Burlington County Institute of Technology

Westampton Campus

CAREER MAJOR PROGRAMS

Course Title: Pre-Engineering

Curriculum Area: CTE

Credits: 5

Board Approved: November, 2018

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Pre - Engineering
Curriculum

I. Program Descriptor:

Engineering is a multi-level program for students interested in pursuing careers in the fields of mechanical and civil engineering. Students will build a deep foundational knowledge in mathematics and basic sciences and that will prepare them for higher level education. The program includes theory and practical applications of engineering theory, design, manufacturing, structural analysis, and research. The students will also learn about the career and postsecondary education opportunities of the trade. Due to the heavy use of technology in the engineering sector, students will also be introduced to using computer software pertinent to the the educational outcomes of the program.

II. Program Outcome:

Graduates of this program should be able to communicate technical information both verbally and in writing effectively, demonstrate mathematical skills and application of scientific principles in problem solving, and apply critical thinking and problem solving skills to analyze data, in the creation of experimental procedures and analysis of the outcome.

III. Course of Study:

A.	Principles of Engineering	(9th)	S1 B4
B.	Kinematics and Statics	(9th)	S2 B4
C.	Thermal-Fluids Theory	(10th)	S1 B1
D.	Thermal-Fluids Lab	(10th)	S1 B2
E.	Computer-Aided Design 1/2	(10th)	S2 B1/2
F.	Computer-Aided Design 3/Advanced CADD Project	(11th)	S1 B1/2
G.	Materials and Manufacturing	(11th)	S2 B1
H.	Strength of Materials	(11th)	S2 B2
I.	Drone Technology	(12th)	S1 B3
J.	Finite Element Analysis	(12th)	S2 B3
K.	Engineering Research	(12th)	S1 B4
L.	Engineering Projects	(12th)	S2 B4
M.	Engineering School to Work (optional)	(12th)	S1/2 B3/4

IV. Course Descriptions:

A. Principles of Engineering (9th)

This course presents an introduction to engineering involving teams of students working on engineering design projects. Electronic and mechanical topics along with schematic drawing software are incorporated in lecture and lab modules. Additional topics include: technical communications, analytic and computer-based tools and the engineering design process. These topics are designed to give students the skills to design, build, document and present a working project. Projects have elements of Electronic and Mechanical Engineering design. Each team prepares a written report, gives an oral presentation and demonstrates their project. Cross-list with RCBC ENG 104

B. Kinematics and Statics (9th)

This course focuses on the fundamental principles of engineering mechanics including statics of particles and rigid bodies in two and three dimensions. It covers mathematical analysis as applied to the study of trusses, frames, and machines; frictional forces; distributed forces; center of gravity and moment of inertia; as well as methods of virtual work. The free-body diagram approach and vector analysis methods are used. This course will also focus on the basic motion of particles using energy and momentum methods.

C. Thermal-Fluids Theory (10th)

This course introduces students to thermal-fluid sciences. It deals primarily with thermodynamic property relations, energy transfer, and mass, momentum, and energy balance principles. Students will be able to analyze engineering systems from a mass, momentum, and energy standpoint as well as perform heat transfer, thermodynamic, fluid static, fluid momentum, fluid energy calculations, the second law of thermodynamics, internal/external flow, and steady flow devices.

D. Thermal-Fluids Lab (10th)

This course introduces students to applications of thermal-fluid sciences covered in Thermal-Fluids Theory.

E. Computer-Aided Design 1/2 (10th)

This course covers beginning to intermediate CAD software with emphasis on the use of the CAD software packages over drafting principles. This course also covers advanced AutoCAD techniques. It covers orthographic projection; isometric projection; sections; auxiliary views; three-dimensional detailed drawings and engineering design projects. All projects involve use of the AutoCAD software. Cross-list with RCBC ENG 110 and 113.

F. Computer-Aided Design 3/Advanced CADD Project (11th)

This course continues to develop the skills learned in EGR 113.It uses the advanced capabilities of AutoCAD for drafting and design to create complex three-dimensional models. It focuses on the application of solid modeling and rendering techniques and applies them to an advanced design concept. This course also is designed so a student selects and completes one or more projects throughout the semester. The student selects, with the approval of the instructor,an industrial application. The student prepares a formal proposal and a final project report based on the completed project. Cross-list with RCBC ENG 210 and 220

G. Materials and Manufacturing (11th)

This course provides students with an introduction to material science and engineering. Students will apply the basics of chemistry, such as atomic bonding, to develop an understanding of the structure-property relationships in materials. Materials designed for mechanical, electrical, and optical applications will be studied. The rheology of various materials becomes the transition into how they are developed into useful products through various manufacturing methods including casting, extrusion, molding, sintering, machining and through composite fabrication techniques. Students will also be introduced to the machine shop and operating manual mills, lathes, drill press, band saws, grinders, and computerized mills safely for their chosen process and material. Cross-list with RCBC ENG 212.

