PROVOSTINST 1531.21G

01 AUGUST 2023

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Core Course Compendium

DEPARTMENT OF THE NAVY
OFFICE OF THE PROVOST
UNITED STATES NAVAL ACADEMY
589 MCNAIR ROAD
ANNAPOLIS MARYLAND 21402-1300

PROVOSTINST 1531.21G
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From: Provost, U.S. Naval Academy

Subj: THE CORE CURRICULUM

Ref: (a) ACDEANINST 1531.21F

Encl: (1) Core Course Compendium

1. Purpose. To provide descriptions on the courses comprising the core curriculum at the Naval Academy.

2. Cancellation. Academic Dean Instruction 1531.21F

3. Background. The four-year curriculum at the Naval Academy is designed to enable each midshipmen to meet the basic criteria necessary to graduate. It consists of core courses, elective courses, and courses in selected majors. The core portion of the curriculum provides the technical and professional foundation for all midshipmen, and it consists of courses offered by the Schools of Engineering and Weapons, Humanities and Social Sciences, Mathematics and Science, and Professional Development.

4. Information. Enclosure (1) contains descriptions of all courses.

5. Records Management.

a. Records created as a result of this notice, regardless of format or media, must be maintained and dispositioned for the standard subject identification codes (SSIC) 1000 through 13000 series per the records disposition schedules located on the Department of the Navy/Assistant for Administration (DON/AA), Directives and Records Management Division (DRMD) portal page at https://portal.secnav.navy.mil/orgs/DUSNM/DONAA/DRM/Records-and-Information-Management/Approved%20Record%20Schedules/Forms/AllItems.aspx.

b. For questions concerning the management of records related to this instruction or the records disposition schedules, please contact your local records manager or the DONAA/DRMD program office.

6. Review and Effective Date. Per OPNAVINST 5215.17A, the Provost will review this instruction annually on the anniversary of its effective date to ensure applicability, currency, and consistency with Federal, DoD, SECNAV, and Navy policy and statutory authority

using OPNAV 5215/40 Review of Instruction.

S. L. FIREBAUGH
Provost

Releasability and distribution: This instruction is cleared for public release and is available electronically via the Provost Instructions internet website:
https://www.usna.edu/Academics/Provost/Rules-Regulations/Instructions.php

MESSAGE FROM THE PROVOST

The academic program at the United States Naval Academy is challenging and yet it is one of the most rewarding undergraduate academic programs offered in the world. Our core curriculum provides all of our graduates with the educational foundation necessary to support any unrestricted line service assignment. It also provides the foundation for our majors programs and future Navy graduate education programs.

The purpose of this booklet is to provide students and faculty with a better understanding of our core courses. A companion document, the Majors Handbook, provides detailed information on the majors offered at the academy.

This booklet contains descriptions of the core courses in terms of individual course prerequisites, objectives, content, and skills that students are expected to have upon completion of each course. After examining the descriptions of the core courses, one should realize the interrelationships that exist among the courses and the fact that the academic program at the Naval Academy is a continuum, with each course building upon previous courses.

I strongly recommend that as our students proceed through the curriculum, they refer to the prerequisites, objectives, and expected skills of each course they are taking or have taken, when appropriate. Similarly, I recommend that our faculty use this booklet to familiarize themselves with the courses that precede or follow the courses that they teach in order to better draw out those themes that thread through the core curriculum.

I hope that this new-found appreciation of how each course connects and contributes to the development of midshipmen will result in a rewarding educational experience for all.

S. L. FIREBAUGH

TABLE OF CONTENTS

SCHOOL OF ENGINEERING AND WEAPONS

Electrical and Computer Engineering

Mechanical Engineering Department

Aerospace Engineering Department

Naval Architecture and Ocean Engineering Department

Weapons, Robotics, and Control Engineering Department

NL110
Applied Behavioral Sciences for the Naval Leader
(2-0-2)

1. Texts
    a. Preparing to Lead- Introduction to Character & Leadership Development (required)

2. Corequisites and Prerequisites.
    a. 4/C Standing

3. Students required to take this course
    a. All midshipmen

4. Course Description

    Midshipmen examine fundamental tenets of leadership in the context of the theories and principles of individual and group leadership during their first semester. Topics include self-knowledge, self-leadership, and team leadership as well as a Brigade Leader seminar on peer leadership. Midshipmen learn about themselves as leaders through inventories such as the Myers-Briggs Type Indicator, StrengthsFinder inventory, and Values in Action survey which culminates in creating a personal life mission statement. The course instructors provide relevant personal and Fleet-based examples and emphasize interactive learning.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:

- Recall the basic processes of their own personhood and interpersonal interaction, and relate this knowledge to leadership tasks and challenges at the Naval Academy.
- Be able to analyze the students' own personality, values, and talents, and the sources of and influences on these aspects of the self.
- Apply course concepts in order to function as an active, thoughtful, effective follower, and demonstrate the knowledge, attitudes, and behaviors consistent with thoughtful and effective leadership.
- Create a vision for continued development in preparation for leadership roles at the Naval Academy and in the Fleet.

6. Course Content Hours of Classroom Instruction

NE203
ETHICS AND MORAL REASONING
(3-0-3)

1. Texts
    a. Ethics and Moral Reasoning for Naval Leaders (Revised Edition) (required)

2. Corequisites and Prerequisites.
    a. 3/C Standing

3. Students required to take this course
    a. All midshipmen

4. Course Description
    a. This course is designed for Midshipmen to evaluate the moral responsibilities inherent in military leadership, responsibilities that require discerning moral perception, reflective ethical deliberation, and the development of moral virtue. Recent and historical case studies are combined with insights from ethical theory in order to consider how the long history of ethical thought can best be applied to the life of a modern, professional military leader.

5. Course Learning Outcomes.

    At the successful completion of this course the student will be able to:

    1. Analyze the social and situational pressures that complicate and influence moral perception.
    2. Synthesize different moral considerations to aid in making complex moral decisions.
    3. Evaluate the proper role of moral excellences, especially in light of experimenting with and reflecting upon the role of virtues in a flourishing, fulfilling life.
    4. Apply objectives 1-3 in order to evaluate the moral obligations and responsibilities of military leadership.
    5. Apply objectives 1-3 in order to evaluate moral questions regarding warfare, specifically when considering questions of *jus ad bellum* and *jus in bello.*

6. Course Content — Hours of Classroom Instruction
    a. Moral Perception — 6
    b. Moral Deliberation — 15
    c. Moral Excellence (Virtue) — 15
    d. Morality of War — 12

NL310
ORGANIZATIONAL BEHAVIOR FOR THE NAVAL LEADER
(3-0-3)

1. Texts
    a. Hughes, R. L., Gwinnett, R. C., Curphy, G. J. (2022) Leadership: Enhancing the lessons of experience. (10th edition) New York: McGraw-Hill.Text 2 (required)
    b. Wray, R.O., Ledford, A.K., Mustin, J.B, LeClair, T.P. S. (2021) Saltwater Leadership: A Primer on Leadership for the Sea Services. (2nd edition), Annapolis: Naval Institute Press (required)

2. Corequisites and Prerequisites.
    a. 2/C Standing

3. Students required to take this course
    a. All midshipmen

4. Course Description

    Students examine the theory and research of the contingent and dynamic process of leadership. Students refine and further develop their understanding of personal strengths, values, and growth opportunities in the context of team, group, and organizational leadership, as well as through the creation of a leadership vision and professional development plan. The course combines literature from the fields of social psychology, organizational behavior, and group dynamics to help students understand the factors that influence leadership in a military context.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Have a better understanding on how to think critically as leaders.
    b. Have an understanding of how their personal strengths, personal and organizational values, and opportunities for growth impact their leadership style.
    c. Have an in-depth knowledge of the most recognized and accepted theories of leadership, and group and interpersonal dynamics.
    d. Have a foundation of tools associated with providing counseling and feedback, oral and written communication, decision making, team building and motivation, conflict management, and peer leadership to assume the mantle of leadership within the Brigade and as junior officers in the fleet.

e. Have an understanding of the unique human factors that influence the leadership process in a combat and operational environment.

f.

6. Course Content	Hours of Classroom Instruction
a. Leadership Process	4
b. Ethical Leadership	2
c. Personality	2
d. Motivation	2
e. Performance Management	3
f. Culture and Values	7
g. Team Dynamics	6
h. Warrior Toughness	5

NL400
LAW FOR THE NAVAL OFFICER

1. Texts
    a. Law for the Junior Officer electronic coursebook (required)

2. Corequisites and Prerequisites
    a. 1/C standing or permission of department chair

3. Students required to take this course
    a. All midshipmen

4. Course Description. This course provides a broad survey of military law applicable to the junior officer. Students examine operational law concepts including the Law of Armed Conflict and the Law of the Sea. The course also explores a variety of military justice topics including constitutional issues such as search and seizure and self-incrimination, judicial and non-judicial forums and the administrative separation of enlisted service members from the Navy and Marine Corps.

5. Course Learning Outcomes.
    a. Understand the legal and administrative tools available to military leaders at various levels of command when confronting possible servicemember misconduct and also understand servicemembers' rights in these situations.
    b. Understand the basic purpose of the Uniform Code of Military Justice (UCMJ), including offenses unique to the UCMJ, and understand the regulations outlining military policy on equal opportunity and ethics.
    c. Apply administrative law and military justice knowledge when creating a complete, cohesive, and correctly-formatted Command Investigation in accordance with applicable provisions of the Manual of the Judge Advocate General, JAGINST 5800.7G.
    d. Understand and analyze the legal concepts governing International Law, Law of the Sea, and the Law of Armed Conflict.

6. Course Content — Hours of Classroom Instruction
    a. Administrative Law — 9
    b. Military Justice — 13
    c. Operational Law — 6

NS101
FUNDAMENTALS OF SEAMANSHIP
(1-2-2)

1. Texts
    a. Navigation Rules & Regulations Handbook (72 COLREGS) (required)
    b. Dutton's Nautical Navigation, 15th edition (provided)
    c. Naval Shiphandler's Guide (provided)
    d. Bluejacket's Manual, 24th edition (provided)
    e. Watch Officer's Guide, 15th edition (provided)
    f. USNA Version of MTP 1(D), Vol. II (provided)
    g. ACP-125(F) Radiotelephone Communications (provided)
    h. Publication 9: American Practical Navigator ("Bowditch") (provided)
    i. Publication 102: International Code of Signals (ICS) (provided)
    j. Chart No. 1 – Nautical Chart Symbols, Abbreviations & Terms (provided)
    k. Pub 1310 (Radar Navigation and Maneuvering Board Manual) (provided)

2. Corequisites and Prerequisites.
    a. Courses: None
    b. Placement: None
    c. Class year: 4/C

3. Students required to take this course
    a. All midshipmen

4. Course Description:

    Provide basic maritime background in general ship characteristics, ship handling, and international and inland navigational rules (i.e. Rules of the Road). Includes at-sea labs on 108 foot Yard Patrol (YP) Craft and shore-based simulator labs, providing midshipmen with hands-on experience navigating in and out of harbors, ship handling, and practical application of the navigation rules.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Understand and operate underway using standard commands, shiphandling concepts, types of direction, shipboard instruments, and aids to navigation.
    b. Explain the characteristics of naval vessels, the relationships between common watch teams, and how vessels conduct the special operations and evolutions.
    c. Understand and apply the USCG Rules of the Road - International and Inland.
    d. Solve basic maneuvering for contact tracking and understanding of relative motion.

