Proposed Revised Graduate Course

Course Title

Theory and Performance of Propellants and Explosives II

Program

Mechanical Engineering

Proposed Course No.

ME506

Catalog Description

The class covers the treatment of the physical and chemical theoretical principles which govern the characteristics and performance of propellants and explosives. This will include the theories to explain stability, sensitivity, combustion, detonation, initiation, power, thermochemical and thermodynamic calculations to enable performance to be predicted. Select topics in shock physics will be presented.

Course Objectives

The course is designed for students who will work in munitions systems utilizing explosives and/or propellants. This course will provide the students with an understanding of the materials, technologies, and science behind munition systems' explosive and propellant components.

List of Course Outcomes

The student will be able to:

- Determine graphically and compute numerically the state properties resulting from a high-speed collision.
- Compute the Chapman Jouget conditions at the detonation front.
- Compute the pressure caused by a detonation wave impacting a material.
- Explain the meaning of the various UN classifications of explosives.
- Compute the velocity of explosively thrown fragments.
- Understand and make simple computations for high pressure equations of state.
- Be able to compute safe and lethal distances from a detonating charge.
- Understand the basics of chemical rockets design.
- Identify types of warheads and the uses for each.
- Describe the basic test methods for detonation testing.
- Understand basic safety testing and the relationships to production and use.
- Understand the needs for Insensitive Munitions and the relationship to safety and operations

Prerequisites

Acceptance into Stevens masters program.

Cross-listings

N/A

Grading Percentages

Homework	☒ _20%	Class work	☐ ___%	Projects	☒ _20%	Quizzes	☐ ___%
Mid-term	☒ _20%	Final	☒ _30%	Other	☒ _10% Specify: _Attendance_____		

Number of Credits

3 credits ☒ Other ☐ Specify: ___

For Graduate Credit toward Degree or Certificate

Yes ☒ No ☐ Other ☐ Specify: _____

Textbooks or References

- Meyers, Marc A., Dynamic Behavior of Materials, John Wiley & Sons, 1994.
- Cooper, Paul W., Explosives Engineering, Wiley-VCH, 1996.

Mode of Delivery

In-class ☒ Online ☐ Modules ☐

Other ☐ Specify: _____Online may be used occasionally_____

Department Ownership

Department of Mechanical Engineering

Syllabus

	Topic(s)	Reading(s)	Class Exercises (Optional)	Homework
1	Shock Waves in Solids Review	Meyers Chapter 2, 4 Cooper chapters 16-19		Research a technical journal article for the class assignment. Reading assignment
2	Detonation Physics Review	Meyer chapter 10, Cooper chapter 20, 21		Write a MATLAB or Excel program to compute state properties resulting from a high speed collision. Use program and graphical methods for an assigned collision and compare results.
3	High Strain Rate Modeling	Meyer chapter 6		Essay questions on Eulerian and Lagrangian modeling, and the Courant condition.
4	Air Blast	Cooper chapter 28		Computations of shock waves and safe distances
5	Explosive Equivalence Relative Equivalence			Compute the relative equivalence of several explosives
6	Gurney and Taylor Angle Formulation	Cooper Chapter 27		Compute velocity and direction of a flat plate driven by and explosive.
7	Warheads	None		Take-home Midterm exam
8	Warheads	None		
9	Fragment Impact Models			Computation of velocity required for Initiation
10	Equations of State	None		Computations using the JWL Equation of State
11	Rocketry			Thrust computations
12	Aging	None		
13	Safety Testing	None	Run an analysis from data generated in class	From provided data, determine reliability of initiation using Bruceton analysis.
14	Insensitive Munitions Student Presentations Thing not covered earlier			
15	Things not covered earlier	Cooper chapters 23-24, 30	Student Presentations	Take-home final exam
16	Final review	None		Final exam collected.

Select an area of your interest in a research area related to the course

For the class project the student will select an area of interest in a research area related to the course and obtain instructor approval. The student will individually write and submit a review article in the format of a technical journal (IEEE) and prepare a PowerPoint presentation. The following elements are required:

- References from the journals and papers used.
- Statements on the next steps in the research to push the technology.
- Your prediction where the technology is going.

The power point presentation will be given to the class.

Homework is assigned each week with the following grading system:

- Correct 100%
- Incorrect but fair attempt 100%
- Incomplete but with a clear explanation of your problems understanding the assignment, 100%
- Otherwise 0%