# Matlab Homework 3*a*

In the online book:

- Do the "Challenge Activities" of: 4.1-3,12; 5.1,4,5
- Do the "Participation Activities" of: 3.5-7; 6.14,15

# Matlab Homework 3*b*

*The same general requirements as for homework 1b, etc, apply. You must study the posted lesson(s) and have done the online book part above before you can ask a TA or the instructor for help.*

*In addition, from now on any final answer must be printed out neatly using* `fprintf`. *(Intermediate results may still be printed out using Matlab's default 'VARIABLE=VALUE' compact format unless it says otherwise.)*

*Homework Motivation:* Consider a drum whose membrane is flexibly attached to the drum rim. If you hit such a drum in the center of the membrane, the nondimensionalized frequencies (tones) $\omega$ that are produced satisfy the equation

$$k\omega J_1(\omega) = J_0(\omega)$$

where $J_0$ and $J_1$ are Bessel functions of the first kind and the given constant $k$ is a nondimensionalized flexibility of the membrane attachment.

1. Since you probably do not know how the two Bessel functions look, plot both $J_0(\omega)$ and $J_1(\omega)$ in a single graph. Make $J_0$ blue and $J_1$ red. Plot 201 equally spaced $\omega$ values between 0 and 3.5 $\pi$. (See help on the Matlab `linspace` command on a somewhat simpler way to do that than by defining an array manually.) Use a grid, suitable labels on the axes, and a suitable title. The tick marks on the horizontal axis should correspond to whole multiples of 0.5 $\pi$ and the horizontal axis length should be 3.5 $\pi$. Let Matlab decide the size and labels on the vertical axis (specify the vertical limits as '`-inf inf`').

2. Next create a function `drumFreqEq0pt5Error` that gives the error in the equation in the *motivation* above. To keep it simple, in this function assume that $k = 0.5$. Make sure that this function multiplies correctly and does not print out any values while it is doing its thing. This function must be in a separate file named 'drumFreqEq0pt5.m' that you `include` in your published solution

   Plot this function. The plot should satisfy the same requirements as the previous one.

3. By looking at your graph, ballpark a very close value `omega1Approx` for the first frequency. Use the ballpark to let `fzero` find the frequency to about 16 digits accuracy. Print the results out using `fprintf` as

```
For k = 0.5, omega1 is: 12.1234567 (12.123 approximate).
```

where you replace the shown digits by the correct ones, but keep the same number of digits behind the decimal points. The number within the parentheses must be your ballpark. Make sure *none* of the four printed numbers is in the format string! The variables with their values *must* only be in the list trailing the string.

Next ballpark an interval $[a\ b]$ in which the first frequency, and no other, is located. Take the end points $a$ and $b$ of this interval to be whole multiples of $\pi$.

You must now first check that the errors at $a$ and $b$, call them `errora` and `errorb`, are of different sign.

Then let `fzero` again find the root, now by searching in the interval. Print the results out as

```
For k = 0.5, omega1 is: 12.1234567 (inside [12.123 12.123]).
```

using similar requirements as before. The interval you selected must be in the square brackets.

Check that you get the same answer as before. But the interval method always works, if used correctly. The initial point method can fail (and readily does so in Octave).

4. We no longer want to assume a priori that $k = 0.5$. So, create a function `drumFreqEqError` with input arguments $\omega$ and $k$. It must return the error in the frequency equation for any $\omega$ and $k$.

   Your function should be very well commented; compare the posted lecture notes of lesson 2. Show to the grader that

   ```
   help drumFreqEqError
   ```

   gives clear and complete information on your function to any user.

   Check that with `drumFreqEqError`, for $k = 0.5$ you get the same value for $\omega_1$ using the interval method as using `drumFreqEq0pt5Error`.

   Change $k$ to 2 and remake the plot of the error now using `drumFreqEqError` with $k$ equal to 2.

5. Finally, use `drumFreqEqError` to find the first four frequencies $\omega_n$ for $n = 1$ to 4 and $k = 2$.

   First do it from an initial ballpark. As initial ballpark use

   $$\omega_{n,\text{approx}} = (n - 0.75)\pi$$

   This ballpark should be acurate if $n$ is high enough. Display the results in a neat table using the same format as before for the ballpark approach.

   Next do it by having `fzero` search in an interval. As end points of the interval use

   $$a = (n - 1)\pi \qquad b = n\pi$$

   Display the results in a neat table using the same format as before for the interval approach.