Department of Aeronautics and Astronautics
School of Engineering
Massachusetts Institute of Technology

Graduate Program (S.M., Ph.D., Sc.D.)

Field: *Communications and Networks*
Date: *10/20/2020*

Introduction and Purpose

The purpose of track documents is to provide incoming master and doctoral level students with guidance in planning the courses for their graduate program. In particular, this track focuses on the area of *Communications and Networks*. The suggestions outlined here are to be considered as guidance and not as a mandatory, rigid framework. The final decision on which courses to take and in what sequence will be decided between each student and their academic advisor and/or doctoral committee. In addition to these recommendations, the requirements for the completion of S.M. and doctoral degrees must be taken into account during the design of a graduate program.

What is *Communications and Networks*?

The increasing reliance on information technology in aerospace makes communications a critical element of most modern space, air, and ground operations. In many scenarios, communication resources and networks are essential for delivering critical information. Both terrestrial and satellite-based networks are needed for providing modern communication-intensive and information-rich services. Department faculty are engaged in a wide range of research activities in the communications and networks area, including wireless and sensor networks, space networks, satellite and hybrid communication networks, location-aware networks, and ultra-wideband systems. Please consult faculty web pages for more detailed information about current research activities.

Educational Goals of the Graduate Program in *Communications and Networks*

A student completing a degree in the area of communications and networks will obtain solid knowledge of distributed sensing and communication networks. In addition, a student will obtain knowledge in a number of closely related fields, such as information theory, optimization, control, as well as statistical inference. The specific educational plan would depend on the student's research interests.

To achieve this goal each student should develop an educational plan in discussion with an academic advisor.

Educational Plan

A. Core Subjects

16.37J Data Networks (FE)
16.393 Statistical Communication and Localization Theory (FE)
16.363 Communications Systems and Networks

B. Additional Relevant subjects

FE subjects:

6.255 Optimization Methods
6.431 Introduction to Probability
6.441 Information Theory
16.391J Statistics for Engineers and Scientists

In addition to the above core communications and networking classes, students who are doing research in this area are likely to take classes from the following areas:

Algorithms

6.046 Design and Analysis of Algorithms
6.852 Distributed Algorithm
6.854 Advanced Algorithms
6.856 Randomized Algorithms
6.860J Statistical Learning Theory and Applications

Optimization

6.231 Dynamic Programming and Reinforcement Learning
6.251 Mathematical Programming
6.252 Nonlinear Programming
6.254 Game Theory with Engineering Applications
6.255 Optimization Methods

Probability/Statistics/Stochastic processes

6.265J Discrete Probability and Stochastic Processes
6.431 Introduction to Probability
6.436 Fundamentals of Probability
16.391J Statistics for Engineers and Scientists
18.338 Eigenvalues of Random Matrices

A. Typical track for an S.M. degree

A S.M. student would take two of the header classes (either 16.363 and 16.393 or 16.37 and 16.393). In addition, they may take two math courses and two courses on optimization and algorithms.

Header courses in communications and networks:

16.393 Statistical Communication and Localization Theory
16.363 Communications Systems and Networks
16.37 Data Networks

Math courses:

16.391J Statistics for Engineers and Scientists
6.431 Introduction to Probability

Two introductory courses in optimization and algorithms: e.g.,

6.231 Dynamic Programming and Reinforcement Learning
6.251 Mathematical Programming

B. Typical track for a Ph.D. degree

A Ph.D. student would take the two field exam header classes (16.37, 16.393), two math courses, and about four or five additional courses depending on the focus area. Outlined below are example courses for people with a communication focus and networking focus.

1. Sample Schedule with Focus on Communications

Core:
16.37J Data Networks
16.393 Statistical Communication and Localization Theory

Math Req.:
16.391J Statistics for Engineers and Scientists
6.436 Fundamentals of Probability

Electives:
6.231 Dynamic Programming and Reinforcement Learning
6.241J Dynamic Systems and Control
6.255 Optimization Methods
6.438 Algorithms for Inference
6.441 Information Theory

2. Sample Schedule with Focus on Networking

Core:
16.37J Data Networks
16.393 Statistical Communication and Localization Theory

Math Req.:
16.391J Statistics for Engineers and Scientists
6.431 Introduction to Probability

Electives:
6.231 Dynamic Programming and Reinforcement Learning
6.255 Optimization Methods
6.436 Fundamentals of Probability
6.437 Inference and Information
6.438 Algorithms for Inference

Faculty and Staff with Interest in *Communications and Networks*

Eytan Modiano (modiano@mit.edu), Professor

Professor Modiano's primary interest is in networked systems, with a focus on communication networks, autonomous wireless networks, space networks, and cyber physical systems. Please consult the Communications and Networks Research Group's web page (http://cnrg.mit.edu/) for more information about Professor Modiano's research activities in the area of communication networks.

Moe Win (moewin@mit.edu), Professor

Professor Win's interest is in the broad area of communication and sensing, with a focus on network localization and navigation, quantum information science, adaptive diversity techniques, ultra-wideband systems, and space communication systems. Please consult the Wireless Information and Network Science Group's web page (http://winslab.lids.mit.edu/) for more information about Professor Win's current research activities.