Robotics Engineering

COURSE OF STUDY

BHPRSD
Technology Education
Department

Written by:
Kyle O'Donnell,
Steve Arena,
Ygor Carvalho,
Laura Whitaker

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Supervisor:
Glenn Smith

Approved by:

COURSE DESCRIPTION

ROBOTICS ENGINEERING Full Year 5 Credits Grades 11 & 12

Prerequisite: Students need to have successfully completed Algebra 2 and one Technology Education course.

ROBOTICS ENGINEERING is a course created to teach students how to design, engineer, program, and build robots. Students will learn how to use specific engineering steps to create robots that will perform a variety of tasks. Projects in this course will culminate with students testing their designs by competing against each other. ROBOTICS ENGINEERING students will use Computer Aided Drawing (CAD) software to create and fabricate custom robot parts with 3D Printing, CNC machining, and traditional hands-on prototyping in the robot fabrication process. While the course is largely Project-Based, advanced mathematical concepts related to robotics programing and engineering are another component of this exciting class.

Unit I - Intro to Engineering and Robotics Design

1. Technological Design Process

Learn to solve open ended problems using the technological design process.
Students will practice free hand isometric sketching techniques, mechanical drawing skills, and precision measuring. Students will also learn basic safe shop practices, along with specific precision tool and machine instruction.

2. Introduction to Robotics

Build Lego Mindstorms robots and learn to utilize sensors during autonomous computer programing.

3. Computer Aided Drafting and Solid Modeling

Use Auto-Desk Inventor to draw in both 2D and 3D solid modeling.

4. Electrical Engineering and Schematics

Students will learn to draw electrical schematics to represent complex electrical systems that are used in robotics.

Unit II – Computer Controlled Manufacturing

5. **Additive manufacturing**

Learn to use a CNC 3D rapid prototype. Students will design a solution to a product design challenge using Autodesk inventor and manufacture the project using a 3D printer. Students will present their product to the rest of the class.

6. **CNC Machining**

Design and machine robotics parts using a CNC laser engraver and CNC router. Both vector cutting and raster imaging will be used.

Unit 3 – NXT/Tetrix Robotics

7. **Tetrix robotics system**

Build and program a Tetrix robot to perform remote controlled and autonomous tasks and competitions. Learn to use advanced labview programing software.

8. **Mathematical analysis for Engineering**

Students will understand that robotics design in not only a mechanical process, but a data driven process. They will apply quantitative data driven design approaches to meet strict design requirements in robotics engineering.

9. **Robotics Design**

Design, build, and program a Tetrix robot to compete in the annual Black Horse Pike Robotics Challenge.

Course Expectations and Skills

1. Keep and maintain an engineering notebook.
2. Apply and document the technological design process while solving challenges.
3. Practice proper attitude and safe discipline.
4. Develop an acceptable degree of craftsmanship in each activity.
5. Participate and contribute equally to a group generated solutions.
6. Apply and analyze science and math related concepts to the challenge.
7. Prepare students to be successful in higher level technology courses and engineering related careers.

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: **ROBOTICS ENGINEERING** **Technological Design Process**	**Unit Summary:** **Students will learn to use the technological design process (TDP) to solve open ended problems. Students will learn to safely use tools and machines to extend human capabilities. Students will apply this knowledge with the TDP to research, brainstorm, sketch, refine, build, test, rebuild, re-test, and reflect on a solution and project to open ended design problems, the district technological design challenge and multiple robotics challenges.**
Grade Level(s): **11-12**	
Essential Question(s): **How can we strategically solve problems?** **Why is safety important and what precautions can we take to ensure safety?**	**Enduring Understanding(s):** **This unit is designed to introduce the technological design process. This process will be used to solve all challenges throughout all engineering courses and projects. It is also designed to safely introduce students to the technology, tools, and machines used to prototype solutions to challenges and projects. The students will learn to solve open ended problems and to design and build the solutions and projects. The goal is for the students to gain better skills toward problem-solving, the ability to confidently use tools and machines to process multiple types of materials, and to work cooperatively with others.**

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable

Learning Target	NJCCCS or CCS
1. Identify and apply the technological design process to a real design challenge	1. TEC.9-12.8.1
2. Design a working set of mechanical drawings	2. TEC.9-12.8.2.12 B.3
3. Students will learn to safely operate tools and machines to process materials	3. TEC.9-12.8.2.12.E.1
4. Write a creative fictional story that applies to this years challenge	4. TEC.9-12.8.1.12 B.9
5. Solve challenge related geometric, algebraic, and statistical math problems	5. ELL.9-12.S.B.3
6. Apply the TDP to more complex and technologically advanced problems and mediums including open ended robotics mechanical design problems, and strategic robotics programing systems.	6. ELL.9-12.R.E.6
	7. MA.9-12.4.2.12 D.2
	8. MA.9-12.4.5
	9. MA.9-12.4.5.12 E

Inter-Disciplinary Connections:

MATH - fractional inch, fractions, measurement, geometric principles, English - An engineering notebook including written documentation of the technological design process

Students will engage with the following textbook

TECHNOLOGY EDUCATION: LEARNING BY DESIGN Pearson
Prentice Hall
ISBN 0133639894
Periodicals to include but not limited to newspapers, magazine articles, internet web pages.

<u>Students will write:</u>

Students will maintain a design journal throughout the unit. In this journal students will write a design brief problem statement including all constraints and rules of the challenge.

Students will write a creative fictional story that explains why the challenge must take place and why the design problem must be solved.

Students will write a reflection essay on the entire Tech. Challenge process and their results

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

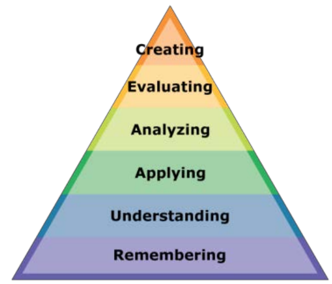
Students will read a Technological Design Challenge design packet. This will include all of the information related to this years challenge including the challenge rules, constraints, materials, design journal components, timeline, and rubric.

Students will now create a technical design journal schedule as they document the process in which they solve the challenge. This starts with students writing a design brief statement showing comprehension and understanding of the challenge and project at hand. Students will design and sketch a team logo and cover page. Students will write a creative fictional story related to the design challenge. Students will then brainstorm and sketch multiple solutions to the challenge using only the required and limited materials. Students will now list pros and cons of each design and then choose their favorite design to make a detailed rough sketch of. Next, the design will be developed into a final working mechanical drawing with an included bill of materials and order of operations. Students will also solve a challenge related engineering math worksheet. During this entire design journal work students will also document a timesheet listing what was accomplished on each day.

After the design journal is done, students will collect their materials and begin to safely process materials and construct their designs. After building students will test and re-build their project to get the best potential result. The challenge will then move forward with a tournament and the winning students will go to the district Tech. Challenge Championship to compete against the other schools.

After the project students will write an essay reflecting upon the entire technological design process and their own personal results.

Students will continue to apply the TDP to more complex and technologically advanced problems and mediums including open ended robotics mechanical design problems, and strategic robotics programing systems.



PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS.
IDENTIFY BLOOM'S LEVELS.

