

REPORT

Homework II
Numerical Methods
MAT202E - 21257
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First Question

$$\begin{bmatrix} 41214.3 & 0 & -6869.05 & 11897.5 & -27476.2 & 0 & 0 \\ 0 & 41214.3 & 11897.5 & -20607.1 & 0 & 0 & 0 \\ -6869.05 & 11897.5 & 68690.5 & 0 & -6869.05 & -11897.5 & -27476.2 \\ 11897.5 & -20607.1 & 0 & 41214.3 & -11897.5 & -20607.1 & 0 \\ -27476.2 & 0 & -6869.05 & -11897.5 & 41214.3 & 0 & -6869.05 \\ 0 & 0 & -11897.5 & -20607.1 & 0 & 41214.3 & 11897.5 \\ 0 & 0 & -27476.2 & 0 & -6869.05 & 11897.5 & 34345.2 \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \\ x_7 \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \\ 0 \\ -250000 \\ 0 \\ 0 \\ 0 \end{Bmatrix}$$

A -

clc

clear

% Coefficients Matrix

```
A = [41214.3, 0, -6869.05, 11897.5, -27476.2, 0, 0;

      0, 41214.3, 11897.5, -20607.1, 0, 0, 0;

      -6869.05, 11897.5, 68690.5, 0, -6869.05, -11897.5, -27476.2;

      11897.5, -20607.1, 0, 41214.3, -11897.5, -20607.1, 0;

      -27476.2, 0, -6869.05, -11897.5, 41214.3, 0, -6869.05;

      0, 0, -11897.5, -20607.1, 0, 41214.3, 11897.5;

      0, 0, -27476.2, 0, -6869.05, 11897.5, 34345.2];
```

% Right-hand side Matrix

```
B = [0, 0, 0, -250000, 0, 0, 0];
```

```
[m,n] = size(A);
```

% Upper Matrix

```
s=0;
```

```
for j = 1:n
```

```
    for i = s+1:m-1
```

```
        t = A(i+1,j) / A(j,j);
```

```

A(i+1,:) = A(i+1,:) - t * A(j,:);
B(i+1) = B(i+1) - t * B(j);
f(i+1,j) = t;
end
s=s+1;
end
U = A; % Upper Matrix
L = f; L(:,n) = zeros(n,1);
for i=1:n
    L(i,i)=1;
end
U % Upper Matrix;
L % Lower Matrix;

U =

1.0e+04 *

    4.1214         0    -0.6869     1.1898    -2.7476         0         0
         0     4.1214     1.1898    -2.0607         0         0         0
         0         0     6.4111     0.7932    -1.1448    -1.1898    -2.7476
         0         0         0     2.6495    -0.2549    -1.9135     0.3399
         0         0         0         0     2.0607    -0.3966    -1.1448
         0         0         0         0         0     2.4423     0.7050
         0         0         0     0.0000         0         0     1.3738


L =

    1.0000         0         0         0         0         0         0
         0     1.0000         0         0         0         0         0
   -0.1667     0.2887     1.0000         0         0         0         0
     0.2887    -0.5000     0.1237     1.0000         0         0         0
   -0.6667         0    -0.1786    -0.0962     1.0000         0         0
         0         0    -0.1856    -0.7222    -0.1924     1.0000         0
         0         0    -0.4286     0.1283    -0.5556     0.2887     1.0000

```

```

B-
clc
clear
n= 7;
A = zeros(n,n+1);
A = [41214.3,    0,          -6869.05,   11897.5,   -27476.2,    0,          0;

      0,          41214.3,   11897.5,   -20607.1,    0,          0,          0;

     -6869.05,   11897.5,   68690.5,    0,          -6869.05,   -11897.5,   -27476.2;

     11897.5,   -20607.1,    0,          41214.3,   -11897.5,   -20607.1,    0;

    -27476.2,    0,          -6869.05,   -11897.5,   41214.3,    0,          -6869.05

      0,          0,          -11897.5,   -20607.1,    0,          41214.3,   11897.5;

      0,          0,          -27476.2,    0,          -6869.05,   11897.5,   34345.2];

A(1,1) = sqrt(A(1,1));
for j = 2 : n
    A(j,1) = A(j,1)/A(1,1);
end
m = n-1;
for i = 2 : m
    kk = i-1;
    s = 0;
    for k = 1 : kk
        s = s-A(i,k)*A(i,k);
    end
    A(i,i) = sqrt(A(i,i)+s);
    jj = i+1;
    for j = jj : n

