Washington Township School District

The mission of the Washington Township Public Schools *is to provide a safe, positive, and progressive educational environment that provides opportunity for all students to attain the knowledge and skills specified in the NJ Learning Standards at all grade levels, so as to ensure their full participation in an ever-changing world as responsible, self-directed and civic-minded citizens.*

Course Title:	**Robotics Engineering**
Grade Level(s):	10-12

Duration:	*Full Year:*	**x**	*Semester:*		*Marking Period:*	
Course Description:	Robotics is designed to assist students in the following areas of career exploration for technology, and related employment opportunities, application of computer programming skills with computer - controlled devices and Drone Technology. The exploration of a variety of robotic manipulator designs based on work envelopes and motions produced by model autonomous mobile robots. The introduction of robotics technology and robot project construction tasks, integration of computer - controlled equipment in developing flexible manufacturing systems, identification of high-tech skills needed for today's changing workplace, and to develop a team-work concept for problem solving. Student achievement of these goals will be obtained through formal discussion / note taking procedures, active participation in class discussions, computer applications, IMC and internet research assignments and presentations, completion of homework assignments, laboratory experiments, and technology learning activities.					
Grading Procedures:	Assignments will consist of: Rubric based Major & Minor Projects Competiton Based activities with partner Quiz /Tests Classwork Rubric based Participation Final Grades will be based on District Policy					
Primary Resources:	Robotics – Theory & Industrial Applications G-W Second Edition, Ross, Fardo, Masterson & Towers VEX Robotics					

Washington Township Principles for Effective Teaching and Learning

- Implementing a standards-based curriculum
- Facilitating a learner-centered environment
- Using academic target language and providing comprehensible instruction
- Adapting and using age-appropriate authentic materials
- Providing performance-based assessment experiences
- Infusing 21st century skills for College and Career Readiness in a global society

Designed by:	Matt Persichetti

Under the Direction of:	Malika Moore

Written: 8/2023

Revised: _____

BOE Approval: _____

Unit Title: 1 **Intro to Course / Lab Safety / Careers**

Unit Description:
This unit introduces students to basic safety information necessary to prevent injury in the lab throughout the year. Students will become aware of the types of injuries that might occur and ways to prevent them. Information in this unit will also include basic introductory robotics terminology needed to communicate in a technical manor. The class will also explore various career opportunities in the field of robotics technology.

Unit Duration: 1 week

Desired Results

Standard(s):
9.3.ST-ET.5, 9.3.ST-ET.6, 9.3.ST-SM.1, 9.3.ST-SM.2, 9.4.12.CI.1, 9.4.12.CI.2, 9.4.12.CI.3, 9.4.12.CT.1 ,9.4.12.CT.2

Indicators:

Understandings:
Students will understand that…

- Cite important developments in the evolution of robots.

Essential Questions:
1. What are the behavioral requirements needed to maintain a safe environment in the lab?

2. How has the "Robotics revolution" changed the manufacturing industry?

3. What impact has the "Robotics revolution" had on our workforce in America and throughout the world?

Assessment Evidence

Performance Tasks:
1. Each student will list ten safety steps to follow in the lab to prevent injury.
2. All students will complete safety labs.
3. Each student will pass a classroom safety test on procedures and operational safety.
4. Each student will be able to describe at least three reasons for choosing a particular career.
5. All students will describe a career choice in the Robotics and Manufacturing Industry and list three valid reasons for this choice.
6. Students will identify a minimum of five careers in the Robotics and Manufacturing Industry.
7. Each student will be able to describe the impact of high tech careers on lifestyles, relocation, income, etc.

Other Evidence:

Formative Assessment:
Class discussions

Summative Assessment
Procedures Quiz
Classroom layout Quiz

Benchmarks:
<u>Class Requirements</u>
A. Classroom Rules & Regulations
B. Course Proficiencies
C. Daily Procedures
D. Fire Drill Procedures

<u>Shop Safety in Lab</u>
A. Shocks- terms of

Learning Plan

Learning Activities:

1. Each student will list ten safety steps to follow in the lab to prevent injury.
2. All students will complete safety labs.
3. Each student will pass a classroom safety test on procedures and operational safety.
4. Each student will be able to describe at least three reasons for choosing a particular career.
5. All students will describe a career choice in the Robotics and Manufacturing Industry and list three valid reasons for this choice.
6. Students will identify a minimum of five careers in the Robotics and Manufacturing Industry.

Resources:

Instructional Materials

Textbook, pages 11–22

Review Questions, page 22

Learning Extensions, page 22

Instructor's Handout Masters HM 1-1 What Is an Industrial Robot?

HM 1-2 Robot Classifications

HM 1-3 Three Generations of Industrial Robots

Lesson Slides LS 1-1 Industrial Robots LS 1-2 Flexible Manufacturing Work Cell

LS 1-3 Robot Applications

Chapter 1 Quiz

Unit Modifications for Special Population Students	
Advanced Learners	Provide ample opportunities for creative behavior. Create assignments that call for original work, independent learning, critical thinking, problem solving, and experimentation. Show appreciation for creative efforts Respect unusual questions, ideas, and solutions. Encourage students to test their ideas. Provide opportunities and give credit for self-initiated learning. Avoid overly detailed supervision and too much reliance on prescribed curricula. Allow time for reflection. Resist immediate and constant evaluation. Avoid comparisons to other students.
Struggling Learners	Assist students in getting organized. Give short directions. Use drill exercises. Give prompt cues during student performance. Let students with poor writing skills use a computer. Break assignments into small segments and assign only one segment at a time. Demonstrate skills and have students model them. Give prompt feedback. Use continuous assessment to mark students' daily progress. Prepare materials at varying levels of ability
English Language Learners	Use a slow, but natural rate of speech; speak clearly; use shorter sentences; repeat concepts in several ways. When possible, use pictures, photos, and charts. Corrections should be limited and appropriate. Do not correct grammar or usage errors in front of the class. Give honest praise and positive feedback through your voice tones and visual articulation whenever possible. Encourage students to use language to communicate, allowing them to use their native language to ask/answer questions when they are unable to do so in English. Integrate students' cultural background into class discussions. Use cooperative learning where students have opportunities to practice expressing ideas without risking language errors in front of the entire class.
Learners with an IEP	Each special education student has in Individualized Educational Plan (IEP) that details the specific accommodations, modifications, services, and support needed to level the playing field. This will enable that student to access the curriculum to the greatest extent possible in the least restrictive environment. These include: • Variation of time: adapting the time allotted for learning, task completion, or testing • Variation of input: adapting the way instruction is delivered • Variation of output: adapting how a student can respond to instruction • Variation of size: adapting the number of items the student is expected to complete • Modifying the content, process or product Additional resources are outlined to facilitate appropriate behavior and increase student engagement. The most frequently used modifications and accommodations can be viewed here. Teachers are encouraged to use the Understanding by Design Learning Guidelines (UDL). These guidelines offer a set of concrete suggestions that can be applied to any discipline to ensure that all learners can access and participate in learning opportunities. The framework can be viewed here www.udlguidelines.cast.org

