Uppsala University
Department of Information Technology
Division of Systems and Control

Spectral Analysis of Signals

Instructors

Name	Room	Phone	Email	Responsibilities
Petre Stoica	2-135	018/4717619	ps@it.uu.se	Lectures, examination
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Course literature

P. Stoica and R. Moses, *Introduction to Spectral Analysis*, Prentice Hall, NJ, USA, 1997.

(an errata is available for download at the course homepage (see below))

Course Homepage

http://www.it.uu.se/edu/course/homepage/spekana/ht04

Lectures

1.	Spectral Analysis – A Tutorial Introduction	
2.	Basic Definitions and the Spectral Analysis Problem	Chap. 1
3.	Periodogram and Correlogram Methods	Sect. 2.1 – 2.3
4.	Improved Periodogram Based Methods	Sect. 2.4
5.	Parametric Methods for Rational Spectra	Chapt. 3
6.	Parametric Methods for Line Spectra	Sect. 4.1 – 4.3 & 4.7
7.	Filter Bank Methods	Chap. 5
8.	Spatial Methods	Sect. 6.1 – 6.3
9.	Selected Applications (presented by instructors)	
10.	Selected Applications (presented by students)	

The OH transparencies used in Lecture 2 - Lecture 8 can be found at:
http://www.prenhall.com/stoica

As a general rule, you need to read only the material in the textbook strictly related to the presentations in the lectures. You are not required to study the more advanced parts of the textbook (such as technical statistical analyses, complements and topics that are not discussed during the lectures). However, the textbook will be useful to understand some topics which are only briefly addressed in the class. The whole book may also become a useful reference after graduation, as Spectral Analysis is a universal tool in engineering applications and elsewhere.

Homework Assignments

The homeworks will be based on the exercises specified below. For each homework you will receive additional instructions along with some hints. This information will be made available via the course homepage (see the first page of this syllabus).

We recommend that you start immediately after the topic has been dealt with in the class. You will have at least one week for each homework (see below for exact dates).

In the solutions you are expected to clearly state your conclusions (e.g. do not only claim that something works better/worse than something else, also explain how you came to this conclusion and how the results relate to the theory). The solutions should be put into the box marked *Inlämningsuppgifter SA04* on the second floor in house 2.

Matlab files for the exercises can be found at *http://www.prenhall.com/stoica/*
or, alternatively, they can be downloaded from the course homepage.

HW 1. Periodogram Methods DEADLINE: SEPT. 17

Exercise C2.20: Refined Methods: Variance–Resolution Tradeoff.

HW 2. Rational Parametric Methods DEADLINE: SEPT. 24

Exercise C3.18: AR and ARMA Estimators applied to Measured Data

HW 3. Rational Parametric Methods for Line Spectra DEADLINE: OCT. 1

Exercise C3.17: AR and ARMA Estimators for Line Spectral Estimation.

HW 4. Parametric Methods for Line Spectra DEADLINE: OCT. 8

Exercise C4.10: Line Spectral methods applied to Measured Data.

HW 5. Spatial Methods DEADLINE: OCT. 15

Exercise C6.14: Spatial Spectral Estimators applied to Measured Data.

Lab Assignments

Similarly to the homeworks the computer-lab assignments are based on exercises from the book (see listing below). Further information about the computer exercises will be handed out before each lab.

Solutions should be reported to the lab supervisors at the end of each lab session. Please come well prepared for the labs (e.g. study your notes and/or read about the methods in advance).

Matlab files for the exercises below can be found at *http://www.prenhall.com/stoica/*
or, alternatively, they can be downloaded from the course homepage.
For the computer-lab assignments, little or no extra Matlab programming by the student will be needed.

An UpUnet-S (the university computer network for students) account is required for the PC-labs. Information about UpUnet-S can be found at *http://www.student.uu.se/upunets/*

Note that passing all 5 labs is a pre-requirement for passing the course.

Lab 1. Periodogram Methods

Exercise C2.17: Zero Padding Effects on Periodogram Estimators.

Exercise C2.18: Resolution and Leakage Properties of the Periodogram.

Lab 2. Parametric Methods for Rational Spectra

Exercise C3.16: Comparison of AR, ARMA and Periodogram Methods for ARMA Signals

Lab 3. Parametric Methods for Line Spectra

Exercise C4.9: Resolution Properties of Subspace Methods for Estimation of Line Spectra.

Lab 4. Filter Bank Methods

Exercise C5.13: The Capon Method.

Lab 5. Spatial Methods

Exercise C6.12: Comparison of Spatial Spectral Estimators.

Examination

Your final grade is based on your solutions to the 5 homeworks. For each homework assignment you may get a maximum of 20 points. Hence the total maximum is 100 points.

Since the examination is based on the homeworks, discussing the solutions to the homework assignments with your colleagues or anybody else is **strictly forbidden**. Note that in grading the homework solutions we will put an emphasis on your interpretations of the results. Also note that there will be a session of 3 hours in October (exact date to be determined) during which you will be expected to be able to present your solutions to any of the 5 homeworks. During this session your presence is **mandatory** (otherwise you will fail the course). We will randomly select 5 students to present each solution to the 5 homeworks. Hence, since you may be selected to present any of the solutions, you should have slides/transparencies prepared for each of them. Each presentation (including discussions) will last 30 minutes. After this session we will collect all presentations.

During the last lecture, L10, up to 4 students may choose to present some applications of spectral analysis. Each presentation will last 25 minutes (including discussions) and its topic can be selected by the student or suggested by us. For each presentation you may get a maximum of 20 points.

Grading

Points	**Grade**
$\leq$40	Fail
41 – 70	3
71 – 90	4
$\geq$91	5