```

```

s = 0;
kk = i-1;
for k = 1 : kk
    s = s - A(j,k)*A(i,k);
end
A(j,i) = (A(j,i)+s)/A(i,i);
end
end

s = 0;
for k = 1 : m
s = s-A(n,k)*A(n,k);
end
A(n,n) = sqrt(A(n,n)+s);
fprintf('The matrix L output by rows:\n');
for i = 1 : n
    for j = 1 : i
        fprintf(' %11.8f', A(i,j));
    end
    fprintf('\n');
end

```

The matrix L output by rows:

```

203.01305377
 0.00000000  203.01305377
-33.83550896  58.60460586  253.20181379
 58.60460586 -101.50628059  31.32541633  162.77282778
-135.34203584  0.00000000 -45.21459185 -15.66273348  143.55191673
 0.00000000  0.00000000 -46.98821001 -117.55754950 -27.62641833  156.27991453
 0.00000000  0.00000000 -108.51502045  20.88357277 -79.75106697  45.11365874  117.20960643

```

C-

% Now use a vector y to solve 'Ly=b'

y=zeros(m,1); % initiation for y

y(1)=B(1)/L(1,1);

for i=2:m

%y(i)=B(i)-L(i,1)*y(1)-L(i,2)*y(2)-L(i,3)*y(3);

```

y(i)=-L(i,1)*y(1);
    for k=2:i-1
        y(i)=y(i)-L(i,k)*y(k);
    end
    y(i)=(B(i)+y(i))/L(i,i);
end
y
% Now we use this y to solve Ux = y
x=zeros(m,1);
x(m)=y(m)/U(m,m);
i=m-1;
q=0;
while (i~= 0)
    x(i)=-U(i,m)*x(m);
    q=i+1;
    while (q~=m)
        x(i)=x(i)-U(i,q)*x(q);
        q=q+1;
    end
    x(i)=(y(i)+x(i))/U(i,i);
    i=i-1;
end
x

```

$y =$	$x =$
$1.0e+05 *$	9.1078
	-14.0762
0	5.5693
0	-24.9371
0	1.4714
-2.5000	-19.2574
-0.4811	13.5219
-3.7500	
1.8576	

D-

% To inverse calculation Forward elimination, solve $LB = I$

$b = \text{eye}(n);$

for $i = 1:m$

$B(1,i) = b(1,i)/L(1,1);$

for $k = 2:m$

sum = 0;

for $j = k-1:-1:1$

sum = sum + $L(k,j)*B(j,i);$

end

$B(k,i) = (b(k,i) - \text{sum})/L(k,k);$

end

end

% Backward substitution, solve $U*A_{\text{inv}} = B$

for $i = 1:m$

$A_{\text{inv}}(m,i) = B(m,i)/U(m,m);$

for $k = m-1:-1:1$

sum = 0;

for $j = k+1:m$

```

        sum = sum + U(k,j)*Ainv(j,i);

    end

    Ainv(k,i) = (B(k,i)- sum)/U(k,k);

end

end

% Inverse of A
fprintf('\n Inverse OF A :\n');

Ainv

Ainv =

1.0e-04 *

    0.6824    -0.1839     0.2730    -0.2101     0.5004    -0.1313     0.3640
   -0.1839     0.4701    -0.1576     0.3639    -0.0788     0.1971    -0.2101
    0.2730    -0.1576     0.3640    -0.1051     0.2730    -0.0525     0.3640
   -0.2101     0.3639    -0.1051     0.6672     0.0000     0.3639    -0.2101
    0.5004    -0.0788     0.2730     0.0000     0.6824    -0.0263     0.3640
   -0.1313     0.1971    -0.0525     0.3639    -0.0263     0.4701    -0.2101
    0.3640    -0.2101     0.3640    -0.2101     0.3640    -0.2101     0.7279

