COURSE TITLE

Advanced Design Applications

LENGTH

Full Year

DEPARTMENT

STEM Department

SCHOOL

Rutherford High School

DATE

September 10, 2018

Initial BOE Approval Date (Born on): 6/15/2015

Advanced Design Applications

I.   Introduction/Overview/Philosophy

Advanced Design Applications consists of four units including Manufacturing, Energy and Power, Construction and Transportation. The Manufacturing unit examines the advances that maintain manufacturing efficiency, how human consumption affects manufacturing, how manufacturing affects the standard of living of various peoples, and how processing and changing raw materials can produce more desirable products. The Construction unit examines a number of the factors influencing the design and construction of permanent and semi-permanent structures, the practices related to construction maintenance, alteration, and renovation, and the functions of the primary systems installed in those structures. The Energy & Power unit explores the relationship between energy and power technologies and all other technologies, and how modern energy and power systems impact cultures, societies, and the environment. It also offers an examination of how energy and power systems can be made more efficient and how they may be utilized in problem solving. The Transportation unit examines the complex networks of interconnected subsystems that each transportation system comprises and the roles of these components in the overall functional process of the system. It also analyzes of the improvements and the impacts of transportation technologies on the environment, society, and culture.

II.   Objectives

Course Outline:

1. Construction
   a. Scale design using REVIT
   b. Building to Scale
   c. Infrastructure
   d. Green Building
   e. Construction Surveying
2. Energy and Power
   a. Types of energy
   b. Electric Circuits
   c. Energy Transfer
3. Transportation
   a. Safety in Transportation
   b. Creating Movement / Braking system
   c. Torque
4. Manufacturing
   a. Product Manufacturing
   b. Product Development
   c. Quality Control
   d. Computer Control Manufacturing
   e. Automation & Relay Manufacturing
5. SeaPerch
   a. ROV

  b. Buoyancy
  c. Propulsion

Student Outcomes:

After successfully completing this course, the student will:
- Develop an innovative solution to a real-world problem
- Research and analyze the impact of the design constraints
- Analyze a current technology and the resources used
- Create scaled engineering drawings of products both manually and digitally with materials and measurements labeled
- Research an existing product, reverse engineer and redesign it to improve form and function
- Use a design process to devise a technological product or system

New Jersey Student Learning Standards

CAREER READY PRACTICES
CRP1 Act as a responsible and contributing citizen and employee.
Career-ready individuals understand the obligations and responsibilities of being a member of a community, and they demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them. They think about the near-term and long-term consequences of their actions and seek to act in ways that contribute to the betterment of their teams, families, community and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.

CRP2 Apply appropriate academic and technical skills.
Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation

CRP4 Communicate clearly and effectively and with reason.
Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice, and organization, and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.

CRP5. Consider the environmental, social and economic impacts of decisions.
Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact and/or mitigate negative impact on other people, organization, and the environment. They are aware of and utilize new technologies, understandings, procedures, materials, and regulations affecting the nature of their work as it relates to the impact on the social condition, the environment and the profitability of the organization.

CRP6. Demonstrate creativity and innovation.

Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices, and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.

CRP7. Employ valid and reliable research strategies.
Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies. They use reliable research process to search for new information. They evaluate the validity of sources when considering the use and adoption of external information or practices in their workplace situation.

CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.
Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem; they thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.

CRP9. Model integrity, ethical leadership and effective management.
Career-ready individuals consistently act in ways that align personal and community-held ideals and principles while employing strategies to positively influence others in the workplace. They have a clear understanding of integrity and act on this understanding in every decision. They use a variety of means to positively impact the directions and actions of a team or organization, and they apply insights into human behavior to change others' action, attitudes and/or beliefs. They recognize the near-term and long-term effects that management's actions and attitudes can have on productivity, morals and organizational culture.

CRP10. Plan education and career paths aligned to personal goals.
Career-ready individuals take personal ownership of their own education and career goals, and they regularly act on a plan to attain these goals. They understand their own career interests, preferences, goals, and requirements. They have perspective regarding the pathways available to them and the time, effort, experience and other requirements to pursue each, including a path of entrepreneurship. They recognize the value of each step in the education and experiential process, and they recognize that nearly all career paths require ongoing education and experience. They seek counselors, mentors, and other experts to assist in the planning and execution of career and personal goals.

CRP11. Use technology to enhance productivity.
Career-ready individuals find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring new technology. They are proficient with ubiquitous technology applications. They understand the inherent risks-personal and organizational-of technology applications, and they take actions to prevent or mitigate these risks.