H. Strength of Materials (11th)

The course presents the theory and analytical techniques used in the design and analysis of engineered structural components. The course addresses the principles of stress and strain, mechanical properties of materials, and beam and bar analysis. The study of structural components includes axial forces, torsion, bending, shear, combined loading, buckling, and design. Concepts such as principal stresses, Hooke's Law for plane stress, and failure criteria are introduced.

I. Drone Technology (12th)

This course covers the theory and practice of designing and building a radio-controlled drone. The course will go over some of the basic flight dynamics and aerodynamic properties of a drone. Student will also be able to program, learn basic flight instruction of a multi-rotor drone/UAV, learn FPV setup and installation of camera, TX/RX on a multi-rotor drone/UAV, this also includes setting up a ground station, monitor, FPV goggles/headsets set-up, and advanced FPV flight instruction in controlled indoor/outdoor environment.

J. Finite Element Analysis (12th)

Fundamental concepts for the development of finite element analysis are introduced. The element stiffness matrices are developed using shape functions defined on the elements. Aspects of global stiffness formulation, consideration of boundary conditions, and nodal load calculations are presented. Use of pre-existing computer software will be utilized, along with use of student written code using industry software.

K. Engineering Research (12th)

This course is available for students who have completed all prior courses. This course will guide students through the engineering process from start to finish. This includes problem identification, problem research, and proposing possible solutions at the end of the course. Students will be responsible for documentation and meeting deadlines as if they were working for a real company. Research can then be approved to become an engineering project during the next semester.

L. Engineering Projects (12th)

This course is available to students that have completed the engineering research course. Students in this course will continue the process started in the previous course into solution design, prototyping, testing, and finalization of a product. Students will be responsible for documentation and meeting deadlines as if they were working for a real company.

M. Engineering School to Work (optional) (12th)

This experience is available to qualified students that have the ability to demonstrate their skills and proficiencies in a practical setting. Student will earn credit and income during their school to work experiences in their field of study. Students must provide their own transportation to available themselves for this opportunity. This experience is coordinated by the school to work coordinator and have the recommendation of the instructor.

Course: Principles of Engineering **S1** **Grade 9** **Unit: What is Engineering?/Engineering Fields**

CTE Proficiencies	Essential Questions	Content	Skills	Assessments
NJSLS RST.9-10.1, 9-10.2, 9-10.3, 9-10.4, 9-10.5, 9-10.6, 9-10.7, 9-10.8 NJSLS WHST.9-10.1, .9-10.2, .9-10.4, .9-10.5, .9-10.6, .9-10.7, .9-10.10 NJSLS 8.1.12.A.1, .C.1, .D.5, .E.1 NJSLS 8.2.12.A.3, .B.3, .B.4 NJSLS CRP1, 2, 4, 5, 6, 7, 10 NJSLS 9.2.12.C.1, .2, .3,.6, .7 NJSLS 9.3.ST.3, .4, .5, ST-ET.1, .2, ST-SM.1, .3	What is engineering? Engineering has several components to it, what key elements do you identify as being at the core? Why is it important to always keep ethics in mind when engineering a product? What field of engineering interests you the most? What knowledge must you obtain to reach your goal?	Engineering career pathways Fundamentals of Research. Determining units and conversion factors. Determining universal constants.	Students will identify and compare the different fields of engineering and determine the requirements for acquiring a career in each. Students will be able to research, construct opinions, and provide comparisons with technical literature both verbally and through writing.	Group/Individual assignments Research, career planning assignment. Includes looking into salaries, education requirements, and job requirements.

