MATHDEPTINST 5420.4E

21 DECEMBER 2024

MATHEMATICS DEPARTMENT HONORS PROGRAM

CONTENTS

HONORS PROGRAM DESCRIPTION

1. **GOALS**

   The Honors program offers academically exceptional, highly motivated students an intellectually stimulating course of study, that challenges their abilities with a curriculum that: emphasizes mathematical rigor and problem-solving; nurtures their creative, independent inquiry and scholarship; and provides them with an excellent background and skill set for a potential transition to advanced graduate studies.

2. **OUTCOMES**

   Upon completing the Honors program, students will be able to:

   - **a.** read, understand, evaluate, produce, and support sophisticated mathematical arguments;
   - **b.** access, analyze, and synthesize technical information and ideas from multiple sources in the literature;
   - **c.** independently develop and carry out a significant, technical project in their discipline;
   - **d.** use oral and written communication skills to explain sophisticated technical ideas with clarity and precision.

3. **PROGRAM DESCRIPTION**

   All students interested in pursuing an Honors major must take SM291 ("Fundamentals of Mathematics") by the 3/C Spring semester, and submit an application to the Honors program (see section 5 below). In order to graduate with Honors in Mathematics, Applied Mathematics, or Operations Research, a midshipman must complete all the requirements of the SMAH, SMPH, or SMOH matrix. There are two main differences[1] between the Honors and the regular matrices. Honors majors must:

   - **a.** Complete the course sequence SM331H-SM332H (Honors Real Analysis I & Honors Real Analysis II).
   - **b.** Complete an Honors thesis (SX495/96). This includes writing a paper and giving an oral presentation to the faculty.

     IMPORTANT NOTE: SMO majors who plan to apply for the Honors program should register for SM291 – a prerequisite for Honors Real Analysis – in the 3/C Spring semester.

   Additionally, in accordance with Ref.a, in order to graduate with Honors, a midshipman must meet the same standards in honor, conduct, military performance, physical education, and summer training required for all degrees at the USNA, and must achieve the following yard-wide standards for Honors:

   - **c.** A minimum CQPR of 3.0 in all academic courses taken for credit at the Naval Academy.
   - **d.** A minimum CQPR of 3.5 in all courses that comprise the majors portion of the honors major. Where a midshipman completes a course in excess of that required in the matrix for that major and the course is interchangeable with another that appears in the matrix, the course that yields the higher major CQPR will be used. Core courses in the discipline will not be included in this computation.
   - **e.** No grade below "C-" may appear in the midshipman's matrix unless an equivalent or a more rigorous course is subsequently taken and a grade of "C-" or higher is earned. Where

[1] There are some smaller, major-specific differences, mostly regarding restrictions to electives.

the student completes courses in excess of the matrix, with those courses appearing below the matrix, one or more of those courses may have a grade lower than a "C-" with the approval of the Chair of the relevant department and the Associate Provost for Academic Affairs.

A general timeline for the Honors program may be found in Appendix A. (This, and other timelines in this document, assume completion of the Honors thesis during the 1/C Spring semester. Students planning to complete their thesis early, in the Fall semester of 1/C year, should adjust the relevant deadlines by a semester.)

4. **ADMINISTRATION:** The Honors program is administered by the Honors committee, appointed by the Chair of the department. The Honors Committee's responsibilities are:
    a. Advertise with appropriate classes of midshipmen, collecting applications, and inviting students to join the Honors Program.
    b. Monitor Honors students' progress in the program, including continued eligibility.
    c. Establish and maintain standards consistent with relevant Provost instructions, and clearly communicate these standards to both students and faculty mentors.
    d. Help Honors students to find appropriate projects and mentors.
    e. Review and approve research and reading course proposals.
    f. Maintain clear expectations for readers and assist faculty mentors with finding appropriate readers.
    g. Monitor student progress on honors projects.
    h. Provide support to the department chair, MCC, and Senior Advisors in other matters pertaining to the Honors Program.
    i. Promulgate the milestones and expectations for research courses and collect and archive research course final papers.
    j. Maintain a list of available faculty members willing to mentor honors project, including research interests.
    k. Make recommendations to the Department Chair for midshipmen honors designation on diplomas.
    l. Make recommendations to the Department Chair for nominees for the National Intelligence Foundation award, and coordinate completion of required documentation.

