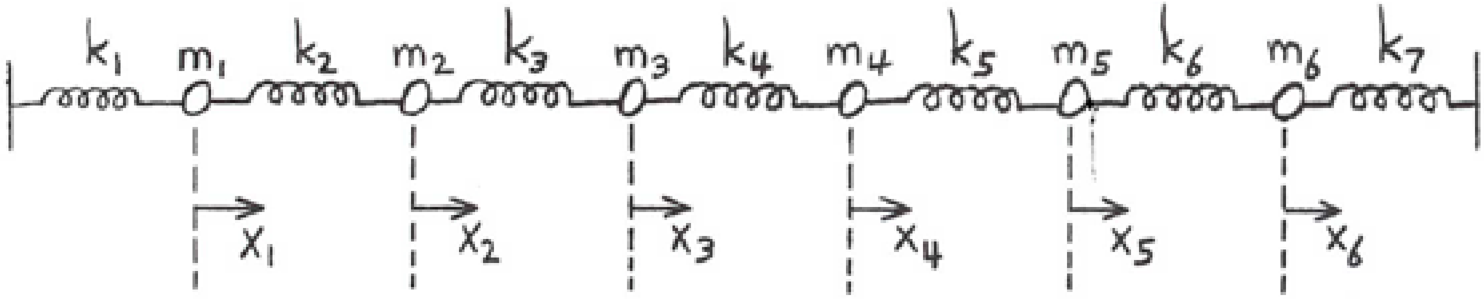
CSC 2262, Spring 2020, Lab 6



In the mass-spring system shown above, the masses m_1, m_2, m_3, m_4, m_5 and m_6 are .4, .7, .7, .2, .6 and .5, the spring constants k_1, k_2, k_3, k_4, k_5, k_6 and k_7 are 3.9, 3.2, 2.2, 2.7, 1.3, 4.9 and 4.4, and x_1, x_2, x_3, x_4, x_5 and x_6 are the displacements of m_1, m_2, m_3, m_4, m_5 and m_6 from their equilibrium positions.

Write a MATLAB program as follows:

1) t will go from 0 to 10 sec in steps of .001 sec.
2) For each of the 6 normal modes of oscillation (in each normal mode, the masses all oscillate with the same frequency; these frequencies are called the natural frequencies of the mass-spring system), plot x_1, x_2, x_3, x_4, x_5 and x_6 versus t using the colors blue, red, green, black, magenta, and cyan and the t axis in black (there will be 6 figures). Only Figures 1-4 are attached, but the program must plot all 6 figures and the title of each figure must have a different figure number. The horizontal and vertical axes of all 6 figures should look like the ones on the attached Figures 1-4.
3) For each of the 6 normal modes, print the frequency, the maximum amplitude and the minimum amplitude, where the frequency, f, is the angular frequency, ω, divided by 2π :

   $f = \omega/(2\pi)$

The graphs should look like the attached graphs.

The printed output of this program should look like this:

```
Mode 1:  Frequency=0.18094  Max Amplitude=0.60975  Min Amplitude = 0.14734
Mode 2:  Frequency=0.32434  Max Amplitude=0.72898  Min Amplitude = 0.09798
Mode 3:  Frequency=0.42681  Max Amplitude=0.54545  Min Amplitude = 0.20135
Mode 4:  Frequency=0.72139  Max Amplitude=0.88047  Min Amplitude = 0.02371
Mode 5:  Frequency=0.75170  Max Amplitude=0.80147  Min Amplitude = 0.10716
Mode 6:  Frequency=0.81010  Max Amplitude=0.77525  Min Amplitude = 0.03695
```

The equations are given on the back.