6. Course Content	Hours of Classroom Instruction
a. Ship Fundamentals	2
b. Watchstations & Equipment	1
c. Marine Weather, Forces & Standard Commands	2
d. Shiphandling	1
e. YP Static Display	1
f. YP/Simulator Lab 1 for Standard Commands and Shiphandling	2
g. Terrestrial Sphere & Direction	1
h. Charts, Aids to Navigation	1
i. Rules of the Road	6
j. Tactical Communications	1
k. YP/Simulator Lab 2 for Rules of the Road	2
l. Special Evolutions	2
m. Relative Motion & Contact Reports	4
n. YP/Simulator Lab 3 for Special Evolutions	2
o. ORM/BRM	1
p. Case Study	1

NN220
NAVIGATION AND PILOTING
(1-2-3)

1. Texts
    a. COMDTINST M16672.2D Navigation Rules (required)
    b. Bowditch 2019 edition (provided)
    c. Pub 1310 (RADAR Navigation Manual) (provided)
    d. COMNAVSURFOR/COMNAVAIRFOR 3530.4 series (NAVDORM) (provided)
    e. PRODEVINST 3120.2 series (YP SOP) (provided)

2. Prerequisites.
    a. Courses: NS101 prerequisite
    b. Placement: None
    c. Class year:3/C

3. Students required to take this course
    a. All midshipmen

4. Course Description:

    A comprehensive introduction to basic navigation concepts, celestial navigation, and voyage planning. The course objective is to develop skills in the practical uses of the navigation chart, electronic navigation systems, and STELLA. Yard Patrol (YP) Craft will provide hands-on experience for both paper plotting and electronic navigation in and out of the harbor. Navigation Seamanship will be reinforced.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:

    a. Prepare a navigation plan, including a nautical chart with a track and an electronic route. Conduct voyage planning, present a navigation brief, and operate safely underway while plotting the ship's position on a prepared chart.

    b. Understand and apply the fundamentals of GPS, RADAR navigation, and celestial navigation. Understand the basic theory behind each and the application to naval operations. Understand Bridge Resource Management and the processes to mitigate risk through Error Chain Analysis and emergency navigation.

    c. Understand and apply the USCG Rules of the Road - International and Inland

6. Course Content	Hours of Classroom Instruction
a. Introduction to Marine Navigation	1
b. Nautical Chart Principles	2
c. Nautical Publications	1
d. Short Range Aids to Navigation	1
e. Chart Preparation	2
f. Track Preparation	2
g. Dead Reckoning and Piloting	2
h. Introduction to Electronic Navigation	2
i. Introduction to Voyage Management System	2
j. RADAR Navigation	2
k. Time and Navigation	2
l. Preparations for Getting Underway	2
m. Introduction to Celestial Navigation Theory	2
n. Celestial Days Work in Navigation (DWIN)	2
o. PLANETARIUM PRACTICAL DEMONSTRATION	2
p. STELLA	2
q. Emergency Navigation	2
r. Bridge Resource Management	2

NN310
ADVANCED NAVIGATION
(1-2-2)

1. Texts
    a. Bowditch 2019 edition (provided)
    b. Dutton's Nautical Navigation Fifteenth edition (provided)
    c. Pub. 217 (Maneuvering Board Manual) (provided)
    d. Pub 1310 (RADAR Navigation Manual) (provided)
    e. COMNAVSURFOR/COMNAVAIRFOR 3530.4 series (NAVDORM) (provided)
    f. PRODEVINST 3120.2 series (YP SOP) (provided)
    g. COMDTINST M16672.2D Navigation Rules (provided)

2. Prerequisites.
    a. Courses: NS101, NN210, NN220
    b. Placement: None
    c. Class year: 2/C

3. Students required to take this course
    a. All midshipmen

4. Course Description

    A comprehensive introduction to electronic and celestial navigation topics. Midshipmen will use Navy approved systems such as Voyage Manage System (VMS) and STELLA for hands-on learning during labs. This course will build upon the foundation of navigation and seamanship skills established in NS101 and NN210, reinforcing and expanding upon topics such as voyage planning, time zones, Rules of the Road, maneuvering boards, and Bridge Resource Management.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Design and safely operate an electronic navigation plan utilizing the Electronic Chart Display and Information System (ECDIS) and the Navy's Voyage Management System (VMS).
    b. Understand and apply the fundamentals of GPS, RADAR navigation, and celestial navigation.
    c. Understand and apply the USCG Rules of the Road - International and Inland.
    d. Solve advanced maneuvering board problems to include contact tracking, contact avoidance, stationing/intercept and true/desired winds.

6. Course Content — Hours of Classroom Instruction

a.	Introduction to electronic navigation/ECDIS	1
b.	Global navigation satellite system (GNSS)/GPS/Datum	1
c.	Voyage Planning	3
d.	VMS Intro and Chart Prep	4
e.	RADAR Navigation	1
f.	Celestial Navigation Theory	5
g.	STELLA	2
h.	Maneuvering Boards	5

NS384 / NS300
MARITIME WARFARE
(2-2-0)

1. Texts
    a. Joint Publication 1&3 (provided)
    b. National Security Strategy (provided)
    c. MMCDP (provided)
    d. Force Design 2030 (provided)
    e. Distributed Maritime Operations (provided)
    f. Stand-in-Forces (provided)
    g. TM-EABO (provided)
    h. Annual Threat Assessment of the U.S. Intelligence Community (provided)
    i. Expeditionary Operations (provided)

2. Corequisites and Prerequisites.
    a. Courses: NS101, NN220
    b. Placement: None
    c. Class year: 2/C (Spring 2024 experimental class will be 3/C)

3. Students required to take this course
    a. All midshipmen

4. Course Description

    This course provides midshipmen with critical knowledge of the maritime environment in which they will be operating and leading as junior officers. Midshipmen will develop an understanding of the organization and structure of the fleet, the integration of our Naval and Marine Corps assets, capabilities and limitations of our mission areas, and execution of maritime strategy. This course will challenge midshipmen to understand what strategic challenges the Department of the Navy faces, and how our naval force is developed and operationally employed to address these challenges.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Comprehend current maritime strategy.
    b. Comprehend the mission and basic organization of the Navy and Marine Corps.
    c. Know the basic characteristics and capabilities of the major weapons systems and platforms of the U.S. Naval Forces.

6. Course Content	Hours of Classroom Instruction
a. Theory of War	1
b. Strategy and Levels of Operation	1
c. Missions and Organization of the Navy and Marine Corps.	1
d. Joint Operations	1
e. Command and Control	1
f. Geographic Baseline	1
g. Fleet Operations	1
h. Surface Combatant Caps and Lims	2
i. Submarine Caps and Lims	1
j. Navy Aircraft Caps and Lims	1
k. Carrier Strike Group Operations	1
l. Adversaries	3
m. Amphibious Operations and Marine Corps Capabilities	1
n. Building a Tactical Environment	1
o. Wargaming Simulation	8

NS43X
JO PRACTICUM
(1-2-2)

1. Texts
    a. Community Specific (various)

2. Corequisites and Prerequisites.
    a. Courses: N/A
    b. Placement: Based upon Fall Service Assignments
    c. Class year: 1/C

3. Students required to take this course
    a. All midshipmen

4. Course Description

    This course provides information about the duties and responsibilities required of a junior officer in the various communities within the Navy and Marine Corp. Instruction and labs incorporates operational procedures and practical applications of leadership and management principles tailored to the specific communities to ensure each midshipmen is ready to assume the ranks as Ensigns or 2nd Lieutenants in the United States Navy or Marine Corps.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Understand the missions, capabilities, and limitations of the United States Navy and Marine Corps and apply to a basic warfare scenario.
    b. Understand the basic organization of the Navy and Marine Corps.
    c. Understand the career pipeline, training and qualification processes for your community.
    d. Understand/Demonstrate the basic administrative responsibilities of a junior officer.
    e. Discuss/Understand/Demonstrate the ethos practical skills associated with your community.

6. Course Content — Hours of Classroom Instruction
    a. Organization of the Fleet and Chain of Command — 1
    b. Career Pipeline — 1
    c. Junior Officer Administrative Responsibilities — 1

HE111
Rhetoric and Introduction to Literature I
(3-0-3)

1. Texts
    a. *The Little Seagull Handbook* (or similar writing handbook)
    b. Selection of essays, plays, and short stories (anthologies or single-author collections, instructor's choice)

2. Corequisites and Prerequisites.
    a. No prerequisites
    b. May validate in one of three ways: Department's placement exam, AP score of 5 on either AP English exam, IB score of 7
    c. Fourth-class midshipmen

3. Students required to take this course
    a. All fourth-class midshipmen, unless they 1) validate or 2) take the honors variant (HE111S) or 3) are placed into HE101 for more intensive writing instruction

4. Course Description

    The first in a two-course sequence. Through the study of a diverse range of essays, short fiction, and drama, students will learn the fundamentals of literary and rhetorical analysis while developing an understanding of writing as a process—from brainstorming, to outlining, to drafting and revising. Assignments will focus on crafting analytical arguments and may include personal essays and public speaking/presentations.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Achieve <u>writing competency</u> by demonstrating ability to
        1) compose a persuasive thesis about a complex topic
        2) support an argument using evidence derived from analytical thinking about a topic
        3) structure a paper in logically and rhetorically effective ways
        4) employ an effective writing style that expresses ideas with clarity and concision
        5) use the grammatical and mechanical conventions of American English

    b. Achieve <u>critical reading competency</u> by demonstrating ability to

1) understand a text's argument and/or idea, its implications, and what it responds to
2) distinguish the characteristics of and employ reading strategies particular to different literary genres (specifically, the essay, short story and drama)
3) analyze texts by showing how choices in textual construction and parts and patterns in the text contribute to meaning and/or purpose

c. Achieve multicultural awareness by demonstrating ability to
1) identify social practices or values of non-dominant or historically marginalized groups in relevant texts
2) examine how their own social locations, cultural backgrounds, and identities shape how they perceive texts

6. Course Content — Hours of Classroom Instruction

a.	Writing process	5
b.	Crafting an analytical argument	7
c.	Grammar & style	3.5
d.	Academic integrity / plagiarism	2
e.	Textual analysis	9
f.	Characteristics & function of genres (short story, play)	4
g.	Rhetorical analysis	2
h.	Public speaking	2
i.	Cross-cultural understanding	3

HE112
Rhetoric and Introduction to Literature II
(3-0-3)

1. Texts
    a. *The Little Seagull Handbook* (or similar writing handbook)
    b. Selection of novels and poems (instructor's choice)

2. Corequisites and Prerequisites.
    a. HE111 or validation
    b. May be placed in course in one of three ways: Department's placement exam, AP score of 5 on either AP English exam, IB score of 7
    c. Fourth-class midshipmen. (For those midshipmen taking the 3-semester intensive sequence, 112 is taken in the third-class year.)