Learners with a 504	Refer to page four in the Parent and Educator Resource Guide to Section 504 to assist in the development of appropriate plans.

Interdisciplinary Connections

Visual and Performing Arts	English Language Arts	Mathematics	Science	Social Studies
1.2.12prof.Cr1a 1.2.12prof.Cr1b 1.2.12prof.Cr1c 1.2.12prof.Cr1d 1.2.12acc.Cr1c 1.2.12adv.Cr1c 1.2.12acc.Cr2a 1.2.12acc.Cr2b 1.2.12acc.Cr2c	Gr.11-12, NJSLSA. R-1,3,4,8,10 RL- 1,2,3,7 RI- 1,3,9 RST- 7,8,9 Gr. 9-10, NJSLSA. R- 1,3,4,8,10 RL- 1,2,3,7 RI- 1,3,9 RST- 7,8,9	NJSLS N-Q.1-3 NJSLS F.BF.1 NJSLS F.LE.1	HS-ETS1-1 HS-ETS1-2 HS-ETS1-3 HS-ETS1-4	

Integration of 21st Century Skills

Indicators:

8.1.12.CS.1 8.1.12.CS.2
8.1.12.CS.3 8.1.12.CS.4
8.2.12.ED.1 8.2.12.ED.2
8.2.12.ED.3 8.2.12.ED.5
8.2.12.NT.1, 8.2.12.NT.2

Unit Title: 2 **Introduction to Industrial Robotics**

Unit Description:
This unit will introduce students to the history, evolution and current applications of industrial robots in today's manufacturing industries. For centuries the idea of robots has captured people's imagination. This unit discusses the origins of the robot and explores ways in which robots began to be used in industry. Students will trace the evolution of the industrial robot, become familiar with the necessary robotic terms, and understand the most common uses of robots in today's manufacturing processes. Students will also assess most common misconceptions about the use of robots and the productivity and economic impacts associated with their use.

Unit Duration: 5 weeks

Desired Results

Standard(s):

Indicators:

Understandings:
Students will understand that…

- After studying this unit, the students will be able to:
- List and explain the classifications of industrial robots.
- Define the types of automation.
- Discuss the role of robots in our society.

Essential Questions:
1. What identifies a machine as an industrial Robot that is classified as an Anthropomorphic robot?

2. How can the Industrial robot be reprogrammable (can be given new instructions to meet changed requirements and perform new tasks)?

3.How can we make the robot flexible so that it can perform a variety of operations to meet special needs?

Assessment Evidence

Performance Tasks:
1. Examine robots in the classroom and identify their classification and type.
2. Describe how and where the word robot got its origin.
3. Describe the specific purpose of the computer and how it relates to the world of robotics
4. Explain what the early uses of robots were and how they have evolved into the work place of the 21 century.
5. Review the evolution of the industrial robot.
6. Name the different types of industrial robots.

List RIA definition of an Industrial

Other Evidence:

Formative Assessments:

Chapter 1 Quiz

Benchmarks:
1. Cite important developments in the evolution of robots.

2. Robots serve an economical and safety advantage in today's manufacturing systems.

3. List and explain the classifications of industrial robots.

4. Define the types of automation.

5. Robots do not threaten today's workers, but create new technical opportunities.

Learning Plan

Learning Activities:

1. **(**Lecture/Discussion:
2. Handout- What is an Industrial
3. Handout: Types of Automation

Resources:

Textbook, pages 11–22

Review Questions, page 22 Learning Extensions, page 22

Handout Masters HM 1-1 What Is an Industrial Robot?

HM 1-2 Robot Classifications

HM 1-3 Three Generations of Industrial Robots

Lesson Slides

LS 1-1 Industrial Robots

LS 1-2 Flexible Manufacturing Work Cell

LS 1-3 Robot Applications

Unit Modifications for Special Population Students	
Advanced Learners	Provide ample opportunities for creative behavior. Create assignments that call for original work, independent learning, critical thinking, problem solving, and experimentation. Show appreciation for creative efforts Respect unusual questions, ideas, and solutions. Encourage students to test their ideas. Provide opportunities and give credit for self-initiated learning. Avoid overly detailed supervision and too much reliance on prescribed curricula. Allow time for reflection. Resist immediate and constant evaluation. Avoid comparisons to other students.
Struggling Learners	Assist students in getting organized. Give short directions. Use drill exercises. Give prompt cues during student performance. Let students with poor writing skills use a computer. Break assignments into small segments and assign only one segment at a time. Demonstrate skills and have students model them. Give prompt feedback. Use continuous assessment to mark students' daily progress. Prepare materials at varying levels of ability.
English Language Learners	Use a slow, but natural rate of speech; speak clearly; use shorter sentences; repeat concepts in several ways. When possible, use pictures, photos, and charts. Corrections should be limited and appropriate. Do not correct grammar or usage errors in front of the class. Give honest praise and positive feedback through your voice tones and visual articulation whenever possible. Encourage students to use language to communicate, allowing them to use their native language to ask/answer questions when they are unable to do so in English. Integrate students' cultural background into class discussions. Use cooperative learning where students have opportunities to practice expressing ideas without risking language errors in front of the entire class.
Learners with an IEP	Each special education student has in Individualized Educational Plan (IEP) that details the specific accommodations, modifications, services, and support needed to level the playing field. This will enable that student to access the curriculum to the greatest extent possible in the least restrictive environment. These include: • Variation of time: adapting the time allotted for learning, task completion, or testing • Variation of input: adapting the way instruction is delivered • Variation of output: adapting how a student can respond to instruction • Variation of size: adapting the number of items the student is expected to complete • Modifying the content, process or product Additional resources are outlined to facilitate appropriate behavior and increase student engagement. The most frequently used modifications and accommodations can be viewed here. Teachers are encouraged to use the Understanding by Design Learning Guidelines (UDL). These guidelines offer a set of concrete suggestions that can be applied to any discipline to ensure that all learners can access and participate in learning opportunities. The framework can be viewed here www.udlguidelines.cast.org

Learners with a 504	Refer to page four in the Parent and Educator Resource Guide to Section 504 to assist in the development of appropriate plans.