Formative Assessments:

WARM UP ACTIVITIES

Students will read the timeline, direction and constraint page for the current design journal page.
Students will check the daily entry log to ensure see where they left off and ensure it is up to date
Students will get safety glasses on and get their plans and materials ready.

CHECKPOINTS OF UNDERSTANDING

The design journals with be checked and graded after every component.

Accommodations/Modifications:

Students have guided packets with questions that outline the research, and brainstorming.
The students will have an adjusted writing and mathematics packet to suit particular needs.
Students will receive extra one on one instruction to ensure safety and understanding.

Alternative assignments, additional time for assignments, preferential seating arrangements one on one interaction, after school help, and assistance for organization. Check frequently for student understanding.

Summative Assessments:

Final evaluation of the project based on a rubric.
Final grade of design journal as it is re-graded in its entirety
Reflection paper about the entire project

Accommodations/Modifications:

Alternative assignments, additional time for assignments, preferential seating arrangements one on one interaction, after school help, and assistance for organization. Check frequently for student understanding.
Allow students to get their work checked frequently as the assessments are build-ups.

Performance Assessments:

Construction of a solution to the challenge
Safely utilizing shop tools and machines

Accommodations/Modifications:

Alternative assignments, additional time for assignments, preferential seating arrangements one on one interaction, after school help, and assistance for organization. Check frequently for student understanding.
Allow students to get their work checked frequently as the assessments are build-ups.

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: **ROBOTICS ENGINEERING** **Introduction to Robotics**	**This course is designed to introduce students to real world engineering applications and robotics programing. It is designed to incorporate mathematical engineering concepts, computer aided drawing, advanced CNC machining, rapid prototyping, advanced mechanical engineering, autonomous robotics programing and statistical analysis to prepare students to enter engineering and robotics fields and higher education.** **Unit Summary:** • **In this course students will expand their knowledge of control systems by engaging in designing and building robotics. This course is an overview of robotic systems where students will explore the following topics, motion planning, mobile mechanisms, sensors, control mechanisms and programming. Students in this course will be engaged in designing, building, and programming autonomous robots.**
Grade Level(s): **11-12**	

Essential Question(s):	Enduring Understanding(s):
How can robotics technologies extend human capabilities? What approach do we use to solve technological problems using advanced technological systems? How will effective planning effect the outcome of autonomous programming? How can we analyze the accuracy and outcomes of a robots work and predict troubleshoot variances in the system?	• Technology is used to extend human capabilities and is constantly growing, changing, and improving. • The Technological design process is a systematic approach to solving complicated open ended problems and design challenges. • The impacts of robotics in the technological and economic world are drastic and human paradigms must shift to adapt to the new emerging technological resources. • Quality control must be maintained and analyzed throughout a system.

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable

Learning Target	NJCCCS or CCS
1. Organize and identify all Mindstorms components 2. Build the advanced Task bot from the construction booklet in the kit 3. Become familiar with NXT programing software 4. Control robot movement using the NXT brick with autonomous programing 5. Solve a distance challenge course 6. Alter the robot design to accept various sensors 7. Utilize sensors and autonomous programing to solve sensor challenges 8. Re-Design and add multiple sensors to the robot to solve a complicated robot design challenge 9. Calculate and create gear trains to alter torque and speed of the robot. 10. Become familiar with datalogging section of software – run a live program (the NXT brick is connected to the computer, stationary and just collecting data) 11. Manipulate graph and use analysis from the datalogging software	1. TEC.9-12.8.2.12.A.1 - 2. TEC.9-12.8.1.12 B.3 3. TEC.9-12.8.1.12 B.9 4. TEC.9-12.8.1.12 B.11 5. TEC.9-12.8.2.12 B.4 7. TEC.9-12.8.1.12 A.4 8. MA.K-12.4.5.A.1 9. MA.K-12.4.5.F.2 10. MA.K-12.4.5.A.5 11.MA.K-12.4.5.C.4 12. MA.K-12.4.5.C.6

Inter-Disciplinary Connections:

MATH - fractional inch, fractions, measurement, geometric principles, rotational measurements, degrees of movement. English - An engineering notebook including written documentation of the technological design process Science – Robotics is used in many medical and highly controlled scientific studies Social Studies – Impacts of emerging technologies on the social and economic level

Students will engage with the following textbook

TECHNOLOGY EDUCATION: LEARNING BY DESIGN Pearson
Prentice Hall
ISBN 0133639894
Periodicals to include but not limited to newspapers, magazine articles, internet web pages.

Students will write:

Students will write the following in their engineering notebooks:

Program plan summaries explaining the sequence of events for their robot

Reflections to analyze information learned and improvements for future challenges

Robotics and engineering current events

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

Students will learn robotics fundamentals, terminology and real life applications through presentations, videos, and current events.

Students will then be introduced to the Lego Mindstorms robotics kits. Next, all kits will be organized and all parts identified. Students will follow the construction booklet and build the Taskbot robot. Students will then be given demonstrations using the NXT programming software and the NXT brick. Students will now program their robots to move a certain distance. Students must use math to calculate the amount of tire rotations necessary to move a given distance.

The first challenge is a distance challenge, students must measure and record a course and then write a written summary of the course obstacles and necessary calculations and actions needed to complete the course. Students will now use the NXT programming software to program the NXT brick to complete the course. Students will need to use the TDP to solve the challenge.

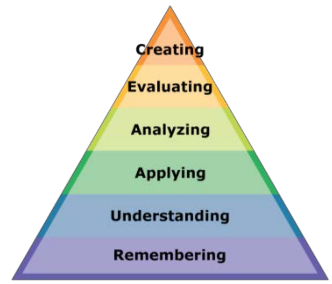
The next part of this unit deals with added robotics sensors. Students will add the touch, light, infrared, and noise sensors independently and solve a challenge designed for that particular sensor. The final sensor challenge is an open ended problem course that must be completed with the use of multiple sensors.

Students will learn about the mechanical advantage of gears and create a gear train on the robot to create a robot with greater speed or more torque. Students will calculate the mechanical advantage and torque/speed ratios.

Introduce datalogging section of software – run a live program (the NXT brick is connected to the computer, stationary and just collecting data) – walk students through how to manipulate graph and use the analysis software.

PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS.
IDENTIFY BLOOM'S LEVELS.



Formative Assessments:

WARM UP ACTIVITIES

All activities will be based on either student exploration of content area, or reflection of prior lessons.

CHECKPOINTS OF UNDERSTANDING

Note worksheets
Checkpoints at each robot stage, sensor and challenge
Written program summaries
Engineering notebook checks

Accommodations/Modifications:

Alternative assignments, additional time for assignments, preferential seating arrangements one on one interaction, after school help, and assistance for organization. Check frequently for student understanding.
Allow students to get their work checked frequently as the assessments are build-ups.

Summative Assessments:

Robotics test
Mindstorms robotics reflective essay

Accommodations/Modifications:

Alternative assignments, additional time for assignments, preferential seating arrangements one on one interaction, after school help, and assistance for organization. Check frequently for student understanding.
Allow students to get their work checked frequently as the assessments are build-ups.

