# Homework 11 (Last homework!)
# Due: Thursday, May 5, 2005, at 11:30am

**Reading** OWN Chapter 11.

**Please write your section day and time on the upper left of the front page of your homework.** This will help us return your homeworks.

You may work in (small) groups to do the homework, but each person must write up their own answers. Note that working together does not mean dividing up the problems and sharing answers later.

For any Matlab problems, submit computer generated plots only.

**Problem 0** *(An all-pass system.)* **THIS QUESTION IS OPTIONAL**

OWN Problem 10.50, *only* Part (a).

**Problem 1** *(Difference equations.)*

OWN 10.47

**Problem 2** *(Poles and zeros.)*

OWN 10.48

**Problem 3** *(Pole/Zero plots.)*

Match the pole/zero plots (a)-(e) with the corresponding magnitude responses (1)-(5). In each case, provide a brief justification. (For example: "must have two symmetric peaks, therefore can only be plot (x)".)

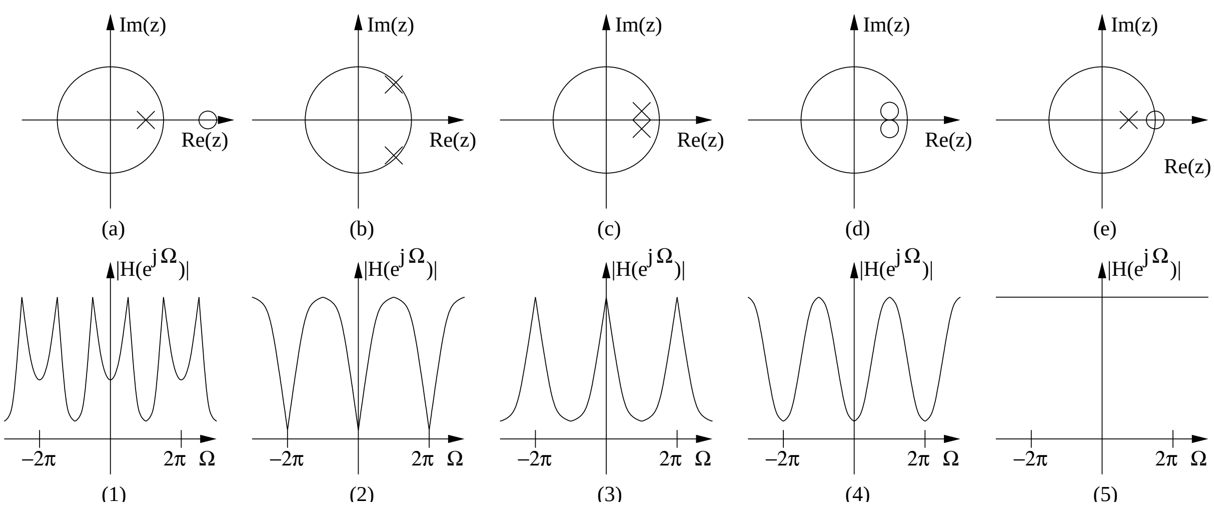


Figure 1: Matching of Pole/Zero Plots and Frequency response.

**Problem 4 and 5 introduction** *(MATLAB, z-transform review.)*

Recall how to draw a pole-zero plot for a rational function. Consider, for example $X(z) = \frac{z^2+2}{z3+3z+1}$. First define the MATLAB arrays `b` and `a` that give the coefficients of the numerator and denominator polynomials respectively. In this case `b = [ 1 0 2 ]` and `a = [ 1 0 3 1 ]`.

The MATLAB command

```
zeros = roots(b)
```

will give the roots of the numerator polynomial (the zeros of X(z)) in the array zeros. Similarly,

```
poles = roots(a)
```

will give the roots of the denominator polynomial (the poles of X(z)) in the array poles. You can now create a pole-zero plot by the sequence of commands:

```
plot(real(zeros),imag(zeros), 'o');
hold on
plot(real(poles),imag(poles), 'x');
grid axis([-1 1 -3 3]);
```

The choices in the axis command are made based on aesthetic considerations.

The questions to answer, for the difference equations given later, are the following:

*(a)* Find the rational function H(z) such that Y (z) = H(z)X(z), where X(z) and Y (z) denote respectively the z-transforms of the input signal x[n] and the output signal y[n].

*(b)* Use MATLAB to get the pole-zero plot of H(z). Submit this plot.

*(c)* What are the possible regions of convergence for the rational function H(z)?

*(d)* What is the system function of the causal LTI system defined by this linear constant coefficient difference equation? Note: Answering this question comes down to specifying the correct ROC to use for H(z).

*(e)* Is the causal LTI system you defined in the preceding part of the problem stable?

*(f)* Does it make sense to talk of the frequency response of this causal LTI system?

Please answer each of the questions above for each of the linear constant coefficient difference equations listed below.

**Problem 4** *(MATLAB, z-transform review.)* **THIS QUESTION IS WORTH DOUBLE POINTS**

Do the Matlab question with the linear constant coefficient difference equation:

$$5y[n] + y[n-2] = x[n] + 3x[n-1]$$

**Problem 5** *(MATLAB, z-transform review.)* **THIS QUESTION IS WORTH DOUBLE POINTS**

Do the Matlab question with the linear constant coefficient difference equation:

$$2y[n] + 12y[n-1] + 24y[n-2] + 16y[n-3] = x[n-5]$$