CRP12. Work productively in teams while using cultural global competence.
Career-ready individuals positively contribute to every team, whether formal or informal. They apply an awareness of cultural difference to avoid barriers to productive and positive interaction. They find ways to increase the engagement and contribution of all team members. They plan and facilitate effective team meetings.

TECHNOLOGY

Standard 8.1 Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.

Strand A. Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.

8.1.12.A.1- Create a personal digital portfolio which reflects personal and academic interests, achievements, and career aspirations by using a variety of digital tools and resources.

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.

8.1.12.A.3- Collaborate in online courses, learning communities, social networks or virtual worlds to discuss a resolution to a problem or issue.

8.1.12.A.5- Create a report from a relational database consisting of at least two tables and describe the process, and explain the report results.

Strand B. Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.

8.1.12.B.2- Apply previous content knowledge by creating and piloting a digital learning game or tutorial.

Strand C. Communication and Collaboration: Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.

8.1.12.C.1- Develop an innovative solution to a real world problem or issue in collaboration with peers and experts, and present ideas for feedback through social media or in an online community.

Strand D. Digital Citizenship: Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior.

8.1.12.D.1- Demonstrate appropriate application of copyright, fair use and/or Creative Commons to an original work.

8.1.12.D.2- Evaluate consequences of unauthorized electronic access (e.g., hacking) and disclosure, and on dissemination of personal information.

8.1.12.D.3- Compare and contrast policies on filtering and censorship both locally and globally.

8.1.12.D.4- Research and understand the positive and negative impact of one's digital footprint.

8.1.12.D.5- Analyze the capabilities and limitations of current and emerging technology resources and assess their potential to address personal, social, lifelong learning, and career needs.

Strand E: Research and Information Fluency: Students apply digital tools to gather, evaluate, and use information.

8.1.12.E.1- Produce a position statement about a real world problem by developing a systematic plan of investigation with peers and experts synthesizing information from multiple sources.

8.1.12.E.2- Research and evaluate the impact on society of the unethical use of digital tools and present your research to peers.

Strand F: Critical thinking, problem solving, and decision making: Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.

8.1.12.F.1- Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs.

Standard 8.2 Technology Education, Engineering, Design, and Computational Thinking - Programming: All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.

Strand A. The Nature of Technology: Creativity and Innovation Technology systems impact every aspect of the world in which we live.

8.2.12.A.1- Propose an innovation to meet future demands supported by an analysis of the potential full costs, benefits, trade-offs and risks, related to the use of the innovation.

8.2.12.A.2- Analyze a current technology and the resources used, to identify the trade-offs in terms of availability, cost, desirability and waste.

8.2.12.A.3- Research and present information on an existing technological product that has been repurposed for a different function.

Strand B. Technology and Society: Knowledge and understanding of human, cultural and societal values are fundamental when designing technological systems and products in the global society.

8.2.12.B.1- Research and analyze the impact of the design constraints (specifications and limits) for a product or technology driven by a cultural, social, economic or political need and publish for review.

8.2.12.B.2- Evaluate ethical considerations regarding the sustainability of environmental resources that are used for the design, creation and maintenance of a chosen product.

8.2.12.B.3- Analyze ethical and unethical practices around intellectual property rights as influenced by human wants and/or needs.

8.2.12.B.4- Investigate a technology used in a given period of history, e.g., stone age, industrial revolution or information age, and identify their impact and how they may have changed to meet human needs and wants.

8.2.12.B.5- Research the historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product, and present the competing viewpoints to peers for review.

Strand C. Design: The design process is a systematic approach to solving problems.

8.2.12.C.1- Explain how open source technologies follow the design process.

8.2.12.C.2- Analyze a product and how it has changed or might change over time to meet human needs and wants.

8.2.12.C.3- Analyze a product or system for factors such as safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, and human factors engineering (ergonomics).

8.2.12.C.4- Explain and identify interdependent systems and their functions.

8.2.12.C.5- Create scaled engineering drawings of products both manually and digitally with materials and measurements labeled.

8.2.12.C.6- Research an existing product, reverse engineer and redesign it to improve form and function.

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.

Strand D. Abilities for a Technological World: The designed world is the product of a design process that provides the means to convert resources into products and systems.

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.

8.2.12.D.2- Write a feasibility study of a product to include: economic, market, technical, financial, and management factors, and provide recommendations for implementation.

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.

8.2.12.D.4- Assess the impacts of emerging technologies on developing countries.