5. **ADMISSION TO THE PROGRAM**

An invitation to apply for the Honors program, together with a description of the program, will be sent to all sophomore (3/C) SMA, SMP, and SMO majors by the end of March. The application may be as simple as a mere statement of interest in being considered for the program, but midshipmen may choose to include other information for the consideration of the Honors committee (e.g. reasons for pursuing an Honors degree, particular areas of interest for an Honors thesis, etc.). Exceptionally strong 4/C (rising 3/C) students may also be considered for early admission to the Honors program.

The Honors committee will meet soon after 12th week grades have been reported, to review all applications. Selection criteria for admission to the Honors program include: a very strong overall academic record, exceptional performance in major courses, with particular emphasis on "Fundamentals of Mathematics" (SM291), demonstrated ability for independent study and

problem-solving, and strong recommendations from prior instructors. **Except in rare circumstances, students without SM291 will not be admitted to the honors program.**

The Honors committee will finalize the list of students admitted to the Honors program, after final grades for the 3/C Spring semester have been reported, taking also into account faculty availability to supervise student research. The list will be forwarded to the department Chair for approval. All applicants will be informed of the committee's decision soon thereafter.

6. HONORS REAL ANALYSIS

Real Analysis I and II (SM331H-SM332H) is a year-long, rigorous, proof-based, fast-paced course sequence on real function theory. This sequence develops the rigorous foundation needed for many fields within mathematics and operations research and is critical for mastery of these topics. Specifically, SM331H covers the properties of the real line, the completeness axiom, Euclidean spaces, cardinality, topology of Euclidean, normed and/or metric spaces, connectedness, compactness, the Heine-Borel theorem, convergence of sequences, limit superior and limit inferior, the Bolzano-Weierstrass theorem, completeness, numerical series, limits and continuity of functions, the intermediate value theorem, the extreme value theorem, uniform continuity, fixed point theorems. SM332H is the continuation, covering differentiability, the mean value theorem, Taylor's theorem, the Riemann integral, sequences and series of functions, modes of convergence, power series, Taylor series, Weierstrass approximation, the Stone-Weierstrass theorem, and applications.

Midshipmen who plan to apply for the Honors program, should include SM333 (Sequences, Series, and Functions) in their 3/C Fall preregistration. If admitted to the Honors program, they will be transferred into SM331H by the department Chair. SMO majors not admitted to the program should contact their advisors to possibly replace SM333 with another course.

7. HONORS THESIS

The Honors thesis is typically a year-long project completed during the 1/C year, one-on-one with a faculty advisor. Formally, the Honors thesis consists of two separate courses: a reading course (SM485H or SA485) one semester and a research course (SM496 or SA496) in a subsequent semester. During the reading course, the student learns foundational material for their project and begins preliminary research (such as literature review, etc.); during the research course, the student conducts the proposed research, writes a formal thesis, and delivers a concise presentation to faculty. The content of the research project need not be new or original, but it should convey the student's rigorous mastery of a topic beyond the standard curriculum.

A reading course is not a requirement for completing an Honors thesis. In rare circumstances (study abroad, academy exchange, etc.), a reading course may not be feasible. In these cases, it is the student's responsibility to coordinate with their academic and research advisors to ensure their other courses have appropriate depth and quality to allow them to begin their thesis work so that it can be completed in one semester. In which case, the student may forgo the reading course and only complete a research course. In general, without such rare circumstances, forgoing a reading course will not be approved.

Midshipmen participating in a qualified research program (e.g., Bowman, Trident, etc.) with a mathematically-appropriate topic, may use work related to those programs to fulfill the reading course and research course requirements.

a. **Finding an Advisor:** Students should approach several of their instructors and other faculty during their 2/C year, to discuss possible ideas for their thesis. Honors majors are responsible for finding a general topic for their thesis and an advisor willing to supervise it. Academic advisors could be a source of help in this process. The Honors committee will also maintain a list of faculty interested in supervising an Honors thesis (and potential project descriptions, when possible), and help to pair students with advisors, if necessary.

   The process of finding a general thesis topic and an advisor should be complete by the end of March of the 2/C year.

b. **Reading Course:** During 2/C Spring, Honors majors should preregister for a 1/C Fall reading course (SM485H or SA485). Once they have an advisor, they should submit, with their advisor's help, a proposal that includes a detailed description of the content of the course, with a bibliography. The course should serve as preparation for the Honors thesis research course that will follow. Course policy, outcomes, and grading are up to the advisor. However, one of the deliverables should be a well written proposal (see below) for the Honors thesis that will be completed in the following semester, due to the Honors committee around the 14th week of the semester. It is important to note that approval of the reading course proposal does not entail automatic approval of the subsequent research proposal.