```

2-

```

clear;

clc;

% T
x0 = 50;
x1 = 100;
x2 = 150;
x3 = 200;
x4 = 250;
x5 = 300;
x6 = 400;
x7 = 500;

% (v) (m^3/kg)

```


$v_0 = 14.867;$

$v_1 = 17.196;$

$v_2 = 19.513;$

$v_3 = 21.826;$

$v_4 = 24.136;$

$v_5 = 26.446;$

$v_6 = 31.063;$

$v_7 = 35.680;$

% S values for (v)

$Sv1y0 = (v_1 - v_0) / (x_1 - x_0);$

$Sv1y1 = (v_2 - v_1) / (x_2 - x_1);$

$Sv1y2 = (v_3 - v_2) / (x_3 - x_2);$

$Sv1y3 = (v_4 - v_3) / (x_4 - x_3);$

$Sv1y4 = (v_5 - v_4) / (x_5 - x_4);$

$Sv1y5 = (v_6 - v_5) / (x_6 - x_5);$

$Sv1y6 = (v_7 - v_6) / (x_7 - x_6);$

$Sv2y0 = (Sv1y1 - Sv1y0) / (x_2 - x_0);$

$Sv2y1 = (Sv1y2 - Sv1y1) / (x_3 - x_1);$

$Sv2y2 = (Sv1y3 - Sv1y2) / (x_4 - x_2);$

$Sv2y3 = (Sv1y4 - Sv1y3) / (x_5 - x_3);$

$Sv2y4 = (Sv1y5 - Sv1y4) / (x_6 - x_4);$

$Sv2y5 = (Sv1y6 - Sv1y5) / (x_7 - x_5);$

$Sv3y0 = (Sv2y1 - Sv2y0) / (x_3 - x_0);$

$Sv3y1 = (Sv2y2 - Sv2y1) / (x_4 - x_1);$

$Sv3y2 = (Sv2y3 - Sv2y2) / (x_5 - x_2);$

$Sv3y3 = (Sv2y4 - Sv2y3) / (x_6 - x_3);$

$Sv3y4 = (Sv2y5 - Sv2y4) / (x_7 - x_4);$

$Sv4y0 = (Sv3y1 - Sv3y0) / (x_4 - x_0);$

$Sv4y1 = (Sv3y2 - Sv3y1) / (x_5 - x_1);$

$Sv4y2 = (Sv3y3 - Sv3y2) / (x_6 - x_2);$

$Sv4y3 = (Sv3y4 - Sv3y3) / (x_7 - x_3);$

```

Sv5y0 = (Sv4y1-Sv4y0)/(x5-x0);
Sv5y1 = (Sv4y2-Sv4y1)/(x6-x1);
Sv5y2 = (Sv4y3-Sv4y2)/(x7-x2);
Sv6y0 = (Sv5y1-Sv5y0)/(x6-x0);
Sv6y1 = (Sv5y2-Sv5y1)/(x7-x1);
Sv7y0 = (Sv6y1-Sv6y0)/(x7-x0);
Xv = zeros(46,1);
Yv = zeros(46,1);
% (u) kJ/kg
u0 =2443.3;
u1 =2515.5;
u2 =2587.9;
u3 =2661.4;
u4 =2736.1;
u5 =2812.3;
u6 =2969.3;
u7 =3132.9;
% S values for (u)
Su1y0 = (u1-u0)/(x1-x0);
Su1y1 = (u2-u1)/(x2-x1);
Su1y2 = (u3-u2)/(x3-x2);
Su1y3 = (u4-u3)/(x4-x3);
Su1y4 = (u5-u4)/(x5-x4);
Su1y5 = (u6-u5)/(x6-x5);
Su1y6 = (u7-u6)/(x7-x6);
Su2y0 = (Su1y1-Su1y0)/(x2-x0);
Su2y1 = (Su1y2-Su1y1)/(x3-x1);