3. Students required to take this course
    a. All midshipmen

4. Course Description

    The second in a two-course sequence. With a focus on a diverse range of poetry and novels, students will learn how to use secondary sources and develop critical thinking and close reading skills. Engaging with multiple points of view, students will complete advanced research projects using professional citation systems. Assignments will advance skills introduced in HE111 and may include longer essays and public speaking / presentations.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Achieve <u>writing competency</u> by demonstrating ability to
        1) compose a persuasive thesis about a complex topic
        2) support an argument using evidence derived from analytical thinking about a topic
        3) structure a paper in logically and rhetorically effective ways
        4) employ an effective writing style that expresses ideas with clarity and concision
        5) use the grammatical and mechanical conventions of American English

    b. Achieve <u>critical reading competency</u> by demonstrating ability to

1) understand a text's argument and/or idea, its implications, and what it responds to
2) distinguish the characteristics of and employ reading strategies particular to different literary genres (specifically, the novel and poetry)
3) analyze texts by showing how choices in textual construction and parts and patterns in the text contribute to meaning and/or purpose

c. Achieve multicultural awareness by demonstrating ability to
1) identify social practices or values of non-dominant or historically marginalized groups in relevant texts
2) examine how their own social locations, cultural backgrounds, and identities shape how they perceive texts

d. Achieve research proficiency by demonstrating ability to
1) Find, analyze, and assess secondary sources for use in a research paper
2) Develop an argument by evaluating and using evidence derived from research of secondary sources
3) Engage critically and thoughtfully with multiple points of view
4) Cite sources using one or more professional formatting styles

6. Course Content — Hours of Classroom Instruction

a.	Writing process	4
b.	Crafting an analytical argument	7
c.	Grammar & style	3
d.	Academic integrity / plagiarism / citation styles	2.5
e.	Information literacy (finding, evaluating sources)	3
f.	Textual analysis	9
g.	Characteristics & function of genres (short story, play)	4
h.	Public speaking	2
i.	Cross-cultural understanding	3

HH104
AMERICAN NAVAL HISTORY
(3-0-3)

1. Texts
    a. Instructor choice
    b. Instructors share common resources

2. Corequisites and Prerequisites.
    a. Courses: None.
    b. Placement
    c. Class year: 4/C

3. Students required to take this course
    a. All midshipmen

4. Course Description

    Description from course catalog:

    This course examines the antecedents, origins and development of the United States Navy and Marine Corps within the framework of America's growth as a continental and, eventually, global power, with particular emphasis on the development of naval and maritime strategy.

5. Course Learning Outcomes.

    All History Core Courses emphasize same four (4) shared common themes:

    - Seapower
    - War & Society
    - Human Differences
    - Global Perspectives

    Upon completion of this course, students will possess:

    A. Historical Competence. Midshipmen will be able to identify factors that shape change over time; to explain historical narratives; and to analyze historical evidence as well as apply it to historical questions. (Common to all History core courses).

B. Communications Competence. Midshipmen will be able to express their ideas in writing clearly, precisely, and in an organized fashion. (Common to all History core courses).

C. Professional Competence. Midshipmen will be able to identify and explain in historical context the basic concepts inherent to the profession of arms, such as tactics, doctrine, strategy, technology, civil-military relations, and combat leadership. (Particularly emphasized in HH104)

HH104 Sub-outcomes of professional competence:

. Describe, explain, and apply to historical examples basic concepts inherent to the profession of arms, such as tactics, doctrine, strategy, technology, logistics, and civil-military relations.

ii. Summarize and explain factors contributing to America's growth to world power status.

iii. Analyze and explain the causes, conduct, and consequences of major wars the United States Navy has fought.

D. Cultural Competence. Midshipmen will be able to compare the political, constitutional, moral, religious, and intellectual traditions, as well as the military organizations and martial values, of the historical societies studied. (Particularly emphasized in HH215/M/A)

E. Geopolitical Competence. Midshipmen will be able to analyze and explain how geography, politics, economics, and demography relate to one another over time in the historical societies studied. (Particularly emphasized in HH216)

6. Course Content

American Naval History teaches the *history* of the U.S. Navy and the U.S. Marine Corps—the actual history as opposed to the mythology, the unrelenting challenge of adaptive leadership as Navy and Marine Corps leaders made decisions with limited resources about better organizing sailors and Marines and choosing new weapon systems ahead of and during tests of conflict. The hardest and most consequential decisions often were made in peacetime missions of naval diplomacy, the protection of American interests, and in preparation for war. The course explores the challenges and successes in creating effective teams from diverse sailors and Marines. It focuses on the rise of American sea power and the projection of American influence beyond the continental United States in rivalry with other sea powers—Britain and France, Germany and Japan, the Soviet Union and China. It traces the development, setbacks, and successes of the Navy and Marine Corps in conflicts from the American Revolution to Iraq and Afghanistan.

HH215X
THE WEST/ASIA/MIDDLE EAST IN PREMODERN HISTORY
(3-0-3)

1. Texts
    a. Instructor choice
    b. Instructors share common resources

2. Corequisites and Prerequisites.
    a. Courses: None.
    b. Placement
    c. Class year: 4/C or 3/C

3. Students required to take this course
    a. All midshipmen

4. Course Description

Description from course catalog:

The West in the Premodern World (HH215)
This course analyzes the historical evolution of ethical thought and its impact upon European society and culture from Antiquity to the Enlightenment in a comparative context of world religions and values. By studying the cultural expressions of Western ethical concerns, ideals and aspirations in light of other civilizations, this course broadens knowledge of the West's global context, cultivates the development of critical thinking about human beings and their societies, and deepens understanding of the competing values, institutions, and challenges of the modern West. The course fulfills the graduation requirement listed on matrices as HH2XY.

Asia in the Premodern World (HH215A)
This course is designed to provide an alternative to HH215, *The West in the Premodern World*. It introduces students to pre-modern Asian civilization, including China, India, Japan and Southeast Asia. This course traces the dynamic manifestations of cultural, political, military and intellectual patterns, and examines them through a global perspective. Students will study ancient Asian societies, cultures, and ethical thought in comparison with other world traditions including Classical, Judeo-Christian and Islamic cultures. The course fulfills the graduation requirement listed on matrices as HH2XY.

The Middle East in the Premodern World (HH215M)
This course is designed to provide an alternative to HH215 *The West in the Premodern World.* It introduces students to pre-modern Middle Eastern civilizations. This course

traces the dynamic manifestations of cultural, political, military and intellectual patterns, and examines them through a global perspective. Topics include Middle Eastern ways of war. Moreover, students will encounter ancient Middle Eastern sages and their ethical ruminations not only in their own regard, but also in comparison with their counterparts in other world traditions including Classical, Asian, Judeo-Christian and Islamic cultures. The course fulfills the graduation requirement listed on matrices as HH2XY.

5. Course Learning Outcomes.

All History Core Courses emphasize same four (4) shared common themes:

- Seapower
- War & Society
- Human Differences
- Global Perspectives

Upon completion of this course, students will possess

A. Historical Competence. Midshipmen will be able to identify factors that shape change over time; to explain historical narratives; and to analyze historical evidence as well as apply it to historical questions. (Common to all History core courses).

B. Communications Competence. Midshipmen will be able to express their ideas in writing clearly, precisely, and in an organized fashion. (Common to all History core courses).

C. Professional Competence. Midshipmen will be able to identify and explain in historical context the basic concepts inherent to the profession of arms, such as tactics, doctrine, strategy, technology, civil-military relations, and combat leadership. (Particularly emphasized in HH104)

D. Cultural Competence. Midshipmen will be able to compare the political, constitutional, moral, religious, and intellectual traditions, as well as the military organizations and martial values, of the historical societies studied. (Particularly emphasized in HH215/M/A)

HH215/M/A sub-outcomes of cultural competence:

. Describe and explain the most important factors leading to change over time between 500 BCE and 1750 CE in one of the following areas: Europe (HH215), the Middle East (HH215M), or Asia (HH215A).

i. Compare political, ethical, and religious features of civilizations before 1750 CE from at least two of the following areas: Europe, the Middle East, Asia, Africa, or the Americas.
ii. Compare the development of the idea of citizenship in Europe with the evolution of social rights and duties of the individual in one of the following areas: Asia, the Middle East, Africa, or the Americas.

E. Geopolitical Competence. Midshipmen will be able to analyze and explain how geography, politics, economics, and demography relate to one another over time in the historical societies studied. (Particularly emphasized in HH216)

6. Course Content

This first course in a two-course world history sequence covers premodern history—roughly the world before 1700. Students select one of the three versions of this course: *The West in the Premodern World* (HH215)*, Asia in the Premodern World* (HH215A)*,* or *The Middle East in the Premodern World*. (HH215M). All three versions cover world history, but with a different predominant geographic and cultural focus. Students learn the premodern events, some that go back thousands of years, that shaped and continue to shape the everyday lives, worldviews, policies, and self-conceptions of modern nations. They learn how complex agrarian societies developed, how the rulers and peoples of these societies organized to better protect themselves from their neighbors, and how innovations in the arts of war and governance enabled them to conquer and rule others. They learn belief systems, ethical perspectives, and worldviews very different from their own. By studying the origins of world religions such as Judeo-Christianity, Islam, Buddhism, and Hinduism, and ethical systems such as Confucianism and Greek and Roman philosophy, midshipmen are better prepared to understand the potency of these beliefs in the contemporary world. Midshipmen learn about the importance of the Mediterranean, the Indian Ocean, the South China Sea, and the Atlantic and Caribbean, and the great seafaring peoples—Greeks, Arabs, Vikings, and the Ming China fleets of Zheng He, as well as the European mariners who developed the nautical skills to sail anywhere on the planet and return home. Thus, midshipmen learn the premodern roots of globalization, and the context that gave rise to modern capitalism, colonialism, and Atlantic slavery.

HH216
THE WEST IN THE MODERN WORLD
(3-0-3)

1. Texts
    a. Instructor choice
    b. Instructors share common resources

2. Corequisites and Prerequisites.
    a. Courses: None.
    b. Placement: NA
    c. Class year: 3/C or 2/C

3. Students required to take this course
    a. All midshipmen

4. Course Description

    Description from course catalog:

    Focusing chiefly on the period from the 18th century to the present, this course analyzes the most significant political, social, intellectual and economic trends that have shaped contemporary societies. HH216 examines the global impact of European and American cultures over the past three centuries and explores the most important reactions to modernity in both Western and non-Western societies. In doing so, the course situates the West in a global context and prepares students to think critically and comparatively about a changing world.

5. Course Learning Outcomes.

    All History Core Courses emphasize same four (4) shared common themes:

    - Seapower
    - War & Society
    - Human Differences
    - Global Perspectives

    Upon completion of this course, students will possess:

    A. Historical Competence. Midshipmen will be able to identify factors that shape change over time; to explain historical narratives; and to analyze

historical evidence as well as apply it to historical questions. (Common to all History core courses).

B. Communications Competence. Midshipmen will be able to express their ideas in writing clearly, precisely, and in an organized fashion. (Common to all History core courses).