   The reading course counts as a breadth elective in the SMAH and SMPH matrix. At most one spot in those matrices can be filled by a reading course. Reading courses count as track electives in the SMOH matrix, and there is no restriction on the number of spots that can be filled by such courses.

c. **Honors thesis proposal:** Honors majors should prepare a proposal for their thesis using the research course proposal form. The proposal shall be written by the student with close supervision and support from the advisor. It should be endorsed by the advisor and submitted to the Chair of the Honors committee around the 14th week of the previous semester (typically 1/C Fall semester). The proposal must be approved by the Honors committee.

   The mathematical content of the proposal shall include:

   - a detailed description of the problem/topic to be addressed;
   - a description of the techniques that will be used;
   - adequate background for context;
   - a clear overview of the scope of the work to be done, and concrete goals that the student hopes to achieve.

   In addition, the proposal shall disclose important administrative details including:

   - which matrix requirement the research course is intended to meet;
   - whether or not the project involves human research and whether Internal Review Board (IRB) approval has/will be received;
   - whether or not the project can be achieved with Academy facilities and within Midshipmen regulations; and
   - any funding expenditures that are necessary to complete the project.

   Honors students intending to use a qualified scholar program project as their Honors thesis, may use materials form the proposal for that project to complete their Honors thesis proposal.

d. Writing an Honors Thesis

i. General guidelines: An Honors thesis is an original presentation of advanced mathematical content that goes beyond the standard undergraduate curriculum in scope, depth, and mathematical sophistication. It should include: an introduction that explains the problem to be addressed and places it in a broader mathematical context; background material and/or literature review, as appropriate to the topic; adequate definitions and explanation of notation; and sustained technical mathematical argument and analysis, focused on a well-defined mathematical question or subject. The thesis may contain original results, but this is not required.

The thesis should have a clear, logical organization, that develops the central ideas in a coherent way. All mathematics should be correct, written with precision and clarity, and with enough detail for a reader with a reasonable mathematical background to follow the exposition. It should be typed and properly typeset. It should be grammatically correct, free of typos and spelling errors. It should contain proper citations and bibliography.

The Honors thesis must be single-authored. The exposition must be original, in the student's own words. The writing should demonstrate the student's mastery of the mathematical content of the thesis. Results obtained in collaboration with others may be included, but such results should be written up by the author and the collaboration should be acknowledged.

Any major-appropriate subject with substantial mathematical content at the advanced undergraduate level is suitable for a thesis. Typically, narrower, circumscribed topics work better. There is no specific model that a thesis should follow, but below are a few examples:

- For a pure math major, an Honors thesis could be an original synthesis of mathematical theory and results digested from multiple sources in the mathematical journal or textbook/monograph literature into a well-written expository paper with detailed explanations of definitions, proofs, worked-out examples, etc. This model may be also suitable for applied mathematics majors, when the subject is appropriate.
- For an applied math major, an Honors thesis may include the formulation, investigation, and analysis of mathematical and/or statistical models, and the use of sophisticated mathematical tools (e.g., differential equations, probability, linear algebra, numerical analysis, statistics, computer programming), in order to draw appropriate conclusions and discuss the limitations of those models.
- For an operations research major, an Honors thesis might detail and model specific complex problems, conduct appropriate analysis using operations research tools (e.g., optimization techniques, probability

theory, statistics, stochastic processes, simulation) and discuss the operations research model and the resulting solutions.

ii. **Research Course:** To write an Honors thesis, students must register for SX495 or SX496 (Trident scholars are excepted from this requirement). The administration of this course is governed by Ref.b. In particular, the course policy, outcomes, and grading are up to the advisor. In accordance with Ref.b. however, advisors are encouraged to consider the assessments of other faculty members – in this case the readers of the thesis – as they assign interim and semester grades in the course.
A sample timeline for writing a thesis (i.e., for completing SX496) is included in Appendix B.

iii. **Readers**: Two faculty members, other than the advisor, will be assigned as readers of the Honors thesis. This will be done in consultation with the faculty mentor of the thesis. When possible, one of the readers should be a member of the Honors committee and/or an expert in the area of the project. Readers will be provided drafts at different stages of the project and work with and through the advisor to provide timely, constructive feedback to the student (see Appendix B). Specifically, readers should point out areas that need more exposition and/or elaboration, point out mathematical and other errors in the presentation, suggest ways to improve the writing, etc.
Readers may suggest but **s**hould not request an expansion of the project beyond the scope of the original proposal that was approved by the Honors committee. If in doubt about the scope, the readers should refer to the proposal or to the initial report, or consult with the Honors committee.

iv. **Presentation:** Honors majors will give a 30-minute oral presentation of the results of their thesis to the Faculty, at the end of the semester. This is typically a 20-25 minute talk followed by 5-10 minutes of questions.

e. **Trident Scholars:** Trident scholars may use their Trident project to fulfill their Honors thesis requirement. They still need to follow the thesis timeline, by submitting a thesis proposal, initial report, and drafts of their paper, but they can use the materials from their Trident project to do so.

f. **Double Majors:** Midshipmen attempting a double major in the Mathematics department will have to complete two separate Honors theses. While there may be overlap between the two theses, each one should have enough major-specific content to merit separate approval for Honors in each individual major.