Interdisciplinary Connections				
Visual and Performing Arts	English Language Arts	Mathematics	Science	Social Studies
1.2.12prof.Cr1a 1.2.12prof.Cr1b 1.2.12prof.Cr1c 1.2.12prof.Cr1d 1.2.12acc.Cr1c 1.2.12adv.Cr1c 1.2.12acc.Cr2a 1.2.12acc.Cr2b 1.2.12acc.Cr2c	Gr.11-12, NJSLSA. R-1,3,4,8,10 RL- 1,2,3,7 RI- 1,3,9 RST- 7,8,9 Gr. 9-10, NJSLSA. R- 1,3,4,8,10 RL- 1,2,3,7 RI- 1,3,9 RST- 7,8,9	NJSLS N-Q.1-3 NJSLS F.BF.1 NJSLS F.LE.1	HS-ETS1-1 HS-ETS1-2 HS-ETS1-3 HS-ETS1-4	

Integration of 21st Century Skills

Indicators:

8.1.12.CS.1 8.1.12.CS.2
8.1.12.CS.3 8.1.12.CS.4
8.2.12.ED.1 8.2.12.ED.2
8.2.12.ED.3 8.2.12.ED.5
8.2.12.NT.1 8.2.12.NT.2

Unit Title: 3 **Fundamentals of Robotics**

Unit Description:
This unit will introduce students to the technical definition of an industrial robot. It will include the four basic components as well as how the robot moves in space. Working in a small group, students will create various working models of robots to visualize robot motion in the four types of coordinate systems, the type of robot motion, as well as the size and shape of work envelopes and work cells. Culminating activities will be the presentation and testing of model performance.

Unit Duration: 5 weeks

Desired Results

Standard(s):

Indicators:

Understandings:
Students will understand that…

- Identify the parts of a robot.
- Explain degrees of freedom.
- Discuss the difference between servo and non-servo robots.
- Identify and explain the different robot configurations.

Essential Questions:
1. What is the technical name for the robots hand?

2. What is meant by degrees of freedom?

3. What determines the shape of a robots work envelope?

Assessment Evidence

Performance Tasks:
Identify the five major components of a robot and explain the purpose of each.

Define Degrees of freedom as it relates to the movement of a robot

Explain why a human's hand is able accomplish movement that are more fluid and complex that a robots gripper.

List and explain the six degrees of freedom used for robots.

Other Evidence:

TLA Grading
Activity sheets

Laboratory Activities
Rubrics
Chapter 2 Quiz

Unit 3 exam

Benchmarks:
1. Identify five major components of a robot and explain the purpose of each.

2. List and identify three types of power used in the robot actuators.

3. Explain why a human hand is able to accomplish more fluid and complex movements that a robot's gripper

4. List and describe the six degrees of freedom used by a robot.

Learning Plan

Learning Activities:

1. Lecture/Discussion:

Textbook, pages 23–58Review Questions, page 58 Learning Extensions, page 58

Lecture/Discussion: on

Handout MastersHM 2-1 Parts of a Robot

HM 2-2 Relationships Among the Five Major Robot Systems

HM 2-3 Robot's Six Degrees of Freedom

HM 2-4 Degrees of Freedom—Using a Spray Gun

HM 2-5 Ways of Classifying Robots

HM 2-6 Work Envelope Shapes

–58Review Questions, page 58 Learning Extensions, page 5

Resources:

Textbook, pages 23–58

Review Questions, page 58 Learning Extensions, page 58

Lesson Slides

Unit Modifications for Special Population Students	
Advanced Learners	Provide ample opportunities for creative behavior. Create assignments that call for original work, independent learning, critical thinking, problem solving, and experimentation. Show appreciation for creative efforts Respect unusual questions, ideas, and solutions. Encourage students to test their ideas. Provide opportunities and give credit for self-initiated learning. Avoid overly detailed supervision and too much reliance on prescribed curricula. Allow time for reflection. Resist immediate and constant evaluation. Avoid comparisons to other students.
Struggling Learners	Assist students in getting organized. Give short directions. Use drill exercises. Give prompt cues during student performance. Let students with poor writing skills use a computer. Break assignments into small segments and assign only one segment at a time. Demonstrate skills and have students model them. Give prompt feedback. Use continuous assessment to mark students' daily progress. Prepare materials at varying levels of ability.
English Language Learners	Use a slow, but natural rate of speech; speak clearly; use shorter sentences; repeat concepts in several ways. When possible, use pictures, photos, and charts. Corrections should be limited and appropriate. Do not correct grammar or usage errors in front of the class. Give honest praise and positive feedback through your voice tones and visual articulation whenever possible. Encourage students to use language to communicate, allowing them to use their native language to ask/answer questions when they are unable to do so in English. Integrate students' cultural background into class discussions. Use cooperative learning where students have opportunities to practice expressing ideas without risking language errors in front of the entire class.
Learners with an IEP	Each special education student has in Individualized Educational Plan (IEP) that details the specific accommodations, modifications, services, and support needed to level the playing field. This will enable that student to access the curriculum to the greatest extent possible in the least restrictive environment. These include: • Variation of time: adapting the time allotted for learning, task completion, or testing • Variation of input: adapting the way instruction is delivered • Variation of output: adapting how a student can respond to instruction • Variation of size: adapting the number of items the student is expected to complete • Modifying the content, process or product Additional resources are outlined to facilitate appropriate behavior and increase student engagement. The most frequently used modifications and accommodations can be viewed here. Teachers are encouraged to use the Understanding by Design Learning Guidelines (UDL). These guidelines offer a set of concrete suggestions that can be applied to any discipline to ensure that all learners can access and participate in learning opportunities. The framework can be viewed here www.udlguidelines.cast.org

Learners with a 504	Refer to page four in the Parent and Educator Resource Guide to Section 504 to assist in the development of appropriate plans.