8.2.12.D.5- Explain how material processing impacts the quality of engineered and fabricated products.

8.2.12.D.6- Synthesize data, analyze trends and draw conclusions regarding the effect of a technology on the individual, society, or the environment and publish conclusions.

Strand E. Computational Thinking: Programming: Computational thinking builds and enhances problem solving, allowing students to move beyond using knowledge to creating knowledge.

8.2.12.E.1- Demonstrate an understanding of the problem-solving capacity of computers in our world.

8.2.12.E.2- Analyze the relationships between internal and external computer components.

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).

8.2.12.E.4- Use appropriate terms in conversation (e.g., troubleshooting, peripherals, diagnostic software, GUI, abstraction, variables, data types and conditional statements).

21ST CENTURY LIFE AND CAREERS
9.2 Career Awareness, Exploration, and Preparation
Strand C: Career Preparation
9.2.12.C.1 Review career goals and determine steps necessary for attainment.

9.2.12.C.3 Identify transferable career skills and design alternate career plans.

COMPANION STANDARDS FOR SCIENCE AND TECHNICAL SUBJECTS
RST.11-12.1. Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.

RST.11-12.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

WHST.11-12.6. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information.

WHST.11-12.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

WHST.11-12.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

III.   Proficiency Levels

Advanced Design Applications is a full year elective course appropriate for students that have completed both Technological Foundations and Design & Innovation.

IV.   Methods of Assessment

Student Assessment
Students will be assessed using a variety of methods, including but not limited to homework, projects, and journals.

Curriculum/Teacher Assessment
The teacher will provide the subject area supervisor with suggestions for changes on an ongoing basis.

V.   Grouping

This is a high school elective course offered to students that have completed both Technological Foundations and Design & Innovation.

VI.   Articulation/Scope & Sequence/Time Frame

Course length is one year.

VII.   Resources

Texts/Supplemental Reading/References

Resources include but are not limited to:
1. Engineering by Design Curriculum
2. Instructor supplied resource materials (Instructional handouts, drawings, etc)
3. Internet
4. Supplemental reading
5. Equipment/supplies as ordered
6. Household materials

VIII. Suggested Activities

Appropriate activities are listed in the curriculum map.

IX.   Methodologies

The following methods of instruction are suggested: lecture, group projects, demonstration, hands-on applications, and class presentations.

X.   Interdisciplinary Connections

The primary focus of this course is to reinforce concepts taught in the classroom to the real world. Connections will be made to social studies, mathematics, and science.

XI.   Differentiating Instruction for Students with Special Needs: Students with Disabilities, Students at Risk, English Language Learners, and Gifted & Talented Students

Differentiating instruction is a flexible process that includes the planning and design of instruction, how that instruction is delivered, and how student progress is measured. Teachers recognize that students can learn in multiple ways as they celebrate students' prior knowledge. By providing appropriately challenging learning, teachers can maximize success for all students.

Differentiating in this course includes but is not limited to:

Differentiation for Support (ELL, Special Education, Students at Risk)
- Peer mentoring on problems
- Differentiated teacher feedback on assignments
- Modeling out problems on whiteboard
- Visual aids as we project problems on whiteboard
- Study guides
- Tiered assignments
- Scaffolding of materials and assignments
- Re-teaching and review
- Guided note taking
- Exemplars of varied performance levels
- Multi-media approach to accommodating various learning styles

Differentiation for Enrichment
- Supplemental reading material for independent study
- Flexible grouping
- Tiered assignments
- Topic selection by interest
- Enhanced expectations for independent study
- Elevated questioning techniques using Webb's Depth of Knowledge matrix

XII. Professional Development

The teacher will continue to improve expertise through participation in a variety of professional development opportunities.