Performance Assessments:

Construct the Taskbot
Write autonomous programing
Solve multiple autonomous challenges
Build a robotic gear train

Accommodations/Modifications:

Alternative assignments, additional time for assignments, preferential seating arrangements one on one interaction, after school help, and assistance for organization. Check frequently for student understanding.
Allow students to get their work checked frequently as the assessments are build-ups.

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

<table>
<tr>
<td>Course Title:
Robotics Engineering

Unit 3
Computer Aided Drafting and Solid Modeling</td>
<td rowspan="2">Unit Summary:
CAD is used for detailed engineering of 2D drawings and 3D models of physical components. It is used throughout the engineering process from conceptual design through completion of a product. The use of CAD has lowered product development costs and has greatly shortened the design cycle. The skills learned are in high demand in today's technical world.</td>
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<td>Grade Level(s):
11, 12</td>
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<td>Essential Question(s):

Why do we create solid models?
How do I setup a solid modeling profile?
How do I manage layers?
How can I use the views of an orthographic projection to create a 3D Model?
What are parametric constraints?
How do I sketch 2d geometry to create solid models?
How do I use geometry to calculate and dimension objects?
What are work planes and why are they important?
How do you use the advanced 3D modeling tools?
What are some of the basic Modify tools?
</td>
<td>Enduring Understanding(s):

Determine and explain the use of 3D modeling in engineering world.
Determine when to use 2D and 3D modeling.
Understand why it is important to create detailed models.
Understand the difference between part files, assembly files, and drawing files.
Value the importance of an organizing projects and creating a clean workspace to make solid modeling run smoother and easier.
Explain when to use different layers and annotative styles for different types of projects.
Interpret the dimensions of an orthographic projection and apply problem solving skills to determine the missing dimensions.
Comprehend the use of parametric constraints and summarize the different situations where they are used.
Explain the difference between sketch mode and modeling mode.
Predict what an object will look like by using geometry calculations.
Outline the importance of work planes when creating advanced 3D models.
Explain and determine when to use the different advanced modeling techniques including sweep, extrude, revolve and loft.
Summarize the different types of modify tools when finalizing a part file including fillet, shell, split, and join.
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PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable

Learning Target	**NJCCCS or CCS**
1. Recognize the importance of solid modeling	**1. *TEC.9-12.8.2.12 B.4* *TEC.9-12.8.2.12 B.6* *TEC.9-12.8.2.12.B.3* *MA.9-12.4.2.12 A.1* *SCI.9-12.5.4.12 A.1***
2. List the advantages and disadvantages are of 3D modeling compared to 2D modeling.	**2. *TEC.9-12.8.2.12 B.1* *TEC.9-12.8.1.12.F.2* *LA.9-12.3.1.12.A.1***
3. Identify when 3D models need to be drawn.	**3. *TEC.9-12.8.1.12 B.9* *TEC.9-12.8.1.12.A.4***
4. Organize the layers of a drawing file and arrange the workspace to suit the need of the drawing format.	*4.* ***TEC.9-12.8.1.12 B.3 TEC.9-12.8.1.12 B.4***
5. Be able to take two views of an orthographic projection and create a solid model from these views.	*5.* ***TEC.9-12.8.2.12 B.3 TEC.9-12.8.2.12 B.1 MA.9-12.4.2.12 A.2***
6. Construct parts using parametric constraints including, parallel, horizontal, perpendicular, vertical, tangent, coincident, and equal constrains and troubleshoot over-constrained sketches.	***6. TEC.9-12.8.1.12 B.10 TEC.9-12.8.1.12 B.11***
7. Create a sketch of an object in the sketch mode and be able to finish the sketch that includes a closed entity to be able to extrude the object making it 3D.	*7.* ***TEC.9-12.8.2.12 B.4***
8. Use math to determine missing lengths and angles of an object.	***8. TEC.9-12.8.2.12 B.6 MA.9-12.4.2.12 A.2 MA.9-12.4.2.12 A.1***
9. Create work planes where sketches can be drawn on to increase the complexity of a part.	***9. TEC.9-12.8.1.12 B.11 TEC.9-12.8.2.12.F.3***
10. Demonstrate the ability to use the advanced modeling techniques by extruding, sweeping, lofting, and/or revolving a part.	*10.* ***TEC.9-12.8.2.12 B.4 MA.9-12.4.2.12 A.1***
11. The student will learn the basic commands of solid modeling which are Regions, Extrude, Union, Subtract, Press-Pull, Model space vs paper space, Viewports, Scaling, and Plotting	***11. TEC.9-12.8.2.12 B.4 TEC.9-12.8.2.12.F.3***
12. Apply the finishing modify tools by creating fillets, shelling, splitting, and or joining an object.	***12. TEC.9-12.8.2.12 B.3***

	TEC.9-12.8.2.12.F.3 *MA.9-12.4.2.12 A.1*

Inter-Disciplinary Connections:

STEM, Mathematics, Geometry, Engineering

Students will engage with the following text:

- **Mechanical Drawing CAD Communications 12th Edition**
- **TECHNOLOGY EDUCATION: LEARNING BY DESIGN Pearson Prentice Hall ISBN 0133639894**
- **Periodicals to include but not limited to newspapers, magazine articles, internet web pages**

Students will write:

- **Use of Cornell Notes will be used to understand the procedures for completing drawings.**
- **Students will keep an engineering notebook**

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

Project based and self-exploration

Real life engineering problems

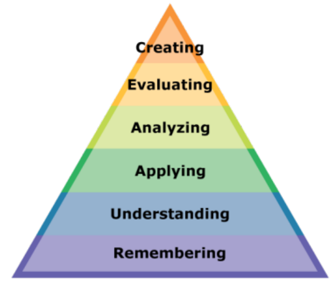
Examples of solution will be given first then students will problem solve and explore to create their own solutions to the problems.

1. **Students will be completing sketches of models before they complete them on the computer.**
2. **Students will use 3D models to create the same model**
3. **Students will use all three views of an orthographic projection to create a 3D solid model.**
4. **Students will use two views to create a solid model.**
5. **Students will use the revolve tool to create round objects**
6. **Students will use the sweep tool to create a profile that will be extruded and a path that with will follow to create parts.**
7. **Students will use the loft tool to create complex parts that include tapers.**
8. **Students will use real objects and take measurements to create a solid model.**

Students will need to have access to Autodesk AutoCAD and Inventor. Drawing will come from the text and other engineering drawings produced by the teacher.

PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS. IDENTIFY BLOOM'S LEVELS.



Formative Assessments:

Observation of student progress and skill development, checkpoints of understanding at:

1. Set-up of program, layers, and workspace
2. Sketching of models
3. Parts created coping another model
4. Models created by looking at the three views of an orthographic projection
5. Create using two views
6. Revolving
7. Sweeping
8. Lofting
9. Measure and create part from looking at a real object.

Do-now's and checkpoint quizzes will be given during and at the conclusion of these topics

Accommodations/Modifications:

One-on-one interaction, alternate assessments

Summative Assessments:

Completed drawings, tests, design journal, test drawing after each mini-unit listed in Part III

Accommodations/Modifications:

Additional time, alternate assessment, after-school help

Performance Assessments:

Completion of Portfolio

Completion of a real object that the students bring in will be the culmination of the understanding the unit.

