Amusement Parks 101
Engineering 360
Dynamics
Syllabus

Fall 2023

What is this course all about?

In a nutshell, Dynamics is the study of anything that moves: cars, turbines, pumps, robots, prosthetics, athletes, and yes most of the attractions at an amusement park. This semester we will use 12 attractions at Hershey Park to introduce each of our 12 skills. The analytical skills you will learn in this course will provide a conceptual foundation for modeling, designing, and analyzing mechanical systems. You will be expanding your engineering toolbelt, extending your mastery of Newtonian mechanics beyond the particle dynamics of physics I. We will focus on mechanism kinematics (what is the required force of an actuator on a backhoe?) and rigid body dynamics (why do your front brakes wear faster than the rear brakes?).

The Big Picture

If we are going to be responsible and effective **Engineers for Society,** it is critical that we develop a strong mastery of engineering science fundamentals. As engineers we live out the Etown motto Educate for Service by creating environmental, social, and economic value for our society, our companies, and our communities.

We are developing an **Etown Engineering Mindset**. This mindset frames our approach to engineering. We start with genuine curiosity to explore new ideas and become life-long learners. From our multidisciplinary framework we connect information from many sources to figure it out and solve novel problems.

One key to developing this mindset is to persist through and learn from failure.

We learn by doing, exploring, asking questions, figuring out why and how. We will make mistakes; that's a GOOD thing! Mistakes unlock new insights. We need to challenge ourselves and keep learning from every attempt and failure.

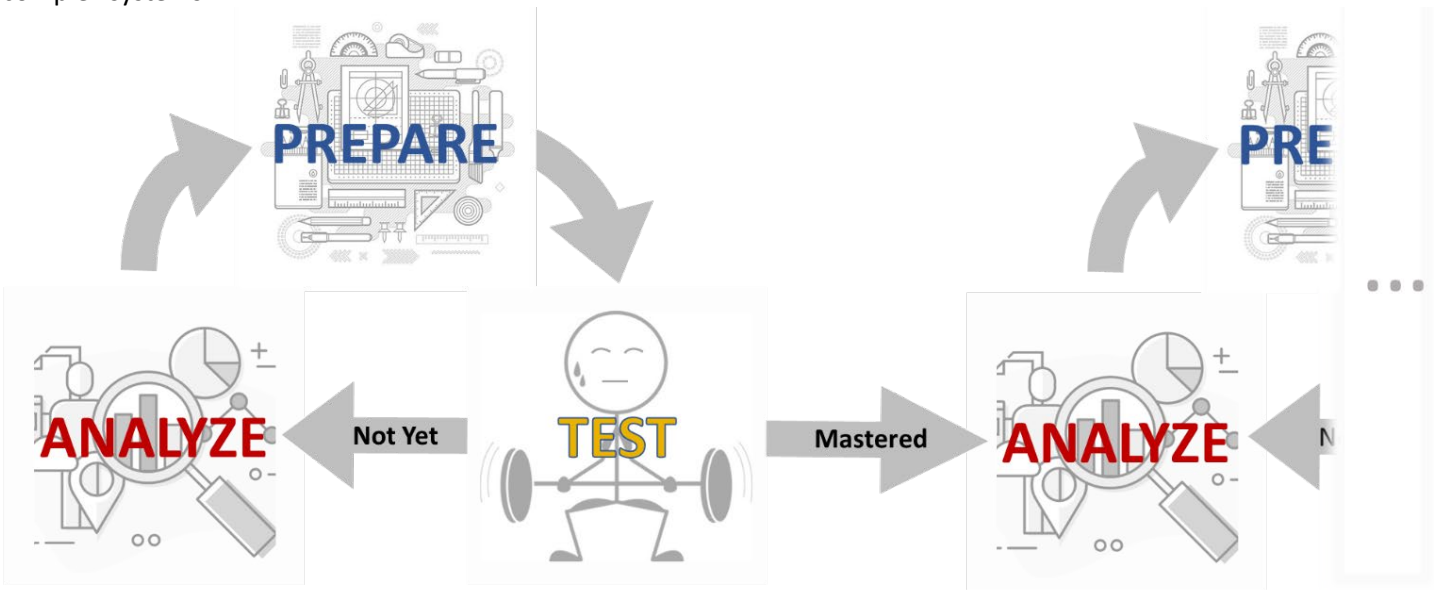
This mindset will drive our daily work in this course and will model an approach that will serve you well in any of your courses and as a professional.

