Kinnelon Public Schools

Curriculum Scope and Sequence

for

Electronics and Robotics
Grade 9-12

General Overview, Course Description or Course Philosophy
This semester course emphasizes the application of integrated STEM (Science, Technology, Engineering and Mathematics) principles and the design method to invent solutions to real world problems. Students will identify problems, research, design and fabricate solutions. Problem solving, critical thinking and design skills are taught through a variety of activities. Hands-on themes include structural and robotic systems, as well as system control technology. This course provides all students with valuable skills such as: problem solving, design, creative thinking, systems thinking, team work, documentation, programming and computer applications.

Created by	Jason Potzer	**Date**	06/25/2018	**Board Approval Date**	09/27/2018

CURRICULUM SCOPE AND SEQUENCE			
Content Area	Technology	**Course Title/Grade Level**:	Electronics and Robotics/9-12

GENERAL OVERVIEW AND PACING		
Topic/Unit Name		**Suggested Pacing (Days/Weeks/Periods)**
Topic/Unit 1	Lab/Machine Safety and Material Processing	3.5 weeks
Topic/Unit 2	Design Loop	2 weeks
Topic/Unit 3	Orthographic Drawing	2 weeks
Topic/Unit 4	Mechanical Advantage in Gears	3 weeks
Topic/Unit 5	Engineering Logs	2 weeks
Topic/Unit 6	Design and build a technological product - Rover	5 weeks
Topic/Unit 7	Electronic Components and Programming Introduction	2.5 weeks

Unit/Topic Title	Lab/Machine Safety and Material Processing	Approximate Pacing	3.5 weeks

OBJECTIVES, ESSENTIAL QUESTIONS, ENDURING UNDERSTANDINGS

Students will understand:

- Lab, machine and eye safety policies and procedures.
- How to properly utilize safety equipment, hand and machine tools.
- The appropriate procedures for processing material utilizing hand tools and machines.
- How to create and maintain a safe working environment for a students, teachers and guests.

CONTENT AREA STANDARDS

NJSLS #	Standard Language
8.2.12.D.3	Determine and use the appropriate resources (e.g., CNC (Computer Numerical Control) equipment, 3D printers, CAD software) in the design, development and creation of a technological product or system.

RELATED STANDARDS

(e.g., Technology Standard 8, 21st Century Life and Careers, Standard 9, NJSLS ELA Companion Standards are required for all 6-12 non-ELA courses, and/or others: ISTE, AASL, etc.)

NJSLS #	Standard Language
CRP2	Apply appropriate academic and technical skills.

STUDENT LEARNING TARGETS

Declarative Knowledge	Procedural Knowledge
Students will know: ● Identify the rules associated with lab, eye and machine safety. ● Identify how to use safety equipment, hand tools and all machines. ● Identify errors when processing material.	***Students will be able to:*** ● Demonstrate the ability to utilize lab equipment properly, following and applying safety principles. ● Select the best method for machining a part.

EVIDENCE OF LEARNING

Formative Assessments (Ongoing during the unit; link formative data tracking forms and/or samples of formative assessments)	● Observation of students using safety equipment, hand tools and machines. ● Quizzes - General lab safety, Eye Safety, Hand tools, Drill Press, Band Saw, Scroll Saw, Compound Miter Saw, Disc and Belt Sander. ● Observation of material processing project
Summative Assessments (At the end of the unit; link samples of summative assessments)	● Material Processing Widget (Hands on Project Based Rubric Assessment)

RESOURCES

- Eye, lab and machine safety notes and quizzes.
- Eye safety policy.

DIFFERENTIATED INSTRUCTIONAL STRATEGIES / RESOURCES / MATERIALS

Students may be provided with extra time and/or printed notes. The unit is structured to support students at various level of skill and knowledge of the topic.

Unit/Topic Title	Design Loop	Approximate Pacing	2 weeks

OBJECTIVES, ESSENTIAL QUESTIONS, ENDURING UNDERSTANDINGS

Students will understand:

- The importance of utilizing the eleven steps of the design loop when designing a solution to a problem..
- The significance of ignoring specific steps of the design loop.
- The design loop is not linear.

CONTENT AREA STANDARDS

NJSLS #	Standard Language
8.2.12.C.7	Use a design process to devise a technological product or system that addresses a global problem, provide research, identify trade-offs and constraints, and document the process through drawings that include data and materials.
8.2.12.D.1	Design and create a prototype to solve a real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.

RELATED STANDARDS

(e.g., Technology Standard 8, 21st Century Life and Careers, Standard 9, NJSLS ELA Companion Standards are required for all 6-12 non-ELA courses, and/or others: ISTE, AASL, etc.)

NJSLS #	Standard Language
CRP6	Language from the standards (Copy and paste recommended. Remove formatting before pasting into this document)
CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.