Equations

$$m_1 \frac{d^2 x_1}{dt^2} = -k_1 x_1 \qquad + k_2 (x_2 - x_1)$$

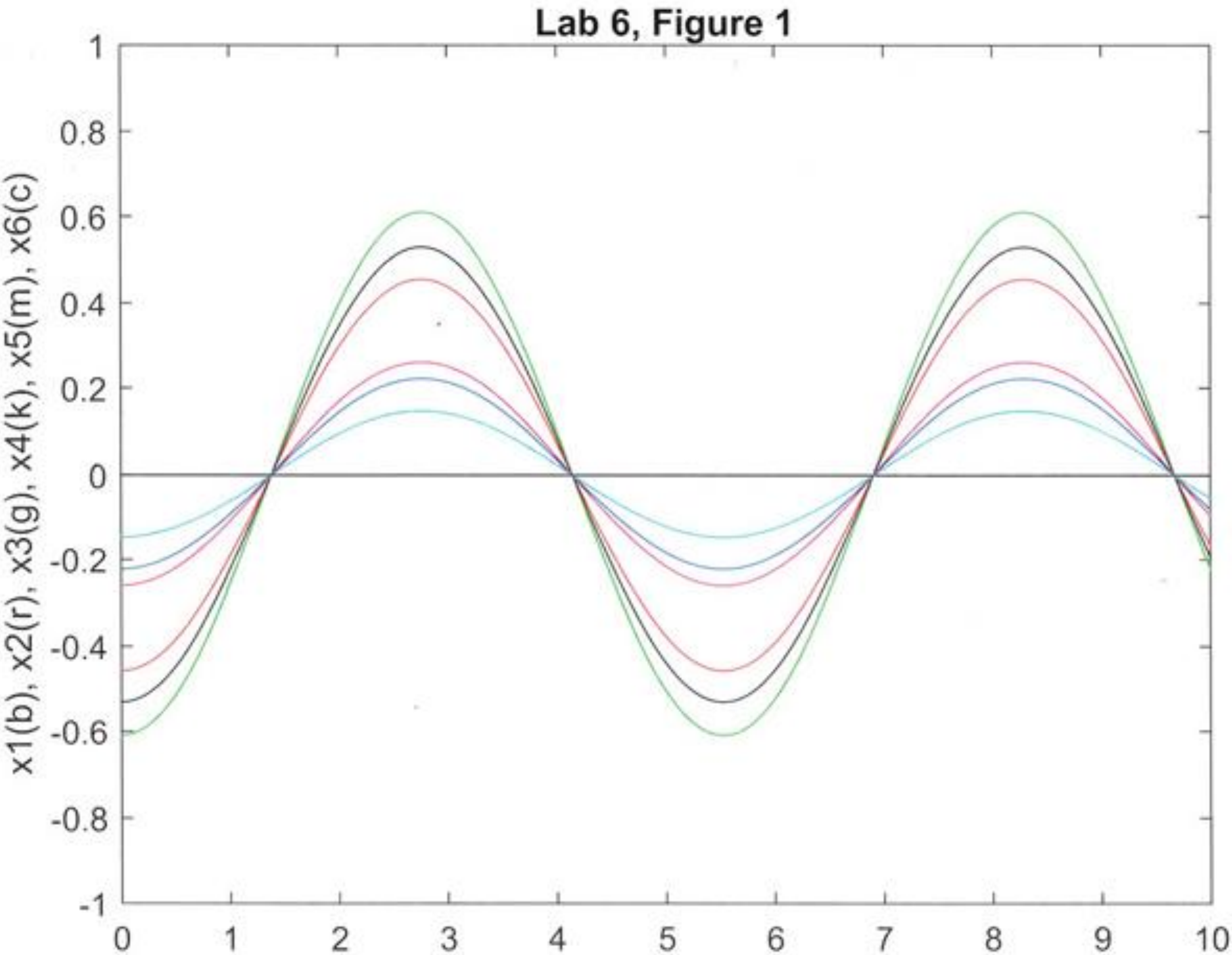
$$m_2 \frac{d^2 x_2}{dt^2} = -k_2 (x_2 - x_1) + k_3 (x_3 - x_2)$$

