AYEOMERETSE EWORITSE N YOMERE

16/ENG05/014

MECHATRONICS ENGINEERING

ENG 382- ENGINEERING MATHEMATICS IV

MID-SEMESTER TEST

QUESTION 4A
FIXED-POINT ITERATION

```
commandwindow
clear
clc
format long g
p=0.35;
g = 9.81;
m = 68.1;
t = 10;
v = 40;
for i=1:inf;
    iter(i+1) = i;
    p(i+1)=((g*m)/v)*(1- exp((-p(i)*t)/m));
    Ea(i+1)=abs(((p(i+1)-p(i))/p(i+1))*100);
    if Ea(i+1) <= 1E-11
        break
    end
end
p';
iter'
Ea'
table=[iter',p',Ea']
```

RESULTS

```
ans =

     0
     1
     2
     3
     4
     5
     6
     7
     8
     9
    10
    11
    12
    13
    14
    15
    16
    17
```

```
    18
    19
    20
    21
    22
    23
    24
    25
    26
    27
    28
    29


ans =

                         0
          58.1684968584692
           56.669170693217
          53.1717510236431
          45.6425646403538
          32.3839488151734
          16.8088340221021
```

6.32456769857547
1.96466586886192
0.566465947309014
0.159564313514515
0.0446451872560936
0.0124678002591076
0.00347996226683956
0.000971169120216692
0.000271017433573531
7.56300831260318e-05
2.11052513095223e-05
5.88960389572715e-06
1.64354478048921e-06
4.58645315383666e-07
1.27988917260608e-07
3.57164100223082e-08
9.9669733513094e-09
2.78135729191509e-09
7.76172357999009e-10
2.16590888698186e-10
6.04395032683219e-11
1.68620933463022e-11
4.71658554099392e-12

table =

0	0.35	0
1	0.836689991310678	58.1684968584692
2	1.93093463636917	56.669170693217
3	4.12343975821962	53.1717510236431
4	7.58578790728007	45.6425646403538
5	11.2189158851417	32.3839488151734
6	13.4857057877063	16.8088340221021
7	14.3962034189633	6.32456769857547
8	14.6847088823159	1.96466586886192
9	14.7683666503639	0.566465947309014
10	14.79196935472	0.159564313514515
11	14.7985762067788	0.0446451872560936
12	14.8004214937681	0.0124678002591076
13	14.8009365607756	0.00347996226683956
14	14.801080304297	0.000971169120216692
15	14.8011204179137	0.000271017433573531
16	14.8011316120218	7.56300831260318e-05
17	14.8011347358385	2.11052513095223e-05
18	14.8011356075668	5.88960389572715e-06

19	14.80113585083	1.64354478048921e-06
20	14.8011359187148	4.58645315383666e-07
21	14.8011359376586	1.27988917260608e-07
22	14.801135942945	3.57164100223082e-08
23	14.8011359444202	9.9669733513094e-09
24	14.8011359448319	2.78135729191509e-09
25	14.8011359449468	7.76172357999009e-10
26	14.8011359449788	2.16590888698186e-10
27	14.8011359449878	6.04395032683219e-11
28	14.8011359449903	1.68620933463022e-11
29	14.801135944991	4.71658554099392e-12

NEWTON-RAPHSON METHOD

```
Commandwindow
Clear
Clc
Format long g
syms p
g = 9.81;
v = 40;
t = 10;
m = 68.1;
b =v - (((g*m)/p)*(1- exp((-p*t)/m)))
pretty(b)
q = diff(b)
pretty(q)
p = 0.35;
for i= 1:10;
```

```
    iter(i+1) = I;
    pf(i) = p;
    p = double(subs(p - (b/q)));
    pf(i+1) = p;
    Ea(i+1) = abs(((pf(i+1)-pf(i))/pf(i+1))*100);
    if Ea(i+1) <= 1E-11
        break
    end
end
iter'
pf'
Ea'
table(iter',pf',Ea')
```

RESULTS

```
b =


(2938163350254649*(exp(-(100*p)/681) - 1))/(4398046511104*p) + 40


/    /   100 p \     \
| exp| - ----- | - 1 | 2938163350254649
\    \    681  /     /
---------------------------------------- + 40
            4398046511104 p
```

```
q =

-(73454083756366225*exp(-(100*p)/681))/(748767418515456*p)-       (2938163350254649*(exp(-
(100*p)/681) - 1))/(4398046511104*p^2)

     /   100 p \                     /    /   100 p \     \
  exp| - ----- | 73454083756366225   | exp| - ----- | - 1 | 2938163350254649
     \    681  /                     \    \    681  /     /
- -------------------------------- - ----------------------------------------
          748767418515456 p                                    2


                                                   4398046511104 p
ans =
     0
     1
     2
     3
     4
     5
     6
     7
```

```
ans =
                      0.35
          8.34099580691024
          13.3210094965819
          14.7172021430025
          14.8008605185077
          14.8011359420219
          14.8011359449913
          14.8011359449913
```

```
ans =
                         0
          95.8038583389523
          37.3846568531425
          9.48680756609994
         0.565226429913042
       0.00186082686707078
      2.00616185516846e-08
                         0
```

```
ans =

  8×3 table
```

Var1	Var2	Var3
0	0.35	0
1	8.34099580691024	95.8038583389523
2	13.3210094965819	37.3846568531425
3	14.7172021430025	9.48680756609994
4	14.8008605185077	0.565226429913042
5	14.8011359420219	0.00186082686707078
6	14.8011359449913	2.00616185516846e-08
7	14.8011359449913	0

COMMENT ON RESULTS

When using newton-raphson method, the values converged faster than when the fixed-point iteration method was used.