Course: Principles of Engineering **S1** **Grade 9** **Unit: Design Process**

CTE Proficiencies	Essential Questions	Content	Skills	Assessments

NJSLS RST.9-10.1, 9-10.2, 9-10.3, 9-10.4, 9-10.5, 9-10.6, 9-10.7, 9-10.8 NJSLS WHST.9-10.1, .9-10.2, .9-10.4, .9-10.5, .9-10.6, .9-10.7, .9-10.10 NJSLS 8.1.12.A.1, .C.1, .D.5, .E.1 NJSLS 8.2.12.A.3, .B.3, .B.4, .C.1, .C.2 NJSLS CRP1, 2, 4, 5, 6, 7, 10 NJSLS 9.2.12.C.1, .2, .3,.6, .7 NJSLS 9.3.ST.3, .4, .5, ST-ET.1, .2, .4, ST-SM.1, .3	What are the steps of the engineering design process? What does each step contribute to the solution of a problem?	**Engineering Design Process** Problem Identification Research Generating specifications Brainstorm Prototype Test Solution Communicate or Try again	Students will be able to demonstrate an application of the full engineering process. Students will be able to effectively and logically go about problem solving an engineering situation.	Student project in which students will be required to demonstrate the use of each step of the design process. Individual/Group tasks. Decision making exercises.

CTE Proficiencies	Essential Questions	Content	Skills	Assessments
NJSLS RST.9-10.1, 9-10.2, 9-10.3, 9-10.4, 9-10.5, 9-10.6, 9-10.7, 9-10.8 NJSLS WHST.9-10.1, .9-10.2, .9-10.4, .9-10.5, .9-10.6, .9-10.7, .9-10.10 NJSLS 8.1.12.A.1, .C.1, .D.5, .E.1 NJSLS 8.2.12.A.3, .B.3, .B.4, .C.1, .C.2 NJSLS CRP1, 2, 4, 5, 6, 7, 10 NJSLS 9.2.12.C.1, .2, .3,.6, .7 NJSLS 9.3.ST.3, .4, .5, ST-ET.1, .2, .4, ST-SM.1, .3	What principles of mechanics is similar to that of electronics? Why is documenting everything important to an engineer?	Fundamentals of Electronics and Circuits Series Circuits Parallel Circuits Combination Circuits Capacitors Inductors Resistors Basic ICs. Motors. Fundamentals of Basic Mechanical Elements Gears Chain and Sprockets Belts Fasteners	Students will be able to create, build, and document basic electronic circuits. Students will be able to create, build, and document basic mechanical element mechanisms.	Main project combining an electrical system to control a basic mechanical system. Performance tasks in which students demonstrate several skills on a breadboard or electronically.

Course: Kinematics and Statics **S2** **Grade 9** **Unit: Kinematics**

CTE Proficiencies	Essential Questions	Content	Skills	Assessments
NJSLS RST.9-10.1, 9-10.2, 9-10.3, 9-10.4, 9-10.5, 9-10.6, 9-10.7, 9-10.8 NJSLS WHST.9-10.1, .9-10.2, .9-10.4, .9-10.5, .9-10.6, .9-10.7, .9-10.10 NJSLS 8.1.12.A.1, .C.1, .D.5, .E.1 NJSLS 8.2.12.A.3, .B.3, .B.4, .C.1, .C.2 NJSLS CRP1, 2, 4, 5, 6, 7, 10 NJSLS 9.2.12.C.1, .2, .3,.6, .7 NJSLS 9.3.ST.3, .4, .5, ST-ET.1, .2, .4, ST-SM.1, .3	In what ways can we predict and measure motion? How can understanding various physical properties about motion be useful in understanding everyday occurrences? How do we know that an object has energy? How is an object's change in energy driven by the forces acting on it? In what way does energy maintain equilibrium?	Math Concepts of Vectors, Dot Products, Cross Products, Matrix. Motion's relation to force. Motion on a straight line Motion in two dimensions and three dimensions. Work and Power Formulating kinetic and potential energy from change in work. Conservation of Energy	Students will be able to understand the principles of mechanics. Students will be able to relate the imbalance of forces to the change in motion. Students will be able to analyze motion problems. Student will be able to assess changes in energy based on an object's change in height and velocity. Student will be able to identify underlying concept of how energy and forces are related.	Quizzes/Tests. Determine the central ideas or conclusions. Project tasks to demonstrate application of knowledge. Either by experimentation or theoretical. Assignments to improve theory understanding and scientific process. Technical reading reports and vocabulary development.