Su2y2 = (Su1y3-Su1y2)/(x4-x2);
Su2y3 = (Su1y4-Su1y3)/(x5-x3);
Su2y4 = (Su1y5-Su1y4)/(x6-x4);
Su2y5 = (Su1y6-Su1y5)/(x7-x5);

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Su3y0 = (Su2y1-Su2y0)/(x3-x0);
Su3y1 = (Su2y2-Su2y1)/(x4-x1);
Su3y2 = (Su2y3-Su2y2)/(x5-x2);
Su3y3 = (Su2y4-Su2y3)/(x6-x3);
Su3y4 = (Su2y5-Su2y4)/(x7-x4);
Su4y0 = (Su3y1-Su3y0)/(x4-x0);
Su4y1 = (Su3y2-Su3y1)/(x5-x1);
Su4y2 = (Su3y3-Su3y2)/(x6-x2);
Su4y3 = (Su3y4-Su3y3)/(x7-x3);
Su5y0 = (Su4y1-Su4y0)/(x5-x0);
Su5y1 = (Su4y2-Su4y1)/(x6-x1);
Su5y2 = (Su4y3-Su4y2)/(x7-x2);
Su6y0 = (Su5y1-Su5y0)/(x6-x0);
Su6y1 = (Su5y2-Su5y1)/(x7-x1);
Su7y0 = (Su6y1-Su6y0)/(x7-x0);
Xu = zeros(46,1);
Yu = zeros(46,1);
%Enthalpy (h) kJ/kg
h0 =2592.0;
h1 =2687.5;
h2 =2783.0;
h3 =2879.6;
h4 =2977.5;
h5 =3076.7;
h6 =3280.0;
h7 =3489.7;
% S values for (h)
Sh1y0 = (h1-h0)/(x1-x0);
Sh1y1 = (h2-h1)/(x2-x1);
Sh1y2 = (h3-h2)/(x3-x2);
Sh1y3 = (h4-h3)/(x4-x3);

```

```

Sh1y4 = (h5-h4)/(x5-x4);
Sh1y5 = (h6-h5)/(x6-x5);
Sh1y6 = (h7-h6)/(x7-x6);
Sh2y0 = (Sh1y1-Sh1y0)/(x2-x0);
Sh2y1 = (Sh1y2-Sh1y1)/(x3-x1);
Sh2y2 = (Sh1y3-Sh1y2)/(x4-x2);
Sh2y3 = (Sh1y4-Sh1y3)/(x5-x3);
Sh2y4 = (Sh1y5-Sh1y4)/(x6-x4);
Sh2y5 = (Sh1y6-Sh1y5)/(x7-x5);
Sh3y0 = (Sh2y1-Sh2y0)/(x3-x0);
Sh3y1 = (Sh2y2-Sh2y1)/(x4-x1);
Sh3y2 = (Sh2y3-Sh2y2)/(x5-x2);
Sh3y3 = (Sh2y4-Sh2y3)/(x6-x3);
Sh3y4 = (Sh2y5-Sh2y4)/(x7-x4);
Sh4y0 = (Sh3y1-Sh3y0)/(x4-x0);
Sh4y1 = (Sh3y2-Sh3y1)/(x5-x1);
Sh4y2 = (Sh3y3-Sh3y2)/(x6-x2);
Sh4y3 = (Sh3y4-Sh3y3)/(x7-x3);
Sh5y0 = (Sh4y1-Sh4y0)/(x5-x0);
Sh5y1 = (Sh4y2-Sh4y1)/(x6-x1);
Sh5y2 = (Sh4y3-Sh4y2)/(x7-x2);
Sh6y0 = (Sh5y1-Sh5y0)/(x6-x0);
Sh6y1 = (Sh5y2-Sh5y1)/(x7-x1);
Sh7y0 = (Sh6y1-Sh6y0)/(x7-x0);
Xh = zeros(46,1);
Yh = zeros(46,1);
%Entropy (s) kJ/kg.K
s0 =8.1741;
s1 =8.4489;
s2 =8.6893;
s3 =8.9049;