Interdisciplinary Connections				
Visual and Performing Arts	English Language Arts	Mathematics	Science	Social Studies
1.2.12prof.Cr1a 1.2.12prof.Cr1b 1.2.12prof.Cr1c 1.2.12prof.Cr1d 1.2.12acc.Cr1c 1.2.12adv.Cr1c 1.2.12acc.Cr2a 1.2.12acc.Cr2b 1.2.12acc.Cr2c	Gr.11-12, NJSLSA. R-1,3,4,8,10 RL- 1,2,3,7 RI- 1,3,9 RST- 7,8,9 Gr. 9-10, NJSLSA. R- 1,3,4,8,10 RL- 1,2,3,7 RI- 1,3,9 RST- 7,8,9	NJSLS N-Q.1-3 NJSLS F.BF.1 NJSLS F.LE.1	HS-ETS1-1 HS-ETS1-2 HS-ETS1-3 HS-ETS1-4	

Integration of 21st Century Skills

Indicators:

8.1.12.CS.1 8.1.12.CS.2
8.1.12.CS.3 8.1.12.CS.4
8.2.12.ED.1 8.2.12.ED.2
8.2.12.ED.3 8.2.12.ED.5
8.2.12.NT.1 8.2.12.NT.2

Unit Title: 4 **Programming the Robot**

Unit Description:
This unit will introduce students to the technical definition of an industrial robot. It will include the four basic components as well as how the robot moves in space. While working in small groups, students will create various working models of robots to visualize robot motion in the four types of coordinate systems, the type of robot motion, as well as the size and shape of work envelopes and work cells. Culminating activities will be the presentation and testing of model performance.

Unit Duration: 2 Week Lesson – Used throughout the course

Desired Results

Standard(s):

9.3.12.AC.1 9.3.12.AC.2 9.3.12.AC-DES.1 9.3.12.AC-DES.2 9.3.12.AC-DES.6 9.3.12.AC-DES.8 9.3.12.BM.1	9.3.MN-HSE.3 9.3.MN-MIR.1 9.3.MN-PPD.3 9.3.MN-PRO.3 9.3.MN-PRO.4 9.3.ST.1	9.3.ST.2 9.3.ST.6 9.3.ST-ET.1 9.3.ST-ET.3 9.3.ST-ET.4 9.3.ST-ET.6 9.3.ST-SM.1	9.3.ST-SM.2 9.3.ST-SM.4 9.4.8.TL.2 9.4.8.TL.3: 9.4.12.CI.1 9.4.12.CT.1

Indicators:

Understandings:
Students will understand that…

- Identify the different motion control applications.
- Explain the various programming methods.
- Discuss the characteristics of the different types of programming.
- Describe various peripheral applications, such as vision and voice recognition

Essential Questions:
1. Why are there different motion control applications?

2. What are some of the advantages of having various programming methods?

3. Discuss the characteristics of the different types of programming.

4. How have various peripheral applications, such as vision and voice recognition become part of today's robots?

Assessment Evidence

Performance Tasks:
1. Identify the different motion control applications.
2. Explain the various programming methods.
3. Discuss the characteristics of the different types of programming.
4. Use Computer software to operate Robots autonomously.

Other Evidence:

Formative Assessments:

Unit 4 exam
Programming Test

Summative Assessment(s)
Programming challenges

Benchmarks:
1. Students will be able to briefly trace the evolution of the industrial robot.
2. Students will define the term industrial robot
3. Describe the most common need/use of robots in industry.
4. Explain the economic advantage of using robots in the automotive and electronics manufacturing industry.
5. Describe the most common misconceptions about the use of robots in manufacturing today.
6. Describe productivity and economic impacts when applying robots in the manufacturing industry.

Learning Plan

Learning Activities:

Review Questions, page 80

Learning Extensions, page 80

Laboratory Manual, pages 7–26

Activity 3-1—Programming Environment, pages 7–8

Activity 3-2—Axis Movement Commands, pages 9–10 Activity 3-3—Circular Interpolation Commands, pages 11–12

Activity 3-4—Delay or Timer Commands, page 13Activity 3-5—Speed Control Commands, pages 15–16

Activity 3-6—Program Control GOTO Function, pages 17–18 Activity 3-7—Program Control If...Then...Else, pages 19–20

Activity 3-8—Program Control Subroutines, pages 21–22 Activity 3-9—Program Control Repetition, pages 23–24 Activity 3-10—Robot I/O, pages 25–26

Resources:

Textbook, pages 59–80

Review Questions, page 80

Learning Extensions, page 802w`

Chapter 3

Programming the Robot 1 Handout Masters

HM 3-1 Evolution of Programming HM 3-2 Motion Control HM 3-3 Common Programming Languages

HM 3-4 Common Task-level Programming Functions Lesson SlidesLS 3-1 Manual Programming