STUDENT LEARNING TARGETS

Declarative Knowledge	Procedural Knowledge
Students will know: ● State, recognize and identify the 11 steps of the design loop. ● Describe how skipping design loop steps can negatively affect the process..	***Students will be able to:*** ● Select the best solution when designing a prototype/problem solving ● Test and evaluate designs/prototypes. ● Research how to improve current designs/prototypes.

EVIDENCE OF LEARNING

Formative Assessments (Ongoing during the unit; link formative data tracking forms and/or samples of formative assessments)	Design Loop Quiz, Hands-on project observation
Summative Assessments (At the end of the unit; link samples of summative assessments)	Bridge/Tower Design Project Rubric

RESOURCES

- Teacher Presentations, Quiz and Project Rubric

DIFFERENTIATED INSTRUCTIONAL STRATEGIES / RESOURCES / MATERIALS
Students may be provided with extra time and/or printed notes. The unit is structured to support students at various level of skill and knowledge of the topic.

Unit/Topic Title	Orthographic Drawing	Approximate Pacing	2 weeks

OBJECTIVES, ESSENTIAL QUESTIONS, ENDURING UNDERSTANDINGS

Students will understand:

- The difference between drawing and sketching.
- Which tools to use, and how to use them properly when creating drawings.
- How to draw visible, hidden, and centerlines properly.
- How to properly measure and annotate drawings.
- How to properly align views in an orthographic drawing.

CONTENT AREA STANDARDS

NJSLS #	Standard Language
8.2.12.C.5	Create scaled engineering drawings of products both manually and digitally with materials and measurements labeled.

RELATED STANDARDS

(e.g., Technology Standard 8, 21st Century Life and Careers, Standard 9, NJSLS ELA Companion Standards are required for all 6-12 non-ELA courses, and/or others: ISTE, AASL, etc.)

NJSLS #	Standard Language
CRP4	Communicate clearly and effectively and with reason.
CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.

STUDENT LEARNING TARGETS

Declarative Knowledge	Procedural Knowledge
Students will know: ● State how to draw visible, hidden and centerlines. ● List the tools required to create an orthographic drawing.	***Students will be able to:*** ● Edit and revise orthographic drawings. ● Select the best front view for starting a drawing. ● Distinguish when to use visible vs. hidden lines.

EVIDENCE OF LEARNING

Formative Assessments (Ongoing during the unit; link formative data tracking forms and/or samples of formative assessments)	Worksheets 101 and 102, Observation of Widget drawings (2)
Summative Assessments (At the end of the unit; link samples of summative assessments)	Widget Drawings (2)

RESOURCES

- Orthographic worksheets 101 and 102
- Teacher Presentation

DIFFERENTIATED INSTRUCTIONAL STRATEGIES / RESOURCES / MATERIALS

Students may be provided with extra time and/or printed notes. The unit is structured to support students at various level of skill and knowledge of the topic.

Unit/Topic Title	Mechanical Advantage in Gears	**Approximate Pacing**	3 weeks

OBJECTIVES, ESSENTIAL QUESTIONS, ENDURING UNDERSTANDINGS

Students will understand:

- How gears are used to increase power or speed in a technological system.
- How to calculate gear ratios for power and speed.
- How to design and build simple and complex (compound) gear systems.

CONTENT AREA STANDARDS

NJSLS #	Standard Language
Code #	Language from the standards (Copy and paste recommended. Be sure to remove formatting). Add rows as necessary. Delete blank rows. To add a row, highlight a row and right click. Click add row above/below.
8.2.12.D.1	Design and create a prototype to solve a real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.

RELATED STANDARDS

(e.g., Technology Standard 8, 21st Century Life and Careers, Standard 9, NJSLS ELA Companion Standards are required for all 6-12 non-ELA courses, and/or others: ISTE, AASL, etc.)

NJSLS #	Standard Language
CRP2	Apply appropriate academic and technical skills.
CRP6	Demonstrate creativity and innovation
CRP11	Use technology to enhance productivity.
MP1	Make sense of problems and persevere in solving them.
MP3	Construct viable arguments and critique the reasoning of others.
MP4	Model with mathematics.

STUDENT LEARNING TARGETS

Declarative Knowledge	Procedural Knowledge
Students will know: ● Identify different types of gears. ● Define the purpose of different types of gears. ● Explain when and how to utilize different types of gears. ● State the formula for calculating mechanical advantage.	***Students will be able to:*** ● Determine when to increase or decrease mechanical advantage in a system. ● Demonstrate the ability to design, build and apply gears in a system to increase or decrease mechanical advantage in order to solve a problem. ● Calculate the mechanical advantage of simple and complex (compound) gear systems.