The Mastery Flow

In this course we will look at each new skill together, do a bit of guided practice, then work together in small groups to dig in and solve a set of 15-30 problems applying these skills. We'll solve as many of these problems as many times as needed to master the skills; sometimes working several of the problems multiple times. After that investment, we will test ourselves with a Quiz on that skill. If we're not quite there yet, we will analyze what when wrong:

- Where do we need more practice?
- What are we not understanding?
- What can our mistakes teach us?
- What aspects of the skill have we not yet mastered?

and dig back in for more practice. Once we've mastered that skill, we will connect that mastery to the next skill set and repeat the process. Each tool in our tool belt provides skills for learning later skills and analyzing and designing more complex systems.



What can I expect class sessions to look like?

Our class sessions will each take one of three forms. On Presentation days (Tuesdays) we will all work together exploring one of the skills in the course and doing some guided problem solving together. We will all work together in these sessions no matter which skills you have mastered to date. This ensures that all students explore all the topics in the course and will be ready to dig into deep practice on each topic when they are ready. Many of the skills will also reinforce earlier skills because they do tend to build on each other.

On Coaching days (Thursdays), you will work in small groups on one of the skills in the course. You will work problems between class sessions and should bring problems that have been giving you trouble to class to discuss with your classmates and with me. I will rotate from table to table during these sessions helping you understand difficult analyses.

On Power Up days (Fridays) you can test yourself and demonstrate mastery of new skills.

About your professor: I earned my BS in Engineering Physics from Hope College (Holland Michigan), my MS in Mechanical Engineering from Case Western Reserve University (Cleveland), and my PhD in Mechanical Engineering from the University of Michigan (Ann Arbor). I spent 3 years as an engineering project manager at Ford Motor Company between degrees. I've been at Etown for 23 years and have taught at all levels of the curriculum. I have been married for over 30 years and my wife and I have two children. My son is a PhD student at Cornell and my daughter is a senior journalism major at Hofstra. I also mentor the cross-country and track teams – running with the team 2-3 times each week, I play tenor saxophone in the jazz band, and I commute by bike about 32 miles/week year-round.

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My research expertise is in human performance and injury biomechanics. I also run a short-term cross-cultural study abroad experience in The Gambia, West Africa, and study engineering teaching methods and run workshops across the country on Mastery Based Assessments.

You can find me on campus in my office:

- **160E Esbenshade Hall**
- (717) 361-1380, anytime
- **degoedek@etown.edu**, anytime
- Cell: (717) 419-9568 (text only)
  - 9:00 AM – 9:00 PM
  - no messages between 1:00 PM Saturday and 4:00 PM on Sunday please
- **Student Hours ("Help me!" sessions):**
  - **M 3:00 – 4:00**
  - **T 2:00 – 3:30**
  - **W 11:00 – 12:00**
  - **H 1:00 – 2:00**
  - **F 9:30 – 11:00**

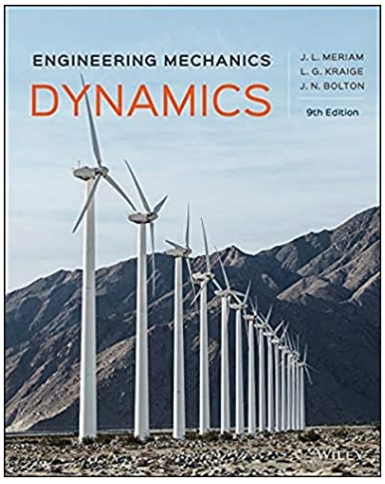
Please feel free to stop by my office anytime, if I am not available when you stop by, please leave a note on the whiteboard.

Class Hours: **Tu Th 9:30 – 10:50 (A)** or **11:00 – 12:20 (B),**
in Esbenshade 164

Power-Up Sessions: **F 9:30 – 11:00 (All Sections)**
in Gibble Auditorium

Prerequisites: PHY201, MA122 – you should have a foundational understanding of the Newtonian Dynamics of a particle, constructing Free Body Diagrams, vector calculus and introductory differential equations.

Textbook: Embedded WileyPLUS text
(Integrated into our Canvas Page)



Supplemental Material: There are numerous Dynamics texts available in E161, or as "on reserve" from my office.