LS 3-2 Teach Pendant ProgrammingLS 3-3 Hierarchical Control Programming

LS 3-4 Task-level Programming LS 3-5 Programming Screen

Unit Modifications for Special Population Students	
Advanced Learners	Provide ample opportunities for creative behavior. Create assignments that call for original work, independent learning, critical thinking, problem solving, and experimentation. Show appreciation for creative efforts Respect unusual questions, ideas, and solutions. Encourage students to test their ideas. Provide opportunities and give credit for self-initiated learning. Avoid overly detailed supervision and too much reliance on prescribed curricula. Allow time for reflection. Resist immediate and constant evaluation. Avoid comparisons to other student.
Struggling Learners	Assist students in getting organized. Give short directions. Use drill exercises. Give prompt cues during student performance. Let students with poor writing skills use a computer. Break assignments into small segments and assign only one segment at a time. Demonstrate skills and have students model them. Give prompt feedback. Use continuous assessment to mark students' daily progress. Prepare materials at varying levels of ability.
English Language Learners	Use a slow, but natural rate of speech; speak clearly; use shorter sentences; repeat concepts in several ways. When possible, use pictures, photos, and charts. Corrections should be limited and appropriate. Do not correct grammar or usage errors in front of the class. Give honest praise and positive feedback through your voice tones and visual articulation whenever possible. Encourage students to use language to communicate, allowing them to use their native language to ask/answer questions when they are unable to do so in English. Integrate students' cultural background into class discussions. Use cooperative learning where students have opportunities to practice expressing ideas without risking language errors in front of the entire class.
Learners with an IEP	Each special education student has in Individualized Educational Plan (IEP) that details the specific accommodations, modifications, services, and support needed to level the playing field. This will enable that student to access the curriculum to the greatest extent possible in the least restrictive environment. These include: • Variation of time: adapting the time allotted for learning, task completion, or testing • Variation of input: adapting the way instruction is delivered • Variation of output: adapting how a student can respond to instruction • Variation of size: adapting the number of items the student is expected to complete • Modifying the content, process or product Additional resources are outlined to facilitate appropriate behavior and increase student engagement. The most frequently used modifications and accommodations can be viewed here. Teachers are encouraged to use the Understanding by Design Learning Guidelines (UDL). These guidelines offer a set of concrete suggestions that can be applied to any discipline to ensure that all learners can access and participate in learning opportunities. The framework can be viewed here www.udlguidelines.cast.org

Learners with a 504	Refer to page four in the Parent and Educator Resource Guide to Section 504 to assist in the development of appropriate plans.

Interdisciplinary Connections

Visual and Performing Arts	English Language Arts	Mathematics	Science	Social Studies
1.2.12prof.Cr1a 1.2.12prof.Cr1b 1.2.12prof.Cr1c 1.2.12prof.Cr1d	Gr.11-12, NJSLSA. R-1,3,4,8,10 RL- 1,2,3,7 RI- 1,3,9 RST- 7,8,9 Gr. 9-10, NJSLSA. R- 1,3,4,8,10 RL- 1,2,3,7 RI- 1,3,9 RST- 7,8,9	NJSLS N-Q.1-3 NJSLS F.BF.1 NJSLS F.LE.1	HS-ETS1-1 HS-ETS1-2 HS-ETS1-3 HS-ETS1-4	

Integration of 21st Century Skills

Indicators:

8.2.12.ED.1
8.2.12.ED.2
8.2.12.ED.3
8.2.12.ED.5
8.2.12.NT.1
8.2.12.NT.2

Unit Title: 5 **Industrial Applications**

Unit Description:
This unit will introduce students to the three methods of moving robots. These methods include electrical, pneumatic, and hydraulic power systems. Knowledge of simple machines and mechanical advantages is stressed. Students will be designing and constructing simple robot structures that will incorporate the three power systems. Culminating activities will be the presenting and testing of models.

Unit Duration: 5 weeks

Desired Results

Standard(s):

9.3.12.AC.1 9.3.12.AC.2 9.3.12.AC-DES.1 9.3.12.AC-DES.2 9.3.12.AC-DES.6 9.3.12.AC-DES.8 9.3.12.BM.1	9.3.MN-HSE.3 9.3.MN-MIR.1 9.3.MN-PPD.3 9.3.MN-PRO.3 9.3.MN-PRO.4 9.3.ST.1	9.3.MN-HSE.3 9.3.MN-MIR.1 9.3.MN-PPD.3 9.3.MN-PRO.3 9.3.MN-PRO.4 9.3.ST.1	9.3.ST-SM.2 9.3.ST-SM.4 9.4.8.TL.2 9.4.8.TL.3: 9.4.12.CI.1 9.4.12.CT.1

Indicators:

Understandings:
Students will understand that…

- Describe how robots are integrated into a manufacturing process.
- Select the proper robot for a given task.
- Identify processes where robots are used.
- List peripheral devices used to complete tasks.

Essential Questions:
1. What key design criteria should product engineers consider?

2. When in manufacturing would it be more productive to let human workers or dedicated machines assemble rather than to incorporate robots?

3. What is the difference between accuracy and repeatability?

Assessment Evidence

Performance Tasks:

1. Working in groups of 2-3, students will successfully construct and test the two types of robots listed above.

2. Each student group will be able to apply the const. principles of the kits to future robot design of their own.

3. Each student group will submit a written report describing the operational principles of the types of robots and two other uses of service robot technology.

Other Evidence:

Formative Assessments:

Chapter 4 Quiz

Robotic activities

Summative Assessment(s)

Robot programming and Performance

Benchmarks:
1. Each student group will be able to describe the operational principle for the types of robots.
2. Describe the operation of a sound operated service robot.
3. Describe the operation of an infra-red line tracing service robot.

Learning Plan

Learning Activities:

Review all safety
procedures and
discuss clean up procedures

- Working in groups of 2-3, construct the two types of service robots

  Test operation

*Written report on operation principles

Resources:

Textbook, pages 81–113

Review Questions, page 113

Learning Extensions, page 113

Laboratory Manual, pages 27–40

Activity 4-1—Palletizing, pages 27–31

Activity 4-2—Control with DC Stepping Motors, pages 33–36

Activity 4-3—Automatic Stepping Motor Control, pages 37–40

Handout MasterHM 4-1 Degrees of Freedom and Corresponding Axes

Unit Modifications for Special Population Students	
Advanced Learners	Provide ample opportunities for creative behavior. Create assignments that call for original work, independent learning, critical thinking, problem solving, and experimentation. Show appreciation for creative efforts Respect unusual questions, ideas, and solutions. Encourage students to test their ideas. Provide opportunities and give credit for self-initiated learning. Avoid overly detailed supervision and too much reliance on prescribed curricula. Allow time for reflection. Resist immediate and constant evaluation. Avoid comparisons to other students.
Struggling Learners	Assist students in getting organized. Give short directions. Use drill exercises. Give prompt cues during student performance. Let students with poor writing skills use a computer. Break assignments into small segments and assign only one segment at a time. Demonstrate skills and have students model them. Give prompt feedback. Use continuous assessment to mark students' daily progress. Prepare materials at varying levels of ability.
English Language Learners	Use a slow, but natural rate of speech; speak clearly; use shorter sentences; repeat concepts in several ways. When possible, use pictures, photos, and charts. Corrections should be limited and appropriate. Do not correct grammar or usage errors in front of the class. Give honest praise and positive feedback through your voice tones and visual articulation whenever possible. Encourage students to use language to communicate, allowing them to use their native language to ask/answer questions when they are unable to do so in English. Integrate students' cultural background into class discussions. Use cooperative learning where students have opportunities to practice expressing ideas without risking language errors in front of the entire class.
Learners with an IEP	Each special education student has in Individualized Educational Plan (IEP) that details the specific accommodations, modifications, services, and support needed to level the playing field. This will enable that student to access the curriculum to the greatest extent possible in the least restrictive environment. These include: • Variation of time: adapting the time allotted for learning, task completion, or testing • Variation of input: adapting the way instruction is delivered • Variation of output: adapting how a student can respond to instruction • Variation of size: adapting the number of items the student is expected to complete • Modifying the content, process or product Additional resources are outlined to facilitate appropriate behavior and increase student engagement. The most frequently used modifications and accommodations can be viewed here. Teachers are encouraged to use the Understanding by Design Learning Guidelines (UDL). These guidelines offer a set of concrete suggestions that can be applied to any discipline to ensure that all learners can access and participate in learning opportunities. The framework can be viewed here www.udlguidelines.cast.org

Learners with a 504	Refer to page four in the Parent and Educator Resource Guide to Section 504 to assist in the development of appropriate plans.

Interdisciplinary Connections				
Visual and Performing Arts	English Language Arts	Mathematics	Science	Social Studies
1.2.12prof.Cr1a 1.2.12prof.Cr1b 1.2.12prof.Cr1c 1.2.12prof.Cr1d	Gr.11-12, NJSLSA. R-1,3,4,8,10 RL- 1,2,3,7 RI- 1,3,9 RST- 7,8,9 Gr. 9-10, NJSLSA. R- 1,3,4,8,10 RL- 1,2,3,7 RI- 1,3,9 RST- 7,8,9	NJSLS N-Q.1-3 NJSLS F.BF.1 NJSLS F.LE.1	HS-ETS1-1 HS-ETS1-2 HS-ETS1-3 HS-ETS1-4	

Integration of 21st Century Skills

Indicators:

8.2.12.ED.1
8.2.12.ED.2
8.2.12.ED.3
8.2.12.ED.5
8.2.12.NT.1
8.2.12.NT.2

Unit Title: 6 **Power Supplies and Movement Systems**

Unit Description:
This unit will introduce students to the three methods of moving robots. These methods include electrical, pneumatic, and hydraulic power systems. Knowledge of simple machines and mechanical advantages is stressful. Students will be designing and constructing simple robot structures that will incorporate the three power systems. Culminating activities will be the presenting and testing of models.

Unit Duration: 5 weeks

Desired Results

Standard(s):

9.3.12.AC.1 9.3.12.AC.2 9.3.12.AC.5 9.3.12.AC.6 9.3.12.AC-CST.2 9.3.12.AC-CST.3 9.3.12.AC-CST.5 9.3.12.AC-CST.7 9.3.12.AC-CST.8 9.3.12.AC-CST.9	9.3.12.AC-DES.1 9.3.12.AC-DES.2 9.3.12.AC-DES.5 9.3.12.AC-DES.6 9.3.12.AC-DES.8 9.3.12.ED.3 9.3.ST.1 9.3.ST.6	9.3.ST-ET.1 9.3.ST-ET.2 9.3.ST-ET.3 9.3.ST-ET.4 9.3.ST-ET.5 9.3.ST-ET.6 9.3.ST-SM.1 9.3.ST-SM.2	9.3.ST-SM.4 9.4.12.CI.1 9.4.12.CI.3 9.4.12.CT.1 9.4.12.CT.2

Indicators:

Understandings:
Students will understand that…

- Discuss the use of electromechanical systems with robots.
- Explain the function of control systems used with robots.
- Summarize the characteristics of direct current, single-phase ac, and three-phase ac motors.
- Describe the type of motion that rotary electric actuators produce.

Essential Questions:
1. How does a simple electric motor work?

2. What applications require pneumatic or hydraulic power systems?

3. What are simple machines and how do they aid in task completion?

Assessment Evidence

Performance Tasks:

1. Each student will be able to explain how varying source voltage can control the speed of a universal motor.
2. Each student will be able to list two uses of each type of motor in the unit.
3. Each student will be able to describe an optical encoder and its need for motor positioning.
4. All students will be able to describe the principles of operation for hydraulic and pneumatic power systems.
5. Each student will be able to list and define Pascal's Laws as they apply to fluid power.
6. All students will be able to diagram and describe linear and rotary actuators used in fluid power systems.
7. Working in groups and following established safety steps, all students will complete TLA to reinforce fluid power principles and robot motion/ degrees of freedom.

Other Evidence:

Formative Assessments:
Chapter 5 Quiz

Robotic Avtivities

Summative Assessment(s)

Robotic programs & Robotic chellenges

Benchmarks:

1. Each student will know and be able to describe the need/operation of each of the basic parts of DC motor.
2. Describe how electromagnetic fields effect motor operation.
3. Describe the need of internal components in electric motors.
4. List the different uses of specific types of motors.
5. Describe the need of feedback systems for motor position.
6. Describe a pneumatic fluid power system.
7. Describe a hydraulic fluid power system.
8. Use Pascal's Law to describe

Learning Plan

Learning Activities:

*Reading assignments
*Discuss and label the following parts of a DC motor: field, armature, commutator, and brushes
*Discuss electromagnetic fields used in universal motors
*Discuss operation with AC or DC current
*TLA: Construct a single phase synchronous motor and test for proper operation
*Discuss speed of synchronous motor and line frequency
*Diagram motor parts and discuss alternating field
*Discuss uses of synchronous type motor

Resources:

Textbook, pages 115–138

Review Questions, page 138

Learning Extensions, page 138

Laboratory Manual, pages 41–75

Activity 5-1—Basic Electrical Symbols, pages 41–42

Activity 5-2—Electrical Components, Equipment, and Symbols, pages 43–46

Unit Modifications for Special Population Students	
Advanced Learners	Provide ample opportunities for creative behavior. Create assignments that call for original work, independent learning, critical thinking, problem solving, and experimentation. Show appreciation for creative efforts Respect unusual questions, ideas, and solutions. Encourage students to test their ideas. Provide opportunities and give credit for self-initiated learning. Avoid overly detailed supervision and too much reliance on prescribed curricula. Allow time for reflection. Resist immediate and constant evaluation. Avoid comparisons to other students.
Struggling Learners	Assist students in getting organized. Give short directions. Use drill exercises. Give prompt cues during student performance. Let students with poor writing skills use a computer. Break assignments into small segments and assign only one segment at a time. Demonstrate skills and have students model them. Give prompt feedback. Use continuous assessment to mark students' daily progress. Prepare materials at varying levels of ability.
English Language Learners	Use a slow, but natural rate of speech; speak clearly; use shorter sentences; repeat concepts in several ways. When possible, use pictures, photos, and charts. Corrections should be limited and appropriate. Do not correct grammar or usage errors in front of the class. Give honest praise and positive feedback through your voice tones and visual articulation whenever possible. Encourage students to use language to communicate, allowing them to use their native language to ask/answer questions when they are unable to do so in English. Integrate students' cultural background into class discussions. Use cooperative learning where students have opportunities to practice expressing ideas without risking language errors in front of the entire class.
Learners with an IEP	Each special education student has in Individualized Educational Plan (IEP) that details the specific accommodations, modifications, services, and support needed to level the playing field. This will enable that student to access the curriculum to the greatest extent possible in the least restrictive environment. These include: • Variation of time: adapting the time allotted for learning, task completion, or testing • Variation of input: adapting the way instruction is delivered • Variation of output: adapting how a student can respond to instruction • Variation of size: adapting the number of items the student is expected to complete • Modifying the content, process or product Additional resources are outlined to facilitate appropriate behavior and increase student engagement. The most frequently used modifications and accommodations can be viewed here. Teachers are encouraged to use the Understanding by Design Learning Guidelines (UDL). These guidelines offer a set of concrete suggestions that can be applied to any discipline to ensure that all learners can access and

	participate in learning opportunities. The framework can be viewed here www.udlguidelines.cast.org
Learners with a 504	Refer to page four in the Parent and Educator Resource Guide to Section 504 to assist in the development of appropriate plans.

Interdisciplinary Connections

Visual and Performing Arts	English Language Arts	Mathematics	Science	Social Studies
1.2.12prof.Cr1a 1.2.12prof.Cr1b 1.2.12prof.Cr1c 1.2.12prof.Cr1d 1.2.12acc.Cr1c 1.2.12adv.Cr1c	Gr.11-12, NJSLSA. R-1,3,4,8,10 RL- 1,2,3,7 RI- 1,3,9 RST- 7,8,9 Gr. 9-10, NJSLSA. R- 1,3,4,8,10	NJSLS N-Q.1-3	HS-ETS1-1 HS-ETS1-2 HS-ETS1-3 HS-ETS1-4	

Integration of 21st Century Skills

Indicators:

8.1.12.CS.1
8.1.12.CS.2
8.1.12.CS.3
8.1.12.CS.4
8.2.12.ED.1
8.2.12.ED.2

Unit Title: 7 **Drone Technology**

Unit Description:

This unit provides students with a comprehensive understanding of unmanned aerial systems (UAS), commonly known as drones. Drones have revolutionized numerous industries, from aerial photography to agriculture, and this course aims to equip students with the knowledge and skills needed to operate, maintain, and leverage drones effectively.

Unit Duration: 4 weeks

Desired Results

Standard(s):

9.3.12.AC.1 9.3.12.AC.2 9.3.12.AC.5 9.3.12.AC.6
9.3.12.AC-CST.2 9.3.12.AC-CST.3 9.3.12.AC-CST.5 9.3.12.AC-CST.7
9.3.12.AC-CST.8 9.3.12.AC-CST.9 9.3.12.AC-DES.1 9.3.12.AC-DES.2
9.3.12.AC-DES.5 9.3.12.AC-DES.6 9.3.12.AC-DES.8 9.3.12.ED.3
9.3.ST.1 9.3.ST.6
9.3.ST-ET.1 9.3.ST-ET.2 9.3.ST-ET.3 9.3.ST-ET.4
9.3.ST-ET.5 9.3.ST-ET.6 9.3.ST-SM.1 9.3.ST-SM.2
9.3.ST-SM.4 9.4.12.CI.1 9.4.12.CI.3 9.4.12.CT.1 9.4.12.CT.2

Indicators:

Understandings:

Students will understand that…

- **Understand Drone Technology:** Gain a fundamental understanding of drone technology, including components, classifications, and the principles of flight.
- **Drone Safety and Regulations:** Comprehend the essential safety guidelines and legal regulations governing drone operation, ensuring responsible and lawful usage.
- **Drone Operations:** Develop hands-on skills in flying drones, including takeoff, landing, maneuvering, and responding to various flight scenarios.
- **Aerial Photography and Videography:** Explore the world of aerial imaging, learning techniques for capturing stunning photos and videos using drones.
- **Data Collection and Analysis:** Learn to use drones for data collection and analysis in fields like agriculture, environmental monitoring, and surveying.
- **Maintenance and Troubleshooting:** Understand drone maintenance practices, troubleshooting common issues, and performing basic repairs.
- **Drone Applications:** Investigate the diverse applications of drones in various industries, including agriculture, construction, emergency response, and more.
- **Emerging Trends:** Stay updated with the latest trends and advancements in drone technology, such as AI integration and automation.
- **Ethical and Environmental Considerations:** Discuss the ethical use of drones and their environmental impact, fostering responsible drone use.

Essential Questions:

1. What are drones, and how do they work?
2. What are the various types and classifications of drones?
3. What are the current regulations and laws governing drone usage?
4. What are the safety considerations associated with drone operation?
5. What are the applications of drones in different industries?
6. How can drones be used for environmental monitoring and conservation?
7. What are the ethical implications of drone technology?
8. What are the economic impacts of the drone industry?
9. What role do drones play in disaster response and emergency services?
10. What advancements in drone technology are on the horizon?
11. What are the environmental effects of drone technology?
12. How can drones be integrated into education and research?
13. What skills and training are necessary for drone operators?
14. What are the privacy concerns related to drone use in the public and private sectors?
15. What are the global perspectives on drone technology and usage?