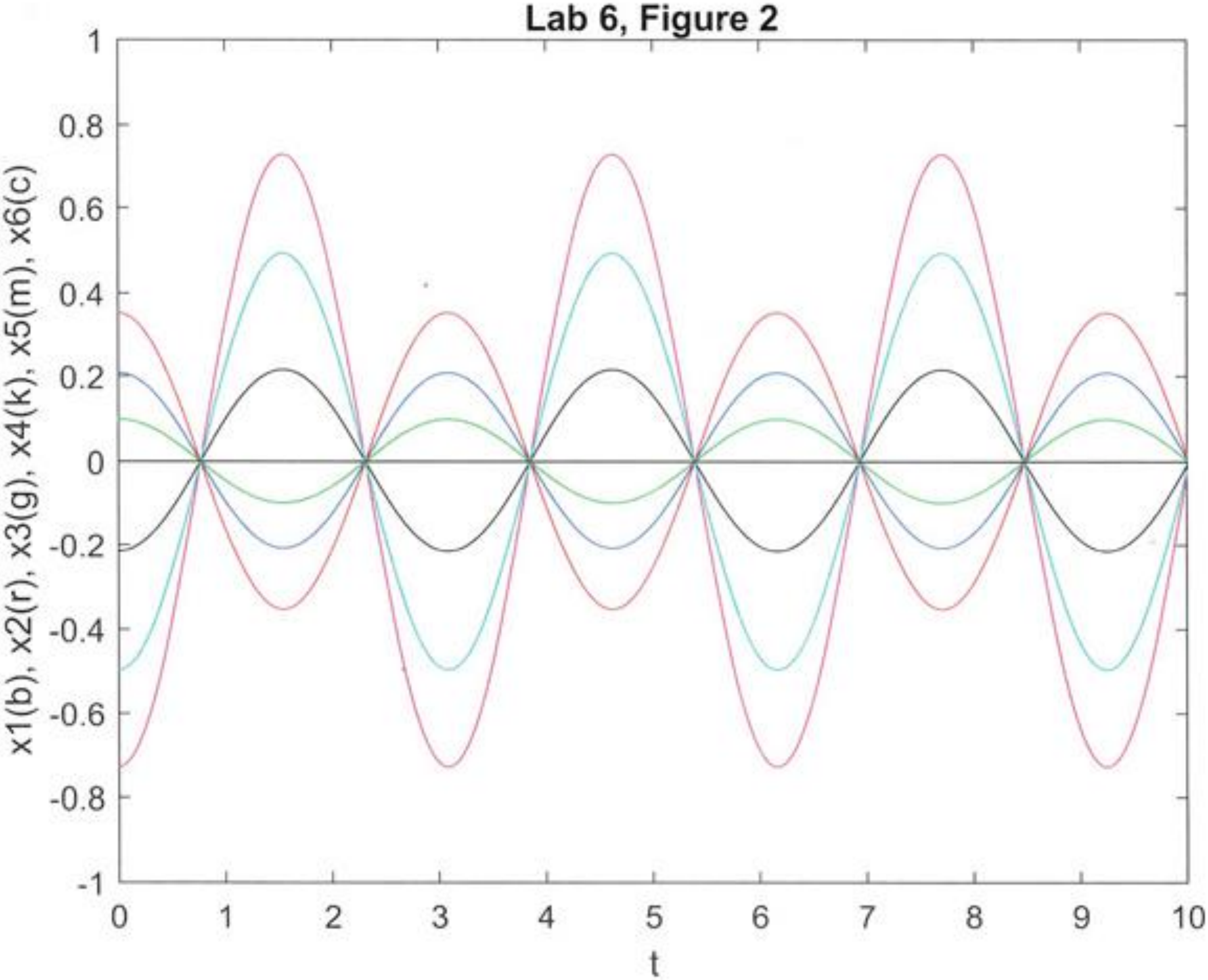
$$m_3 \frac{d^2 x_3}{dt^2} = -k_3 (x_3 - x_2) + k_4 (x_4 - x_3)$$

