rotation of rigid body, relative motion, principles of work and energy, impulse, momentum and impact.

PREREQUISITES
ENGI 101 and MATH 172 are prerequisites for this course.

REQUIRED TEXT AND MATERIALS

PARTICIPATION
Active participation in this course by all students is required and expected. Attendance for all lectures is strongly advised.

If you have a documented disability and would like to request an accommodation and/or academic adjustment, contact the Disability Services Office at (732) 224 2730 or TTY (732) 842 4211.

GRADING
The course consists of a three-hour lecture per week. Homework will be assigned at the end of each class and the explanations or solutions will be given at the beginning of the next class. Students are expected to do the homework after class.

Class participation, the homework grade and examinations will evaluate student progress.

There are a total of 7 units that comprise this course. There will be for examinations, each comprising 20% of the total class grade. The exams will cover Units 1-2, 3, 4-5, and 6-7. In addition to the 4 examinations, there will be an evaluation of the homework, which will constitute the remaining 20% of the course grade.

The following scale will be used to determine satisfactory progress on each assignment and for determining the final grade based on the following:

<table>
<thead>
<tr>
<th>GRADE</th>
<th>RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>90 to 100</td>
</tr>
<tr>
<td>B</td>
<td>80 to 89</td>
</tr>
<tr>
<td>C</td>
<td>70 to 79</td>
</tr>
<tr>
<td>D</td>
<td>65 to 69</td>
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<tr>
<td>F</td>
<td>Below 65</td>
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</tbody>
</table>

You must obtain a grade of C or higher before taking any course for which this is a prerequisite.
FINAL GRADE
The final grade will be determined by averaging each section and assigning them the following weights:

- 20% Exam #1
- 20% Exam #2
- 20% Exam #3
- 20% Exam #4
- 20% Homework Grade
- 100% Grade for the Course

INCOMPLETE
It is the student’s responsibility to submit all classwork on a timely basis, and it is expected that all course requirements be completed by the last class meeting. However, in cases of hardship or emergency, a grade of INC may be granted by your instructor. In order to be considered for the grade INC, the student must have satisfactorily completed all assignments except the final project, have a passing average, and must meet with the instructor prior to the last class meeting to discuss this option. Your instructor is under no obligation to grant a INC. In the event that you are granted a INC, it must be completed by the second week of the following semester or an earlier date specified by the instructor.

CORE COMPETENCIES
In this course, the student is required to solve problems dealing with dynamics of particles, systems of particles and rigid bodies. Students will utilize the following methods to solve these problems:
- Direct application of Newton’s 2nd Law
- Principles of Work and energy
- Principles of Impulse and Momentum

Students will learn to present their solutions a clear, consistent, logical and professional manner.
This course meets the following Core Competencies:

COMMUNICATION SKILLS
Students will develop and enhance the skills that allow them to think critically and communicate ideas in a clear, concise manner. Students will:

1.1 Communicate information and ideas clearly and effectively in writing form.
1.2 Communicate information and ideas clearly and effectively in spoken form.
1.5 Demonstrate effective listening skills.
1.6 Demonstrate effective reading skills.
CRITICAL THINKING, PROBLEM SOLVING
Students will use critical thinking and problem solving skills in analyzing information.

2.1 Identify a problem and analyze it.
2.2 Create or develop hypotheses.
2.3 Recognize and construct logical forms of argumentation.
2.4 Recognize and identify examples of faulty ways of reasoning.

MATHEMATICAL SKILLS
Students will apply appropriate mathematical concepts and operations to interpret data and to solve problems, and understand connections between mathematics and other disciplines mathematical problems.

4.1 Be able to analyze, discuss and use quantitative information.
4.2 Be able to apply algebraic and/or geometric techniques to analyze and solve mathematical problems.
4.3 Use appropriate problem solving technologies.

SCIENTIFIC PERSPECTIVE
Students will develop a familiarity with the principles and methods of scientific inquiry, and with its significance to society.