Accommodations/Modifications:

Alternate drawings, additional time, assistance with organization

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: **ROBOTICS ENGINEERING** **Electrical Engineering**	**This course is designed to introduce students to real world engineering applications and robotics programing. It is designed to incorporate mathematical engineering concepts, computer aided drawing, advanced CNC machining, rapid prototyping, advanced mechanical engineering, autonomous robotics programing and statistical analysis to prepare students to enter engineering and robotics fields and higher education.** **Unit Summary:** • **This unit is designed to review and expand upon their electrical knowledge from engineering classes. Students will more about transistors and how integrated circuits can add the ability to control robotic systems. Students will review DC and AC electrical systems, series and parallel circuitry, electrical motor function, ohms law, and electronics components. Students will practice reading and drawing electrical schematics. Students will apply the electrical concepts with a hands on intermediate circuit build project for a simple machine and a final robot build project.**
Grade Level(s): **11-12**	
Essential Question(s): **What is an integrated circuit and how can it be used to build a motor?** **How do technological systems work together to accomplish goals and extent human capabilities?**	**Enduring Understanding(s):** • **Most of our mechanical systems are all reliant on the successful utilization of the electrical systems.** • **Plans are used to ensure correct placement of components in a complicated system.**

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable

Learning Target	NJCCCS or CCS
1. Identify series versus parallel circuits. 2. Calculate current, voltage, and resistance in a circuit. 3. Identify various electronic components based on their appearance. 4. Safely use a soldering iron to solder an electronics circuit board. 5. Understand the advantage of using electromagnets in mechanical systems. 6. Build an electromagnetic motor for a simple machine. 7. Create a CAD schematic diagram of the circuit to control a mechanical system. 8. Build an electronic circuit with transistors or an IC to control a robotic mechanical system.	1. 9.4.O.1, 8.1.E, 9.1.C, 8.2.G 2. 9.4.O.1, 9.4.O.2, 8.2.G, 9.1.C 3. 9.4.O.1, 8.1.E, 9.1.C, 8.2.G 4. 9.4.O.1, 8.2.G, 9.1.C 5. 9.4.O.1, 8.1.B, 9.1.B, 9.1.C, 8.1.E, 8.2.G, 8.1.F, 9.1.A, 9.4.B.1, 8.2.A, 8.2.B 6. 9.4.O.1, 8.1.B, 9.1.B, 9.1.C, 8.1.E, 8.2.G, 8.1.F, 9.1.A, 9.4.B.1, 8.2.A, 8.2.B 7. 9.4.O.1, 8.1.B, 9.1.B, 9.1.C, 8.1.E, 8.2.G, 8.1.F, 9.1.A, 9.4.B.1, 8.2.A, 8.2.B

Inter-Disciplinary Connections:

MATH – Concept of parallel, Solving equations.

English - An engineering notebook including written documentation of the technological design process

Science – Concept of electricity and its basic principles

Social Studies –

Students will engage with the following textbook

TECHNOLOGY EDUCATION: LEARNING BY DESIGN Pearson Prentice Hall

ISBN 0133639894

Periodicals to include but not limited to newspapers, magazine articles, internet web pages.

Students will write:

- **Students will keep an engineering notebook.**
- **Final reflection on robot challenge will include a summary of electrical learnings.**

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

Students will engage in a presentation and watch videos that will explain where electricity comes from, how it is transmitted, and how it is converted into useful AC and DC current and how that can be converted into mechanical energy. Students will learn about series and parallel circuits, voltage, amperage, resistance, and ohms law in electric circuits. Students will take notes and fill out a worksheet during this presentation, and solve math equations and conversions with an ohms law worksheet. Students will build series and parallel circuits.

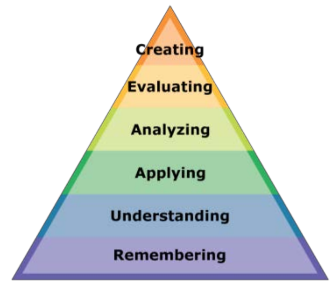
Next, students will apply their knowledge of electromagnets and DC circuitry as they follow directions and build an electric DC motor for a simple machine. Students will troubleshoot their motors and fix any problems in the circuitry.

Next, students will learn about electronics circuitry and components through presentation and examples. Students will learn to identify different electronics components. Students will learn safe soldering techniques through demonstration, then students will practice soldering on electronics.

Students will take an electronics test to test knowledge of concepts, vocabulary, and electrical schematics.

Students will plan, draw, and build an electronic circuit to control a robot in the final robot build project.

Students will reflect upon their electrical learnings in the final reflection document at the completion of the robot build project.



PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS.

IDENTIFY BLOOM'S LEVELS.

Formative Assessments:

WARM UP ACTIVITIES

All activities will be based on either student exploration of content area, or reflection of prior lessons.

CHECKPOINTS OF UNDERSTANDING

- **Ohm's Law worksheet**
- **Electronic Component worksheet**
- **Soldering safety worksheet**
- **Soldering practice circuit**
- **Intermediate project and final robot build project checkpoints**

Accommodations/Modifications:

Alternative assignments, additional time for assignments, preferential seating arrangements one on one interaction, after school help, and assistance for organization. Check frequently for student understanding.

Allow students to get their work checked frequently as the assessments are build-ups.

Summative Assessments:

Electronics Test

Robot Final Challenge

Accommodations/Modifications:

Alternative assignments, additional time for assignments, preferential seating arrangements one on one interaction, after school help, and assistance for organization. Check frequently for student understanding.
Allow students to get their work checked frequently as the assessments are build-ups.

Performance Assessments:
Students will construct an electro-magnetic motor
Students will solder and troubleshoot an electronics kit
Students will build an electronic circuit to control a robot

Accommodations/Modifications:

Alternative assignments, additional time for assignments, preferential seating arrangements one on one interaction, after school help, and assistance for organization. Check frequently for student understanding.
Allow students to get their work checked frequently as the assessments are build-ups.

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course Title: Robotics Engineering Unit 5 Preparation of Drawings and Additive Manufacturing with 3D Printer **Grade Level(s):** **11, 12**	**Unit Summary**: CAD is used for detailed engineering of 2D drawings and 3D models of physical components. It is used throughout the engineering process from conceptual design through completion of a product. With the use of a 3D printer and CAD software, this has drastically lowered product development costs and has greatly shortened the design cycle. The skills learned are in high demand in today's technical world.
Essential Question(s): • **What's the purpose of the Cartesian coordinate system?** • **How do I convert AutoCAD drawing to Inventor sketch and reverse?** • **What is 3d modeling?** • **What are the benefits of solid modeling a part or object?** • **How to create objects with several components?** • **Why add dimensions and constrains?** • **How do I create an assemble drawing?** • **Why generating an engineering drawing?** • **How do you create orthographic views from a solid model?** • **What is the most common view for engineering drawings?** • **Why are constraints important in an assembly drawing?**	**Enduring Understanding(s):** • Have a fluent understanding of terminology used in solid modeling. • Analyze and contrast the differences Coordinate Systems. • Determine and explain the use of 3D modeling in engineering world. • Examine and determine what industry would most benefit from using solid modeling techniques and rapid prototyping with a 3D printer . • Examine and determine what industries would benefit from Prototyping. • Understand the purpose of creating sketches and profiles? • Understand the relationship between sketches, solid models and engineering drawings. • Understand the organization and discipline necessary to create efficient solid models. • Explain the purpose of adding parts to an assemble drawing. • Compare and contrast the different types of constraints used in assembly drawings. • Investigate and understand the different between dimensions and constraints. • Understand the procedure for placing views into a drawing. • Review and demonstrate the proper techniques necessary to create an engineering drawing. • Utilize proper techniques necessary to insert dimensions into engineering drawings. • Understand the concept of creating scaled drawings as a "shop working drawing" for production use of 3D modeling in engineering world.