$$m_4 \frac{d^2 x_4}{dt^2} = -k_4 (x_4 - x_3) + k_5 (x_5 - x_4)$$

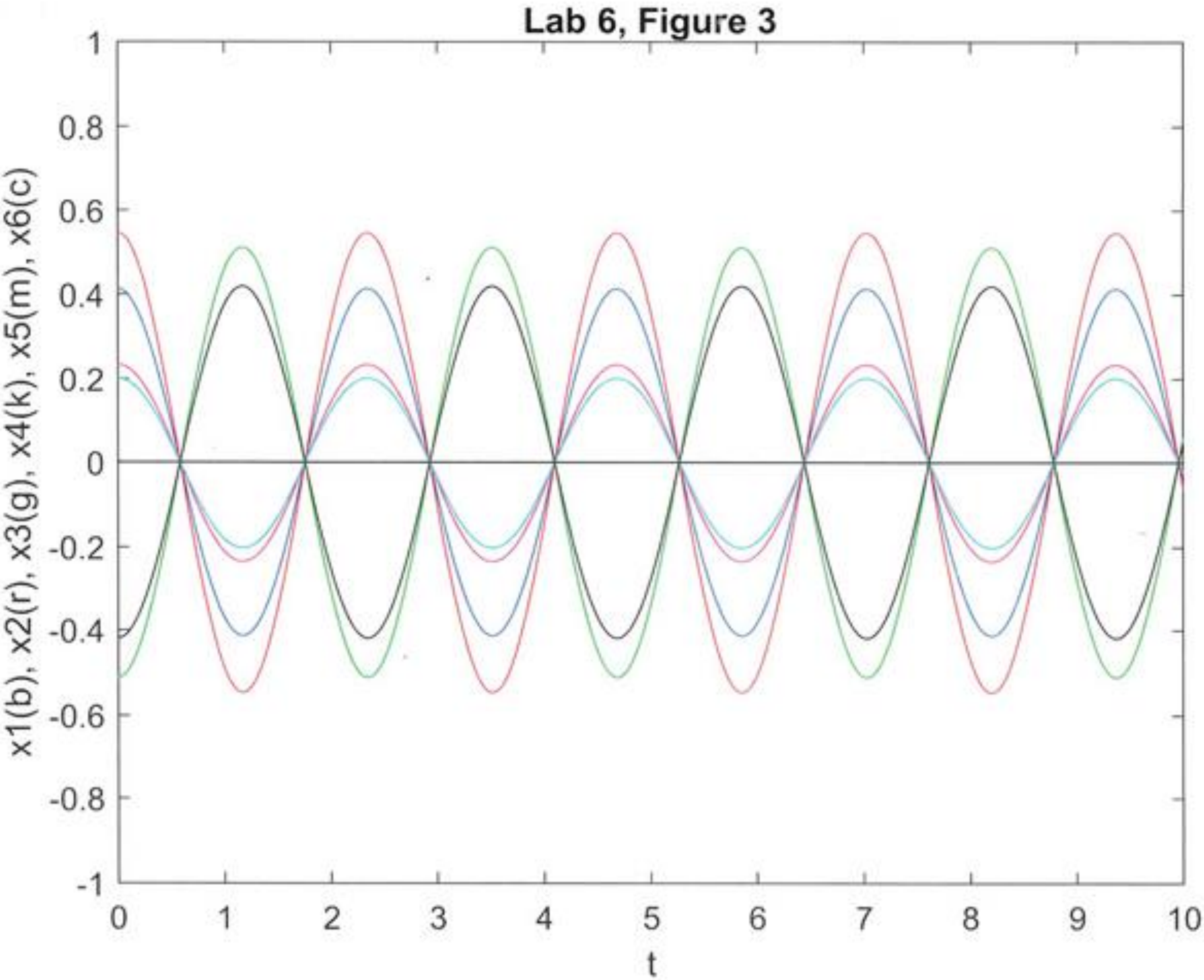
$$m_5 \frac{d^2 x_5}{dt^2} = -k_5 (x_5 - x_4) + k_6 (x_6 - x_5)$$