```

```

s4 =9.1015;
s5 =9.2827;
s6 =9.6094;
s7 =9.8998;
% S values for (s)
Ss1y0 = (s1-s0)/(x1-x0);
Ss1y1 = (s2-s1)/(x2-x1);
Ss1y2 = (s3-s2)/(x3-x2);
Ss1y3 = (s4-s3)/(x4-x3);
Ss1y4 = (s5-s4)/(x5-x4);
Ss1y5 = (s6-s5)/(x6-x5);
Ss1y6 = (s7-s6)/(x7-x6);
Ss2y0 = (Ss1y1-Ss1y0)/(x2-x0);
Ss2y1 = (Ss1y2-Ss1y1)/(x3-x1);
Ss2y2 = (Ss1y3-Ss1y2)/(x4-x2);
Ss2y3 = (Ss1y4-Ss1y3)/(x5-x3);
Ss2y4 = (Ss1y5-Ss1y4)/(x6-x4);
Ss2y5 = (Ss1y6-Ss1y5)/(x7-x5);
Ss3y0 = (Ss2y1-Ss2y0)/(x3-x0);
Ss3y1 = (Ss2y2-Ss2y1)/(x4-x1);
Ss3y2 = (Ss2y3-Ss2y2)/(x5-x2);
Ss3y3 = (Ss2y4-Ss2y3)/(x6-x3);
Ss3y4 = (Ss2y5-Ss2y4)/(x7-x4);
Ss4y0 = (Ss3y1-Ss3y0)/(x4-x0);
Ss4y1 = (Ss3y2-Ss3y1)/(x5-x1);
Ss4y2 = (Ss3y3-Ss3y2)/(x6-x2);
Ss4y3 = (Ss3y4-Ss3y3)/(x7-x3);
Ss5y0 = (Ss4y1-Ss4y0)/(x5-x0);
Ss5y1 = (Ss4y2-Ss4y1)/(x6-x1);
Ss5y2 = (Ss4y3-Ss4y2)/(x7-x2);
Ss6y0 = (Ss5y1-Ss5y0)/(x6-x0);

```

```

Ss6y1 = (Ss5y2-Ss5y1)/(x7-x1);
Ss7y0 = (Ss6y1-Ss6y0)/(x7-x0);

Xs = zeros(46,1);
Ys = zeros(46,1);

d1 = 50;

for x=50:10:500

f2 = u0 + Su1y0*(x-x0) + Su2y0*(x-x0)*(x-x1) +
Su3y0*(x-x0)*(x-x1)*(x-x2) + Su4y0*(x-x0)*(x-x1)*(x-x2)*(x-x3) +
Su5y0*(x-x0)*(x-x1)*(x-x2)*(x-x3)*(x-x4) +
Su6y0*(x-x0)*(x-x1)*(x-x2)*(x-x3)*(x-x4)*(x-x5) +
Su7y0*(x-x0)*(x-x1)*(x-x2)*(x-x3)*(x-x4)*(x-x5)*(x-x6);

d1 = d1 + 10;

a = (x/10)-4;

Xu(a)=f2;

end

for y=50:10:500

a = (y/10)-4;

Yh(a)=y;

end

d2 = 50;

for x=50:10:500

f1 = v0 + Sv1y0*(x-x0) + Sv2y0*(x-x0)*(x-x1) +
Sv3y0*(x-x0)*(x-x1)*(x-x2) + Sv4y0*(x-x0)*(x-x1)*(x-x2)*(x-x3) +
Sv5y0*(x-x0)*(x-x1)*(x-x2)*(x-x3)*(x-x4) +
Sv6y0*(x-x0)*(x-x1)*(x-x2)*(x-x3)*(x-x4)*(x-x5) +
Sv7y0*(x-x0)*(x-x1)*(x-x2)*(x-x3)*(x-x4)*(x-x5)*(x-x6);

fprintf('Degree: %d          Value: %d\n',Degree, Function);

d2 = d2 + 10;

a = (x/10)-4;

Xv(a)=f1;

end

for y=50:10:500

a = (y/10)-4;

Yu(a)=y;