C. Professional Competence. Midshipmen will be able to identify and explain in historical context the basic concepts inherent to the profession of arms, such as tactics, doctrine, strategy, technology, civil-military relations, and combat leadership. (Emphasized in HH104)

D. Cultural Competence. Midshipmen will be able to compare the political, constitutional, moral, religious, and intellectual traditions, as well as the military organizations and martial values, of the historical societies studied. (Emphasized in HH215/M/A)

E. Geopolitical Competence. Midshipmen will be able to analyze and explain how geography, politics, economics, and demography relate to one another over time in the historical societies studied. (Emphasized HH216)

6. Course Content

The second course in the two-course world history sequence, *The West in the Modern World* (HH216), focuses on the two great developments of the past 250 years: An economic revolution based on markets, technological innovation, and international trade, which raised material standards of living for billions; and the emergence of democratic systems of governance, and the ensuing debate that continues today over the relative effectiveness of democratic versus authoritarian forms of government. These twin developments were central to 20th-century history, evident in the Great Depression, the World Wars, and the Cold War, as communists, fascists, and liberal democrats experimented, argued, and fought with one another over which political and economic systems best furthered human welfare. In addition, it focuses on the emergence of nation states and nationalism as well as great power rivalry on land, sea, air, and space. It explains the rise and decline of European power, the rise of the United States, the birth of new states after European colonial rule, and the fall and sudden dramatic return of China to world power. It also covers the end of slavery, the emergence of pseudo-scientific racist ideologies that led to Jim Crow and the Holocaust, and the humanitarian and human rights revolutions that have struggled with some success against the pernicious historical legacies of bias to raise the dignity of all people.

FP130
U.S. GOVERNMENT AND CONSTITUTIONAL DEVELOPMENT
(3-0-3)

1. Texts (instructor choice out of four options)
    a. Lowi, Ginsberg, Shepsle, and Ansolabehere, *American Government: A Brief Introduction* (Optional).
    b. O'Connor and Sabato, *American Government: Roots & Reform* (Optional).
    c. Kernell, Jacobson, Kousser, and Vavreck, *The Logic of American Politics* (Optional).
    d. Abernathy, *American Government: Stories of a Nation* (Optional).

2. Corequisites and Prerequisites.
    a. 4/C Standing.

3. Students required to take this course
    a. All Midshipmen.

4. Course Description
    a. This course introduces Midshipmen to the basic concepts of American democracy, the Constitution, political process, structure and functions of national government and factors influencing its operation; emphasis on legal and ethical demands placed on government officials, both civilian and military, as defined by the Constitution and statute.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Understand the Constitution and its ethical implications.
    b. Apply political concepts to scenarios in context.
    c. Analyze and interpret foundational documents and other sources.
    d. Develop an argument in essay format.

6. Course Content	Hours of Classroom Instruction
a. Constitutional Foundations	10
b. Institutions of American Government	10
c. Political Behavior	10
d. Public Policy & Civil-Military Relations	10

SM005
Pre-Calculus Mathematics
(4-1-4)

1. Texts
    a. Jay Abramson, Algebra and Trigonometry (required)
    b. Matthew Boelkins, Active Prelude to Calculus (required)

2. Corequisites and Prerequisites.
    a. Courses
    b. Placement: by Department Chair
    c. Class year: 4C

3. Students required to take this course
    a. All midshipmen who do not place in a higher-level course

4. Course Description

    Basic review of algebraic and arithmetic operations, analysis of functions and their graphs, and trigonometry. This course may be required in addition to stated graduation requirements for certain midshipmen

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Solve equations, simple systems of equations, and inequalities using algebraic techniques.
    b. Identify and manipulate polynomial, absolute value, power, rational, exponential, logarithmic, and trigonometric functions using algebraic, numerical, graphical, and verbal techniques.
    c. Find domains, ranges, values and compositions of functions.
    d. Determine if functions are one-to-one and find inverses of those that are.
    e. Solve equations containing trigonometric functions in routine and applied problems.

6. Course Content — Hours of Classroom Instruction
    a. Fraction addition, multiplication — 4
    b. Exponent rules — 4
    c. Perimeter and area — 4
    d. Independent and dependent variables — 4
    e. Transformations of functions — 4

f.	Composition of functions	4
g.	Quadratic Equations	4
h.	Polynomials	4
i.	Functions and equations	4
j.	Degrees and radians	4
k.	Inverse trigonometric functions	4
l.	Exponential functions	4
m.	Logarithm and exponential functions	8

SM121
Calculus I
(4-0-4)

1. Texts
    a. Calculus: Early Transcendentals, 8th Edition, by James Stewart (required)

2. Corequisites and Prerequisites.
    a. Courses: None
    b. Class year: 4C

3. Students required to take this course
    a. All midshipmen

4. Course Description

    The first of a traditional two course sequence covering differential and integral calculus of one real variable and infinite series. [fall, spring]

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Interpret, analyze, create, and communicate mathematical models involving derivatives.
    b. Carry out computations involving order of growth, limits, and derivatives.
    c. Relate geometry, formulas, and data to one another.
    d. Interpret mathematical statements in context.
    e. Recognize and solve applied problems, including related rates and optimization.
    f. Explain simple proofs of mathematical results.

6. Course Content — Hours of Classroom Instruction
    a. Geometry and trigonometry — 2
    b. Functions — 7
    c. Continuity, rates of change and derivatives — 8
    d. Rules of differentiation — 13
    e. Approximations — 3
    f. Curve Sketching and Optimization — 13

SM122
Calculus II
(4-0-4)

1. Texts
    a. Calculus, Early Transcendentals, Eighth Edition, by James Stewart (required)

2. Corequisites and Prerequisites.
    a. Courses: Calculus I (SM121).
    b. Class year: 4C

3. Students required to take this course
    a. All midshipmen

4. Course Description

    Continuation of Calculus I. [fall, spring]

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Explain the relationship between derivatives and integrals and decide which of these tools is most appropriate for any given application or problem.
    b. Choose and apply appropriate techniques to evaluate given integrals.
    c. Use integrals to model various applications including motion, volume, and work.
    d. Formulate elementary differential equations to model population growth, interest, heat dispersion and other applications.
    e. Explain the difference between convergent and divergent series and correctly classify simple series.
    f. Express functions as power (Maclaurin, Taylor) series.
    g. Compute and use dot products and cross products in 3-dimensional space.
    h. Write equations of lines and planes in 3-dimensional space.

6. Course Content	Hours of Classroom Instruction
a. Areas and the definite integral	6
b. Volumes and work	5
c. Techniques of integration	7
d. Differential equations	5
e. Series	8
f. Power series	5

g.	Polar coordinates	1
h.	Vectors, lines and planes in space	9

SM208
DATA SCIENCE FOR DECISION-MAKING
(3-0-3)

1. Texts
    a. Computational and Inferential Thinking, The Foundations of Data Science by Ani Adhikari and John DeNero with contributions by David Wagner and Henry Milner (required)

2. Corequisites and Prerequisites.
    a. Courses: SM221 or SM223

3. Students required to take this course
    a. Specific majors: none
    b. Other majors: fulfills SM2XY

4. Course Description

    An introduction to data science with particular attention focused on the needs of decision makers. Topics include: descriptive statistics, requirements for causal inference, data manipulation, data visualization and exposition, data generation via probability models, hypothesis testing and confidence intervals via resampling techniques, the Central Limit Theorem and its implications, regression for prediction and inference, additional machine learning methods, ethical issues in machine learning, and critical thinking in the context of data science. Midshipmen will make extensive use of appropriate computer tools.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Call on standard statistical tools. [This includes conducting hypothesis tests, constructing confidence intervals, fitting predictive models such as linear regression or k-nearest neighbors.]
    b. Identify appropriate methods. [This includes both statistical and visualization methods.]
    c. Properly interpret statistical results. [In particular, interpret p-values, z-scores, t-scores, and confidence intervals.]
    d. Critically assess statistical analysis. [Using the vocabulary of the Paul-Elder model for critical thinking.]

6. Course Content	Hours of Classroom Instruction
a. Univariate data and statistical models	8
b. Multivariate data	3
c. Visualization and data manipulation	5
d. Probability distributions and Bayes' rule	4
e. Hypothesis testis and bootstrapping	6
f. Central Limit Theorem	4
g. Prediction analysis	6
h. Machine learning and data science for decision making	6

SM212
Differential Equations
(4-0-4)

1. Texts
    a. Differential Equations with Boundary Value Problems, 9th ed., by Dennis G. Zill (required)

2. Corequisites and Prerequisites.
    a. Courses: SM221 or SM223

3. Students required to take this course
    a. Specific majors: E*, FAS*, SCB, SCH, SGS, SOC, SP*
    b. Other majors: fulfills SM2XY

4. Course Description

    Linear and simultaneous differential equations; solution by Laplace transform; partial differential equations and Fourier series.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Classify and identify different types of differential equations,
    b. Explicitly solve two important classes of ordinary differential equations: first order separable and first or higher order linear with constant coefficients,
    c. Apply knowledge from linear algebra in order to solve systems of linear differential equations,
    d. Use the Laplace transform to solve differential equations and systems of differential equations with initial conditions,
    e. Use numerical methods to solve differential equations and systems of differential equations,
    f. Use the method of separation of variables in order to solve some basic partial differential equations via Fourier series,
    g. Model certain physical phenomena using differential equations and interpret their solutions.

6. Course Content — Hours of Classroom Instruction
    a. First order linear differential equations — 5
    b. Applications of first order LDE — 3

c.	Homogeneous linear equations and applications	8
d.	Non-homogeneous linear equations and applications	7
e.	Laplace Transform	10
f.	Linear systems and matrices	7
g.	Systems of differential equations	5
h.	Fourier series and heat equations	8

SM221
CALCULUS III WITH VECTOR FIELDS
(4-0-4)

1. Texts
    a. Calculus: Early Transcendentals, 8th Edition, by James Stewart (required)

2. Corequisites and Prerequisites.
    a. Courses: SM122

3. Students required to take this course
    a. Specific majors: SM*, SP*, E*

4. Course Description

    Differential and integral calculus of several real variables; vector analysis including integral theorems.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. describe basic curves and space motion using vector functions and their derivatives and integrals; describe basic surfaces using rectangular, cylindrical, and spherical coordinates; describe basic surfaces using parameterizations
    b. find partial derivatives, directional derivatives, and gradient vectors; demonstrate proficiency in relating these to the changes in a function; demonstrate intuitive understanding of the curl, divergence, and the main theorems in vector calculus
    c. solve extreme value problems by classification of critical points
    d. demonstrate proficiency in evaluating double and triple integrals in various coordinate systems; establish connections between density and mass, center of mass; demonstrate proficiency in evaluating line integrals and surface integrals of vector fields and interpreting the results in connection to work, potential, or flux for the field
    e. write well-organized, coherent solutions to application problems.

6. Course Content — Hours of Classroom Instruction
    a. Vectors — 2
    b. Lines and Planes, Quadratic Surfaces — 4
    c. Vector Functions — 3
    d. Arc Length and Motion in Space — 2

SM223
Calculus III with Optimization
(4-0-4)

1. Texts
    a. Calculus: Early Transcendentals 8th edition, James Stewart (required)

2. Corequisites and Prerequisites.
    a. Courses: SM122

3. Students required to take this course
    a. Specific majors: SME, FL*, FQE, HEG, HHS, SC*, SMO, SCY, SCB, SCH, SDS, FPS
    b. Other: All midshipmen who don't take SM221

4. Course Description

    Differential and integral calculus of several real variables; vector analysis; optimization techniques for functions of several variables.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Describe basic curves and space motion (including projectile motion) using vector functions and their derivatives and integrals.
    b. Draw and interpret level sets and graphs of a real valued function.
    c. Use partial derivatives, directional derivatives, and gradient vectors to describe the behavior of a real valued function.
    d. Solve extreme value problems by finding and classifying critical points and by the method of Lagrange multipliers.
    e. Evaluate double and triple integrals in rectangular and polar coordinates and use integrals to find centers of mass and probabilities.
    f. Write well-organized, coherent solutions to applications problems.