XII. Curriculum Map/Pacing Guide

Unit Topic	Time Allocated	Differentiating Instruction for Students with Disabilities, Students at Risk, English Language Learners, & Gifted & Talented Students	Standards	Assessments
Construction ● Scale design using REVIT ● Building to Scale ● Infrastructure ● Green Building ● Construction Surveying	9 weeks	*For Support:* Pairing students to work on project Modified assessment *For Enhancement:* Provide extension activities in constructing green building Independent study on types of green building	8.1.12.A.5, 8.1.12.C.1, 8.1.12.E.1 8.2.12.A.2 8.2.12.A.3 8.2.12.B.4 8.2.12.C.1, 3 & 7 8.2.12.D.1-6 9.2.12.C.1,3 CRP1,2,4,7,8,10,12 RST.11-12.1,3 WHST.11-12.6,8,10	*Formative Assessment:* Project: Building design Homework. Journal Entry. Brief Constructed Response. *Summative Assessment* Project: Building model (Preliminary & Primary challenge). Project: Gravity Water Distribution Green Building Quiz: Interactive surveying quiz. Benchmark
Energy and Power ● Types of energy ● Electric Circuits ● Energy Transfer	9 weeks	*For Support:* Pairing students in creating a circuit. Rephrase the problems *For Enhancement:* Provide extension activities on the use of resistor. Student-driven projects	8.1.12.C.1 8.1.12.D.5 8.1.12.E.1 8.1.12.F.1 8.2.12.A.1-3 8.2.12.C.1-7 8.2.12.D.1,3,5,6 8.2.12.E.1,3,4 9.2.12.C.1,3	*Formative Assessment:* Resistor color chart practice. Ohm & Kirchhoff Practice problems. Homework. Journal Entry. Brief Constructed Response. *Summative Assessment*

Unit Topic	Time Allocated	Differentiating Instruction for Students with Disabilities, Students at Risk, English Language Learners, & Gifted & Talented Students	Standards	Assessments
		Real-world problems and scenarios(solving energy problem)	CRP1,2,4,7,8,10,12 RST.11-12.1,3 WHST.11-12.6,8,10	Project: Preliminary & Primary challenge. (Renewable energy). Assessment Interactive quiz. Test on potential & kinetic energy math problem Benchmark: Rube Goldberg
Transportation • Safety in Transportation • Creating Movement / Braking system • Torque	9 weeks	*For Support:* Pairing students Rephrase explanations Teacher modeling *For Enhancement:* Real-world problems and scenarios as relates to mode of transportation. Provide extension activities on torque. Student-driven projects.	8.1.12.C.1 8.1.12.D1-5 8.1.12.E.1&2 8.1.12.F.1 8.1.12.A.2&3 8.2.12.B.1-5 8.2.12.C.1-7 8.2.12.D.1,3,4,5 9.2.12.C.1,3 CRP1,2,4,7,8,10,12 RST.11-12.1,3 WHST.11-12.6,8,10	*Formative Assessment:* Impact forces practice. Safety features in structural subsystem Homework. Journal Entry. Brief Constructed Response. *Summative Assessment* Project: Preliminary & Primary challenge. (Engineering design challenge). Assessment Interactive quiz. Test on gear math problem Benchmark:
Manufacturing • Product Manufacturing • Product Development • Quality Control • Computer Control Manufacturing • Automation & Relay	9 weeks	*For Support:* Rephrase problem definition. Modified project *For Enhancement:* Provide extension activities on product manufacturing	8.1.12.A.1 8.1.12.C.1 8.1.12.D1-5 8.1.12.E.1&2 8.1.12.F.1 8.1.12.A.2&3 8.2.12.B.1-5	*Formative Assessment:* Homework. Journal Entry. Brief Constructed Response. *Summative Assessment* Project: Preliminary & Primary challenge. (Soap

Unit Topic	Time Allocated	Differentiating Instruction for Students with Disabilities, Students at Risk, English Language Learners, & Gifted & Talented Students	Standards	Assessments
Manufacturing		Real-world automation problems.	8.2.12.C.1-7 9.2.12.C.1,3 CRP1,2,4,7,8,10,12 RST.11-12.1,3 WHST.11-12.6,8,10	Dispenser) Reverse Engineering Assessment Interactive quiz on product manufacturing.
SeaPerch • ROV • Buoyancy • Propulsion	4 weeks	*For Support:* Pairing students Rephrase design brief Modified project assessment *For Enhancement:* Provide extension activities on remotely operated vehicle. Independent study on buoyancy Student-driven ROV projects Real-world problems and scenarios	8.1.12.A.1 8.1.12.B.2 8.1.12.C.1 8.1.12.E.1&2 8.1.12.F.1 8.1.12.A.2&3 8.2.12.B.1-5 8.2.12.C.1-7 8.2.12.D.1-6 8.2.12.E.1-4 9.2.12.C.1,3 CRP1,2,4,7,8,10,12 RST.11-12.1,3 WHST.11-12.6,8,10	*Formative Assessment:* Homework. Journal Entry. Brief Constructed Response. *Summative Assessment* Project: Preliminary & Primary challenge. (Underwater ROV) Assessment Interactive quiz on product manufacturing.