5.1 Develop appropriate skills in observation and experimentation to solve problems.
5.2 Be able to analyze and interpret scientific data.
5.3 Be able to evaluate and apply appropriate technology.

INFORMATION AND TECHNOLOGICAL LITERACY
Students will process information including defining, accessing, gathering, organizing, evaluating, and presenting information.

7.1 Recognize a need for information.
7.2 Conduct and complete effective research.
7.3 Assess, use, document and present information objectively and effectively.
7.4 Use appropriate technologies and services to access and process information.
## COURSE SCHEDULE

<table>
<thead>
<tr>
<th>UNIT</th>
<th>WEEK</th>
<th>SUBJECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>INTRODUCTION TO DYNAMICS</td>
</tr>
<tr>
<td>2</td>
<td>1-3</td>
<td>KINEMATICS OF PARTICLES</td>
</tr>
<tr>
<td>3</td>
<td>3-8</td>
<td>KINETICS OF PARTICLES</td>
</tr>
<tr>
<td>4</td>
<td>9-10</td>
<td>PLANE KINEMATICS OF RIGID BODIES</td>
</tr>
<tr>
<td>5</td>
<td>10-13</td>
<td>PLANE KINETICS OF RIGID BODIES</td>
</tr>
<tr>
<td>6</td>
<td>13-14</td>
<td>INTRODUCTION TO 3-D DYNAMICS OF RIGID BODIES</td>
</tr>
<tr>
<td>7</td>
<td>15</td>
<td>VIBRATION AND TIME RESPONSE</td>
</tr>
</tbody>
</table>

## ACADEMIC INTEGRITY

Academic integrity is submitting one's own work, and properly acknowledging the work of others. Any violation of this principle constitutes academic dishonesty and is liable to result in disciplinary action. Forms of academic dishonesty include:

**Plagiarism**

Submitting another's work, in whole or part, as one's own. This includes an examination, a computer program, a laboratory report, or a written assignment.

**Facilitating Academic Dishonesty**

Helping another commit an act of dishonesty, such as substituting for an examination or completing an assignment for someone else.

**Cheating**

Using or attempting to use unauthorized materials on an examination or assignment, such as using unauthorized texts or notes or improperly obtaining, or attempting to obtain, copies of an examination or answers to an examination.

**Illegal System Access**

Altering, transmitting, or permitting unauthorized individuals access to your account, or an attempt to alter or destroy system files on any server or computer. This also includes altering, transmitting, or attempting to alter or transmit academic information or records by unauthorized individuals.

**Students that participate in dishonest activities**

- will receive a 0 for that project, examination, or assignment
- may be given a grade of F for the course
- may be reported to the Dean for disciplinary action

For additional information, refer to the current Brookdale Community College Student Handbook.
## UNIT 1 OF 7

### Name Of Unit
- INTRODUCTION TO DYNAMICS

### Unit Objective

### Method Of Evaluation
- Class participation, and the grading of written examinations, and homework assignments.

### Estimated Time To Achieve
- .5 Weeks.

### Learning Objectives

Students will understand and be able to explain the following fundamental concepts:

- Space and Time
- Newton’s Laws
- Newtonian Gravitation
- Numbers
  - Significant digits
  - Accuracy
- Units
  - SI system
  - US customary units
  - Angular units
  - Conversion

### Recommended Learning Experiences

- **Attend**
  - Class and participate in the lecture.

- **Read**
  - The text Chapter 1.1–1.4

- **Submit**
  - Assigned homework problems
UNIT 2 OF 7

Name Of Unit          KINEMATICS OF PARTICLES

Unit Objective

Method Of Evaluation Class participation, and the grading of written examinations, and homework assignments.

Estimated Time To Achieve 2.5 Weeks.

Learning Objectives

1. Students will be able to study the motion of a particle and determine:
   • Position
   • Velocity
   • Acceleration

2. Students will be able to analyze the motion for the following special cases:
   • Straight-line Motion
   • Acceleration given as a function of time
   • Acceleration given as a function of velocity
   • Acceleration given as function of position

3. Students will understand and analyze curvilinear motion for:
   • Cartesian/Rectangular coordinates
     - Projectile motion
     - Angular Motion
   • Normal and Tangential coordinates
     - Circular Motion
     - 3D Motion
   • Polar and Cylindrical

4. Students will understand the concept of relative motion and apply it in determining positions, velocities and accelerations.