6. Course Content — Hours of Classroom Instruction
    a. Vectors — 4
    b. Lines. Planes, Quadratic Surfaces — 5
    c. Vector Functions, Motion in Space — 5
    d. Partial Derivatives — 5
    e. Linear Approximations and Chain Rule — 5

f.	Gradients and Optimization	9
g.	Double Integrals and Applications	10
h.	Triple Integrals	8

SM230
PROBABILITY WITH NAVAL APPLICATIONS
(3-0-3)

1. Texts
    a. Statistics for Engineers and Scientists Fifth Edition by Navidi, W. C. (2020). (required)

2. Corequisites and Prerequisites.
    a. Courses: SM122

3. Students required to take this course
    a. Specific majors: SGS
    b. Other majors: fulfills SM2XY

4. Course Description

    An elementary treatment of the basic concepts of probability with an emphasis on naval applications. Sample spaces, discrete and continuous random variables and standard distributions. Selected topics of naval applications of probability theory such as random search, minefields and lateral range curves. Conditional probability and Bayes' theorem. Credit will not be given for both SM230 and SM239.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Understand and apply basic probability axioms and counting techniques.
    b. Solve problems (e.g. search and detection) using conditioning and Bayes' Rule.
    c. Express probability statements in terms of the probability mass or density function, or the cumulative distribution function of random variables.
    d. Understand and compute the expected value of a random variable and functions of a random variable.
    e. Model phenomena and quantify uncertainty using key discrete and continuous distributions.

6. Course Content	Hours of Classroom Instruction
a. Probability Axioms and Rules	7
b. Bayes’ Rule and Applications	2
c. Discrete Random Variables	3
d. Continuous Random Variables	3

e.	Functions of Random Variables	3
f.	Joint random variables; covariance	4
g.	Probability distributions and applications	15
h.	Central limit theorem and applications	3

SM239
PROBABILITY AND STATISTICS I
(3-0-3)

1. Texts
    a. Introduction to Probability by J. Blitzstein and J. Hwang (required)

2. Corequisites and Prerequisites.
    a. Courses: SM221 or SM223

3. Students required to take this course
    a. Specific majors: FAS*, SCY, SDS, SMA, SMP
    b. Other majors: fulfills SM2XY

4. Course Description

    An applied study of a variety of discrete and continuous probability models. Probability models covered include binomial, Poisson, exponential, gamma, normal, Student-t, and chi-squared. Methods for calculating probabilities and estimating parameters are included. The Law of Large Numbers and the Central Limit Theorem are included. This course is both a stand-alone course and a prerequisite for Applied Statistics I (SM339). Credit will not be given for both SM239 and SM230.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Understand and apply basic probability axioms and counting techniques.
    b. Solve problems using conditioning and Bayes' Rule.
    c. Express probability statements in terms of the probability mass or density function, or the cumulative distribution function of random variables.
    d. Model phenomena and quantify uncertainty using key discrete (binomial, hypergeometric, geometric, and Poisson) and continuous (uniform, normal, and exponential) distributions.
    e. Compute joint, marginal, and conditional distributions and understand correlation.
    f. Perform basic random variable transformations.
    g. Solve problems using basic probability inequalities, the Law of Large Numbers, and the Central Limit Theorem.
    h. Find estimators using method of moments and maximum likelihood techniques and compute interval estimates.

6. Course Content — Hours of Classroom Instruction

a.	Sample Spaces and Counting	6
b.	Conditional probability and Bayes' rule	4
c.	Random variables	6
d.	Probability distributions, expectations and variance	4
e.	PDFs, uniform, normal, and exponential distributions	5
f.	Joint distributions	3
g.	Convolutions	2
h.	Law of large numbers and the central limit theorem	5
i.	Applications	5

SC111
FOUNDATIONS OF CHEMISTRY I
(3-2-4)

1. Texts
    a. Gilbert, T. R.; Kirss, R. V.; Foster, N.; Bretz, S. L. *Chemistry: An Atoms-Focused Approach*, 2nd ed.; W.W. Norton & Company: New York, 2017. (required)

2. Corequisites and Prerequisites.
    a. Courses - No prerequisite or corequisite courses.
    b. Placement – No placement test.
    c. Class year – Plebe year, Fall semester. Repeat students (those who failed the first semester) would take it again in the Spring.

3. Students required to take this course
    a. All midshipmen unless they have validated the course.
    b. All midshipmen who don't place in a higher-level course
    c. All majors

4. Course Description

    The first in a two-semester sequence presenting the fundamental laws and theories of chemistry. Major topics include chemical stoichiometry, periodic trends, atomic structure, chemical equilibrium, thermodynamics, nuclear chemistry, electrochemistry and kinetics. The lecture material is complemented with experiments designed to develop the student's laboratory skills. Naval applications of chemistry are introduced throughout the courses to provide an awareness of chemistry in normal Navy operations.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Apply the language and fundamental principles of chemistry (atomic/molecular theory, thermodynamics, and kinetics) to explain natural phenomena and to solve problems involving chemical processes.
    b. Collect and critically analyze data sets derived from scientific observations and measurements.
    c. Communicate in written form the process of problem-solving and the results/conclusions derived from experimental results using evidence-based reasoning.

d. Describe how chemistry is essential to issues facing society (such as energy and the environment) and Naval technology (such as explosives, nuclear power, corrosion prevention, submarine air).

6. Course Content	Hours of Classroom Instruction
a. Matter, Chemical and Physical Properties/Changes, Dimensional Analysis	2 (+ 4 lab hours)
b. Atomic Structure, Molecules, Moles	3
c. Electromagnetic Spectrum, Quantum Theory, Periodic Table and Property Trends	4 (+ 4 lab hours)
d. Compounds, Lewis Structures, Bond Properties	4
e. Molecular Geometry & Polarity, Valence Bond Theory	3 (+ 2 lab hours)
f. Intermolecular Forces, Solubility, Properties of Water	2
g. Chemical Reactions, Stoichiometry	4 (+ 2 lab hours)
h. Solutions, Concentration, Reactions of Solutions	3 (+ 2 lab hours)
i. Behavior of Gases	4 (+ 2 lab hours)
j. Thermochemistry: Enthalpy, Heat, and Work	4 (+ 2 lab hours)
k. Explosives	1
l. Organic Chemistry[a]	1 (+ 2 lab hours)
m. Fuels and Fuel Value	1 (+ 2 lab hours)
n. Polymers[b]	1
o. Protein Structure and Function, Enzymes[c]	1
p. Chemical and Biological Warfare[d]	2

[a] Introduction of basic topics from organic chemistry is necessary to discuss Naval applications of chemistry such as fuels, lubricants, and polymers/materials.

[b] There are numerous examples of polymers used across the Navy and Marine Corps for critical applications including body armor, bulletproof materials, and flame-resistant flight suits.

[c] Introduction of basic biochemical principles is needed to discuss the mechanisms and effects of chemical and biological warfare agents, such as Sarin gas.

[d] Topics include a number of examples of toxic agents of military importance such as blister, nerve, choking, blood, and riot control agents.

SC112 / SC151
FOUNDATIONS OF CHEMISTRY II / MODERN CHEMISTRY
(3-2-4)

1. Texts
    a. **SC112**: Gilbert, T. R.; Kirss, R. V.; Foster, N.; Bretz, S. L. *Chemistry: An Atoms-Focused Approach*, 2nd ed.; W.W. Norton & Co.: New York, 2017. (required)

       SC151: Zumdahl, S. S.; DeCoste, D. J. *Chemical Principles*, 7th ed.; Brooks/Cole Cengage Learning: Belmont, CA, 2013. (required)

2. Corequisites and Prerequisites.
    a. Courses – SC111, Foundations of Chemistry I
    b. Placement – No placement test for SC112. Placement into SC151 requires passing SC111 validation exam during Plebe Summer.
    c. Class year –
       SC112: Plebe year, Spring semester. Some students take it during summer school after plebe year if they failed SC112 in the spring OR if they failed SC111 in the fall and then passed SC111 when repeated in the spring.
       SC151: Plebe year, Fall semester

3. Students required to take this course
    a. **SC112**: All midshipmen who don't place in a higher-level course
       SC151: All midshipmen who validate SC111. If there are not enough seats for all validators, then some students would take SC112 in the spring semester instead.
    b. Specific majors – all majors

4. Course Description

   SC112: This is the second in the two-course foundations of chemistry sequence. See SC111 for a general course description. In this version of SC112, naval applications of chemistry including body armor, corrosion, nuclear power, boiler water quality, aircraft deicing, scientific basis of climate change, and scuba diving will be emphasized along with the chemical principles that drive these processes.

   SC151: A one-semester course for the well-prepared student, satisfying the plebe year chemistry requirement. Students entering this course must have demonstrated their

understanding of fundamental chemical concepts by a strong performance on the chemistry validation exam.

5. Course Learning Outcomes.

   Upon completion of this course students will be able to:

   a. Apply the language and fundamental principles of chemistry (atomic/molecular theory, thermodynamics, and kinetics) to explain natural phenomena and to solve problems involving chemical processes.
   b. Collect and critically analyze data sets derived from scientific observations and measurements.
   c. Communicate in written form the process of problem-solving and the results/conclusions derived from experimental results using evidence-based reasoning.
   d. Describe how chemistry is essential to issues facing society (such as energy and the environment) and Naval technology (such as explosives, nuclear power, corrosion prevention, submarine air).

6. Course Content — Hours of Classroom Instruction

   a. Solutions: Reverse Osmosis, Colligative Properties, Gas Solubility — 5 (+ 4 lab hours)
   b. Water Treatment, Boiler Water on Navy Ships — 1 (+ 2 lab hours)
   c. Thermochemistry: Entropy, Gibbs Free Energy — 3 (+ 1 lab hour)
   d. Chemical Kinetics, Catalysts — 4 (+ 2 lab hours)
   e. Chemical and Biological Warfare — 1
   f. Chemical Equilibrium — 5 (+ 2 lab hours)
   g. Submarine Air and CO_2 Scrubbers — 1 (+ 1 lab hour)
   h. Acids and Bases — 5 (+ 2 lab hours)
   i. Buffers, Titrations, Solubility of Solids — 5 (+ 2-4 lab hours)
   j. Electrochemistry, Batteries, Fuel Cells — 5 (+ 2-4 lab hours)
   k. Corrosion, O_2 Production on Submarines — 2 (+ 2 lab hours)
   l. Radioactivity and Nuclear Chemistry — 3 (+ 2 lab hours)
   m. Nuclear Fusion, Fission, Power, and Weapons — 2

   SC151 covers the SC112 topics above (except Solutions) as well as the following material that is otherwise covered in SC111. (Amount of time per topic differs from 112.)

   n. Thermochemistry: Enthalpy — 3 (+ 2 lab hours)
   o. Explosives — 1

p. Organic Chemistry[a] 2

[a] Introduction of basic topics from organic chemistry is necessary to discuss Naval applications of chemistry such as fuels, lubricants, and polymers/materials.

q. Fuels 1 (+ 2 lab hours)

r. Polymers[b] 1 (+ 2 lab hours)

[b] There are numerous examples of polymers used across the Navy and Marine Corps for critical applications including body armor, bulletproof materials, and flame-resistant flight suits.

s. Protein Structure and Function, Enzymes[c] 1

[c] Introduction of basic biochemical principles is needed to discuss the mechanisms and effects of chemical and biological warfare agents, such as Sarin gas.