Course: Kinematics and Statics **S2** **Grade 9** **Unit: Statics**

CTE Proficiencies	Essential Questions	Content	Skills	Assessments
NJSLS RST.9-10.1, 9-10.2, 9-10.3, 9-10.4, 9-10.5, 9-10.6, 9-10.7, 9-10.8 NJSLS WHST.9-10.1, .9-10.2, .9-10.4, .9-10.5, .9-10.6, .9-10.7, .9-10.10 NJSLS 8.1.12.A.1, .C.1, .D.5, .E.1 NJSLS 8.2.12.A.3, .B.3, .B.4, .C.1, .C.2 NJSLS CRP1, 2, 4, 5, 6, 7, 10 NJSLS 9.2.12.C.1, .2, .3,.6, .7, NJSLS 9.3.ST.3, .4, .5, ST-ET.1, .2, .4, ST-SM.1, .3	Why is it crucial for designers and engineers to construct accurate free body diagrams of the parts and structures that they design? Why must designers and engineers calculate the forces acting on bodies and structures?	Forces Free Body Diagrams Equilibrium of Simple Objects Machines and Structures Joined by Engineering Connections Trusses Friction Moments of Inertia	Student will be able to determining the static equilibrium of an object. Student will be able to dissect a system into free-body diagrams. Student will be able to analyze the forces on a truss structure. Student will be able to determine the effects of friction on a system. Student will be able to use moments of inertia to study systems with distributed forces.	Quizzes/Tests. Determine the central ideas or conclusions. Application of knowledge through a construction project. Assignments to improve theory understanding and scientific process. Technical reading reports and vocabulary development.

Course: Thermal-Fluids Theory **S1** **Grade 10** **Unit: Thermo - Fluids I**

CTE Proficiencies	Essential Questions	Content*	Skills*	Assessments

NJSLS RST.9-10.1, 9-10.3, 9-10.4, 9-10.5, 9-10.7, 9-10.9, 9-10.10 NJSLS WHST.9-10.2, 9-10.4, 9-10.5, 9-10.6, 9-10.9, 9-10.10 NJSLS 8.1.12.A.1, 8.1.12.F.1 NJSLS CRP1, 2, 4, 6, 7, 8, 9, 11, 12 NJSLS 9.2.12.C.3 NJSLS 9.3.ST.1, .2, .3, .6, ST-ET.2, .3, ST-SM.1, .2, .4	Why is it important to look at only one section of a system? What important properties of materials can be derived by simple experimentation? Why does flowing fluid dissipate heat faster than standing fluid? What causes air currents on the planet Earth?	Control volumes Conservation of mass Conservation of Energy - Thermal consideration added. Properties of materials Energy analysis of closed systems Energy analysis of control volumes, flowing fluids Bernoulli's Principle ***Note: Covered during theory portion of class.**	Measuring conductivity of solids and fluids. Measuring and determining the state of liquid or a gas. Data collection and analysis of a near closed system. Data and collection of a flowing fluid system. Measuring fluid flow and fluid velocity. ***Note: Covered during laboratory portion of class.**	Lab activities and reports Quizzes/Tests. Determine the central ideas or conclusions. Assignments to improve theory understanding and scientific process. Technical reading reports and vocabulary development.

CTE Proficiencies	Essential Questions	Content	Skills	Assessments
NJSLS RST.9-10.1, 9-10.3, 9-10.4, 9-10.5, 9-10.7, 9-10.9, 9-10.10 NJSLS WHST.9-10.2, 9-10.4, 9-10.5, 9-10.6, 9-10.9, 9-10.10 NJSLS 8.1.12.A.1, 8.1.12.F.1 NJSLS CRP1, 2, 4, 6, 7, 8, 9, 11, 12 NJSLS 9.2.12.C.3 NJSLS 9.3.ST.1, .2, .3, .6, ST-ET.2, .3, ST-SM.1, .2, .4	Why can a bug hold on to a windshield even though a car maybe moving? Why is a gasoline engine considered to be so inefficient? Why would the water pressure in a house be greater at the lowest level versus the highest level?	The second law of thermodynamics Heat engines Reversible and irreversible processes Carnot cycle Entropy and Enthalpy Laminar flow Turbulent flow Head Loss in Pipes ***Note: Covered during theory portion of class.**	Analyze and collect data on the various types of heat cycles. Analyze systems where the there is a reversible process and an irreversible process. Measure a fluid flow in a channel and a pipe. Find the head loss in a piped system by difference in pressure. ***Note: Covered during laboratory portion of class.**	Lab activities and reports Quizzes/Tests. Determine the central ideas or conclusions. Assignments to improve theory understanding and scientific process. Technical reading reports and vocabulary development.

