# WRHS Science Curriculum
# Syllabus

**Course Name: Engineering Physics & Design** **Grade Level: 11 & 12**

**Course Description:**

This course will meet as a combined H-AF class. Students will learn and apply the basic principles of physics, with an emphasis on mechanics, material science, basic engineering design, robotics, CAD, CAM, CNC programming in an integrated problem-solving environment. Students may utilize the Technology Education CAD-CAM system facilities to explore solutions to real life engineering and manufacturing problems. There will also be a variety of guest speakers from the engineering field. They will discuss various opportunities in engineering and provide real life examples of using engineering to solve problems. These could include WPI students who would present the MQP projects and discuss the development of the idea and the work that goes into the solution. The course will be presented jointly on the H and AF level. **An Individual Experimental Research Project is REQUIRED to receive HONORS credit.**

**Links to Student Expectations:**

- All students will develop skills to utilize technology to gather, to evaluate, to assimilate, and to present information.
- All students will utilize critical thinking skills to identify and to provide resources to solve a problem.
- All students will learn to communicate critically, persuasively, and personally in both oral and written expression.
- All students will be able to make decisions and solve problems using logical processes (e.g., scientific method, induction, deduction, syllogism, etc.)
- All students will develop skills to promote a sense of confidence in tackling the rigors of standardized tests such as the required MCAS and optional AP, SAT.

**Interdisciplinary Connections:**

The concepts of physics integrated with engineering practices and procedures extends well beyond those areas alone. Projects may require and apply knowledge in many different and diverse fields, including (but not limited to): computer skills particularly in the field of Computer Aided Design and Computer Aided Manufacturing (CAD/CAM), robotics, chemistry, biology and other life sciences, mathematics, English, communication and presentation skills, history of theory and product, including important inventions, basic research, marketing, manufacturing and advertising, graphic arts, cost breakdown and analysis, product or patent law, ethics.

## I. Essential Questions for Course

- What is physics, and how is it related to all sciences?
- What is technology/engineering and how does it interrelate with the sciences, and to the science of physics?
- How is the job of a physicist different from that of an engineer or technician in background, training, employer, and salary?
- What role does design and manufacturing play in today's society?
- Do all engineers have a basic method or technique in their job?
- What are the effects on the development and production of products with the use Computer Aided Drafting and Computer Aided Manufacturing (CAD/CAM)?
- How have production systems changed since the integration of Robots into manufacturing?
- How is a patent developed and brought to production of a salable product?
- How does the implementation of CAD/CAM increase the productivity of the engineer?
- How has technology developed and evolved over the past five hundred years?
- How can processes and technological applications be refined or modified to improve efficiency?
- What moral, legal and/or ethical questions may engineer□s face in order to assure continued promotion and use of new technologies?
- How can scientists and engineers improve the quality of life?

## II. Student Objectives

- To learn and understand some of the major concepts of physics, in order to be able to identify the underlying principle(s) in technology-based products.
- To learn how to communicate effectively: as an individual, in a group, on paper, on a computer, mathematically, orally, persuasively.
- To understand, and be an active participant in: group dynamics, brainstorming, modification and reinforcement of ideas, cooperative planning and assessment.
- To know what it means to be in a leadership role and the responsibilities that must be defined and applied as such.
- To understand the role of the scientist and the engineer in improving the quality of life.
- To be able to think critically toward the identification and solution of problems, be they scientific, technological, or societal.
- To be able to use Computer Aided Drafting equipment in a project/product design.
- To be able to manipulate a CAD design into Computer Aided Manufacturing code for the purpose of machining and making a project/product.

- Students will be able to program and manipulate robots to simulate a Material Handling work cell.
- Students will be able to use Robots and CNC Machines to create a Flexible Manufacturing System.

## III. Suggestions for Instruction

- Lectures (including A/V devices for enhanced presentation)
- Computer tutorials and simulations
- Field trips
- Discussions (class, small group, etc.)
- Handouts
- Simple individual or small-group introductory projects
- Detailed major long-term group projects
- Teacher conducted demonstrations
- Videos (instructional, documentary, etc.)
- Movies and books (science/engineering themes)
- Internet sites
- Community outreach (professional scientists, engineers, post-secondary students, business and industry leaders, etc.)

## IV. Suggestion for Assessment

- Written assignments with a variety of question types
- Individual or small group project assessment, based on pre-defined expectations, and/or in competitive-based performance
- Depth of understanding of project concepts and involvement based on individual reaction paper
- Performance on team-based and individual tests
- Evaluation by student designated group leader
- Oral and poster presentations on both individual and group level, including results of CAD/CAM, robotics and FMS applications
-

## V. Curriculum

- Physics topic introduction
- Engineering topic introduction and areas of application: this will vary from year to year as specific projects change or rotated. These areas include (but are not restricted to: mechanical and structural, electrical, acoustic, civil, automotive, aerospace, optical, atomic and nuclear.
- Physics topics in sufficient detail relevant to current project (mechanics, thermodynamics, properties of matter, electromagnetism, wave theory, etc.).
- 2D Drafting Techniques to include; geometric construction, multiview drawings, dimensioning, notes, sectional views, auxiliary views, pattern development.

- Advanced Drafting Techniques to include; working drawings, gearing, cams, tolerancing, threads, fasteners, springs, engineering standards.
- 3D Parametrics solid modeling to include; extruding, revolving, sweeping, lofting, coiling, holing, shelling, constraint driving, assembly, motion simulation.
- Computer Aided Manufacturing to include; tool path generation, NC codes, pocketing, engraving, facing, contouring, drilling, surface revolution, ruled surfaces, swept surfaces, turning, facing, grooving, threading, profiling and cutting.
- Robotic Cell Programming to include; live and computer simulation of component manipulation in the XYZ coordinate system, writing and running programs with loops, subroutines, contact and non-contact sensors, conveyors.
- Flexible Manufacturing to include; FMS cell operation, production cycle manipulation and controls, Mill-Robot I/O Communication.

## VI. Lesson Extensions

- Extend the calculations, data collection and analysis for various physics and engineering-based projects and instructions.
- Incorporate the CAD-CAM system facilities to implement and enhance their individual project conception and analysis.
- More rigorous testing done on individual basis to assure comprehension.
- Produce and present an individual experimental research engineering/physics-based project, starting in September and entered in February Science Fair.