

## Roanoke Valley Governor's School for Science and Technology Introduction to Engineering Competency List, 2023-2024

This elective allows students to explore the different aspects of engineering and engineering research. Students will develop technical skills required to take a product through the analytical and design process. These skills include Computer Aided Design, 3D-Printing, Mechanics of Materials, and Structural and Aerodynamic Testing. Students conduct an engineering research project.

This course is taught using best practices in gifted education. Each competency is aligned with Hockett's five principles of gifted education:

**Gifted Education Principles:** ( Hockett, J.A. (2009) "Curriculum for Highly Able Learners That Conforms to General Education and Gifted Education Quality Indicators." *Journal of Education for the Gifted*. Vol. 32, No. 3, p. 394-440)

1. High-quality curriculum for gifted learners uses a conceptual approach to organize or explore content that is discipline based and integrative.
2. High-quality curriculum for gifted learners pursues advanced levels of understanding beyond the general education curriculum through abstraction, depth, breadth, and complexity.
3. High-quality curriculum for gifted learners asks students to use processes and materials that approximate those of an expert, disciplinarian, or practicing professional.
4. High-quality curriculum for gifted learners emphasizes problems, products, and performances that are true to life, and outcomes that are transformational.
5. High-quality curriculum for gifted learners is flexible enough to accommodate self-directed learning fueled by student interests, adjustments for pacing, and variety.

### COMPETENCY I

#### **Conduct scientific investigations using accepted principles of experimental design or engineering goal and analysis.**

*Enabling Objectives:*

1. Apply the definition to identify the major concepts of experimental design or engineering goal within the scenario of an experiment including: hypothesis, dependent variable independent variable, constants, control, repeated trials or problem identification, creating alternate solutions, prototyping, testing, and redesigning.
2. Apply concepts learned in science and math classes to analyze experiments with respect to the major concepts of experimental or engineering design, design strengths and weaknesses, and develop improved designs.

3. Write a clear and precise set of procedures.
4. Apply information learned in science and math courses and use technology available at the school to construct appropriate data tables and graphs for various types of scientific data.
5. Describe the relationship between variables depicted on a graph.
6. Develop and discuss ethical guidelines for research projects.

## COMPETENCY II

### **Gather and analyze relevant background information.**

#### *Enabling Objectives:*

1. Identify relevant library, database, and web resources for specific research problems.
2. Effectively use relevant library, database, and web resources for research and information.
  - a. Use search engines to find information on various topics.
  - b. Explain strengths and weaknesses of various search engines.
  - c. Demonstrate proficiency using advanced search engines.
  - d. Properly use and cite information taken from a variety of sources.
  - e. Recognize and distinguish between different types of websites.
3. Use professionals in industry or academia as resource people for research project information as necessary and document these contacts.
4. Obtain the most relevant articles and books found in library and internet searches.
5. Analyze articles and books for information relevant to a specific research problem and take notes from them, using proper documentation.

## COMPETENCY III

### **Complete the steps necessary to design, implement, and analyze a complex experiment or engineering goal.**

#### *Enabling Objectives:*

1. Design a complex experiment which includes repeated measures over time or subjects, one or more independent variables, and correlation of variables.

2. Successfully meet the established time lines for the performance objectives.
3. Maintain a current, organized, and accurate laboratory logbook.
4. Construct appropriate data tables and graphs for data derived from your experiment.
5. Apply concepts of inferential and descriptive statistics to support conclusions from the experiment.
6. Participate in the RVGS Project Forum and, if appropriate, in the district, regional, state, and international science fairs, and the annual VJAS meeting.

Research presentation competencies

#### COMPETENCY IV

**Create a project display board or poster to depict the work done on the project for use at Project Forum.**

*Enabling Objectives:*

1. All content should be easily read on the board and free of spelling and grammatical errors.
2. All components of the board should be clearly labeled with appropriate headings (Introduction, Purpose, etc.).
3. All graphs and photographs should be clearly labeled with appropriate annotations and citations when necessary.
4. The name of the student should **not** appear anywhere on the display.
5. Size specifications for project display board (ISEF regulations) are followed.

#### COMPETENCY V

**Construct a formal research paper following the format approved by the Virginia Junior Academy of Science.**

*Enabling Objectives:*

1. Create an integrated document.
2. Use information obtained from research to write an introduction and bibliography for the paper.
3. Write a methods and materials section that outlines the procedures followed in the project.

4. Write a results section that includes appropriate tables, graphs, statistics and diagrams. Include a narrative of the results obtained.
5. Analyze the results obtained in the discussion and conclusions section. Relate the project's work to already published work.
6. Submit the research paper, in VJAS format, to the elective teacher.

#### COMPETENCY VI

#### **Create a presentation of the research project and present the research to classmates or at a scientific meeting.**

##### *Enabling Objectives:*

1. Incorporate text and graphics into a presentation.
2. Add appropriate transitions between elements in a slide and transitions between slides.
3. Effectively use color for backgrounds and text to add visual value.
4. Organize key points so that the presentation flows logically and is easy to follow.
5. Use proper enunciation, pronunciation, pace, and volume in communicating the research to one's peers.

#### COMPETENCY VII

#### **Develop an understanding of engineering fundamentals and apply this knowledge in an effective manner.**

##### *Enabling Objectives:*

1. Students will develop their knowledge of mathematics, science, engineering, and technology and be able to apply this knowledge as they design and build engineering products.
2. Students will develop the skill to design and conduct experiments, as well as analyze and interpret data.
3. Students will work individually and in a group to design a system, component or process to meet desired needs.
4. Students will work and function in multidisciplinary team and develop appropriate technical and social skills to become a contributing member of their team.
5. Students will develop the skills to identify, formulate and solve engineering problems.
6. Students will develop an understanding of professional and ethical responsibility

7. Students will increase their understanding of the impact of engineering solutions in a global and societal context.
8. Students will develop an ability to use the techniques, skills and modern engineering tools necessary for engineering practice