CTE Proficiencies	Essential Questions	Content	Skills	Assessments
NJSLS RST.9-10.3, .9-10.4, .9-10.5, .9-10.6, .9-10.7 NJSLS WHST.9-10.4,.9-10.5 NJSLS 8.1.12.A.1, 8.1.12.A.3, 8.2.12.C.2 NJSLS CRP1, 2, 4, 6, 7, 8, 9, 11, 12 NJSLS 9.2.12.C.3 NJSLS 9.3.ST.2, .4, .6, ST-ET.1, .2, .3, .4, ST-SM.2	Why are design programs like AutoCAD so useful to the industry? How do three view drawings and they way drawings we make differ internationally? Why is AutoCAD considered to be an industry standard software? Why do you think it's competitors are still struggling for the market share?	Technical sketching Three view drawing Symbols and Fonts Tolerancing Isometric views AutoCAD Basics *Solidworks Basics ***If additional time**	Students will be able to sketch drawing in three view. Students will be able to properly dimension objects. Students will be able to tolerance drawings to properly define desired manufacturing finishes. Students will be able to use AutoCAD basic features.	Student drawing demonstrating usage of basic AutoCAD features. Student homework identifying features usage in multiple applications. Student project of teacher determined scope. Tests/Quizzes Determine student knowledge of AutoCAD basic features.. Technical reading reports and vocabulary development.

Course: Design Computer Graphics 1/2 **S2** **Grade 10** **Unit: Design Computer Graphics 2**

CTE Proficiencies	Essential Questions	Content	Skills	Assessments
NJSLS RST.9-10.3, .9-10.4, .9-10.5, .9-10.6, .9-10.7 NJSLS WHST.9-10.4,.9-10.5 NJSLS 8.1.12.A.1, 8.1.12.A.3, 8.2.12.C.2 NJSLS CRP1, 2, 4, 6, 7, 8, 9, 11, 12 NJSLS 9.2.12.C.3 NJSLS 9.3.ST.2, .4, .6, ST-ET.1, .2, .3, .4, ST-SM.2	Why is proper symbol usage important on a drawing sent to a machinist? How do three view drawings differ internationally? Why is AutoCAD considered to be an industry standard software? Why do you think it's competitors are still struggling for the market share?	AutoCAD intermediate skills AutoCAD layers and toolbox features. Using prefabricated drawings to speed processes. Sheet Metal Design Proper annotation for manufacturing. *Solidworks ***If additional time**	Students will be able to sketch drawing in 3 dimensional space. Students will be able to properly dimension objects in 3D. Students will be able to tolerance drawings to properly define desired manufacturing finishes. Students will be able to use AutoCAD's intermediate features. Students will be able to generate prefabricated drawings to include in their own drawings. Students will be able to make sheet metals designs.	Student produced drawings. Student replication of premade drawings. Student project drawing scope decided by student with teacher approval. Tests/Quizzes Determine knowledge of AutoCAD usage. Technical reading reports and vocabulary development.

Course: D.C.Graphics 3/Adv. CADD Project **S1** **Grade 11** **Unit: Design Computer Graphics 3**

CTE Proficiencies	Essential Questions	Content	Skills	Assessments

NJSLS RST.11-12.3, .11-12.4, .11-12.7, .11-12.9 NJSLS 8.1.12.A.1, 8.1.12.A.3, 8.2.12.C.2 NJSLS CRP1, 2, 4, 6, 7, 8, 9, 11, 12 NJSLS 9.2.12.C.3 NJSLS 9.3.ST.2, .4, .6, ST-ET.1, .2, .3, .4, ST-SM.2	Why is proper symbol usage important on a drawing sent to a machinist? How do three view drawings differ internationally? Why is AutoCAD considered to be an industry standard software? Why do you think it's competitors are still struggling for the market share?	AutoCAD advanced skills Introduction to 3D AutoCAD Features. Integrating layers. Exporting to other softwares for further refinement. Project using CADD. *Solidworks ***If additional time permits**	Demonstrate effective use of AutoCAD in a project format. Demonstrate effective use of all tools in AutoCAD covered to this point. Demonstrate proper annotation techniques for manufacturing and assembly.	Student semester project with teacher approved scope. Project check ins for continuous progress. Smaller assignments to provide support for larger components of the project. Assignments to improve theory understanding and scientific process. Technical reading reports and vocabulary development.

