HOMEWORK ASSIGNMENT 4
EGM 4344
Linear Systems Concepts

Problems from Chapra book chapters 8 through 12

For all of these problems, feel free to use a simple Matlab program to calculate function values (like using a calculator) when the indicated approach is by hand.

Problem	**Approach**	**Comments**
8.3	Matlab	Note that the coefficient matrix is the *A* matrix.
8.4	Matlab	
8.6	Matlab	
8.10	Matlab	Formulate linear system of equations by hand, solve the equations using Matlab.
9.5	Hand	Only use Matlab for the plot.
9.6	Hand	Solve by hand, check using Matlab.
9.7	Hand	Solve by hand, check using Matlab.
9.8	Hand	
9.12	Matlab	Formulate the equations by hand, solve the equations using Matlab. Hints: Review the case study in Section 9.5 and use central difference equations for the first and second derivative as found on pages 101 and 103, respectively. Use $\Delta x = 1$ in your solution process. Apply the specified boundary conditions for *c* at $x = 0$ and $x = 10$ to the equations for the first and last interior node, respectively. This is a very nice somewhat real-life problem.
10.3	Hand	Factor means convert the *A* matrix into *L* and *U*. Check that $A = LU$ using Matlab.
10.5	Hand	Show all steps including factorization of *A* into *L* and *U*, forward substitution, and back substitution.
10.8	Hand	
11.1	Matlab	Calculate A^{-1} using the *LU* decomposition of *A*. Use the Matlab `lu` command to perform the *LU* decomposition. Use the Matlab backslash \ operator to perform intermediate linear system solutions. Use Matlab matrix multiplication to verify that A^{-1} was correctly calculated.
11.3	Matlab	Hint: Review section 11.1.2 on Stimulus-Response Computations.
11.13	Matlab	Use the Matlab `inv` command to calculate the matrix inverse. Check the help file on the `cond` command.
12.1	Matlab	Write a simple Matlab program to perform each Gauss-Seidel iteration without and with overrelaxation.
12.7	Matlab	Formulate Newton-Raphson equations by hand, implement numerical solution in Matlab.

Answers

8.3

```
x =
-15.1812
-7.2464
-0.1449
```

8.4

No answers to provide without giving the solution away.

8.6

```
F =
-500.0220
433.0191
-866.0381
-0.0000
250.0110
749.9890
```

Therefore,

$F_1 = -500$ $F_2 = 433$ $F_3 = -866$

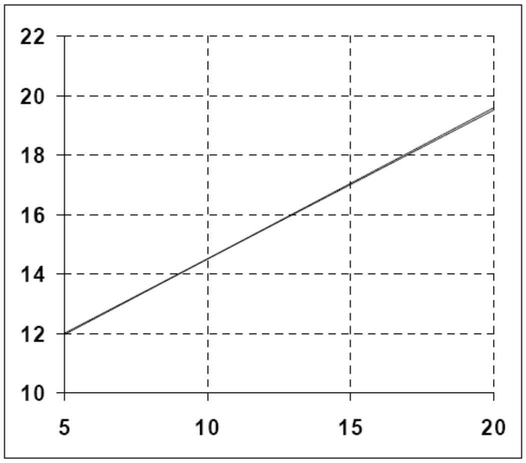
$H_2 = 0$ $V_2 = 250$ $V_3 = 750$

8.10

```
x =
7.3575
12.7530
15.2055
```

9.5

(a)



(b) determinant = 0.02

(d) $x_1 = 10$, $x_2 = 14.5$

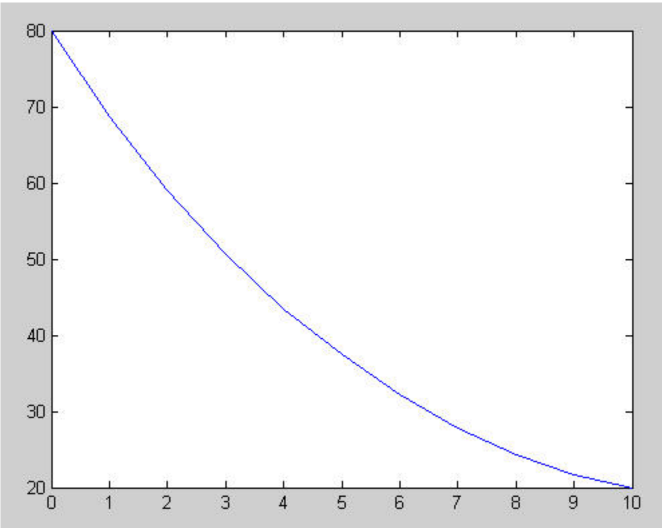
(e) $x_1 = -10$, $x_2 = 4.3$

9.6
(a) $x_1 = 0.5$, $x_2 = 8$, $x_3 = -6$

9.7
(a) $x_1 = 4$, $x_2 = 8$, $x_3 = -2$

9.8
$x_1 = 173.75$, $x_2 = 245$, $x_3 = 253.75$

9.12
Plot of c as a function of x:



10.3

$$[L]\{U\} = \begin{bmatrix} 1 & 0 & 0 \\ -0.3 & 1 & 0 \\ 0.1 & -0.148148 & 1 \end{bmatrix} \begin{bmatrix} 10 & 2 & -1 \\ 0 & -5.4 & 1.7 \\ 0 & 0 & 5.351852 \end{bmatrix}$$

10.5

$$[L]\{U\} = \begin{bmatrix} 1 & 0 & 0 \\ -0.25 & 1 & 0 \\ 0.375 & 0.23913 & 1 \end{bmatrix} \begin{bmatrix} -8 & 1 & -2 \\ 0 & -5.75 & -1.5 \\ 0 & 0 & 8.108696 \end{bmatrix}$$

$x_1 = 4$, $x_2 = 8$, $x_3 = -2$

10.8
(a)

$$[U] = \begin{bmatrix} 2.828427 & 7.071068 & 5.303301 \\ & 5.477226 & 2.282177 \\ & & 5.163978 \end{bmatrix}$$

(c) x =

```
-2.7344
4.8828
-1.7187
```

11.1

$$[A]^{-1} = \begin{bmatrix} 0.110727 & 0.038062 & 0.00692 \\ -0.058824 & -0.176471 & 0.058824 \\ -0.010381 & 0.027682 & 0.186851 \end{bmatrix}$$

11.3

(a)

```
AI =
0.07253886010363 0.01278065630397 0.01243523316062
0.02072538860104 0.06079447322971 0.03212435233161
0.02590673575130 0.00932642487047 0.09015544041451
```

(b)

```
c =
320.2073
227.2021
321.5026
```

(c)

$$\Delta b_3 = 804.1667 \frac{\text{g}}{\text{d}}$$

(d)

$$\Delta c_3 = 15.285 \frac{\text{g}}{\text{m}^3}$$

11.13

(a)

Condition number = 3.8131e+016

(b)

Condition number = 994.8787

12.1

(a)

After 6 iterations, $x_1 = 167.8711$, $x_2 = 239.1211$, $x_3 = 250.8105$, maximum error = 3.5%

(b)

After 6 iterations, $x_1 = 171.423$, $x_2 = 244.389$, $x_3 = 253.622$, maximum error = 4.997%

12.7

iteration	x	y	ε_{a1}	ε_{a2}
0	1.2	1.2		
1	1.26129	0.174194	4.859%	588.889%
2	1.234243	0.211619	2.191%	17.685%
3	1.233319	0.212245	0.075%	0.295%
4	1.233318	0.212245	0.000%	0.000%