8. **RECOMMENDATION TO THE DEPARTMENT CHAIR:** The Honors committee will convene at the end of the semester to discuss its recommendations for graduation with Honors. In making the determination, the committee will confirm that the student has fulfilled all requirements of the Honors program, and will take into account the quality of the Honors thesis (with input from the advisor and from the two readers) as well as the quality of the oral presentation. A list of all midshipmen recommended for Honors will be forwarded to the department Chair.
Midshipmen who are not recommended for Honors will graduate with their regular degree; their Honors thesis will fulfill their capstone requirement.

9. **REFERENCES:**
    a. PROVOST INSTRUCTION 5420.4E "HONORS PROGRAMS"
    b. PROVOST INSTRUCTION 1531.79C "MIDSHIPMAN RESEARCH COURSES"

APPENDIX A

MATHEMATICS DEPARTMENT HONORS PROGRAM

GENERAL TIMELINE

3/C Fall:

- SMO majors interested in Honors, should register for SM291 for the spring.

3/C Spring:

- Preregistration for 2/C Fall: All Midshipmen planning to apply for Honors, should preregister for SM333.
- Late March: Invitation to apply for the Honors program is sent to all 3/C SMA, SMP, SMO majors.
- Mid-April: Applications for the Honors Program are due.
- End of Semester: Honors committee finalizes the list of students admitted to the Honors program and notifies the students accordingly. Those admitted are moved from SM333 to SM331H.
  SMO majors not admitted to the program should contact their advisors to possibly replace SM333 with another course.

2/C Spring:

- Midshipmen start looking for a general thesis topic and for an advisor.
- Preregistration for 1/C Fall: Honors majors should pre-register for a reading course (SM485H or SA485).
- Late March: All 2/C Honors majors should have a thesis advisor.
- 14th week: Reading course proposal due

1/C Fall:

- Preregistration for 1/C Spring: Honors majors should pre-register for a research course (SM496 or SA496).
- After pre-registration: Midshipmen pre-registered for SX496 will receive a research agreement from the Associate Director of Midshipman Research, requesting the name of the advisor, the title of the proposed project, and other project-related information ((IRB approval, funding, acknowledgement of report and presentation requirements, etc.).
- 14th week: Detailed thesis proposal due to the Honors committee.

1/C Spring:

- Complete Honors thesis, following the Honors thesis timeline.

APPENDIX B

SAMPLE RESEARCH COURSE/HONORS THESIS TIMELINE (CLASS OF '25)

FALL SEMESTER

WEEK 13 (Mon): Honors project proposal due to the chair of the Honors committee. It should name the faculty mentor(s). This proposal should include a detailed description of the planned project with a carefully worded discussion of the problem to be solved (with bibliography); the project must be endorsed by the faculty mentor. The format for the proposal will be sent electronically to the students and their advisers after pre-registration.

SPRING SEMESTER

WEEK 4 (Wed): Initial report due (in electronic form) to the chair of the Honors Committee. This report should include the project title, a good start on the introductory material, a complete technical description of the problem of study, and concrete goals for the project, in more detail than the course proposal for SM496 submitted in the fall semester, as well as a list of references. The report must be endorsed by the faculty mentor.

If this and subsequent reports are not submitted by the deadline, the Honors Committee will meet with the student and, if there are no sufficient extenuating circumstances, recommend to the mentor a letter grade deduction in SM496.

WEEK 8 (Wed): First draft due to the chair of the Honors Committee; it must be endorsed by the faculty mentor, who may set an earlier deadline. This draft should include a detailed statement of the problem and methodology and progress on all later parts (in outline form at least) of the thesis. It should be mathematically correct. The Honors Committee, in consultation with mentors, will provide the names of two readers for each project. Where possible, one reader should be a member of the Honors Committee. Faculty readers should provide feedback to the project mentors within a week.