Course Objectives (ABET Outcomes):

1 - Students will be able to apply the fundamental principles of engineering dynamics. See specific list of 12 Skills below (ABET1). Assessed by Mastery-Based Learning (MBL) Exams and Quizzes.
2 – Students will utilize Numerical Tools and Modeling (MATLAB) to analyze complex systems and test alternate designs. These problems require the students to make and justify appropriate estimations and modeling decisions to define and analyze a system (ABET1). Assessed by MBL Project Reports and Practicums.
3 – Students will clearly articulate areas of confusion and mentor peers toward understanding new concepts (ABET7). Assessed by daily Homework Discussion posts.
4 – Students will strengthen their ability to build on their current understandings to understand and solve novel problems (ABET7). Assessed by progress through MBL skills.

Specific Skills:

Foundational:

F1 – Kinematic Analyses in rotating (polar) coordinates (Ch2.6).

F2 – Numerical Differential Equation Solutions: Apply ode45 to solve equations of motion of a 1-DoF point mass (Select Problems from Ch 2 and 3).

F3 – Utilize principles of Work, Energy and Power to solve for the motion of 1 or 2 point-masses (Ch. 3.6, 3.7).

Required Skills (Must master F-Skills before moving to Required skills): Required skills have two levels of competency – Proficiency (P) and Advanced (A) {you must master the corresponding P-Skill + one other P-Skill to earn credit with A-Skills).

P1 – Essential Planar Kinematics and relative motion: Take derivatives in a moving CS, including polar coordinates and calculate the velocities (linear and rotational) of 2 or 3 or more interconnected rigid bodies subject to constraints (Ch5.2-5.4).

A1 – Advanced Planar Kinematics and relative Motion: calculate the velocities and accelerations (linear and rotational) of 2 or 3 or more interconnected rigid bodies including sliding contact (Ch5.6-7).

P2 – Planar Kinetics: Solve for the motion of rigid bodies in curvilinear translation or rotation about a fixed point (Ch6.2-4).

A2 – Advanced Planar Kinetics: Solve for the motion of rigid bodies in general planar motion (Ch6.5).

P3 – Impact: Utilize principles of momentum to solve for the motion of 1 or two point-masses, including oblique impact (Ch3.8-12).

A3 – Utilize Rigid-Body Momentum analysis with FBDs and Energy to complete complex motion analyses (Ch6.5-9).

Computational Skills: (Must pass the at least all 3 F-Skills and 2 P-Skills before earning credit for C skills) {Must submit brief technical report on an individually assigned problem and demonstrate competency on a written/oral practicum}

C1 – Rocket Motion: Set up the Equations of motion for a non-constant mass analyses and solve using ode45 (Ch4.6 and 4.7).

C2 – 3D Analyses: Complete an experimental analysis of simulated free, fixed-axis, and fixed-point motion of rigid bodies in 3D (Ch7).

C3 – Vibration Analyses: Complete an experimental vibrational analysis of simulated a single-degree-of-freedom system (Ch8).

Tuesday	Thursday	Friday (Quizzes)
22		
Intro & PHY201 Review	**F1** Foundational Moving Coordinates	Coaching (GAUD)
29		
P1 Proficiency Kinematics	Coaching	F1, P1
5		
A1 Mastery Kinematics	Coaching	F1, P1
12		
F2 Foundational Numerical Diff Eqs with particle dynamics	Coaching	F1, P1, A1
19		
P2 Proficiency Kinetics	Coaching	F1, P1, P2, P2
26		
A2 Mastery Kinetics	Coaching	F1, P1, P2
Oct 3		
Coaching	FALL BREAK	
10		
F3 Foundational Energy Analysis	Coaching	F1, F3, P1, P2, A2
17		
P3 Proficiency Momentum Analysis	Coaching	F1, F3, P1, P2, P3
24		
C1 Computational Rocket Science	Coaching	F1, F3, P1, P2, P3
31		
A3 Mastery Energy & Momentum	Coaching	F1, F3, P1, P2, P3
Tuesday	**Thursday**	**Friday (Quizzes)**

Tuesday	Thursday	Friday (Quizzes)
Nov 7		
C2 Computational 3D Kinetics	Coaching	F1, F3, P1, P2, P3 A3
14		
C3 Computational Vibrations	Coaching	F1, F3, P1, P2, P3 A1, A2, A3 (move A's to 11/23?)
21		
FE Exam (Bonus Skill) **Bonus F/P Power Up Wed (11/23)**	THANKSGIVING	
28		
Coaching	Coaching	F1, F3, P1, P2, P3

Final Exams F1, F3, P1, P2, P3, A1, A2, A3 and FE Bonus:

- 9:30 AM (**Section A**): **Th 12/7** @ 8:00 AM – 9:30 AM
- 11:00 AM (**Section B**): **Th 12/7** @ 11:00 AM – 12:30 PM

Proficiency Quizzes: To demonstrate proficiency in each F and P skill you must correctly compete a representative analysis on a proctored quiz. Any solution without conceptual errors is considered correct.