SP211
GENERAL PHYSICS I
(4-3-2)

1. Texts
    a. Tipler and Mosca, Physics For Scientists and Engineers, 6th Edition (required)

2. Corequisites and Prerequisites.
    a. Prereq: Chemistry II (SC112 or SC151); Coreq: Calculus III (SM221 or SM223 or SM251) or approval of department chair.
    b. Students who have taken a calculus-based physics course may attempt validation during plebe summer. AP scores are not used for validation.
    c. This course is taken during the 3C Fall semester.

3. Students required to take this course
    a. All midshipmen aside from physics majors (they take SP221 instead).

4. Course Description

    The first of a two course sequence emphasizing the fundamental principles of classical physics and introducing a variety of applications. Topics include mechanics, electricity, magnetism, wave motion, fluids, sound and light. Lectures, recitations, hands-on laboratories, and large-scale demonstration lectures are employed.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Know General Physics I concepts and use them qualitatively to draw general conclusions about physical situations.
    b. Apply General Physics I concepts to solve technical problems quantitatively using both symbolic variables and numeric values.
    c. Use vector mathematics reliably as a natural part of your approach to physics.
    d. Use mathematics from your Calculus I, II, III sequence reliably as a natural part of your approach to physics.

6. Course Content — Hours of Classroom Instruction
    a. Motion in One Dimension — 3
    b. Motion in Two and Three Dimensions — 3
    c. Newton's Laws — 3
    d. Additional Applications of Newton's Laws — 4

e.	Work and Kinetic Energy	3
f.	Conservation of Energy	3
g.	Conservation of Linear Momentum	3
h.	Rotation	5
i.	Angular Momentum	2
j.	Gravity	2
k.	Fluids	2
l.	Oscillations	3
m.	Traveling Waves	3
n.	Superposition and Standing Waves	2

SP212
GENERAL PHYSICS II
(4-3-2)

1. Texts
    a. Tipler and Mosca, Physics For Scientists and Engineers, 6th Edition (required)

2. Corequisites and Prerequisites.
    a. Prereq: Chemistry II (SC112 or SC151); Coreq: Calculus III (SM221 or SM223 or SM251) or approval of department chair.
    b. Students who have taken an analogous calculus-based physics course may attempt validation during plebe summer provided they successfully validated SP211 (the SP212 validation exam is given the week after the SP211 validation exam). AP scores are not used for validation.
    c. This course is taken during the 3C Spring semester.

3. Students required to take this course
    a. All midshipmen aside from physics majors (they take SP222 and SP226 instead).

4. Course Description

    The second of a two course sequence emphasizing the fundamental principles of classical physics and introducing a variety of applications. Topics include mechanics, electricity, magnetism, wave motion, fluids, sound and light. Lectures, recitations, hands-on laboratories, and large-scale demonstration lectures are employed.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Know General Physics II concepts and use them qualitatively to draw general conclusions about physical situations.
    b. Apply General Physics II concepts to solve technical problems quantitatively using both symbolic variables and numeric values.
    c. Use vector mathematics reliably as a natural part of your approach to physics.
    d. Use mathematics from your Calculus I, II, III sequence reliably as a natural part of your approach to physics.

6. Course Content — Hours of Classroom Instruction
    a. The Electric Field I: Discrete Charge Distributions — 4
    b. The Electric Field II: Continuous Charge Distributions — 4

c.	Electric Potential	4
d.	Capacitance	2
e.	Electric Current and Direct-Current Circuits	6
f.	The Magnetic Field	3
g.	Sources of the Magnetic Field	3
h.	Magnetic Induction	5
i.	Alternating-Current Circuits	1
j.	Maxwell's Equations and Electromagnetic Waves	3
k.	Properties of Light	2
l.	Optical Images	2
m.	Interference and Diffraction	3

SY110
CYBER SECURITY I
(2-2-3)

1. Texts
    a. https://www.usna.edu/CyberDept/sy110/ (No book or written text for this course. Online course content provided to students via this link)

2. Corequisites and Prerequisites.
    a. Courses - No prereq or coreq
    b. Placement - No placement test. However, students who come in with adequate cyber background (prior enlisted CTN, for example) have been permitted to take a recent final exam. With a grade of 80 or higher they have been able to validate SY110.
    c. Plebe Year - Done in Fall or Spring with Plebe class split 50-50 over the AY.

3. Students required to take this course
    a. All midshipmen (with caveat on validation as outlined above in 2b)

4. Course Description

    Introduction to Cyber Security is a hands-on lab-based course providing a technically focused introduction to the principles behind the use, function, and operation of computers, networks and applications with an emphasis on cyber security.Description from course catalog.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. **Explain** why the Cyber Domain is important to the Navy, a Junior Officer, and an individual.
    b. **Describe** computers, operating systems, networks, the Internet and the Web with respect to: digital representations of information, their basic operation and associated tools, and the underlying architectures and protocols and how they may be vulnerable to attack.
    c. **Analyze** and **explain** the output of programs and the results of shell commands and **infer** why certain actions are permitted or not in an information system.
    d. **Identify** and **describe** the principles and desired properties of defensible information systems, and the techniques and tools that are used to provide them. **Explain** representative attacks and their prevention and mitigation measures.

e. **Explain**, **differentiate**, and **perform** basic actions related to reconnaissance, attack, defense, and forensics of information systems.
f. **Describe** cyber domain scenarios in which user decisions affect security, **identifying** the user's versus the technology's responsibilities, and **explain** the consequences of potential user actions in terms of risk and the tradeoff between services and security.

6. Course Content	Hours of Classroom Instruction
a. Cyber Battlefield	
i. Introduction to Cyber Security	1hr
ii. Policy and Law	1hr
iii. Human Factors	1hr
iv. Vulnerabilities and Malware	1hr
v. Supply Chain and Cyber Kill Chain	1hr
vi. Digital Data: Bits & Bytes & Files	2hrs
vii. Hardware: Computer Architecture & Supply Chain Lab	2hrs
viii. Operating Systems: File Systems, Permissions & Shell	4hrs
ix. Programs: Input/Output, Conditionals, & Loops	1hr
x. Basic Web: The Web & HTML, Build a Website	3hrs
xi. Client-Side Scripting: Non-Event & Event Driven	1hr
xii. Web: Server-Side Scripting, Injection Attacks & XSS	2hrs
xiii. Networking: Intro to TCP/IP Stack (Wired & Wireless)	8hrs
b. Cyber Security Tools	
i. Encryption: Symmetric, Asymmetric	2hrs
ii. Hashing & Passwords Activity	3hrs
iii. Digital Signatures and Digital Certificates	1hr
iv. Intro to Cryptography & Steganography	1hr
v. Network Security Appliances	1hr
vi. Risk & Assessments	1hr
c. Cyber Operations	
i. Forensics: Digital Forensics, Digital Forensics Lab	3hrs
ii. Reconnaissance: Cyber Recon, Cyber Recon Lab	2hrs
iii. Attack: Cyber Attack, Cyber Attack Lab	2hrs
iv. Defense: Cyber Defense, Cyber Defense Lab	2hrs
v. Researching and Presenting on Recent Cyber Events	3hrs

EE301
ELECTRICAL FUNDAMENTALS AND APPLICATIONS
(3-2-4)

1. Texts
    a. Introductory Circuit Analysis 13th Edition (required)

2. Corequisites and Prerequisites.
    a. SP212 General Physics II or SP222 Electricity and Magnetism I
    b. Fall/Spring/Summer
    c. Second Class year

3. Students required to take this course
    a. All non-engineering majors

4. Course Description

    Provides an introduction to AC and DC circuit theory appropriate to model shipboard systems. Circuits of resistors, capacitors, inductors and sources are analyzed to predict steady state and first-order transient voltage, current, and power. Impedance matching, filters, transformers, motors/generators, and three-phase power distribution systems are introduced in the context of shipboard application. Laboratory exercises use tools and equipment found in the fleet and allow for a comparison of theoretical and actual circuit performance.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Solve technical problems: Apply fundamental principles from science, engineering, and mathematics to solve technical problems in both standard operating and unfamiliar contexts.
    b. Critically reason: Sufficiently obtain, critically analyze, appropriately interpret, and use quantitative data and qualitative information to construct creative solutions to complex problems.

6. Course Content — Hours of Classroom Instruction
    a. Introduction, Voltage And Current — 1
    b. Ohms Law And Resistance — 1
    c. Power And Energy — 1
    d. Series Circuits And Kirchhoff's Voltage Law (KVL) — 1
    e. Parallel Circuits And Kirchhoff's Current Law (KCL) — 1

f.	Series-Parallel Circuits	1
g.	Current Sources, Source Conversion	1
h.	Nodal Analysis I	1
i.	Nodal Analysis II	1
j.	Thévenin's Theorem And Maximum Power Transfer	1
k.	Capacitors And Inductors	1
l.	Capacitor Transients	1
m.	Inductor Transients	1
n.	Intro To Ac And Sinusoids	1
o.	Phasors, Complex Numbers, And Impedance	1
p.	AC Series Circuits	1
q.	AC Parallel Circuits	1
r.	AC Series/Parallel Circuits	1
s.	AC Source Transformation And Nodal Analysis	1
t.	AC Power And Power Triangle	1
u.	AC Power And Power Factor Correction	1
v.	Resonant Circuits	1
w.	Filters	1
x.	Magnetism And Transformers	1
y.	Transformers Ii And Reflected Impedance	1
z.	Linear Motors	1
aa.	DC Motors Part I	1
bb.	DC Motors Part II	1
cc.	AC Generators	1
dd.	Three Phase Sources And Loads	1
ee.	Per Phase Analysis	1
ff.	Three Phase Power	1
gg.	AC Generators Part II	1
hh.	Shipboard Power Systems	1

EE331
FUNDAMENTALS OF ELECTRICAL ENGINEERING
(3-2-4)

1. Texts
    a. Introductory Circuit Analysis 13th Edition (required)

2. Corequisites and Prerequisites.
    a. SP212 General Physics II or SP222 Electricity and Magnetism I
    b. Fall/Spring
    c. Second Class year

3. Students required to take this course
    a. All Engineering Majors

4. Course Description

    A study of DC and AC electrical elements and circuits, including Thevenin equivalence, natural and forced responses of first-order systems, AC power, and AC three-phase systems. Diodes, transformers and rectifier circuits are introduced and drive discussion of applications in power regulation and machine control. AC and DC machines are investigated and discussed the in the context of a shipboard environment.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. **(Circuit analysis).** Identify nodes and branches in a circuit diagram; use fundamental circuit theorems and structured analysis techniques to compute voltage, current, and power in DC and AC circuits.
    b. **(Circuit modeling).** Use Thévenin equivalent circuits to analyze DC and AC circuits under varying load conditions. Use phasors to represent sinusoidal voltages and currents in AC circuits. Develop equivalent circuits for simple electric machines. Represent energy transformation in electric motors and generators.
    c. **(Practical applications).** Explain electrical distribution systems, both terrestrial grid and shipboard. Describe the function of power conversion systems such as rectifiers. Construct simple circuits in the lab involving AC or DC sources and correctly employ voltmeters, ammeters and the oscilloscope to measure various circuit parameters including phase relationships between AC signals.