WEEK 13 (Wed): Second draft due to the chair of the Honors Committee; it must be endorsed by the faculty mentor, who may set an earlier deadline. This version should be nearly complete. Research should be almost done, the mathematics and grammar should be correct, and proofs should be nearly complete. Pictures, graphics, and formatting do not have to be in final form.

An addendum explaining how the readers' comments on the first draft were addressed should be included. Faculty readers should provide feedback within one week, to be incorporated in the student's final written Honors paper.

WEEK 16 (Wed): Final written Honors paper due to the chair of the Honors Committee; it must include the faculty mentor's endorsement in the form of her/his signature on the cover form. The paper will be forwarded to the faculty readers for a final review. An addendum explaining how the readers' comments on the second draft were addressed should be included.

LAST WEEK OF CLASSES: Oral presentation (20 to 25-minute talk, 5-10 minutes for questions) to the Mathematics Department Faculty.

LAST DAY OF CLASSES: Submit an electronic copy of the final written Honors paper to the Mathematics Department.

APPENDIX C

Midshipman Mathematics Reading Course Proposal

Midshipman Name: _____ Alpha #: _____

Major:_____ Reading Course #: _____

Academic Year and Semester for Project: Fall 2025

The course is intended to count in the matrix as:
(e.g. BR EL, TR EL, PROJ, SA475, SA 475E)
SM/SA48X for OR Majors: BR EL or TR EL allowed; multiple SA/SM48X courses allowed in your matrix
SM48X for Math Majors: BR EL allowed; SAA approval for TR EL; at most one allowed in your matrix

1. **Title of the Proposed Project:**

2. **Faculty Mentor(s):**

_____
Name and Academic Rank/Department **(Primary Mentor)** **Signature**

_____
Name and Academic Rank/Department **(Other Mentor)**

_____
Name, Position and Affiliation **(Mentor outside USNA)**

3. **Summary of the Proposed Reading:**
   a. **Topics to be Addressed:**
   b. **Background Information and Motivation**:
   c. **Details of the Proposed Material (include bibliography)**:

4. **Grading policy**
   a. **Deliverable materials (homework sets, tests, paper, lecture, code, poster etc.):**
   b. **Grading methods (the instructor must indicate how 6th week, 12th week, and final grades will be assigned):**

5. The project **does not** involve human subject research. If your research involves human subject research, the project must be approved by HRPP/IRB before any research is conducted. More information can be found at: www.usna.edu/HRPP/

6. The project **is** executable using available facilities and under current Midshipman regulations.

_____ _____

Midshipmen Signature Date

APPENDIX D

Midshipman Research Course: RESEARCH PROPOSAL

Midshipman Name: _____ Alpha #: _____

Major:_____ Research Course #: _____

Academic Year and Semester for Project: Fall 2024

The course is intended to count in the matrix as:

(e.g. BR EL, TR EL, PROJ, SA475, SA 475E)

SA49X: BR EL or TR EL or PROJ allowed

SM49X: BR EL or TR EL or PROJ allowed

1. **Title of the Proposed Project:**
2. **Faculty Mentor(s):**

Name and Academic Rank – Department *(Primary Mentor)* *Signature*

Name and Academic Rank – Department (*Other Mentor*)

Name, Position and Affiliation (*Mentor outside USNA)*

3. **Summary of the Proposed Research:**

a. Problem to be Addressed:

b. Background Information and Motivation:

c. Details of the Proposed Research:

(continue to next page)

4. The project **does not** involve human subject research. If your research involves human subject research, the project must be approved by the Human Research Protection Program (HRPP) before any research is conducted. More information can be found at www.usna.edu/HRPP/.

5. The project **is** executable using available facilities and under current Midshipman regulations.

6. Estimate of Costs:

	Fall semester	**Spring semester**
a. Midshipman travel:	_____	_____
b. Consumable Supplies:	_____	_____
c. Equipment:	_____	_____
f. Other (specify below): _____		_____
TOTALS:	_____	_____

Proposed Funding source (dept, ONR-Midn, faculty research account, DTRA, etc)?

_____

***NOTES*:**

- ***Travel:*** Possible destination:_____

  Probable dates: _____

- ***Expenditure of funds from department or division accounts:*** The budget proposal must be routed via the Department Chair or Division Financial Officer, as appropriate.

- ***Expenditure of reimbursable funds:*** The budget proposal must be routed via the Naval Academy Research Office.

- ***Total expenditures:*** A letter of justification from the adviser **must** be included with this Proposal if the total non-travel costs in either semester exceeds $500.00.

- ***Other costs***: _____

_____

Midn Signature Date