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable

<u>Learning Target</u>	<u>NJCCCS or CCS</u>
1. Become familiar with using solid modeling as an engineering and product development tool. **2.** Use basic knowledge and techniques learned in unit 2 to create more advanced solid models and engineering drawings. **3.** Create sketches and solid models utilizing revolve, sweep and loft commands. 4. Use geometric formulas and techniques to create geometric shapes. 5. Demonstrate the ability to modify and reengineer sketches after they are transformed into 3d models that can be 3D printed. 6. Create engineering drawings with standard, auxiliary and pictorial views 7. Create profiles in ACAD and importing them into an Inventor sketch and solid model. 8. Demonstrate the ability to use problem solving skills to complete drawing and modeling assignments. 9. Complete drawing and modeling assignments using different working planes and axis. 10. Demonstrate the ability to use the advanced modeling techniques by extruding, sweeping, lofting, and/or revolving a part. 11. Demonstrate a working ability to place view within an engineering drawing. 12. Use advanced view placement techniques to create engineering drawings. 13. Creating 3d models capable of being used in an assembly drawing. 14. Demonstrate a working ability to use constraints to position parts within an assembly drawing. 15. Create color and texture to assembly drawing.	**1.** ***TEC.9-12.8.2.12 B.4*** ***TEC.9-12.8.2.12 B.6*** ***TEC.9-12.8.2.12.B.3*** ***MA.9-12.4.2.12 A.1*** ***SCI.9-12.5.4.12 A.1*** **2.** ***TEC.9-12.8.2.12 B.1*** ***TEC.9-12.8.1.12.F.2*** ***LA.9-12.3.1.12.A.1*** **3.** ***TEC.9-12.8.1.12 B.9*** ***TEC.9-12.8.1.12.A.4*** *4.* ***TEC.9-12.8.1.12 B.3*** ***TEC.9-12.8.1.12 B.4*** *5.* ***TEC.9-12.8.2.12 B.3*** ***TEC.9-12.8.2.12 B.1*** ***MA.9-12.4.2.12 A.2*** ***6. TEC.9-12.8.1.12 B.10*** ***TEC.9-12.8.1.12 B.11*** *7.* ***TEC.9-12.8.2.12 B.4*** ***8. TEC.9-12.8.2.12 B.6*** ***MA.9-12.4.2.12 A.2*** ***MA.9-12.4.2.12 A.1*** ***9. TEC.9-12.8.1.12 B.11*** ***TEC.9-12.8.2.12.F.3*** *10.* ***TEC.9-12.8.2.12 B.4*** ***MA.9-12.4.2.12 A.1*** ***11. TEC.9-12.8.2.12 B.4*** ***TEC.9-12.8.2.12.F.3*** ***12. TEC.9-12.8.2.12 B.3***

	TEC.9-12.8.2.12.F.3 *MA.9-12.4.2.12 A.1*

Inter-Disciplinary Connections:

STEM, Mathematics, Geometry, Engineering

Students will engage with the following text:

- Mechanical Drawing CAD Communications 12th Edition
- TECHNOLOGY EDUCATION: LEARNING BY DESIGN Pearson
Prentice Hall
ISBN 0133639894

- Periodicals to include but not limited to newspapers, magazine articles, internet web pages

Students will write:

- Use of Cornell Notes will be used to understand the procedures for completing drawings.
- Students will keep an engineering notebook

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

Project based and self-exploration

Real life engineering problems

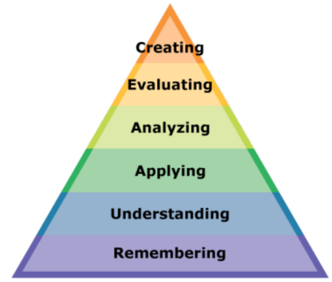
Examples of solution will be given first then students will problem solve and explore to create their own solutions to the problems.

1. **Students will be completing sketches of models before they complete them on the computer.**
2. **Students will use 3D models to create the same model**
3. **Students will use laser to cut and engrave**
4. **Students will use CNC router to carve and cut material**
5. **Students will use vinyl cutter to create graphic stickers**
6. **Students will use the design process to design and create products**
7. **Students will use different programs to design a product and export to the CNC machine**
8. **Students will use real objects and take measurements to create a solid model.**

Students will need to have access to Autodesk AutoCAD, Inventor, and Corel Draw.

PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS. IDENTIFY BLOOM'S LEVELS.



Formative Assessments:

Observation of student progress and skill development, checkpoints of understanding at:

1. Knowledge of machines
2. Set-up CNC machines
3. Sketching of models
4. Exporting of parts
5. Models created by looking at the three views of an orthographic projection
6. Design process
7. Measure and create part from looking at a real object.
8. Editing of NC Code

Do-now's and checkpoint quizzes will be given during and at the conclusion of these topics

Accommodations/Modifications:

One-on-one interaction, alternate assessments

Summative Assessments:

Completed drawings, tests, design journal, test drawing after each mini-unit

Accommodations/Modifications:

Additional time, alternate assessment, after-school help

Performance Assessments:

Completion of Portfolio

Completion of a real object that the students bring in will be the culmination of the understanding the unit.

Accommodations/Modifications:

Alternate drawings, additional time, assistance with organization

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course Title: Robotics Engineering Unit 6 CNC Machining **Grade Level(s):** **11, 12**	**Unit Summary**: CAD is used for detailed engineering of 2D drawings and 3D models of physical components. It is used throughout the engineering process from conceptual design through completion of a product. Not only has this greatly lowered product development costs with new rapid prototyping techniques but this has also aided to the power of manufacturing with the use of CNC Machines. This unit will introduce students to the power of CNC for production and custom work. Examples of machines include a laser cutter and engraver, CNC router, and vinyl cutter.
Essential Question(s): • **What does CNC stand for and what does it mean?** • **What are the different types of CNC machines?** • **What is a brief history of CNC** • **What is the process of production?** • **What is CAD, CAM, CIM, and CNC.** • **What are the advantages of CNC Machining?** • **What should each type of machine be used for?** • **What is the Cartesian coordinate system and why is it so important in CNC Machining?** • **How do you prepare a file to transfer it to a CNC Tool?** • **What are the different file types?** • **What kind of software is used to output it to the CNC machine?** • **What is NC Code and how do you edit this ?** • **What are some general safety practices to follow?** • **What should the various speed, power, frequencies, be for various materials?** • **How is each CNC tool operated?**	**Enduring Understanding(s):** • Identify computer numerically controlled machines and their applications. • Classify different types of CNC machines and explain what the use of each one is. • Identify the order of steps from the design stages to the finish stage. • Have a fluent understanding of terminology used in CNC Manufacturing. • Explain the advantages of CNC Manufacturing. • Analyze and contrast the Cartesian Coordinate Systems. • Identify and employ different file types for use with each machine. • Determine and explain the use of 3D modeling software in engineering world. • Investigate apply NC code that controls the CNC process. • Understand the organization and discipline necessary to create efficient solid models. • Understand and employ proper safety procedure for using CNC machines. • Review and assess the correct settings to use for each machine. • Utilize proper techniques necessary to operate each CNC machine.