Research demonstrates the power of self-assessment. Students have access to all skill bank solutions and should analyze their submitted work to discover any errors and learn from every mistake. Students may make an appeal for credit on any F or P quiz by submitting a written discussion making the case that the errors in the work were not conceptual.

Advanced Skill Exams: Advanced skill (A-skills) exams will be given on select dates. These exams assess the extent you have mastered the content of the P-skills above proficiency level. You will have 3 opportunities for each A-Skill assessment. A-skill exams are scored on a 3-point scale: 2-approaching mastery, 3-mastery. The highest score for each skill will be used and the course grade will be raised as follows:

$$\text{Average} = \frac{A1+A2+A3}{3}$$ (Rounded UP: 1.3 = 2)

Any skills for which you do not submit a worked exam will be scored as a 0 in this Average. The final grade is raised by Average/3 of a letter grade (e.g., if Average = 2, the final grade is raised by 2/3 of a letter grade say from C+ to B).

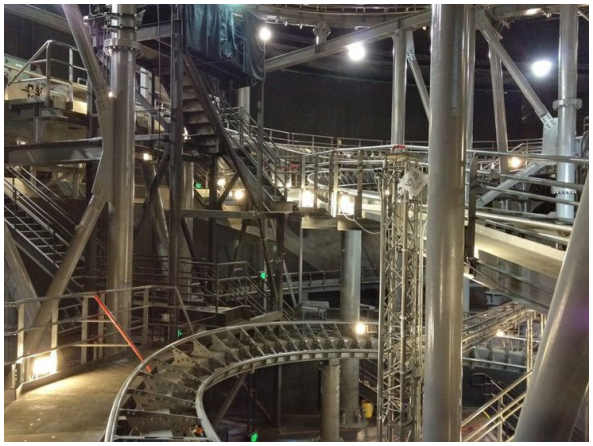
All quizzes and exams will be taken using only the "Bottom Line" packet and a calculator approved for use on the FE/PE exams (http://ncees.org/exams/calculator/). The use of any other electronic device (graphing calculators, cell phones, smartwatches, etc.) is strictly prohibited. If a student is found using one of the prohibited devices, the item(s) will be confiscated, and the student will receive a 3-skill penalty.

Skill assessments are to be taken without communication, except for problem clarification from the instructor. During testing, students are not allowed to access any resources beyond those explicitly permitted by the instructor, including but not limited to online materials and books/note/study guides. Students will not be permitted to leave the classroom (or their zoom window) during assessments. Exceptions will be granted at the professor's discretion.

C-Skill Reports: Each report (C1, C2 and C3) is scored on a 3-point scale.

$$\text{Average} = \frac{C1+C2+C3}{3}$$ (Rounded UP: 1.3 = 2)

Calculated in the same manner as A-Skills.



FE Bonus Skill: You can improve your grade by 1/3 of a letter grade by scoring over 50% on a simulated 12 question FE exam during the final exam session. This is a Bonus Skill (you use this skill to replace any skill in the course you have not yet met). A practice set of FE style problems will be provided.

Design Option: Students may demonstrate mastery of one skill: **A1**, **A2** or **C2** by applying that skill to a technical analyses and redesign proposal for an existing amusement park attraction. Students should discuss their project ideas with the professor before beginning their work. The technical report will be assessed with the same 3-point scale as other A and C skills.