EVIDENCE OF LEARNING

Formative Assessments (Ongoing during the unit; link formative data tracking forms and/or samples of formative assessments)	Observation of "Do Now" mechanical advantage problems during and after lessons. Observation of drivetrains designed and built by students. Drawing of project drivetrain and how to calculate its MA. Quiz on Mechanical Advantage. Quiz on gear types, recognition and definitions.
Summative Assessments (At the end of the unit; link samples of summative assessments)	Design project and engineering log - design and build a drivetrain to solve a real world problem; calculate mechanical advantage and explain rationale. Include sketches, orthographic drawings, rationale, and how to improve. Questions on Unit Test following Rover Unit.

RESOURCES
Teacher notes on gears. Teacher notes on calculating mechanical advantage. Mechanical advantage worksheets. Lego gears, axles and structural components. Problem solving design brief: Compound drivetrain.
DIFFERENTIATED INSTRUCTIONAL STRATEGIES / RESOURCES / MATERIALS
Students may be provided with extra time and/or printed notes. The unit is structured to support students at various level of skill and knowledge of the topic.

Unit/Topic Title	Engineering Logs	**Approximate Pacing**	2 weeks

OBJECTIVES, ESSENTIAL QUESTIONS, ENDURING UNDERSTANDINGS

Students will understand:

- How to create and share an Engineering Log in Google Slides
- How to properly document daily work.
- How to properly format an Engineering Log.

CONTENT AREA STANDARDS

NJSLS #	Standard Language
Code #	Language from the standards (Copy and paste recommended. Be sure to remove formatting). Add rows as necessary. Delete blank rows. To add a row, highlight a row and right click. Click add row above/below.
8.1.12.A.2	Produce and edit a multi-page digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review.

RELATED STANDARDS

(e.g., Technology Standard 8, 21st Century Life and Careers, Standard 9, NJSLS ELA Companion Standards are required for all 6-12 non-ELA courses, and/or others: ISTE, AASL, etc.)	
NJSLS #	**Standard Language**
Code #	Language from the standards (Copy and paste recommended. Remove formatting before pasting into this document)
CRP11	Use technology to enhance productivity.
NJSLSA.W1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
NJSLA.W4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
W.11-12.6	Use technology, including the Internet, to produce, share, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

STUDENT LEARNING TARGETS	
Declarative Knowledge	**Procedural Knowledge**
Students will know: ● How to use Google Slides in order to create and share a log. ● List the items that should be included in the daily log. ● State the proper formatting techniques.	***Students will be able to:*** ● Generate a shared Google Slide ● Properly format a daily log.

EVIDENCE OF LEARNING	
Formative Assessments (Ongoing during the unit; link formative data tracking forms and/or samples of formative assessments)	Observation of log setup/sharing of log with teacher. Mechanical Advantage in gears final project.
Summative Assessments (At the end of the unit; link samples of summative assessments)	Rover Final Log. Electronics/Programming final log.

RESOURCES
Teacher notes on Engineering Logs. Former student log examples. Panasonic Challenge Engineering Log notes and examples.

DIFFERENTIATED INSTRUCTIONAL STRATEGIES / RESOURCES / MATERIALS
Students may be provided with extra time and/or printed notes. The unit is structured to support students at various level of skill and knowledge of the topic.

Unit/Topic Title	Design and build a technological product - Rover	Approximate Pacing	5 weeks

OBJECTIVES, ESSENTIAL QUESTIONS, ENDURING UNDERSTANDINGS
Students will understand: ● How to apply new and previously learned unit knowledge in order to design and build a working tethered rover.

CONTENT AREA STANDARDS	
NJSLS #	**Standard Language**
8.1.12.A.2	Produce and edit a multi-page digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review.
8.2.12.C.5	Create scaled engineering drawings of products both manually and digitally with materials and measurements labeled.
8.2.12.C.7	Use a design process to devise a technological product or system that addresses a global problem, provide research, identify trade-offs and constraints, and document the process through drawings that include data and materials.
8.2.12.D.3	Determine and use the appropriate resources (e.g., CNC (Computer Numerical Control) equipment, 3D printers, CAD software) in the design, development and creation of a technological product or system.

RELATED STANDARDS **(e.g., Technology Standard 8, 21st Century Life and Careers, Standard 9, NJSLS ELA Companion Standards are required for all 6-12 non-ELA courses, and/or others: ISTE, AASL, etc.)**	
NJSLS #	**Standard Language**
Code #	Language from the standards (Copy and paste recommended. Remove formatting before pasting into this document)
CRP2	Apply appropriate academic and technical skills.
CRP4	Communicate clearly and effectively and with reason.
CRP6	Demonstrate creativity and innovation.
CRP7	Employ valid and reliable research strategies.
CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP11	Use technology to enhance productivity.
HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
MP1	Make sense of problems and persevere in solving them.
MP3	Construct viable arguments and critique the reasoning of others.
MP4	Model with mathematics.
NJSLSA.W1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
NJSLA.W4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
W.11-12.6	Use technology, including the Internet, to produce, share, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