Recommended Learning Experiences

Attend Class and participate in the lecture.

Read The text Chapter 2.1-2.4

Submit Assigned homework problems
UNIT 3 OF 7

Name Of Unit  KINETICS OF PARTICLES

Unit Objective

Method Of Evaluation  Class participation, and the grading of written examinations, and homework assignments.

Estimated Time To Achieve  ~5 Weeks.

<table>
<thead>
<tr>
<th>Learning Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct application of Newton’s 2\textsuperscript{nd} Law</strong></td>
</tr>
<tr>
<td>1. Students will be able to use Newton’s 2\textsuperscript{nd} Law to derive the equations of motion for the center of mass of a body.</td>
</tr>
<tr>
<td>2. Students will understand what an inertial reference frame is and its relationship to Newton’s 2\textsuperscript{nd} Law.</td>
</tr>
<tr>
<td>3. Students will use the equations of motion to study systems in:</td>
</tr>
<tr>
<td>- Cartesian coordinates</td>
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<tr>
<td>- Straight-Line Motion</td>
</tr>
<tr>
<td>- Normal and Tangential Coordinates</td>
</tr>
<tr>
<td>- Polar and Cylindrical Coordinates</td>
</tr>
<tr>
<td>- Orbital Mechanics</td>
</tr>
<tr>
<td><strong>Energy Methods</strong></td>
</tr>
<tr>
<td>1. Students will understand and be able to explain the Principle of Work and Energy</td>
</tr>
<tr>
<td>2. Students will be able to calculate Work and Energy.</td>
</tr>
<tr>
<td>3. Students will be able to apply the Principle of Work and Energy in solving kinetics problems.</td>
</tr>
<tr>
<td>4. Students will be able to calculate the Work done by specific forces.</td>
</tr>
<tr>
<td>- Weight</td>
</tr>
<tr>
<td>- Springs</td>
</tr>
<tr>
<td>5. Students will understand what potential energy is and how to calculate it for specific forces.</td>
</tr>
<tr>
<td>6. Students will understand the difference between conservative forces and non-conservative force.</td>
</tr>
<tr>
<td>7. Students will understand what kinetic energy is and how to calculate it.</td>
</tr>
</tbody>
</table>
Momentum Methods

1. Students will understand and be able to explain the Principle of Impulse and Momentum.
2. Students will be able to solve kinetics problems using Conservation of Linear Momentum.
3. Students will be able to solve various impact problems using Conservation of Linear Momentum:
   - Direct Central Impact
   - Oblique Central Impact
4. Students will be able to solve kinetics problems using Conservation of Linear and Angular Momentum.
5. Students will be able to solve problems involving variable mass using Impulse and Momentum methods.

**Recommended Learning Experiences**

<table>
<thead>
<tr>
<th>Attend</th>
<th>Class and participate in the lecture.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read</td>
<td>The text Chapters:</td>
</tr>
<tr>
<td></td>
<td>3.1–3.5</td>
</tr>
<tr>
<td></td>
<td>4.1-4.5</td>
</tr>
<tr>
<td></td>
<td>5.1-5.5</td>
</tr>
<tr>
<td>Submit</td>
<td>Assigned homework problems</td>
</tr>
</tbody>
</table>
UNIT 4 OF 7

Name Of Unit                         PLANE KINEMATICS OF RIGID BODIES
Unit Objective                      
Method Of Evaluation               Class participation, and the grading of written examinations, and homework assignments.
Estimated Time To Achieve           2 Weeks.