```

end

d3 = 50;

for x=50:10:500

f3 = h0 + Sh1y0*(x-x0) + Sh2y0*(x-x0)*(x-x1) +
Sh3y0*(x-x0)*(x-x1)*(x-x2) + Sh4y0*(x-x0)*(x-x1)*(x-x2)*(x-x3) +
Sh5y0*(x-x0)*(x-x1)*(x-x2)*(x-x3)*(x-x4) +
Sh6y0*(x-x0)*(x-x1)*(x-x2)*(x-x3)*(x-x4)*(x-x5) +
Sh7y0*(x-x0)*(x-x1)*(x-x2)*(x-x3)*(x-x4)*(x-x5)*(x-x6);

d3 = d3 + 10;

a = (x/10)-4;

Xh(a)=f3;

end

for y=50:10:500

a = (y/10)-4;

Yv(a)=y;

end

d4 = 50;

for x=50:10:500

f4 = s0 + Ss1y0*(x-x0) + Ss2y0*(x-x0)*(x-x1) +
Ss3y0*(x-x0)*(x-x1)*(x-x2) + Ss4y0*(x-x0)*(x-x1)*(x-x2)*(x-x3) +
Ss5y0*(x-x0)*(x-x1)*(x-x2)*(x-x3)*(x-x4) +
Ss6y0*(x-x0)*(x-x1)*(x-x2)*(x-x3)*(x-x4)*(x-x5) +
Ss7y0*(x-x0)*(x-x1)*(x-x2)*(x-x3)*(x-x4)*(x-x5)*(x-x6);

d4 = d4 + 10;

a = (x/10)-4;

Xs(a)=f4;

end

for y=50:10:500

a = (y/10)-4;

Ys(a)=y;

end

c0=Yv(:,1);

c1=Xv(:,1);

c2=Xu(:,1);

```

c3=Xh(:,1);
c4=Xs(:,1);
Table = (zeros(46,5));
Table(:,1)=c0;
Table(:,2)=c1;
Table(:,3)=c2;
Table(:,4)=c3;
Table(:,5)=c4;
Table

3-
clc
clear
xi = [-1.00618, -0.9457, -0.83748, -0.70018, -0.60838, -0.45486, -0.43177,
-0.30001, -0.15028, -0.08273, -0.04579, 0.142306, 0.180491, 0.305722,
0.42359, 0.464966, 0.598916, 0.675807, 0.810735, 0.915424, 1.040305];
yi = [-0.50212, -0.55886, -0.73497, -0.78201,
-0.76401, -0.73944, -0.71752, -0.51484, -0.4206, -0.25697, -0.09099, 0.226821,
0.377523, 0.474654, 0.602706, 0.77508,
0.787781, 0.688962, 0.651689, 0.549357, 0.515353];
p1 = polyfit(xi,yi,1);
p2 = polyfit(xi,yi,3);
p3 = polyfit(xi,yi,5);
figure
subplot(2,2,1)
plot(xi,yi,':')
grid on
subplot(2,2,2)
plot(xi,yi,':')
plot(p1)
grid on
subplot(2,2,3)
plot(xi,yi,':')

```



```
plot(p2)
grid on
subplot(2,2,4)
plot(xi,yi,':')
plot(p3)
grid on
```