STUDENT LEARNING TARGETS	
Declarative Knowledge	**Procedural Knowledge**
Students will know: ● List engineering log requirements. ● List orthographic drawing requirements. ● Identify the rules associated with lab, eye and machine safety. ● Identify how to use safety equipment, hand tools and all machines. ● Identify errors when processing material. ● Describe proper soldering technique. ● Describe proper hot wire cutter and foam core material processing techniques. ● Identify different types of gears. ● Define the purpose of different types of gears. ● Explain when and how to utilize different types of gears. ● State the formula for calculating mechanical advantage. ● Identify and describe electronics components.	***Students will be able to:*** ● Utilize a variety of methods to research possible solutions. ● Sketch, compare and contrast possible rover solutions. ● Select the best solution for the rover, and defend rationale for final chosen solution. ● Create and format an engineering log. ● Create and annotate an orthographic drawing. ● Select, rationalize and calculate mechanical advantage. ● Properly utilize lab tools and equipment to build the following systems: a tethered remote, rover structure, drivetrain and wheels. ● Test the rover and research methods to improve issues with: Power, friction, mechanical advantage, traction and others. ● Research, propose and document what would happen if changes were made to the vehicle.

EVIDENCE OF LEARNING	
Formative Assessments (Ongoing during the unit; link formative data tracking forms and/or samples of formative assessments)	Weekly log check(s). Orthographic drawing check. Mechanical advantage in gears check. Soldering/electronics components check. Remote structure/plywood/foam core processing check. Vehicle structure check. Wheel design check. Initial testing and evaluation.
Summative Assessments (At the end of the unit; link samples of summative assessments)	Final Testing of Rover Final Grading of Engineering Log Unit Test

RESOURCES
Teacher Notes and lessons: soldering, electronics, hot wire cutter, foam core processing, wheel design. Engineering log template. Project planning template. Rover project rubric.

DIFFERENTIATED INSTRUCTIONAL STRATEGIES / RESOURCES / MATERIALS
Students may be provided with extra time and/or printed notes. The unit is structured to support students at various level of skill and knowledge of the topic.

Unit/Topic Title	Electronics and Programming	Approximate Pacing	2.5 weeks

OBJECTIVES, ESSENTIAL QUESTIONS, ENDURING UNDERSTANDINGS

Students will understand:

- How to create and power circuits utilizing electronics components.
- How to write basic code using a programming language, and integrate it into electronic hardware, for the purpose of solving a problem.

CONTENT AREA STANDARDS

NJSLS #	Standard Language
Code #	Language from the standards (Copy and paste recommended. Be sure to remove formatting). Add rows as necessary. Delete blank rows. To add a row, highlight a row and right click. Click add row above/below.
8.2.12.E.3	Use a programming language to solve problems or accomplish a task (e.g., robotic functions, website designs, applications, and games).

RELATED STANDARDS

(e.g., Technology Standard 8, 21st Century Life and Careers, Standard 9, NJSLS ELA Companion Standards are required for all 6-12 non-ELA courses, and/or others: ISTE, AASL, etc.)

NJSLS #	Standard Language
CRP7	Employ valid and reliable research strategies.
CRP11	Use technology to enhance productivity.
MP1	Make sense of problems and persevere in solving them.
MP3	Construct viable arguments and critique the reasoning of others.
MP4	Model with mathematics.

STUDENT LEARNING TARGETS

Declarative Knowledge	Procedural Knowledge
Students will know: ● Identify and describe a variety of electronic components including: breadboards, resistors, LEDs, jumpers, switches, motors and transistors. ● Recognize and select code for use with electronics coding projects.	***Students will be able to:*** ● Duplicate and explain simple electronic circuits. ● Duplicate and write code for electronic circuits. ● Redesign electronic circuits and code in order to problem solve.

EVIDENCE OF LEARNING

Formative Assessments (Ongoing during the unit; link formative data tracking forms and/or samples of formative assessments)	Component quiz Resistor value quiz Electronic Activities Worksheet #1 Electronic Activities Worksheet #2 Coding Activities Worksheet #1

	Transistor Quiz
Summative Assessments (At the end of the unit; link samples of summative assessments)	Transistor Coding Design Problem Unit Test

RESOURCES

Teacher notes and quizzes: electronic components and resistor values.
Teacher produced electronic and coding worksheets.
www.tinkercad.com
Transistor Coding Design Problem Rubric
Arduino Projects Book

DIFFERENTIATED INSTRUCTIONAL STRATEGIES / RESOURCES / MATERIALS

Students may be provided with extra time and/or printed notes. The unit is structured to support students at various level of skill and knowledge of the topic.