Master of Science in Applied Physics
Learning Outcomes and Assessment

Preamble:
Students in the Master of Science program in Applied Physics choose one of three focus areas that form the core graduate program in Applied Physics. They combine common core courses of fundamental mathematics and physics as well as an interdisciplinary curriculum including at least one hands-on laboratory course with an independent research project under the supervision of an appropriate member of the Engineering or Science graduate faculty at Cornell. A minimum of 12 credit hours per semester is required. The flexibility of the curriculum allows students, in consultation with their special committee members, to select a program of study to meet their individual interests and educational goals.

List of Core Learning Outcomes
1. Broad knowledge in the fundamental areas of Applied Physics and advanced theoretical knowledge and experimental training in a sub-discipline
2. Demonstrate the ability to acquire skills to plan and organize a research or design project
3. Demonstrate the ability to successfully complete a research or design project that advances an area of Applied Physics
4. Demonstrate oral and written communication skills
5. Develop a commitment to life-long learning and professional development

Assessment Tools
1. Coursework-based assessments
2. Evaluation by faculty of AEP7530/AEP7540 MEng/MS seminar presentation and discussion
3. Written thesis
4. Evaluation by Special Committee
5. Alumni and employer feedback (5yr survey)

Assessment Feedback / Program improvement
1. Analysis of assessment information by Applied Physics M.S. Faculty
2. Recommendations for revisions in program
Learning Outcome 1: Demonstrate broad knowledge in the fundamental areas of Applied Physics, experimental skills, and advanced knowledge in a sub-discipline

Description:
Proficiency in basic physics is in part demonstrated by successful completion of coursework in mathematics and physics as described for the respective focus areas. For all focus areas this includes at least one laboratory course. Advanced knowledge in a sub-discipline will in part be acquired in required specialized courses and optional electives. Depending on the student's background some of the required courses may have been taken as part of a preceding undergraduate degree.

Assessment:
• Coursework-based assessments
• Evaluation by faculty of performance in the AEP7530/AEP7540 seminar
• Evaluation by project advisor and Special Committee

Learning Outcome 2: Demonstrate the ability to acquire skills to plan and organize a research or design project

Description:
The research or design project is a full time commitment during the second year and is a central component of the Applied Physics M.S. program. Working with the Special Committee, the student must generate a Research Plan, comprising (1) background and significance, (2) statement of the specific aim, and (3) identification of the approach to achieve the aim. The student must identify and seek out resources and information and apply these to guide his/her independent study plan development. To achieve the aim the student will need to acquire the ability to master and/or innovate research methodologies and techniques.

Assessment:
• Evaluation by faculty of research plan presentation in the AEP7530 seminar
• Evaluation of research or design plan development by Special Committee
• Alumni and employer feedback (5yr survey)

Learning Outcome 3: Demonstrate the ability to successfully complete a substantial research or design project

Description:
With the completion of a substantial research or design project the student demonstrates independent thinking and creativity and generates an advance in an area of Applied Physics. The project is completed with a written thesis, an oral presentation of the results in the AEP7540 seminar, and an extended presentation in a group meeting or seminar series. With guidance from the Project Advisor, the
A student must generate a thesis that covers (1) abstract, (2) background and significance, (3) statement of the specific aim, (4) description of the approach to achieve the aim, (5) results and outcomes, and (6) critical evaluation of the approach, results, and/or outcomes as appropriate.

**Assessment:**
- Evaluation of project report and performance by Special Committee
- Evaluation by faculty and students of final presentation in the AEP7540 seminar
- Alumni and employer feedback (5yr survey)

**Learning Outcome 4: Demonstrate oral and written communication skills**

**Description:**
The ability to effectively communicate the results of a research or design approach and of its outcomes and critical review in written documents and oral presentations is essential. The students are required to present their project proposal or project plan in the AEP7530 MEng/MS seminar. The format is a conference style 12 minute presentation followed by questions from students and faculty and by comments on strengths and weaknesses of the presentation to provide guidance. In the final term the students present the outcome of their project in another presentation in the AEP7540 seminar and an extended presentation in a group meeting or seminar series. A formal written M.S. thesis must be submitted before graduation.

**Assessment:**
- Evaluation of thesis and oral presentations by Special Committee
- Evaluation by faculty and students of final presentation in the AEP7540 seminar
- Alumni and employer feedback (5yr survey)

**Learning Outcome 5: Life-long learning & professional development**

**Description:**
The students should develop a commitment to learning and maintain familiarity with advances in their field. They must understand and maintain ethical standards in their field and in general. They should develop the ability to engage in team work. They should demonstrate the ability to listen, give, and receive feedback effectively. These skills will be developed through mentoring by the Project Advisor and active participation in the MEng/MS seminar as well as other seminars, conferences, group meetings etc.