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable

<u>Learning Target</u>	<u>NJCCCS or CCS</u>
1. List the different types of CNC machines	**1. TEC.9-12.8.2.12.F.3**
2. Summarize and categorize the use and materials for each CNC machine..	**2. TEC.9-12.8.2.12.F.1**
3. Develop an order of operations for a product design to product production.	**3. TEC.9-12.** ***WORK.9-12.9.1.12 B.4.d***
4. Compare and contrast computer-aided design, computer-aided manufacturing, computer-integrated manufacturing, and computer numerical control.	*4.* **TEC.9-12.8.2.12.F.3** **TEC.9-12.8.2.12.F.1**
5. Produce a complex product with and without the use of CAD and CNC and list the advantages and disadvantages of CNC machining.	***5. TEC.9-12.8.2.12 B.***4 ***TEC.9-12.8.2.12 C.3***
6. Use mathematics to practice the quantitative relationships associated with the Cartesian coordinate system.	***6. TEC.9-12.8.2.12.F.3*** ***MA.9-12.4.2.12 C.***1 *MA.9-12.4.2.12 C.2* **MA.9-12.4.2.12 E.1**
7. Create models in CAD software and export them as the right file for the job and machine.	**7. TEC.9-12.8.2.12.F.1**
8. Demonstrate the ability to use problem solving skills to complete drawing and modeling assignments.	**8. TEC.9-12.** **TEC.9-12.8.2.12.E.1**
9. Use a NC or G-Code line editor to revise, edit, compare, backplot basic NC code.	**9. TEC.9-12.8.2.12.F.3**
10. Demonstrate the ability to use the advanced modeling techniques by extruding, sweeping, lofting, and/or revolving a part.	**10. TEC.9-12.8.2.12.F.3**
11. Illustrate proper safety practices when using CNC machines.	**11. WORK.9-12.9.3.12.C.11** **WORK.9-12.9.2.12 F.**
12. Set up the CNC machine with the proper settings and test different applications of them to fine tune the design.	**12. TEC.9-12.8.2.12.F.3** **TEC.9-12.8.2.12.F.1**
13. Create 3d models capable of being used in an assembly drawing that can be exported in the right format and sent to a CNC Machine.	**13. TEC.9-12.8.1.12 B.9** **TEC.9-12.8.2** **TEC.9-12.8.2.12 B.4** **TEC.9-12.8.2.12 C.2**

Inter-Disciplinary Connections:

STEM, Mathematics, Geometry, Engineering

Students will engage with the following text:

- Mechanical Drawing CAD Communications 12th Edition
- TECHNOLOGY EDUCATION: LEARNING BY DESIGN Pearson
  Prentice Hall
  ISBN 0133639894

- Periodicals to include but not limited to newspapers, magazine articles, internet web pages

Students will write:

- Use of Cornell Notes will be used to understand the procedures for completing drawings.
- Students will keep an engineering notebook

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

Project based and self-exploration

Real life engineering problems

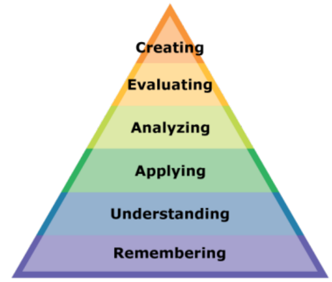
Examples of solution will be given first then students will problem solve and explore to create their own solutions to the problems.

1. **Students will be completing sketches of models before they complete them on the computer.**
2. **Students will use 3D models to create the same model**
3. **Students will use all three views of an orthographic projection to create a 3D solid model.**
4. **Students will use two views to create a solid model.**
5. **Students will use the revolve tool to create round objects**
6. **Students will use the sweep tool to create a profile that will be extruded and a path that with will follow to create parts.**
7. **Students will use the loft tool to create complex parts that include tapers.**
8. **Students will use real objects and take measurements to create a solid model.**

Students will need to have access to Autodesk AutoCAD and Inventor. Drawing will come from the text and other engineering drawings produced by the teacher.

PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS. IDENTIFY BLOOM'S LEVELS.



Formative Assessments:

Observation of student progress and skill development, checkpoints of understanding at:

1. Set-up of program, layers, and workspace
2. Sketching of models
3. Parts created coping another model
4. Models created by looking at the three views of an orthographic projection
5. Create using two views
6. Revolving
7. Sweeping
8. Lofting
9. Measure and create part from looking at a real object.

Do-now's and checkpoint quizzes will be given during and at the conclusion of these topics

Accommodations/Modifications:

One-on-one interaction, alternate assessments

Summative Assessments:

Completed drawings, tests, design journal, test drawing after each mini-unit listed in Part III

Accommodations/Modifications:

Additional time, alternate assessment, after-school help

Performance Assessments:

Completion of Portfolio

Completion of a real object that the students bring in will be the culmination of the understanding the unit.

Accommodations/Modifications:

Alternate drawings, additional time, assistance with organization

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title:	Unit Summary:
ROBOTICS ENGINEERING **Tetrix Robotics Systems** **Grade Level(s): 11-12**	Tetrix Robotics Systems is the platform of choice for this course. Tetrix is a modular system that allows students to design and build robots using standard parts, modules, and sensors. Tetrix also uses the NXT platform for programing, which provides continuity from the previous LEGO robotics Unit. Tetrix robots are build with metal parts that are durable and have a high degree of adaptability for various situations. Students will learn how to use the different available parts, assemble them together, and construct robots that will perform specific tasks.
Essential Question(s): • **What is the Tetrix System?** • **What are the specific safety precautions when working with Tetrix?** • **Which tools are necessary to build Tetrix robots?** • **What are the basic structures that can be built with a Tetrix System?** • **What are the sensors available in the Tetrix System?** • **What type of motor, gears, and wheels are parts of Tetrix?** • **What are Grippers and Actuators?** • **How do you use LEGO with Tetrix?** • **What are the basics of Remote Controlling a Tetrix robot?** • **How does Remote Control communication works?**	**Enduring Understanding(s):** • Identify the components and and parts of a Tetrix robotics System. • Explain and list advantages and disadvantages of working with a Tetrix System. • Identify the parts of the system that one must take care of while working with the system to avoid injuries and ensure safe operation of the system. • Use the available tools to creat and modify parts that can be used in a Tetrix system. • List and build structures that are possible to be constructed with a Tetrix system. • Explain how light, sound, touch and other sensors work to provide feedback in a Tetrix system. • Explain the purpose of gears and how to properly use them in the context of Tetrix robots. • Explain how to add mechanical advantage to Tetrix robots by using the included parts in the kit, or how to build custom parts. • Utilize LEGO NXT to interact with the Tetrix kit. • Explain how Radio Waves and Bluetooth Waves work to control robots remotely. • Utilize the available resources to remotely control robots based on remote feedback of sensors.

