

# Master of Science in Electrophysics

## Comparison of Current and Revised Programs

<b>CURRENT REQUIREMENTS</b> <b>(36 units, 12 courses):</b>	<b>REVISED REQUIREMENTS</b> <b>(30 credits, 10 courses):</b>
<p><b>Required Core Courses:</b> choose 3 out of the following, 3 unit each, total 9 units</p> <ul style="list-style-type: none"> <li>EL551 Electro-Optics I</li> <li>EL575 Introduction to Plasma Engineering</li> <li>EL611 Signals, Systems and Transforms</li> <li>EL651 Statistical Mechanics</li> <li>EL653 Quantum Electronics</li> <li>EL671 Electromagnetic Theory Applications</li> </ul> <p><b>Required Course Sequences:</b> choose 2 sequences, each with 2 courses, one of which may be a core course above. Total 6-12 units</p> <p>List of sequence courses are provided in the Graduate Student Manual. Both sequences must be in EL or PH, and at least one must be an EL sequence.</p> <p><b>Electives:</b> 15 to 21 units            At least 24 unit (including core and sequence courses) must be in EL prefixed courses. Remaining units can be from any graduate courses in science or engineering.</p> <p><b>Thesis and projects:</b>            As part of the elective selection, a student may choose to do a MSEE thesis (EL995, 9 units) or a MS project (EL995/EL996: 3-6 units) and/or a reading course (EL993: 3 unit maximum).</p> <p><b>GPA Requirement:</b>            GPA among core and sequence courses <math>\geq 3.0</math>;            GPA among all courses <math>\geq 3.0</math>.</p>	<p><b>Required Core Courses:</b> choose 3 out of the following, 3 credit each, total 9 credits</p> <ul style="list-style-type: none"> <li>EL5513 Electro-Optics I</li> <li>EL5733 RF and Microwave Systems</li> <li>EL5753 Introduction to Plasma Engineering</li> <li>EL6113 Signals, Systems and Transforms</li> <li>EL6583 Fiber Optic Communications</li> <li>EL6713 Electromagnetic Theory and Applications</li> </ul> <p><b>Required Course Sequences:</b> choose 2 sequences, each with 2 courses, one of which may be a core course above. Total 6-12 credits</p> <p>List of sequence courses are provided in the Graduate Student Manual. Both sequences must be in EL.</p> <p><b>Electives:</b> 9 to 15 credits            Up to 6 credits can be from any graduate courses in science or engineering. An additional 3-credit course in other science or engineering disciplines may be used to substitute a 3-credit EL course upon approval by an ECE graduate adviser.</p> <p><b>Thesis or projects option:</b>            As part of the elective selection, a student is encouraged to do a MSEE thesis (= 6 credits) or a MS project (=3 credits). A maximum of 6 credits are allowed for thesis, projects, and reading combined. Maximum of 3 credits allowed for reading.</p> <p><b>GPA Requirement:</b>            GPA among core and sequence courses <math>\geq 3.0</math>;            GPA among all courses <math>\geq 3.0</math>.</p>

## **THE MASTER OF SCIENCE IN ELECTROPHYSICS**

### **Revised 30 Credit Program, Effective Fall 2007**

Polytechnic offers a program of study leading to the degree Master of Science in Electrophysics. Students entering the program typically have an undergraduate background in electrical engineering or physics, a strong interest in physical phenomena and/or applied mathematics and a desire to participate in research. The Department of Electrical and Computer Engineering administers the Electrophysics Program. The program comprises basic courses in wave propagation, electromagnetic theory and electro-optics. Traditional areas of active research covered include propagation modeling for wireless communications, propagation and scattering of waves, antennas, microwave networks, plasmas and solid-state devices. Areas of modern optics covered include lasers and optical communications. Polytechnic's Electrophysics faculty has made significant contributions to each of the areas cited above. Students in the program are exposed to some of the most current technical developments in each area and can be guided in research at the forefront of these areas. Students wishing to continue graduate study toward a PhD in the area of electrophysics may do so in the Electrical Engineering Program.

### **GOALS AND OBJECTIVES**

The Master of Science program in Electrophysics is intended to prepare students to work at the interface between electrical engineering and physics, where new engineering applications of various physical phenomena are developed. Emphasis is placed on wave propagation, electro-optics and plasmas. For students entering the program with an undergraduate degree in physics, the program provides a view of engineering applications and requirements, as well as an advanced view of the physical processes of interest. Students who are interested in furthering their understanding of these topics may do so by continuing in the PhD program in Electrical Engineering. Students entering the MS program in Electrophysics gain a deep understanding of the basic physical principles in one or more of the following areas: (a) electromagnetic wave propagation, (b) microwave devices and networks and (c) lasers and electro-optics for communications. Students learn the engineering applications and performance measures of the physical principles in the different areas and are able to apply their knowledge to device and system design problems. For those interested in PhD-level studies, the MS in Electrophysics prepares them for independent research that advances the knowledge of engineering applications of physical principles.