Course: Materials and Manufacturing **S1** **Grade 11** **Unit: Material Science**

CTE Proficiencies	Essential Questions	Content	Skills	Assessments
NJSLS RST.11-12.1, .2, .3, .4, .5, .7, .8, .9 NJSLS WHST.11-12.1, .11-12.2, .11-12.5, .11-12.6, .11-12.7, .11-12.8, .11-12.9, .11-12.10 NJSLS 8.1.12.A.4, 8.1.12.A.5 NJSLS CRP1, 2, 4, 6, 7, 8, 9, 11, 12 NJSLS 9.3.ST.2, .3, .4, .5, .6, ST-ET.2, .3, .4, .5, .6, ST-SM.1, .2, .3, .4	What are the defining characteristics of each type of common crystal structures in a material? What are the different types of steel phases? What makes them different? How does the makeup of a polymer differ from a metal? What are the needs for the various types of available materials?	Material types and phases. Crystal structures. Crystal structures effects on properties. Material processing and forming. Material properties and how to test for them. Material treatment options. Reading phase diagrams.	Identifying material atomic and molecular structure. Identifying materials by type and properties. Selecting materials for applications. Testing materials for performance and quality. Identifying material failures and modes.	Lab activities and reports. Quizzes/Tests to test for theory understanding. Assignments to improve theory understanding and scientific process. Technical reading reports and vocabulary development.

CTE Proficiencies	Essential Questions	Content	Skills	Assessments
NJSLS RST.11-12.1, .2, .3, .4, .5, .7, .8, .9 NJSLS WHST.11-12.1, .11-12.2, .11-12.5, .11-12.6, .11-12.7, .11-12.8, .11-12.9, .11-12.10 NJSLS 8.1.12.A.4, 8.1.12.A.5 NJSLS CRP1, 2, 4, 6, 7, 8, 9, 11, 12 NJSLS 9.3.ST.2, .3, .4, .5, .6, ST-ET.2, .3, .4, .5, .6, ST-SM.1, .2, .3, .4	How is the choice of machine determined off of a technical drawing? What particular hazards should one always be aware of in an active machine shop? How does work on a CNC differ from work on a manual machine? What are the characteristics of a good cut? What important factors are there in determining if a machine is powerful enough to produce a product?	Reading and using technical drawing for manufacturing. Machine shop safety/OSHA standards. Hand and power tools. Industrial machine setup, usage, and maintenance. Machining techniques for differing types of materials. CNC programming and CAM.	Manufacturing on various types of industrial manufacturing equipment. Identifying and correcting personal safety in a machining environment. Machine setup for various parts. Selecting tools for jobs. Using G-Code programming and CNC setup.	Safety Tests/Quizzes Shop Professionalism Demonstration of proper tool usage. Projects allowing students to manufacture components for use in other projects or events. Tests/Quizzes to check for understanding of tool theory and machine practices. Assignments to improve theory understanding and scientific process. Technical reading reports and vocabulary development.

Course: Strength of Materials **S2** **Grade 11** **Unit: Strength of Materials**

CTE Proficiencies	Essential Questions	Content	Skills	Assessments
NJSLS RST.11-12.1, .2, .3, .4, .5, .7, .8, .9 NJSLS WHST.11-12.1, .11-12.2, .11-12.5, .11-12.6, .11-12.7, .11-12.8, .11-12.9, .11-12.10 NJSLS 8.1.12.A.4, 8.1.12.A.5 NJSLS CRP1, 2, 4, 6, 7, 8, 9, 11, 12 NJSLS 9.3.ST.2, .3, .4, .5, .6, ST-ET.2, .3, .4, .5, .6, ST-SM.1, .2, .3, .4	What primary factors do most material stresses relate to? How important is the reduction in stress in a part? What methods do we have to look at if the geometry is predefined? How would a material selection be conducted given a stressing condition and sizing parameters?	**Material stress calculations:** Axial stress Shearing stress Stress concentrations Bolt shear stress Torsional stress Bending stress Material property relations. Moore's circle Principal stresses Von Mises stress	Students will be able to calculate component stress from a given static condition. Students will be able to use calculated results to choose appropriate material for job construction. Students will be able to identify possible material failures due to overloading of the material. Students will be able to demonstrate material alternatives to optimize the material(s) usage.	Assignments to improve theory understanding and scientific process. Technical reading reports and vocabulary development. Quizzes/Tests. Determine the central ideas or conclusions. Including designing components to a required specification. Project tasks to demonstrate application of knowledge.