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable

Learning Target	NJCCCS or CCS
1. List the components of a Tetrix System.	**1. 8.2.12.D.3, 8.2.2.D.4**
2. Safely use laboratory equipment to build and alter Tetrix parts.	**2. 8.2.5.D.3, 8.2.12.D.3**
3. Follow specific instructions to build basic functioning robots that perform specific tasks.	**3. 8.2.5.D.3**
4. Use different sensors, gears, and actuators, when building robots.	**4. 8.2.2.D.4, 8.2.12.C.4**
5. Use problem solving and troubleshooting skills to design custom robots to solve different challenges given to student.	**5. 8.2.8.C.4, 8.2.2.C.1**
6. Demonstrate proper planning by keeping an organized documentation of the design and build process in a journal.	**6. 8.2.5.D.2**
7. Successfully control robots remotely to complete challenges.	**7. 8.2.8.D.3**

Inter-Disciplinary Connections:

MATH - fractional inch, fractions, measurement, geometric principles, **English - An engineering notebook including written documentation of the technological design process**

<u>Students will engage with the following textbook</u>

TECHNOLOGY EDUCATION: LEARNING BY DESIGN **Pearson Prentice Hall** **ISBN 0133639894** **Periodicals include, but not limited to newspapers, magazine articles, internet web pages.**

Students will write:

Students will keep an engineering notebook which will contain ideas, sketches, and information on parts and robot building techniques, as well as problem solving strategies pertaining to specific robotic challenges.

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

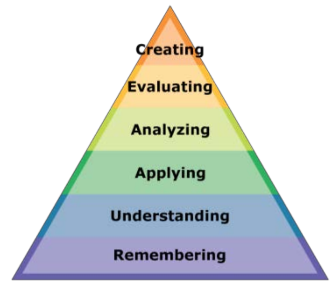
Project Based Learning – Students will learn how to use the Tetrix system by first following building instructions for basic standard robots, which will introduce them to the different building techniques, parts, and sensors.

1. Students will be building basic robots designed to introduce them to the Tetrix System.
2. Students will use basic NXT programming to use the different sensors.
3. Students will use the steps of the Engineering Design Process to come up with solutions for different design challenges.
4. Students will use acquired CAD and CNC knowledge to build custom parts for their robots.
5. Students will work on troubleshooting and problem solving to overcome obstacles in the design build process.
6. Students will be creating custom robots to complete different challenges.
7. Students will use the available lab equipment to build and alter Tetrix parts.

PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS.

IDENTIFY BLOOM'S LEVELS.



Formative Assessments:

Observation of student progress and skill development will be measured by checkpoints of understanding on:

1. Identification of Tetrix parts.
2. Construction of structures.
3. Successful completion of robots.
4. Usage of gearing and sensors.
5. Alteration and adaptation of Tetrix parts.
6. Usage of tools and building equipment.

Checkpoint quizzes, laboratory equipment usage, and proper usage of the Tetrix system will be used as formative assessments.

Accommodations/Modifications:

One-on-one help and interaction, and alternative assessment tools.

Summative Assessments:

Completed robots, and design journals.

Accommodations/Modifications:

Alternative assignments, additional time for assignments, preferential seating arrangements one on one interaction, after school help, and assistance for organization. Check frequently for student understanding.

Performance Assessments:

Successful completion of Robotics Design Challenges will be the culmination of the Unit.

Accommodations/Modifications:

Alternative assignments, additional time for assignments, preferential seating arrangements one on one interaction, after school help, and assistance for organization. Check frequently for student understanding.
Allow students to get their work checked frequently as the assessments are build-ups.

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: **ROBOTICS ENGINEERING** **Mathematical Analysis for Engineering**	**This course is designed to introduce students to real world engineering applications and robotics programing. It is designed to incorporate mathematical engineering concepts, computer aided drawing, advanced CNC machining, rapid prototyping, advanced mechanical engineering, autonomous robotics programing and statistical analysis to prepare students to enter engineering and robotics fields and higher education.** **Unit Summary:** • **Students will learn about the relationship between diameter, circumference, revolutions, and distance traveled.** • **Students will learn about the relationship between gear ratios, torque, and speed.** • **Students will understand how to use statistics and probability (mean, standard deviations, basic confidence intervals, scatterplots) within the design process to understand and communicate robot task accuracy.** • **Students will be introduced to higher level robotics mathematical and engineering vocabulary: rates of change, constraints, critical path optimization.** • **Students will learn how to use basic geometry and trigonometry when building a robot and within the motion planning for an autonomous robot.**
Grade Level(s): **11-12**	
Essential Question(s): **How can mathematical tools (algebra, geometry, statistics, and probability) be used in the design process for robots?**	**Enduring Understanding(s):** • **This unit will reinforce the use of higher level mathematics into robotics development. Students will understand that robotics design in not only a mechanical process, but a data driven process. They will understand that the robotics industry requires quantitative data driven design approaches to meet strict design requirements.**

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable.

Learning Target	NJCCCS or CCS
1. Students will measure wheel diameters and calculate circumference, revolutions, and distance traveled.	1. MA.9-12.CCSS.Math.Content.HSG-MG.A.3
2. Students will calculate gear ratios and use gear ratios to calculate torque, and speed.	2. MA.9-12.CCSS.Math.Content.HSA-CED.A.1; SCI.9-12.5.3.12 C.1
3. Students will find mean, standard deviation, and compute basic confidence intervals for robot distance from targets. They will use statistics and graphical analysis to evaluate robot designs. Students will maintain this data and subsequent analysis in an excel workbook.	3. MA.9-12.CCSS.Math.Content.HSS-ID.A.2; TEC.9-12.8.1.12.A.1; TEC.9-12.8.2.12 B.
4. Students will be taught higher level robotics, mathematical, and engineering vocabulary: rates of change (revolutions per minute), constraints (inequalities: hit target within a given distance), critical path optimization (find quickest path to minimize end time).	4. TEC.9-12.8.2.12.D
5. Students will use measuring and geometry construction skills to meet specific robot specifications.	5. MA.9-12.CCSS.Math.Content.HSG-MG.A.3
6. Students will calculate arm angle bend needs to reach targets using trigonometry for robotics motion planning.	6. MA.9-12.CCSS.Math.Content.HSG-MG.A.3

Inter-Disciplinary Connections:

English - Excel workbook will include written statements about changes completed to meet statistical targets.

Science – Students will use gear ratios, rates of change concepts, and wheel circumference/distance traveled.

Social Studies –

Students will engage with the following textbook

TECHNOLOGY EDUCATION: LEARNING BY DESIGN

Pearson Prentice Hall

ISBN 0133639894

Periodicals to include but not limited to newspapers, magazine articles, internet web page

Students will write:

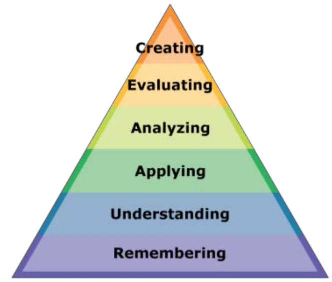
Students will keep an engineering written notebook and an excel workbook for statistical analysis.