For many students nothing captures the joy of applied Dynamics like an amusement park. Our **Learning Assessment** structure will celebrate that joy by working our way through 12 relevant Hershey Park attractions.
Earn your way to coaster master by developing your dynamics skills and earing each ride badge:

Master 1 F/P skill	Reese's Cupfusion (F1)		F
Master 2 F/P skills	The Howler (P1)		D-
Master 3 F/P skills	Storm Runner (F2)		D
Master 4 F/P skills	Pirate Ship (P2)		D+
Master 5 F/P skills	Comet (F3)		C-
Master 6 F/P skills	Fender Bender (P3)		C
Earn 1 A/C skills point*	Starship America (A1)		C+
Earn 2 A/C skills points	Tilt A Whirl (A2)		B-
Earn 3 A/C skills points	Sooper Dooper Looper (A3)		B
Earn 4 A/C skills points	Tidal Force (C1)		B+
Earn 5 A/C skills points	The Claw (C2)		A-
Earn 6 A/C skills points	Frontier Flyers (C3)		A

***** You must earn 5/6 F/P skills to unlock the A/C skills.

Adjustment 1: This will be a fast-paced course and it is critical that every student attend every class session. If you have more than 2 unapproved absences your course grade will be reduced by one ride (1/3 of a letter grade).

Adjustment 2: Participating in daily out-of-class work is essential to your success in this course. If you do not satisfactorily complete 80% of daily discussion assignments, your grade will be reduced by one ride (1/3 of a letter grade).

I am committed to the principle of universal learning. This means that our classroom, our virtual spaces, our practices, and our interactions be as inclusive as possible. Mutual respect, civility, and the ability to listen and observe others carefully are crucial to universal learning. Active, thoughtful, and respectful participation in all aspects of the course will make our time together as productive and engaging as possible. I strive to create a learning environment and classroom where you will be treated with respect, and individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, immigration status, national origins, religious affiliations, sexual orientations, ability – and other visible and nonvisible differences are welcomed.

To help create an environment of learning, please remember all of us must:

- understand that diversity and representation is vital to learning and our community.
- use language that includes everyone.
- know that sex and gender are not binaries.
- acknowledge that race is a social construct with no place in the study of biology.
- address people the way they would like to be addressed, including names and pronouns, and we do not make assumptions based on someone's appearance.

- believe the lived experiences that others share with us.

Your success in this class is important to me. If there are circumstances that may affect your performance in this class, please let me know as soon as possible so that we can work together to develop strategies for adapting assignments to meet both your needs and the requirements of the course.

To help us all expand our cultural understanding and compassion for each other, I ask that you join me in attending at least one Diversity, Equity, and Belonging event this semester (not required for any other course). To unlock the bonus skill opportunities, you must attend one of these events and submit a 150 word reflection on the experience.

Ethics: Students are to act in accordance with the Pledge of Integrity (Etown College Integrity Statement):

> I pledge to respect all members of the Elizabethtown College community, and to act as a responsible member of the College community. I pledge to respect the free exchange of ideas both inside and outside the classroom. I pledge to represent as my work only that which is indeed my own, refraining from all forms of lying, plagiarizing, cheating, and academic dishonesty.
>
> As members of the Elizabethtown College community, we hold each other responsible in the maintaining of these values.

and the NSPE code of ethics (Cannons attached, with Etown Engineering Professional Obligations).

Students will be asked to reaffirm their commitment to the pledge and the code with their signature on each exam. Dishonest practice can result in failure of the course and possibly expulsion from the college.

All work should represent each student's individual efforts. **Students are encouraged to discuss assignments with other students and/or the instructor, however submitted assignments should reflect the student's own work and understanding.**

All work obtained from any source should be properly referenced.

This includes AI. In this course, students shall give credit to AI tools whenever used, even if only to generate ideas rather than usable text or illustrations. When using AI tools on assignments, add an appendix showing (a) the entire exchange, highlighting the most relevant sections; (b) a description of precisely which AI tools were used (e.g. ChatGPT private subscription version or DALL-E free version), (c) an explanation of how the AI tools were used (e.g. to generate ideas, turns of phrase, elements of text, long stretches of text, lines of argument, pieces of evidence, maps of the conceptual territory, illustrations of key concepts, etc.); (d) an account of why AI tools were used (e.g. to save time, to surmount writer's block, to stimulate thinking, to handle mounting stress, to clarify prose, to translate text, to experiment for fun, etc.). Students shall not use AI tools during in-class examinations, or assignments unless explicitly permitted and instructed. Overall, AI tools should be used wisely and reflectively with an aim to deepen understanding of subject matter.

Integrity violations on a Skill assessment will result in a minimum of a 3 skill deduction in the final grade (equivalent to a 0 on an exam in a traditionally graded course).