Course: Drone Technology **S1** **Grade 12** **Unit: Small Drone Technology**

CTE Proficiencies	Essential Questions	Content	Skills	Assessments

NJSLS RST.11-12.1, .2, .3, .4, .5, .7, .8, .9 NJSLS WHST.11-12.1, .11-12.2, .11-12.5, .11-12.6, .11-12.7, .11-12.8, .11-12.9, .11-12.10 NJSLS 8.1.12.A.4, 8.1.12.A.5 NJSLS CRP1, 2, 4, 6, 7, 8, 9, 11, 12 NJSLS 9.3.ST.1, .2, .3, .4, .5, .6, ST-ET.1, .2, .3, .4, .5, .6, ST-SM.1, .2, .3, .4	What is a drone and what are the main categories? What industrial uses are there for drone flight? What are the FAA requirements to become a commercial pilot? What career opportunities are there for someone coming in to the drone industry?	Drone flight mechanics and control systems for smaller drone sizes (larger than 250 mm) FAA regulations and pilot testing. Design and construction of a drone. Drone flight training. Recording video and pictures with drone for surveying.	Identify how drone function and fly. Design a virtual control system for a drone. Identify the rules and regulations for flying in US airspace with a drone. Practice and demonstrate proficiency with drone flight skills. Designing a drone for flight.	Homework assignments based around flight and FAA Regulations. Using drone for practical applications. Reverse engineering drone components and creating an assembly manual. FAA Regulation Test Tests/Quizzes Determine the central ideas or conclusions.

Course: Drone Technology **S1** **Grade 12** **Unit: Large Drone Technology**

CTE Proficiencies	Essential Questions	Content	Skills	Assessments

NJSLS RST.11-12.1, .2, .3, .4, .5, .7, .8, .9 NJSLS WHST.11-12.1, .11-12.2, .11-12.5, .11-12.6, .11-12.7, .11-12.8, .11-12.9, .11-12.10 NJSLS 8.1.12.A.4, 8.1.12.A.5 NJSLS CRP1, 2, 4, 6, 7, 8, 9, 11, 12 NJSLS 9.3.ST.1, .2, .3, .4, .5, .6, ST-ET.1, .2, .3, .4, .5, .6, ST-SM.1, .2, .3, .4	What is a drone and what are the main categories? What industrial uses are there for drone flight? What are the FAA requirements to become a commercial pilot? What career opportunities are there for someone coming in to the drone industry? What are the major difference between a small sized drone and a large sized drone?	Drone flight mechanics and control systems for larger drones (greater than 250 mm) FAA regulations and pilot testing. Design and construction of a drone. Drone flight training. Recording video and pictures with drone for surveying.	Identify how drone function and fly. Design a virtual control system for a drone. Identify the rules and regulations for flying in US airspace with a drone. Practice and demonstrate proficiency with drone flight skills. Designing a drone for flight.	Homework assignments based around flight and FAA Regulations. Using drone for practical applications. Reverse engineering drone components and creating an assembly manual. FAA Regulation Test Tests/Quizzes Determine the central ideas or conclusions.

Course: Finite Element Analysis **S2** **Grade 12** **Unit:Understanding FE Analysis**

CTE Proficiencies	Essential Questions	Content	Skills	Assessments
NJSLS RST.11-12.1, .2, .3, .4, .5, .7, .8, .9 NJSLS WHST.11-12.1, .11-12.2, .11-12.5, .11-12.6, .11-12.7, .11-12.8, .11-12.9, .11-12.10 NJSLS 8.1.12.A.4, 8.1.12.A.5 NJSLS CRP1, 2, 4, 6, 7, 8, 9, 11, 12 NJSLS 9.3.ST.2, .3, .4, .5, .6, ST-ET.2, .3, .4, .5, .6, ST-SM.1, .2, .3, .4	What are the benefits of computer simulation versus physical tests? In what ways can a code custom written for an intended user differ then a pre-packaged code? What are boundary conditions and how are they useful in computer simulations?	Stiffness matrices. Inverting matrices. Using the stiffness matrices and boundary conditions to resolve problems with a simple mesh. Writing computer code to generate a mesh. Writing computer code to generate simulation results based on given starting conditions.	Demonstrate the a basic understanding for the underlying mathematical concepts that drive FEA. Generate computer codes that can create a mesh around an object for simulation. Use of pre-existing code to simulate a component or a system of components.	Assignments to improve theory understanding and scientific process. Technical reading reports and vocabulary development. Demonstrations of pre-existing code to simulate a real world object. Tests/Quizzes Determine the central ideas or conclusions.