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

1. **Students will practice measuring wheel diameter and circumference. They will then measure observed distance traveled. The teacher will then introduce the relationship between diameter, circumference and distance traveled. Students will use this relationship to calculate revolution needs for robot build projects.**
2. **Students will be taught how to calculate gear ratios and resulting torque and speed. Students will use this relationship to calculate resulting torque for robot build projects.**
3. **Students will be introduced through internet research and whole group instruction to mean, standard deviation, and computing basic confidence intervals for robot distance from targets. Students will calculate confidence intervals for various data sets. They will be taught to calculate statistics in an Excel workbook. Students will be taught to graph in Excel scatterplots and analyze them (understand trends, exclude outliers). Students will maintain this Excel workbook (data, graphs, analysis) data for subsequent robot builds.**
4. **Students will complete internet research to discover higher level robotics mathematical and engineering vocabulary: rates of change (revolutions per minute), constraints (inequalities: hit target within a given distance), critical path optimization (find quickest path to minimize end time).**
5. **Students will plan and execute building a robot to provided measurement guidelines which will include using geometrical construction skills for specific shapes.**
6. **Students will measure arm bend angles by hand first, and afterwards, they will be taught to calculate arm angle bend needs to reach targets using basic geometry (trigonometry).**



PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS.

IDENTIFY BLOOM'S LEVELS.

Formative Assessments:

WARM UP ACTIVITIES

All activities will be based on either student exploration of content area, or reflection of prior lessons.

CHECKPOINTS OF UNDERSTANDING

Diameter to distance traveled worksheet & Quiz

Gear ratios, torque, speed activity & Quiz

Statistics workbook checks & Quiz

Robotics vocabulary worksheet

Robotics motion planning worksheet & Quiz

Accommodations/Modifications:

Alternative assignments, additional time, preferential seating, 1:1 assistance, after school help, organizational assistance, frequent checks for understanding.

Summative Assessments:

- Unit test on mathematics robotics principles and concepts covering formative assessment material.
- Robotics challenge is a test of how well mathematical concepts were applied.
- Students will write an end of unit reflective essay explaining practical math uses for robotics design.

Accommodations/Modifications:

Alternative assignments, additional time, preferential seating, 1:1 assistance, after school help, organizational assistance, frequent checks for understanding.

Performance Assessments:

- Robot Design Challenge – Creation of a robot to meet design requirements

Accommodations/Modifications:

Alternative assignments, additional time, preferential seating, 1:1 assistance, after school help, organizational assistance, frequent checks for understanding.

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

<table>
<tr>
<td>Course/Unit Title:
ROBOTICS ENGINEERING

Robotics Design</td>
<td rowspan="2">Unit Summary:
Robotics design requires a specific set of skills that are unique to this discipline, but also cross-over into other design and engineering fields. Project management, planning, brainstorming, and utilization of the Technological/Engineering Design Process are essential to successful robotics design. Students will be taught how to properly plan and organize a robot design project, maintain deadlines, and work in groups.</td>
</tr>
<tr>
<td>Grade Level(s):
11-12</td>
</tr>
<tr>
<td>Essential Question(s):
What is the Technological Design process?
What is, and how do you successfully brainstorm?
What is a flow chart?
What is a Gant chart?
How do you conduct a successful design review?
How do you apply the steps of the TDP to plan and execute projects?</td>
<td>Enduring Understanding(s):
Identify the steps of the Technological Design Process in regards to robot design.
List the proper techniques of a successful brainstorming session.
Create and execute a flow chart to help organize programing and design solutions.
Create and maintain a Gant chart for proper time and project management.
Participate in regular peer-to-peer design reviews to constantly collect feedback and improve designs and processes.
Apply the steps of the Technological/Engineering Design Process in the correct order to systematically solve problems and design robots.</td>
</tr>
</table>

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable

Learning Target	NJCCCS or CCS
1. Identify the steps of the Engineering Design Process	**1. 8.2.8.C.4**
2. Complete a successful brainstorming session	**2. 8.2.2.C.1**
3. Create examples of flow charts to illustrate how a system works	**3. 8.2.2.D.4, 8.2.5.D.1, 8.2.8.C.4**
4. Analyse examples of Gant charts, and use this knowledge to create a project management timeline for a robotics design project.	**4. 8.2.2.D.4**
5. Participate in critical thinking Design Critique sessions to share ideas and design suggestions with peers.	**5. 8.2.5.C.4, 8.2.5.C.7, 8.2.8.C.1, 8.2.5.C.1**
6. Utilize the steps of the Engineering Design Process to solve both large and small problems, and troubleshoot issues that may arise.	**6. 8.2.8.C.7, 8.2.12.C.7, 8.2.5.D.2, 8.2.8.D.3**

Inter-Disciplinary Connections:

MATH - fractional inch, fractions, measurement, geometric principles,

English - An engineering notebook including written documentation of the technological design process

<u>Students will engage with the following textbook</u>

TECHNOLOGY EDUCATION: LEARNING BY DESIGN **Pearson Prentice Hall** **ISBN 0133639894** **Periodicals include but not limited to newspapers, magazine articles, internet web pages.**

Students will write:

Students will keep an engineering notebook to record their progress and project management strategies.

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

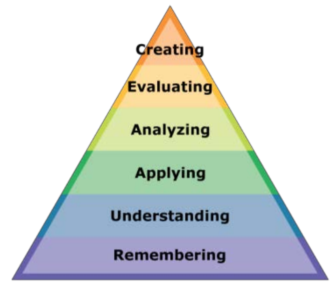
DESCRIBE THE LEARNING EXPERIENCE.

<u>How</u> will students uncover content and build skills.

Students will learn in a project based environment, where they will have to apply design and organizational skills to successfully manage a robotics design project.

Students will be taught specific brainstorming and design techniques that will be utilized in the process. Peer-to-peer sharing of ideas and criticism will be also an essential part of this process, where students will be encouraged to always seek advice and ideas from other students.

Project management techniques will be applied to a real robotics design challenge on peer-to-peer competitions so that student groups can successfully plan and execute their designs.



PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS.
IDENTIFY BLOOM'S LEVELS.

Formative Assessments:

WARM UP ACTIVITIES

All activities will be based on either student exploration of content area, or reflection of prior lessons.

CHECKPOINTS OF UNDERSTANDING

- Brainstorming activities
- Flow chart design
- Use of the TDP
- Documentation of the design process
- Project time management

Accommodations/Modifications:

One-on-one help and interaction, and alternative assessment tools.

Summative Assessments:

Design journals, Project management documentation, Ideation process.

Accommodations/Modifications:

Alternative assignments, additional time for assignments, preferential seating arrangements one on one interaction, after school help, and assistance for organization. Check frequently for student understanding.
Allow students to get their work checked frequently as the assessments are build-ups.

Performance Assessments:

Completion of Online Portfolio to document the entire Robot Design Process, from initial ideation, all the way to a finished prototype.

Accommodations/Modifications:

Alternative assignments, additional time for assignments, preferential seating arrangements one on one interaction, after school help, and assistance for organization. Check frequently for student understanding.

Allow students to get their work checked frequently as the assessments are build-ups.