Re-Grading: Written requests, with full rationale, for re-grading of all course-work will be accepted the next class period after original materials are returned to the students.

Statements on Disability Services, Religious Observances, and COVID-Related Expectations:
Link to Statements

This course has been configured for in person, hybrid, on-line learning. We will continue the learning experience in whatever delivery model is required. Canvas materials are in place for all course topics.

Fine Print: The preceding information represents the *intent* of the course and is subject to change at the discretion of the instructor.

Elizabethtown Engineering Program Code of Ethics

I. **Hold paramount the safety, health, and welfare of fellow students.**
II. **Perform project tasks and assignments only in the areas of their competence.**
III. **Submit assignments only in an objective and truthful manner.**
IV. **Act for team members, instructors, or employers as faithful agents or trustees.**
V. **Avoid deceptive acts.**
VI. **Conduct themselves responsibly, ethically, lawfully, and in line with the integrity policy so as to enhance the honor, reputation, and usefulness of the profession and college's engineering department.**

Professional Obligations (Etown Engineering Students)

1. **Engineering students shall be guided in all their relations by the highest standards of honesty and integrity.**
   A. Be honest about your mistakes.
   B. Do not cheat on exams or assignments.
   C. Do not plagiarize or falsify data.
   D. Do not aid or abet another student in unethical behavior.
2. **Engineers shall at all times strive to gain the knowledge to serve the public's interest.**
   A. Your goal in class should be to gain knowledge to justify your intended degree, not just to obtain a high grade.
   B. Work for the advancement of society and the profession by engaging in the community, and recruiting youth to the engineering profession.
   C. Inform professors of unethical requests from other students.
3. **Engineers shall avoid all conduct or practice that deceives other students, instructors, or the public.**
   A. In lab work, be truthful with ALL data, even if it is not favorable.
   B. All assignments should be your own original work unless otherwise noted.
   C. Do not finish and submit team projects without the approval of ALL your other team members.
4. **Engineers shall not disclose confidential information concerning their own group work to any person outside of their group except for the professor.**
   A. Do not put individual assignments in your public folder.
   B. Do not spread the word of quiz questions or unannounced assignments to later sections of a course.
   C. Engineering students who are or have been a TA shall not disclose information about tests and grades of other students.
   D. Do not disclose or use information learned from the internships that have to do with processes, or techniques of production.
5. **Engineering students shall not be influenced in their scholastic duties by conflicting interests.**
   A. Do not attempt to receive a favorable grade or recommendation by establishing an unprofessional relationship with a professor.
   B. In peer assessments or as a TA, do not allow friendships or grades to sway judgment
   C. Do not attempt to gain favor in class or for assignments through flattery of professors.

6. **Students should not attempt to gain advancement by downgrading other students' work or by other questionable methods.**
   A. Credit should be awarded where it is deserved when submitting group work.
   B. If another student does exceptional work, do not take credit for it if it is not your work.
   C. If another student is performing inadequate work, calmly confront them about it before addressing it to the professor.
   D. Students shall not sabotage the projects or advancements done by other students.
   E. Do not blame group members for their own behavior.
   F. Do not blame professors or staff for their grades.

7. **Engineering students should not attempt to injure the reputation of the engineering department or the reputation of professors and engineers in the department.**
   A. If other engineering students are injuring the reputation of the department, you should inform the head of the department or the professor of their actions.
   B. Every student in the department's actions should coincide with the integrity policy of the college to avoid degrading the department.
   C. Students shall report malicious activities to the Head of the Engineering Department, or appropriate instructor. Yet, the student shall not tell others of the issue.

8. **Engineering students should accept personal responsibility for all of the work they do for the department and for their group.**
   A. Students shall act truthfully when accused of misconduct.
   B. Blame for violations of the integrity policy should not be placed on the department or professors, but rather on the individual who committed them.
   C. Students should also accept the blame if their group submits unethical work because it is their responsibility to ensure any submission with their name on it is held to high ethical standards.

9. **Engineering students shall give credit for engineering work to those to whom credit is due, and will recognize the proprietary interests of others.**
   A. Students shall not steal programs or work from other engineers or students from the internet through illegal networks.
   B. Students shall properly cite information in all manners of presentation such as research papers, essays, PowerPoints, etc.

Obligations written by Etown Engineering students Class of 2021
Cannons adapted from: https://www.nspe.org/resources/ethics/code-ethics