QUESTION 4B

EXCEL CODES

=C2+I2*(2*B2-C2) (the formula was dragged down and applied to the remaining rows)

I2 = 0.1

iter	x	y
0	0	1
1	0.1	0.9
2	0.2	0.83
3	0.3	0.787
4	0.4	0.7683
5	0.5	0.77147
6	0.6	0.794323
7	0.7	0.834891
8	0.8	0.891402
9	0.9	0.962261
10	1	1.046035
11	1.1	1.141432
12	1.2	1.247289
13	1.3	1.36256
14	1.4	1.486304
15	1.5	1.617673

QUESTION 4C

EXCEL CODES

tidal rise (z)	wind speed (w)	relative humidity (x)	Precipitation (y)	zsim	zsimerror	zmerror
0.5	4.5	84	74.8	0.502017	0.03535036	0.033333333
0.4	3.9	82	34	0.342651	-0.124015334	-0.066666667
0.3	3.3	74	32.8	0.484779	0.018112735	-0.166666667
0.4	5.2	81	64	0.4757	0.009033169	-0.066666667
0.5	6.1	76	48.9	0.45436	-0.012306556	0.033333333
0.7	3.2	74	43.1	0.540492	0.073825626	0.233333333

zsimerrorsum	zmerrorsum
0.022640795	0.093333333

zmean
0.466666667

R	Rsquare
0.492524054	0.24258

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.492524
R Square	0.24258
Adjusted R Square	-0.89355
Standard Error	0.188006
Observations	6

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.022641	0.007547	0.213514	0.880524
Residual	2	0.070693	0.035346		
Total	5	0.093333			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.623638	1.76937	0.917636	0.45568	-5.98935	9.236624	-5.98935	9.236624
wind speed(w)	-0.02866	0.085235	-0.33626	0.768674	-0.3954	0.338076	-0.3954	0.338076
relative humidity (x)	-0.01639	0.024472	-0.66957	0.572081	-0.12168	0.08891	-0.12168	0.08891
precipitation(y)	0.005131	0.007027	0.730102	0.541265	-0.02511	0.035367	-0.02511	0.035367

COMMENT ON RESULT OBTAINED

The correlation coefficient (R square) value is less than 0.8, hence the model is inefficient. It shows that tidal rise is not a function of wind speed, relative humidity and precipitation.

MATLAB CODES

```
commandwindow
clear
clc
format long g
eworitse = xlsread('MIDSEMESTERTEST_X')
d = eworitse(:,1);
a = eworitse(:,2)
b = eworitse(:,3)
c = eworitse(:,4)
[xr xc] = size(w)
x0 = ones(xr,1)
x = [x0 a b c]
bembem = regress(z,x)
a0 = bembem(1)
a1 = bembem(2)
a2 = bembem(3)
a3 = bembem(4)
zsim = a0 + a1*a + a2*b + a3*c
Rvalue = corr(z,zsim)
Rsquare = Rvalue^2
```

SOLUTIONS

```
eworitse =
0.5                     4.5                     84                      74.8
0.4                     3.9                     82                        34
0.3                     3.3                     74                      32.8
0.4                     5.2                     81                        64
0.5                     6.1                     76                      48.9
0.7                     3.2                     74                      43.1


d =

                    0.5
                    0.4
                    0.3
                    0.4
                    0.5
                    0.7


a =
                    4.5
                    3.9
                    3.3
                    5.2
```

```
                        6.1
                        3.2

b =

    84
    82
    74
    81
    76
    74

c =

                       74.8
                         34
                       32.8
                         64
                       48.9
                       43.1


xr =

     6


xc =

     1


x0 =
```

```
     1
     1
     1
     1
     1
     1


X =

 1                       4.5                       84                       74.8
 1                       3.9                       82                         34
 1                       3.3                       74                       32.8
 1                       5.2                       81                         64
 1                       6.1                       76                       48.9
 1                       3.2                       74                       43.1


bembem =

          1.62363822964517
       -0.0286615619104322
       -0.0163860041346794
       0.00513075097989349

a0 =
          1.62363822964517


a1 =
       -0.0286615619104322


a2 =
```

```
       -0.0163860041346794


a3 =
       0.00513075097989349

zsim =
         0.502017027031188
         0.342651332467152
         0.484779401514974
         0.475699835515074
          0.45436011067269
          0.54049229279892


Rvalue =
         0.492524054436865


Rsquare =
         0.242579944198928
```

QUESTION 4D

EXCEL FUNCTION

=2*(E11^3) (The formula was dragged throughout the first row as given by the boundary conditions)