### **REQUIREMENTS FOR THE MASTER OF SCIENCE**

The entrance requirements for a Master of Science in Electrophysics are a bachelor's degree in engineering or science from an accredited institution, with a superior undergraduate record, including undergraduate courses in differential equations, electromagnetic theory, quantum and solid-state physics and linear systems. Students with deficiencies in these areas may be admitted if they take appropriate introductory courses to remedy these deficiencies. Outstanding students are advised to apply for financial aid in the form of research fellowships, teaching fellowships or partial tuition remission. To satisfy the requirements for an MS in Electrophysics, students must complete a total of 30 credits of courses, as described below.

**GROUP 1: Core Courses**

Three courses (each 3 credits) from among the following:

EL 5513 Electro-Optics I  
EL5733 RF and Microwave Systems Engineering  
EL 5753 Introduction to Plasma Engineering  
EL 6113 Signals, Systems and Transforms  
EL 6583 Fiber Optic Communications  
EL 6713 Electromagnetic Theory and Applications

9 Credits

**GROUP 2:** Two sequences each containing two courses; one course in each sequence may be a core course in Group 1. Both of these sequences must be in electrical engineering. Approved course sequences for the program are given in the ECE Graduate Student Manual.

6-12 Credits

**GROUP 3:** Approved electives, which may include up to 6 credits of courses offered by any science or engineering program.

9-15 Credits

Minimum Total:

30 Credits

**Out-of-department courses:**

At least 24 credits must be in EL prefixed courses. A 3-credit course in other science or engineering disciplines may be used to substitute an EL course upon approval by an ECE graduate adviser. Remaining credits can be from any graduate courses in science or engineering.

**Thesis, project, and reading:** A master's thesis (EL997x, minimal 6 credits) or an MS project (EL9953 or EL9963, 3 credit each) or a reading course (EL9933 or EL9943, 3 credit each) may be included as part of the elective courses in group 3. Oral defense of the master's thesis with at least three professors in attendance is required. The total credits for thesis, projects, and readings should not exceed 6 credits within the 30 credits required for the MS degree. At most 3 credits can be taken for reading.

A complete course of study, including the choice of the course sequences, should be arranged in consultation with an adviser. At least 24 of the 30 credits must be in courses with an EL prefix. A 3-credit course in other science or engineering disciplines may be used to substitute a 3-credit EL course upon approval by an ECE graduate adviser. An overall GPA of  $\geq 3.0$  in all graduate courses is required. In addition, a 3.0 average is required in the combination of five to seven courses offered to satisfy groups 1 and 2 above. Students should consult the Department of Electrical and Computer Engineering's Graduate Student Manual ([www.poly.edu/ece/graduate](http://www.poly.edu/ece/graduate)) for more detailed rules and procedures, including student status, transfer credits, recommended electives, one-year sequences, current areas of research and disqualification for low grades.

## **Description of Core Courses (3 credits each)**

### **EL5513 Electro-Optics I**

Maxwell's equations. Waves in dielectrics and wave propagation in anisotropic media. Boundary value problems in optics. Coherence effects. Ray tracing and ray matrix. Optical cavities, stability analysis. Phase transformation by a lens. Fourier optics. Gaussian beams and ABCD law. **Prerequisite:** Graduate status

### **EL5733 RF and Microwave Systems Engineering**

Review of EM theory, transmission lines and waveguides. Printed transmission lines. Network descriptions in terms of scattering (S), impedance (Z), admittance (Y) and A B C D matrices. Signal flow graphs technique for network analysis. CAD methods. The transverse resonance technique. Excitation of waveguides. Single and multisection impedance transformer, power divider, directional coupler, hybrid circuits. Microwave resonators: series and parallel, stubs and cavities. Filter theory and designs.

**Prerequisite:** EE3604

### **EL5753 Introduction to Plasma Engineering**

Basic plasma concepts. Parameters describing the plasma; Motion of charged particles in electric and magnetic fields; effects of collisions on charge particle motion and plasma transport. Plasmas as dielectric media; fluid equations and plasma dielectric functions. Dispersion relations describing collective plasma oscillations and electromagnetic wave propagation. Applications are described and illustrated.

**Prerequisite:** EE3604

### **EL6113 Signals, Systems and Transforms**

Continuous and discrete linear systems, system function. Fourier transforms, periodic functions, Z transforms, discrete Fourier series, fast Fourier transforms. Magnitude Characteristics of LTI systems, All-pass Systems and Properties. Analog and digital filters, finite order system functions. Digital processing of analog signals. Sampling theorems.

**Prerequisites:** Graduate status

### **EL6583 Fiber Optic Communications**

Overview of fiber optic communications systems. Optical fibers, modes, and bandwidth/information rate. Light sources, detectors, and modulation techniques. Integrated optics. Distribution networks. Noise and detection. System design: principles and examples.

**Prerequisite:** Graduate status

### **EL6713 Electromagnetic Theory and Applications**

Course introduces Maxwell's equations, wave equation, vector potentials, boundary conditions and Poynting vector. Time-harmonic fields and phasor approach are introduced. The properties of freely propagating plane waves in uniform and layered media are derived, as well as waves guided by structures, including various transmission lines, hollow waveguides, and dielectric waveguides. A unified treatment of wave propagation is given with general theorems and examples drawn from microwaves, integrated circuits and optics.

**Prerequisites:** Graduate status and EE 3604.