Course: Finite Element Analysis **S2** **Grade 12** **Unit: Applying FE Analysis**

CTE Proficiencies	Essential Questions	Content	Skills	Assessments

NJSLS RST.11-12.1, .2, .3, .4, .5, .7, .8, .9 NJSLS WHST.11-12.1, .11-12.2, .11-12.5, .11-12.6, .11-12.7, .11-12.8, .11-12.9, .11-12.10 NJSLS 8.1.12.A.4, 8.1.12.A.5 NJSLS CRP1, 2, 4, 6, 7, 8, 9, 11, 12 NJSLS 9.3.ST.2, .3, .4, .5, .6, ST-ET.2, .3, .4, .5, .6, ST-SM.1, .2, .3, .4	What are the benefits of computer simulation versus physical tests? In what ways can a code custom written for an intended user differ then a pre-packaged code? What are boundary conditions and how are they useful in computer simulations?	Stiffness matrices. Inverting matrices. Using the stiffness matrices and boundary conditions to resolve problems with a simple mesh. Writing computer code to generate a mesh. Writing computer code to generate simulation results based on given starting conditions.	Demonstrate the a basic understanding for the underlying mathematical concepts that drive FEA. Generate computer codes that can create a mesh around an object for simulation. Generate computer code that can properly simulate a component or a system of components Use of pre-existing code to simulate a component or a system of components. Using MATLAB to generate custom code to simulate components or a system.	Assignments to improve theory understanding and scientific process. Technical reading reports and vocabulary development. Demonstrations of pre-existing code to simulate a real world object. Tests/Quizzes Determine the central ideas or conclusions. Student developed code to simulate real world objects, both in macroscale and microscale.

CTE Proficiencies	Essential Questions	Content	Skills	Assessments
NJSLS RST.11-12.1, .2, .3, .4, .5, .6, .7, .8, .9 NJSLS WHST.11-12.1, .11-12.2, .11-12.4, .11-12.5, .11-12.6, .11-12.7, .11-12.8, .11-12.9, .11-12.10 NJSLS 8.1.12.A.4, 8.1.12.A.5 NJSLS CRP1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12 NJSLS 9.3.ST.1, .2, .3, .4, .5, .6, ST-ET.1, .2, .3, .4, .5, .6, ST-SM.1, .2, .3, .4	What are major issues in society today that can be addressed by engineers? What primary methods can be taken to address the identified issue? Is a physical prototype preferable or a virtual one?	Engineering process application. Project planning and research. Writing technical briefs and specifications. Performing customer case studies. Conducting review of research to support one's own proposal. Proposal writing.	Demonstrate proper application of the engineering design process. Analyze prior research to develop own thesis and research on a topic of choosing. Conduct end user surveys to generate specifications. Demonstrate organized project planning.	Engineering Notebook Final research paper Several check-ins with written briefs.

Course: Engineering Research/Project **S2** **Grade 12** **Unit: Engineering Project**

CTE Proficiencies	Essential Questions	Content	Skills	Assessments
NJSLS RST.11-12.1, .2, .3, .4, .5, .6, .7, .8, .9 NJSLS WHST.11-12.1, .11-12.2, .11-12.4, .11-12.5, .11-12.6, .11-12.7, .11-12.8, .11-12.9, .11-12.10 NJSLS 8.1.12.A.4, 8.1.12.A.5 NJSLS CRP1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12 NJSLS 9.3.ST.1, .2, .3, .4, .5, .6, ST-ET.1, .2, .3, .4, .5, .6, ST-SM.1, .2, .3, .4	What are major issues in society today that can be addressed by engineers? What primary methods can be taken to address the identified issue? Is a physical prototype preferable or a virtual one?	Engineering process application. Application of machining practices. Use of prior research to construct an end product. Using an engineering notebook effectively. Identifying product failure modes and FMEA.	Design end product prototype. Conduct field experiments to determine flaws. Conduct FMEA analysis of prototype and address with iterative process. Conduct FMEA on final product and develop maximum operating conditions specifications.	Engineering Notebook Final product / Final prototype fabrication Several check-ins with written briefs.

V. Resources And Supplemental Materials

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Beer, F. P., Johnston, E. R., & Mazurek, D. F. (2018). *Vector mechanics for engineers*. New York, NY: McGraw-Hill Education.

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Çengel, Y. A., & Boles, M. A. (2019). *Thermodynamics: An engineering approach*. New York: McGraw-Hill Education.

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Çengel, Y. A., Cimbala, J. M., & Turner, R. H. (2017). *Fundamentals of thermal-fluid sciences*. New York, NY: McGraw-Hill Education.

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SHIH, R. (2018). *AUTOCAD 2019 TUTORIAL SECOND LEVEL 3D MODELING*. S.l.: SDC PUBNS.

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