1. Read and understand Section B.1-2, Chapter 1, of your textbook (pages 4–14).
2. Read and carry out the commands described below on MATLAB. For a tutorial on MATLAB visit

   `http://users.ece.gatech.edu:80/~bonnie/book/TUTORIAL/tutorial.html`

   A numerical method to find the response of a system to a desired input is to use MATLAB. This can be done as follows.

   - Rewrite the differential equation such that all terms containing the output are on the left hand side and all terms containing the input are on the right hand side. On each side, order the terms in decreasing number of time derrivatives. For example, lets assume after rearranging terms in this way, you have the differential equation

   $$10\,\frac{d^2y(t)}{dt^2} + 3\,\frac{dy(t)}{dt} + 2\,y(t) = 4\,\frac{df(t)}{dt} + 5\,f(t).$$

   - Store the coefficients of the left hand side and the right hand side in two vectors, say `lhs` and `rhs`. In the case of the above example, you would type the following in MATLAB

   ```
   lhs = [10, 3, 2];
   rhs = [4, 5];
   ```

   - To define the system for MATLAB, type

   ```
   G = tf(rhs,lhs);
   ```

     This command tells MATLAB that `G` is a system described by a differential equation whose coefficients on the left hand side & right hand side are `[10, 3, 2]` & `[4, 5]`, respectively.
   - To plot the impulse response, type

   ```
   impulse(G);
   ```

     To plot the step response, type

   ```
   step(G);
   ```

   - [Source: `http://users.ece.gatech.edu:80/~bonnie/book/TUTORIAL/tut_3.html#_Toc377373752`]
     For the response to an arbitrary input, use the command `lsim` in the following way. Create a vector `t` which contains the time values at which you want MATLAB to calculate the response. Typically, this is done by entering

   ```
   t = a:b:c;
   ```

     where `a` is the starting time, `b` is the time step (time increments), and `c` is the end time. For smooth plots, choose `b` so that there are at least 300 elements in `t` (increase as necessary). Define the input `f` as a function of time. For example, a ramp is defined as `f = t` or a decaying exponential is defined as `f = exp(-t)`. Then plot the response by typing

   ```
   lsim(G,f,t);
   ```

3. Using Problem 2 above, plot the impulse response and the step response for each of the following systems. (Please turn in *both* your plots *and* the code you wrote to generate them.)
   (a) RC circuit model of cellular membrane described by

   $$RC\,\frac{dv_o}{dt} + v_o(t) = v_i(t)$$

   for the values $R = 2$, $C = 1$.

   (b) Mass-spring-damper model of building oscillations described by

   $$m\,\frac{d^2y(t)}{dt^2} + b\,\frac{dy(t)}{dt} + k\,y(t) = b\,\frac{df(t)}{dt} + k\,f(t)$$

   for the values $k = 1$, $b = 2$, $m = 1$.

   (c) Repeat Part (b) for the values $k = 1$, $b = 0.5$, $m = 1$. Note that the parameter b corresponds to the amount of damping (i.e., energy dissipation) present in the system. Justify the difference between the responses in Parts (b) and (c) in terms of the change in the amount of damping.

   (d) Consider again the system in Part (c), but this time assume that the input is an earthquake wave described by the decaying cosine `f = exp(-t/5) .* cos(2*t)`. Plot the response of the system to the input `f` on the time interval `t = 0:0.01:20`.