Learning Objectives

1. Students will be able to analyze the motion of rigid bodies, including:
   • Translation
   • Rotation about a fixed axis
   • Planar motion

2. Students will be able to analyze the general motion of rigid bodies including:
   • Velocity Analysis
     – Relative Velocity
     – Angular Velocity as a Vector
     – Instantaneous Centers
   • Acceleration Analysis
   • Sliding Contact
   • Moving Reference Frames

Recommended Learning Experiences

Attend  Class and participate in the lecture.
Read    The text Chapter 6.1-6.6
Submit  Assigned homework problems
UNIT 5 OF 7

Name Of Unit               PLANE KINETICS OF RIGID BODIES

Unit Objective

Method Of Evaluation       Class participation, and the grading of written examinations, and homework assignments.

Estimated Time To Achieve  3 Weeks.

<table>
<thead>
<tr>
<th>Learning Objectives</th>
</tr>
</thead>
</table>

Newton’s formulation of the equations of motion

1. Students will be derive and apply the 2D equations of motion for a rigid body.
2. Students will understand and be able to state the momentum principles for a system of particles.
   - Force-Linear Momentum Principle
   - Moment-Angular Momentum Principle
3. Students will understand and be able to explain the equations of motion for a rigid body for:
   - Rotation about a fixed axis
   - General Planar Motion
4. Students will be able to apply the equations of motion for a rigid body to solve typical application problems including:
   - Translation
   - Rotation about a fixed axis
   - General Planar Motion
5. Students will understand and be able to apply D’Alembert’s principle to solve problems of plane kinetics of rigid bodies.
6. Students will be able to calculate moments of inertia.

Energy and Momentum Methods

1. Students will understand how to extend the Principles of Work and Energy to apply to:
   - A system of particles
   - A Rigid Body in planar motion
2. Students will understand how to determine the following for systems of particles and rigid bodies:
   - Work
   - Potential energy
   - Power
3. Students will be able to apply the principles of Impulse and momentum to solve rigid body dynamics problems, using:
   - Linear momentum
   - Angular momentum
     - Principles of Angular impulse and momentum
     - Impulsive forces and couples
     - Conservation of angular momentum
4. Students will be able to solve impact problems by applying the following concepts from energy methods:
   - Conservation of momentum
     - Linear
     - Angular
   - Coefficient of restitution

**Recommended Learning Experiences**

<table>
<thead>
<tr>
<th>Attend</th>
<th>Class and participate in the lecture.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read</td>
<td>The text Chapter 7.1-7.5</td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8.1-8.5</td>
</tr>
<tr>
<td>Submit</td>
<td>Assigned homework problems</td>
</tr>
</tbody>
</table>
UNIT 6 OF 7

Name Of Unit  INTRODUCTION TO 3-D DYNAMICS OF RIGID BODIES

Unit Objective

Method Of Evaluation  Class participation, and the grading of written examinations, and homework assignments.

Estimated Time To Achieve  1 Week.

Learning Objectives

1. Students will be able to analyze 3D kinematics, including:
   - Velocities
   - Acceleration
   - Moving Reference Frames
2. Students will be able to calculate angular momentum in 3 dimensions.
3. Students will be able to calculate moments and products of inertia of 3D rigid bodies.
4. Students will be able to apply Euler’s Equations of Motion to study the dynamics of 3D rigid bodies.
5. Students will be able to use Eulerian angles to describe the orientation of 2 3D rigid body.

Recommended Learning Experiences

Attend  Class and participate in the lecture.

Read  The text Chapter 9.1-9.5

Submit  Assigned homework problems
UNIT 7 OF 7

Name Of Unit VIBRATION AND TIME RESPONSE

Unit Objective

Method Of Evaluation Class participation, and the grading of written examinations, and homework assignments.

Estimated Time To Achieve 1 Week.

Learning Objectives

1. Students will be able to study and analyze vibrations including:
   - Conservative Systems
   - Damped Vibration
     - Subcritical
     - Critical
     - Supercritical
   - Forced Vibrations
     - Forcing Functions
       ▪ Oscillatory
       ▪ Polynomial

Recommended Learning Experiences

Attend Class and participate in the lecture.

Read The text Chapter 10.1-10.3

Submit Assigned homework problems