

## Homework Assignment no. 3

### RATIONAL PARAMETRIC METHODS FOR LINE SPECTRA

**Deadline: October 5**

This third homework is based on **Exercise C3.17** (old book) / **C3.18** (new book). For your convenience, code for the different spectral estimators can be downloaded at <http://www.prenhall.com/stoica>. Make sure that you use these functions correctly (use “help”. If still in doubt how to use the functions, try by inspecting the code directly). Here follow some explanations and clarifications for the corresponding parts of **Exercise C3.17/C3.18**:

#### **AR and ARMA Estimators for Line Spectral Estimation**

(a)

The true spectrum is given. Verify that the expression for  $\phi(\omega)$  is correct. Use the true spectrum as a reference for the remaining parts.

(b)

The Yule-Walker and modified Yule-Walker methods use the ACS sequence to compute the parameters. Usually the ACS sequence is estimated from the data. Here you have to use the *true* ACS. Use (4.1.6) to compute the true ACS for the given process. Now modify the m-files so as to use this true ACS sequence instead of an estimated sequence. For example, you can modify the function so that the true ACS sequence is passed rather than the data. In that case the computation of  $r(k)$  inside the m-file is unnecessary. Using the true ACS helps to eliminate the effects of estimation errors and makes it easy to study the resolution properties of various methods. Plot the locations of the roots of  $A(z)$  in a separate figure for each example. **Users of the old book: Note that the last sentence in Exercise C3.17b belongs to Exercise C3.17c (see the errata).**

(c)

Note that in this noise-free case ( $\sigma^2 = 0$ ) the covariance matrix  $R$  will have rank = 4 (the number of complex sinusoids in the data). This means that for model orders  $> 4$  there will be a rank deficiency which shows up as warnings in Matlab. Does this fact seem to cause any problems?

(d)

Experimenting with the model orders, SNR,  $K$  and  $M$  is highly recommended in order to understand their impact on the results. Show the plots you think is most relevant to motivate your answers and conclusions.

(e)

This should be straight-forward.

In your handed in solutions, show only the relevant plots and motivate why you show them!