6. Course Content	Hours of Classroom Instruction
a. Course Introduction & Fundamentals	1
b. Kirchoff's Laws and Sources	1
c. Series and Parallel DC Circuits	2
d. Ohm's Law and Nodal Analysis Intro	1
e. Nodal Analysis	2
f. Source Transformation	1
g. Thevenin's Theorem	1
h. Maximum Power Transfer & Practical Sources	1
i. Basic Magnetism and Linear Machines	1
j. Permanent Magnet DC Machine	1
k. Permanent Magnet DC Machine Speed Control	1
l. Capacitors and Inductors	1
m. First Order Capacitor Transients	1
n. First Order Inductor Transients	1
o. Sinusoids and Phasors	1
p. Circuit Elements and Impedance	1
q. AC Equivalent Imedance and Circuit Analysis	1
r. AC Superposition and Source Transformation	1
s. AC Thevenin's Theorem	1
t. AC Power	2
u. AC Max Power & Power Factor Correction	1
v. Three-Phase Circuits; Wye-Wye Configuration	1
w. Three-Phase Circuits; Wye-Delta Configuration	1
x. Power in Balanced 3-Phase Systems	1
y. Three-Phase Power Factor Correction	1
z. AC Synchronous Machines	2
aa. Ideal Transformers	1
bb. Transformer Applications	1
cc. Electrical Power Distribution Systems	1
dd. Circuit Protection and Control	1
ee. Physics of Diodes & Ideal Diode Analysis	1
ff. Rectifiers	1
gg. Capacitor Filters	1
hh. Zener Diode Regulators	1
ii. Power Supply Design	2
jj. Intro to Transistor Switches	1
kk. DC-DC Conversion	1

EC310
APPLICATIONS OF CYBER ENGINEERING
(2-2-3)

1. Texts
    a. "EC310 Applications of Cyber Engineering" Student Notes (required)

2. Corequisites and Prerequisites.
    a. Prerequisite: Cyber 1 (SY110)
    b. Corequisites: Physics II (SP212 or SP222), or Dept Chair permission.
    a. Fall/Spring/Summer
    c. Class year: 2/C

3. Students required to take this course
    a. All midshipmen not in WRC, ECE, SCS, and SCY majors

4. Course Description

    EC310 Applications of Cyber Engineering (2-2-3): This course focuses on the engineering aspects of cyber operations, cyber defense, and cyber attacks, as a follow-on to SY110. There are three main areas of study, including the host section (a single computer terminal), the network section, and the wireless communication section. Each area of study culminates in a detailed description of a common type of cyber attack and the defenses against it. Lecture material is reinforced and supplemented with labs/security exercises that demonstrate the theoretical concepts in an isolated, virtual environment.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Describe in depth the principles, mechanisms, and technologies of information systems' hardware and software in both computers and communications domains, and describe the development of typical exploits used against vulnerabilities in information systems.
    b. Identify action that can be taken to protect information systems' hardware and software in both computers and communication domains against potential exploits.
    c. Trace the lifecycle of a program through development, compilation, and execution to explain the methodology and ramifications of exploiting a process.
    d. Discuss steps that should be taken to prevent a process from being exploited.

e. Describe the fundamental networking technologies and design principles behind internetworking and how these can be exploited by malicious actors.
f. Discuss steps that should be taken to prevent networks from being exploited and identify who or what is responsible for performing these preventative actions and where or when they should be applied.
g. Describe, qualitatively and quantitatively, how underlying electromagnetic spectrum technology is implemented in wireless communication and electronic warfare systems.
h. Evaluate the security and robustness of communications systems by determining which characteristics allow a system to transmit sensitive information to an intended receiver across a noisy or vulnerable channel.

6. Course Content	Hours of Classroom Instruction
a. Number systems	0.5
b. Computer architecture	0.5
c. C-programming	8
d. Computer memory	6
e. Buffer overflow attack	4
f. TCP/IP	1
g. Guided communications	2
h. Unguided communications	2
i. Analog modulation	3
j. Digital modulation	3
k. Analog to digital conversion	2
l. Data Link layer communications	2
m. Network mechanics	6
n. Internet routing	3
o. Inter-domain routing	3
p. Man in the middle attack	4

EC312
APPLICATIONS OF CYBER SECURITY FOR ERC
(2-2-3)

1. Texts
    a. Student Notes (required)

2. Corequisites and Prerequisites.
    a. Prerequisite: SY110 (Introduction to Cyber Security), EW202 (Principles of Mechatronics), and EE331 (Electrical Engineering I).
    b. Spring
    c. Class year: 2/C

3. Students required to take this course
    a. Only midshipmen in ERC major

4. Course Description

    This course focuses on concepts of cyber security applied to electronic communication. Students will first concentrate on computer engineering systems and program design to understand cyber vulnerabilities. They will then focus on wired networking at the physical layer whereby the particular Controller Area Network (CAN) specifications will be used to investigate the details and perform attacks on the nodes. Finally, students will be introduced to wireless communication with a focus on wireless network security, including Fourier analysis, filters, gain and noise. In the labs, they will investigate modulation, antennas and propagation. The course ends with eavesdropping, jamming, error correction and encryption in ZigBee and WIFI networks.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. (Host) Describe the basic operating characteristics of transistors and logic gates, and explain how they are used as the basis for digital computing and Cyber-Physical Systems.
    b. (Host) Analyze basic software programs in C and assembly language, tracing the control flow and how data is manipulated and stored in main memory. Apply the principles of function calls to create a memory schematic depicting the development of the stack.

c. (Host) Identify the vulnerabilities in computer programming that give rise to buffer overflow attacks, design an attack to compromise data integrity, and describe techniques used for more sophisticated attacks. Describe methods for preventing buffer overflow attacks.
d. (Wireless) Express electromagnetic signals in their time and frequency domain representation, and use these concepts to analyze signal modulation and to design tuned circuits.
e. (Wireless) List antenna design parameters and use them to characterize different antenna types. Use the Friis Free Space equation and an understanding of environmental effects to predict the signal power at a given range in a wireless communication system.
f. (Wireless) Demonstrate the process of analog-to-digital conversion, and describe different techniques used in digital communication systems, to include multiplexing, digital modulation, and error correction. Apply this understanding of digital communications to determine bandwidth and transmission rates for various digital modulation schemes.
g. (Wireless) Identify the vulnerabilities in wireless communication systems, and describe how they can be exploited in electronic warfare. Describe methods for securing wireless communications by means of spread spectrum techniques.
h. (Network) Describe the fundamental concepts of networking, to include layer structure, encapsulation, and protocols.
i. (Network) Describe the physical and data link attributes of the Controller Area Network (CAN) protocol. Utilize the CANopen application layer to implement a closed loop Cyber-Physical System. Identify and demonstrate vulnerabilities at each network layer.

6. Course Content	Hours of Classroom Instruction
a. Number systems	0.5
b. C-programming	5
c. Computer memory	5
d. Buffer overflow attack	6
e. Digital logic	3
f. Transistors	2
g. Controller Area Network (CAN)	8
h. Communications	2
i. Analog modulation	2
j. Filters	5
k. Digital modulation	3
l. Analog to digital conversion	2
m. Multiplexing	1

n.	Electronic Warfare	3
o.	Error detection and correction	1
p.	Wireless technology	4

EM300
Principles of Naval Propulsion
(3-2-4)

1. Texts
    a. Principles of Naval Engineering, Propulsion and Auxiliary Systems (M. A. Carr, Naval Institute Press, ISBN 978-1-61251-1047)

2. Corequisites and Prerequisites.
    a. Courses: Physics I (SP211 or SP221)
    b. Placement: N/A
    c. Class year: N/A

3. Students required to take this course
    a. All midshipmen except those pursuing a major within the School of Engineering and Weapons.

4. Course Description

    A study of the principles of energy conversion, fluid flow and hydraulics applied to naval engineering systems, including the basic operation of steam, gas turbine and internal combustion power plants, as well as heat exchangers, air conditioning, and refrigeration.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:

    a. Communicate technical information using proper terminology, units, and ranges of values. Apply analytical problem solving skills and unit analysis to evaluate technical information.

    b. Apply the First Law of Thermodynamics and the Continuity concept to solve fluid flow problems. Apply the concepts of Head Loss, Pump Head, and mechanical Power to determine major and minor head losses, pump performance, and power requirements.

    c. Apply Pascal's Law, the Ideal Gas Law, and the principle of Continuity to evaluate operation of hydraulic and pneumatic systems.

d. Identify the basic components of Reciprocating Engines and describe the operation of both Otto and Diesel ideal cycles. Use Ideal Gas Law relationships to determine cycle parameters, performance, and efficiency.

e. Identify the basic components of Gas Turbine Engines and describe the operation of the Brayton cycle. Determine cycle parameters, performance, and efficiency.

f. Identify the basic components of current steam engines and describe the operation of a Rankine cycle. Use Steam Tables to determine cycle parameters, performance, and efficiency.

g. Explain how the heat from fission powers naval heat engines. Describe the main components and fundamental operation of a naval pressurized water reactor.

h. Describe the construction of common heat exchangers. Use heat transfer relations to determine the transfer of heat between systems. Explain the source and effect of fouling on heat exchanger performance.

i. Explain how air is conditioned for naval applications and use a Psychrometric chart to determine air properties. Describe the operation of a vapor- compression refrigeration plant and use pressure-enthalpy (p-h) charts to determine cycle parameters and performance.

6. Course Content	Hours of Classroom Instruction
a. Introduction/Admin	1
b. Thermodynamics Basics	5
c. Incompressible Fluids	6 (+2 hours lab)
d. Hydraulics & Pneumatics	2
e. Reciprocating Internal Combustion Engines	6 (+2 hours lab)
f. Brayton Cycle Analysis	8 (+2 hours lab)
g. Rankine Cycle Analysis	6 (+1 hour lab)
h. Heat Exchanger Analysis	2 (+1 hour lab)
i. Nuclear Power Familiarization	2
j. Air Conditioning & Refrigeration	7 (+1 hour lab)
k. Additive manufacturing (lab)	1
l. Power System Essay	1

INTRODUCTION TO AERONAUTICS
EA400 (3-2-4)

1. Text: Steven Brandt, *Introduction to Aeronautics,* AIAA, 2015.

2. Prerequisites: SM122 or SM162

3. Students: Non-engineering students must complete either EN400 or EA400.

4. Course Catalog Description: Introduces students to the applied science of air-breathing atmospheric flight. The course describes airplanes and how they fly from a design and application perspective. Included are topics in fluid dynamics, airfoil and wing theory, aircraft performance, stability, structures, and aircraft design.

5. Course Learning Outcomes. Upon the completion of this course, students will be able to:

   a. **Apply** the fundamental one-dimensional fluid dynamic equations (i.e., Hydrostatic, Continuity, Bernoulli, etc.) to solve basic aerospace engineering problems.
   b. **Describe/Explain** the impact of viscosity on external flows over blunt and stream-lined bodies
   c. **Estimate** the lift and drag properties of airfoils and finite wings
   d. **Characterize** the attributes of idealized jet and propeller propulsion systems.
   e. **Demonstrate** an understanding of basic fixed-wing performance for level, climbing, turning, and gliding flight.
   f. **Calculate the** power required for hover for a drone or helicopter
   g. **Explain** the attributes of an airplane that provide stability and control.
   h. **Describe** basic material science properties relevant to aerospace structures.
   i. **Employ** hands-on fabrication techniques to build and fly a lightweight glider.