$$m_6 \frac{d^2 x_6}{dt^2} = -k_6 (x_6 - x_5) - k_7 x_6$$

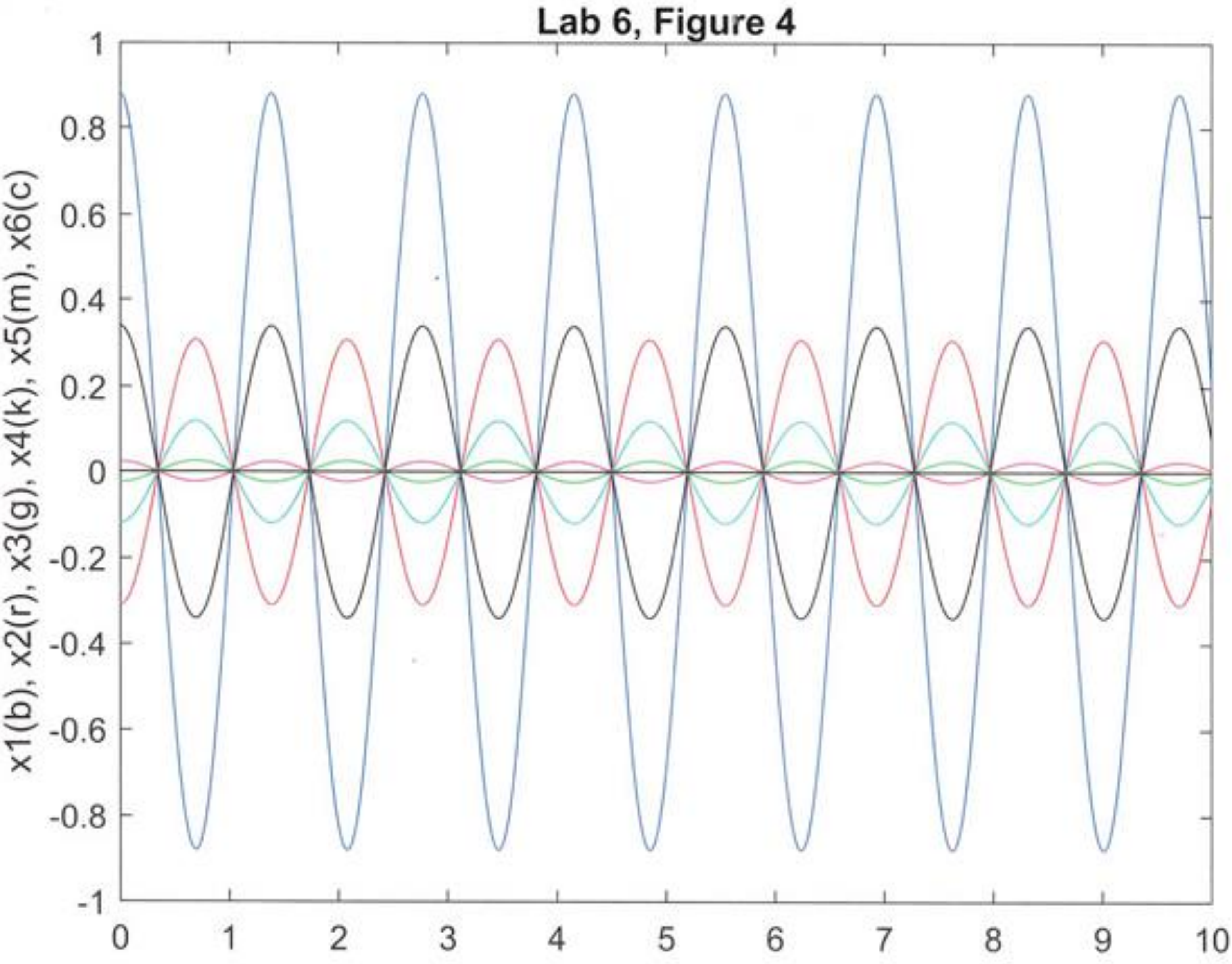

Lab 6, Figure 1
x1(b), x2(r), x3(g), x4(k), x5(m), x6(c)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
1
2
3
4
5
6
7
8
9
10
t



Lab 6, Figure 2
x1(b), x2(r), x3(g), x4(k), x5(m), x6(c)
t
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0 1 2 3 4 5 6 7 8 9 10



Lab 6, Figure 3
x1(b), x2(r), x3(g), x4(k), x5(m), x6(c)
t
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
1
2
3
4
5
6
7
8
9
10



Lab 6, Figure 4
x1(b), x2(r), x3(g), x4(k), x5(m), x6(c)
t
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
1
2
3
4
5
6
7
8
9
10