**Assessment:**
- Active participation in ethics discussions (e.g. as part of AEP7530)
- Evaluation by Special Committee
- Evaluation by faculty in the AEP7530/AEP7540 seminar
- Alumni and employer feedback (5yr survey)

**Appended below are the course lists for the individual focus areas**
Focus Area in Optics

**Fall Courses:**
- AEP 4210 Applied Mathematics

Choose one:
- AEP3550/3610 Introduction to E&M and QM
- AEP5570 Electricity and Magnetism
- Phys6572 Quantum Mechanics
- Chem7930 Quantum Mechanics I

Choose one:
- AEP3300 Modern Optics Lab*
- AEP3630 Electronics Lab*
- Phys6510 Advanced Experimental Physics*
- Optional Elective
- AEP7530 Special Topics in Applied Physics

**Spring Courses:**
- AEP4220 Applied Mathematics

Choose one:
- AEP3560 Intermediate Electrodynamics
- AEP3620 Intermediate QM
- Chem7940 Quantum Mechanics II

Choose one:
- AEP6510 Advanced Experimental Physics*
- Optional Elective
- AEP7540 Special Topics in Applied Physics

*At least one laboratory course must be taken

**Optional Electives**

Student must maintain C average (2.0) or better to remain in good academic standing.

Changes to your curriculum might cause you not to graduate. Please consult with your Advisor before making any changes to your curriculum.

Advisor ___________________________ Date _____________ Student ___________________________ Date _____________
Focus Area in Nanotechnology

Fall Courses:
- AEP 4210 Applied Mathematics

Choose one:
- AEP3550/3610 Introduction to E&M and QM
- AEP5570 Electricity and Magnetism
- Chem7930 Quantum Mechanics I
- Phys6572 Quantum Mechanics

Choose one:
- AEP6610 Nanocharacterization
- Optional Elective
- AEP7530 Special Topics in Applied Physics

Spring Courses:
- AEP4220 Applied Mathematics

Choose one:
- AEP3560 Intermediate Electrodynamics
- AEP3620 Intermediate Quantum Mechanics
- Chem7940 Quantum Mechanics II
- Phys6574 Applications of Quantum Mechanics II

Choose one:
- AEP6620 Micro/Nano-Fabrication and Processing*
- MSE5490 Nanofabrication: Making It Small (Lab)*
- Phys6510 Advanced Experimental Physics*
- AEP7540 Special Topics in Applied Physics

*At least one laboratory course must be taken

Credits

Fall Courses:
- Optional Elective
- Project
- AEP7530 Special Topics in Applied Physics

Spring Courses:
- Optional Elective
- Project
- AEP7540 Special Topics in Applied Physics

Optional Electives

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Advisor ____________________ Date ________________ Student ____________________ Date ________________
Focus Area in Biotechnology: Biophysics Track

**Fall Courses:**
- AEP 4210 Applied Mathematics
- Choose one:
  - AEP3550/3610 Introduction to E&M and QM
  - AEP5570 Electricity and Magnetism
  - Phys6572 Quantum Mechanics
- Choose one:
  - AEP3630 Electronic Circuits
  - AEP4700 Biophysical Methods
  - Phys6510 Advanced Experimental Physics*
  - AEP7530 Special Topics in Applied Physics

**Spring Courses:**
- AEP4220 Applied Mathematics
- Choose one:
  - AEP3560 Intermediate Electrodynamics
  - AEP3620 Intermediate QM
  - Phys6574 Applications of Quantum Mechanics II
- Choose one:
  - AEP3630 Electronic Circuits*
  - AEP5520 Physics of Life
  - AEP5710 Biophysical Methods Advanced Laboratory (if offered)*
  - AEP6510 Advanced Experimental Physics*
  - AEP7540 Special Topics in Applied Physics

*At least one laboratory course must be taken

**Optional Electives**
- Optional Elective
- Project
- AEP7530 Special Topics in Applied Physics
- AEP7540 Special Topics in Applied Physics

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Advisor ___________________________ Date _______ Student ___________________________ Date _______
Focus Area in Biotechnology: Biochemistry Track

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**Fall Courses:**
- AEP 4210  Applied Mathematics
- Choose one:
  - AEP3550/3610 Introduction to E&M and QM
  - AEP5570  Electricity and Magnetism
  - Phys6572  Quantum Mechanics
- BioMG3300  Principles in Biochemistry
- AEP7530  Special Topics in Applied Physics

**Spring Courses:**
- AEP4220  Applied Mathematics
- Choose one:
  - AEP3560  Intermediate Electrodynamics
  - AEP3620  Intermediate QM
  - Phys6574 Applications of Quantum Mechanics II
  - BioMG4400  Laboratory in Biochemistry and Molecular Biology*
  - AEP7530  Special Topics in Applied Physics

*At least one laboratory course must be taken

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**Fall Courses:**
- Optional Elective
- Project
- AEP7530 Special Topics in Applied Physics

**Spring Courses:**
- Optional Elective
- Project
- AEP7530 Special Topics in Applied Physics

**Optional Electives**

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Changes to your curriculum might cause you not to graduate. Please consult with your Advisor before making any changes to your curriculum.

Advisor  Date  Student  Date