Assessment Evidence

Performance Tasks:

1. Drone Familiarization
2. Safety Training
3. Regulatory Compliance
4. Drone Flight Simulation
5. Takeoff and Landing
6. Flight Maneuvers
7. Aerial Photography and Videography
8. Data Collection and Analysis
9. Maintenance and Repairs
10. Flight Planning:
11. Navigation and GPS Usage
12. Weather Considerations
13. Emergency Procedures
14. Problem-Solving:
15. Mapping and GIS
16. Project-Based Learning
17. Legal and Ethical Discussions
18. Examinations and Quizzes
19. Final Project

Other Evidence:

Formative Assessments:

UAS Rule/ Regulation Quiz

Safety Quiz
Flying challenges
Programming Challenges

Summative Assessment(s)

Drone Technology Learning Activity

Benchmarks:

- Students should become familiar with different types of drones, their components, and how they operate.
- Learn and adhere to safety protocols and guidelines for responsible drone operation.
- Understand and comply with local, national, and international regulations governing drone usage.
- Practice flying drones using simulators to develop basic piloting skills before handling real drones.
- Master the fundamental skills of safely taking off and landing a drone.
- Learn to perform various flight maneuvers, including hovering, ascending, descending, and navigating obstacles.
- Explore techniques for capturing photos and videos with a drone, considering composition and camera settings.
- Use drones to collect data for specific applications, such as agriculture, mapping, or environmental monitoring.
- Understand how to maintain and troubleshoot drones, including changing propellers, batteries, and basic repairs.
- Develop skills in mission planning, including setting waypoints and autonomous flight paths.
- Learn to navigate using GPS systems and understand their role in drone flight.
- Understand how weather conditions can impact drone operations and learn to make informed decisions based on weather data.
- Develop skills for handling emergency situations, such as signal loss, low battery warnings, and flyaway scenarios.
- Analyze and solve common issues that may arise during drone flights, such as erratic behavior or connectivity problems.
- Explore how drones are used for creating maps and geospatial data, and work on mapping projects.
- Engage in hands-on projects that involve planning, executing, and analyzing drone missions for specific applications, such as creating 3D models or conducting surveillance.
- Participate in discussions about the legal and ethical aspects of drone use, including privacy concerns and compliance with laws.
- Complete assessments to evaluate understanding of the course material.
- Create a comprehensive final project that showcases the application of drone technology, such as a drone survey, aerial photography portfolio, or a research report.

Learning Plan

Learning Activities:

Teacher lead discussions on:

- Safety / Regulations
- Proper Take off and landing
- Flight manuevers
- Coding

Student quiz

Student practical tests

Resources:

Federal Avation Administration

CISA.gov

DJI

Unit Modifications for Special Population Students

Advanced Learners	Provide ample opportunities for creative behavior. Create assignments that call for original work, independent learning, critical thinking, problem solving, and experimentation.

	Show appreciation for creative efforts Respect unusual questions, ideas, and solutions. Encourage students to test their ideas. Provide opportunities and give credit for self-initiated learning. Avoid overly detailed supervision and too much reliance on prescribed curricula. Allow time for reflection. Resist immediate and constant evaluation. Avoid comparisons to other students.
Struggling Learners	Assist students in getting organized. Give short directions. Use drill exercises. Give prompt cues during student performance. Let students with poor writing skills use a computer. Break assignments into small segments and assign only one segment at a time. Demonstrate skills and have students model them. Give prompt feedback. Use continuous assessment to mark students' daily progress. Prepare materials at varying levels of ability.
English Language Learners	Use a slow, but natural rate of speech; speak clearly; use shorter sentences; repeat concepts in several ways. When possible, use pictures, photos, and charts. Corrections should be limited and appropriate. Do not correct grammar or usage errors in front of the class. Give honest praise and positive feedback through your voice tones and visual articulation whenever possible. Encourage students to use language to communicate, allowing them to use their native language to ask/answer questions when they are unable to do so in English. Integrate students' cultural background into class discussions. Use cooperative learning where students have opportunities to practice expressing ideas without risking language errors in front of the entire class.
Learners with an IEP	Each special education student has in Individualized Educational Plan (IEP) that details the specific accommodations, modifications, services, and support needed to level the playing field. This will enable that student to access the curriculum to the greatest extent possible in the least restrictive environment. These include: • Variation of time: adapting the time allotted for learning, task completion, or testing • Variation of input: adapting the way instruction is delivered • Variation of output: adapting how a student can respond to instruction • Variation of size: adapting the number of items the student is expected to complete • Modifying the content, process or product Additional resources are outlined to facilitate appropriate behavior and increase student engagement. The most frequently used modifications and accommodations can be viewed here. Teachers are encouraged to use the Understanding by Design Learning Guidelines (UDL). These guidelines offer a set of concrete suggestions that can be applied to any discipline to ensure that all learners can access and participate in learning opportunities. The framework can be viewed here www.udlguidelines.cast.org
Learners with a 504	Refer to page four in the Parent and Educator Resource Guide to Section 504 to assist in the development of appropriate plans.

Interdisciplinary Connections

Visual and Performing Arts	English Language Arts	Mathematics	Science	Social Studies
1.2.12prof.Cr1a 1.2.12prof.Cr1b 1.2.12prof.Cr1c 1.2.12prof.Cr1d 1.2.12acc.Cr1c 1.2.12adv.Cr1c 1.2.12acc.Cr2a 1.2.12acc.Cr2b 1.2.12acc.Cr2c	Gr.11-12, NJSLSA. R-1,3,4,8,10 RL- 1,2,3,7 RI- 1,3,9 RST- 7,8,9 Gr. 9-10, NJSLSA. R- 1,3,4,8,10 RL- 1,2,3,7 RI- 1,3,9 RST- 7,8,9	NJSLS N-Q.1-3	HS-ETS1-1 HS-ETS1-2 HS-ETS1-3 HS-ETS1-4	

Integration of 21st Century Skills

Indicators:

8.1.12.CS.1
8.1.12.CS.2
8.1.12.CS.3
8.1.12.CS.4
8.2.12.ED.1
8.2.12.ED.2
8.2.12.ED.3
8.2.12.ED.5
8.2.12.NT.1
8.2.12.NT.2