6. Course Content

a.	Hydrostatics/Altimetry	9 hours
b.	Fluid Dynamics	17 hours
c.	Lift	7 hours
d.	Airplane Performance	10 hours
e.	Helicopter Performance	3 hours
f.	High-Speed Aerodynamics	5 hours
g.	Airplane Stability and Control	4 hours
h.	Aerospace Structures	5 hours
i.	Glider Design/Build/Fly	7 hours

EN400
PRINCIPLES OF SHIP PERFORMANCE
(3-2-4)

1. Texts
    a. Course notes have been compiled and are available online and printed at the USNA bookstore (required)

2. Corequisites and Prerequisites.
    a. Courses N/A
    b. Placement N/A
    c. Class year 2/C standing or permission of department chair.

3. Students required to take this course
    a. NO - All midshipmen
    b. NO - All midshipmen who don't place in a higher level course
    c. YES - Specific majors
        i. All non-engineering majors take this course. For engineers, the combination of EM211 Statics (or equivalent) and EM316/EM317 Thermo/Fluid Sciences include the required demonstrations of strength, buoyancy, stability and ship resistance.
    d. NO - Other

4. Course Description

    This course is an introduction to the applied science of ship systems. The course describes ships and submarines and how they remain afloat from a design and application perspective. Included are topics in hydrostatics, ship stability and operability, materials, fluid dynamics and propulsion. EN400 is an appropriate substitute for all majors where EN200 is required.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Apply the concepts of Static Equilibrium and Archimedes' Principle to the operation of a ship.
    b. Demonstrate the ability to assess the stability condition of a ship. Predict the effect of planned shipboard evolutions on ship stability.

c. Understand the significance of damage to a ship which has compromised its watertight integrity. Use hydrostatics to make intelligent and safe choices to maintain a ship afloat and upright.
d. Understand the structural arrangement of a ship, including the choice of materials and the stresses developed by loads encountered in its operating environment.
e. Understand the different components that make up a ship's resistance and the manner in which the propulsion plant transmits its power to overcome those forces.
f. Understand factors affecting the seakeeping and maneuverability of ships in a seaway.

6. Course Content	Hours of Classroom Instruction
a. Static Equilibrium and Archimedes	10 hours (+4 hours of lab)
b. Ship Stability	6 hours (+4 hours of lab)
c. Damaged Stability	3 hours (+4 hours of lab)
d. Structures	5 hours (+2 hours of lab)
e. Resistance and Powering	4 hours (+4 hours of lab)
f. Seakeeping and Maneuverability	6 hours (+ 2 hours of lab)

Additional hours are allotted to exam preparation, exam review, end-of course review, and the module on submarines (3 hours) which serves as a review of the other topics

EN401
ENGINEERING IN THE LITTORAL ZONE
(3-2-4)

1. Texts
    a. No required texts. Course reference material is delivered via online and hard copy in class notes.

2. Corequisites and Prerequisites.
    a. Courses - NS 100, SP211, 3/C Cruise
    b. Placement - preference in the Spring semester to 1/C MIDN with the service selections of USMC, EOD, and NSW.
    c. Class year - 1/C and 2/C MIDN.

3. Students required to take this course
    a. All midshipmen - All students not majoring in an engineering major. They have the option of taking EN400, EN401, and EA400.

4. Course Description

Description from course catalog - This is an introduction to engineering principles applied to the near-shore environment. Basic engineering mechanics, strength of materials and soil mechanics are studied to provide a base for further investigation. Coastal processes including wave action, sediment transport, beach formation and erosion are discussed. How the combination of such processes and basic mechanics affect such things as small boat hydrostatics, sea-to-shore logistics operations, and coast structure assessment and construction are studied. 1/C midshipmen having selected (or intending to select) Marine Corps service may substitute EN401 for EN400. [fall, Spring]

5. Course Learning Outcomes.

Upon completion of this course students will be able to:

    a. CLO 1 - Understand the basic concepts of near-shore ocean currents and tides, including the effects of sediment transport and waves on beach geometry. Demonstrate how these processes influence coastal structure design.

    b. CLO 2 - Determine the composition of soils and their USCS classifications, calculate the effect of water table levels on soil stress, and describe the considerations of soil properties on building foundation design.

c. CLO 3 - Apply the concepts of centroids, hydrostatic pressure, and weight shifts to determine ship stability, and calculate the location of a ship's center of gravity after imposing a weight shift, addition, or removal.

d. CLO 4 - Mix concrete from its requisite components, test and calculate the strength of concrete at various drying stages, and describe other factors affecting the performance of concrete such as reinforcement and environmental conditions.

e. CLO 5 - Determine the external stress and strain on beams and columns by analyzing basic strength of materials fundamentals to include axial, shear, and bending stresses. Employ basic materials science concepts to select engineering materials for specific applications.

f. CLO 6 - Provided a beam is in static equilibrium, calculate the resultant forces due to an applied load and draw the resulting shear and moment diagrams.

6. Course Content	Hours of Classroom Instruction
a. Vectors, Statics and Centroids	4
b. Archimedes Principle and Hydrostatics	4
c. Ship Stability and Weight Shift	4
d. Stress/Strain, Material Failure	3
e. Concrete	6
f. Wave and their interactions in the Littoral Zone	6
g. Littoral Processes, Coastal Features and Protection	6
h. Soil classification, stress/capacity, Coastal Foundations	6
i. Moment of Inertia, Beam Analysis	7
j. Beam Internal Forces	5

k. Bending Stress/Superposition and Deflection 7

EW300
NAVAL WEAPONS SYSTEMS
(3-0-3)

1. Text
    a. Principles of Naval Weapon Systems, by Craig Payne, 2nd edition, Naval Institute Press, 2010

2. Corequisites and Prerequisites.
    a. Calculus II (SM122 or SM162), Chemistry II (SC112 or SC151), and Physics II (SP212 or SP222)
    b. Placement N/A
    c. Class year N/A

3. Students required to take this course
    a. All midshipmen

4. Course Description
    An introduction to the theory of weapons systems through a study of the principles of sensors, tracking, delivery, and destruction mechanisms.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Adapt the basic theory of sensors to the process of detecting a selected target.
    b. Outline the delivery means of a weapon to the intended target.
    c. Design a warhead to deliver the necessary damage mechanism of fragmentation, blast, and nuclear warheads for a specified target.
    d. Analyze a target scenario in the construct of the Detect to Engage sequence.

6. Course Content — Hours of Classroom Instruction
    a. Energy propagation and antenna systems — 1
    b. RADAR systems and performance factors — 8
    c. Electro-Optic systems and performance factors — 6
    d. SONAR systems and performance factors — 9
    e. Weapon architecture, ballistics, fire control, guidance, and fuzing — 3
    f. Fragmentation, chemical blast, nuclear, and special warhead weapons — 3
    g. Weapon to target pairing and damage prediction — 1

EW370
AUTONOMY AND CONTROL IN NAVAL WEAPONS SYSTEMS
(0-2-1)

1. Texts
    a. N/A

2. Corequisites and Prerequisites.
    a. EW300 (corequisite)
    b. Placement N/A
    c. Class year N/A

3. Students required to take this course
    a. All majors except EAS, EASA, EEE, EME, ENR, ERC

4. Course Description

    An introduction to the fundamentals and design of autonomy for use in naval weapon systems. The course develops conceptual understanding and intuition through a series of demonstrations and hands-on experiences. Topics include fundamentals of feedback control theory and an introduction to the rapidly developing areas of machine learning and artificial intelligence as they relate to naval power.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Describe historical trends in the introduction of autonomy in naval warfare
    b. Understand fundamental negative feedback control techniques that facilitate autonomy.
    c. Differentiate between levels of autonomy in naval weapon systems.
    d. Understand the benefits and limitations of artificial intelligence to the conduct of naval warfare.
    e. Analyze military capabilities to determine challenges associated with fully autonomous systems.

6. Course Content	Hours of Classroom Instruction
a. Intro to Autonomy	2
b. Error and System Response	2
c. Controllers	2
d. Sensors	2

e.	Autonomy Today	2
f.	Computer Vision	2
g.	Machine Learning	2
h.	Deep Neural Networks	2
i.	Networks and Swarms	2
j.	Human Systems Integration	2
k.	Ethics of Autonomous Systems	2

EW410
INTRODUCTION TO CONTROL ENGINEERING
(3-2-3)

1. Texts
    a. Control Systems Engineering 8th Edition, N. Nise, John Wiley

2. Corequisites and Prerequisites.
    a. Physics II (SP212 or SP222), DE (SM212 or SM222), and Electrical Engineering I (EE221 or EE331)
    b. Placement N/A
    c. Class year N/A

3. Students required to take this course
    a. EAS, EASA, EME, ENR

4. Course Description

    Linear control for engineering majors, using analytical, graphical, and computer techniques.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Develop a mathematical model of simple: mechanical, rotational, electrical, and combined (electro-mechanical) systems using Laplace transfer functions.
    b. Analyze the response of a linear system to several standard inputs.
    c. Design a linear control system to meet given specifications.
    d. Use classical root locus to design proportional, integral, and differential controllers to achieve desired requirements.
    e. Use MATLAB tools to design and analyze control systems.
    f. Implement proportional and integral controllers using digital computer software.

6. Course Content — Hours of Classroom Instruction
    a. Laplace transform and solving of Differential Equations — 3
    b. Modeling Translational/Rotational/Electrical/ Geared/DC motor systems — 2
    c. 1st Order System Response/Performance — 9
    d. 2nd Order System Response/Performance — 3

e.	Design by Root Locus	4
f.	Proportional Control Design and Implementation	3
g.	Proportional/Derivative Control Design	3
h.	Proportional/Integral Control Design and Implementation	3
i.	Proportional/Integral/Derivative Control Design and Implementation	3

EW412
CONTROL ENGINEERING FOR ELECTRICAL ENGINEERS
(3-2-4)

1. Texts
    a. Control Systems Engineering 8th Edition, N. Nise, John Wiley

2. Corequisites and Prerequisites.
    a. EE322 and EE353
    b. Placement N/A
    c. Class year N/A

3. Students required to take this course
    a. EEE

4. Course Description

    Linear control engineering for Electrical Engineering majors using analytical, graphical and computer techniques. The course covers both the Frequency Domain and the State Space approaches to control design.

5. Course Learning Outcomes.

    Upon completion of this course students will be able to:
    a. Develop a mathematical model of simple: mechanical, rotational, electrical and combined (electro-mechanical) systems using transfer functions and state space representation..
    b. Analyze the response of a linear system to several standard inputs.
    c. Design a linear control system to meet given specifications.
    d. Use classical root locus to design proportional, integral and differential controllers to achieve desired requirements.
    e. Use MATLAB tools to design and analyze control systems.
    f. Implement proportional and integral controllers using digital computer software.
    g. Find the solutions to the state equations that represent given systems.

6. Course Content	Hours of Classroom Instruction
a. Laplace transform and solving of Differential Equations	3
b. Modeling Translational/Rotational/Electrical/ Geared/DC motor systems	6

c.	1st Order System Response/Performance	3
d.	2nd Order System Response/Performance	3
e.	Design by Root Locus	2
f.	Proportional Control Design and Implementation	2
g.	Proportional/Derivative Control Design	1
h.	Proportional/Integral Control Design and Implementation	2
i.	Proportional/Integral/Derivative Control Design and Implementation	2
j.	State Space Modeling, and transition between State Space and Transfer Function	3
k.	State Variable Feedback	3
l.	State Space Controllability and Akermans Formula	3