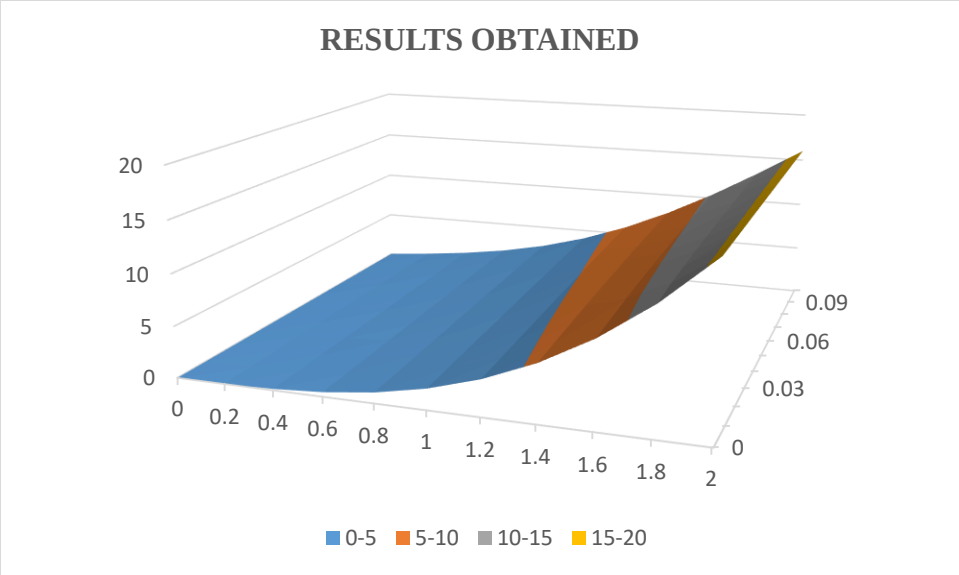
= (B8*D12)+(1-(2*B8))*E12+(B8*F12) (the formula was dragged to the rest of the columns)

tf	0.1

zf	2
n	11
m	11
dt	0.01
dz	0.2
A	1.79
r	0.4475

z											
t	0	0.2	0.4	0.6	0.8	1	1.2	1.4	1.6	1.8	2
0	0	0.02	0.13	0.43	1.02	2.00	3.46	5.49	8.19	11.66	16
0.01	0	0.06	0.21	0.56	1.20	2.21	3.71	5.79	8.54	12.05	16
0.02	0	0.10	0.30	0.69	1.37	2.43	3.97	6.09	8.88	12.25	16
0.03	0	0.14	0.39	0.82	1.54	2.64	4.23	6.39	9.14	12.42	16
0.04	0	0.19	0.47	0.95	1.71	2.86	4.49	6.65	9.38	12.55	16
0.05	0	0.23	0.56	1.08	1.88	3.07	4.73	6.90	9.58	12.67	16
0.06	0	0.27	0.64	1.21	2.06	3.28	4.96	7.13	9.77	12.78	16
0.07	0	0.32	0.73	1.33	2.22	3.48	5.18	7.34	9.93	12.87	16
0.08	0	0.36	0.82	1.46	2.39	3.68	5.39	7.53	10.09	12.96	16
0.09	0	0.40	0.90	1.59	2.55	3.87	5.58	7.72	10.23	13.03	16
0.1	0	0.45	0.99	1.71	2.71	4.05	5.77	7.89	10.36	13.11	16

‘


RESULTS OBTAINED
20
15
10
5
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
0.03
0.06
0.09
0-5
5-10
10-15
15-20

MATLAB FUNCTION

```
commandwindow
clear
clc
format long g
t0 = 0;
z0 = 0;
tf = 0.10;
zf = 2;
dz = 0.2;
dt = 0.01;
c = 1.79;
r = c*(dt/(dz^2));
t = [t0:dt:tf]'
z = [z0:dz:zf]
n = (zf-z0)/dz
m = (tf-t0)/dt
T(1:m+1,1) = zeros(m+1,1);
T(1:m+1,n+1) = 16;
T(1,1:n+1) = 2*(z.^3);
for j = 1:m
    for i = 2:n
        T(j+1,i) = r*T(j,i-1) + (1-(2*r))*T(j,i) + r*T(j,i+1);
    end
end
T
Round(T,2)
mesh(z,t,T)
```

RESULTS

```
t =

                    0
                 0.01
                 0.02
                 0.03
                 0.04
                 0.05
                 0.06
                 0.07
                 0.08
                 0.09
                  0.1


z =

                    0
                  0.2
                  0.4
                  0.6
```

```
                    0.8
                      1
                    1.2
                    1.4
                    1.6
                    1.8
                      2


n =

    10


m =

    10


T =

  Columns 1 through 4
```

0	0.016	0.128	0.432
0	0.05896	0.21392	0.56088
0	0.10192	0.29984	0.68976
0	0.14488	0.38576	0.81864
0	0.18784	0.47168	0.94752
0	0.2308	0.5576	1.0764
0	0.27376	0.64352	1.20528
0	0.31672	0.72944	1.33416
0	0.35968	0.81536	1.46149611285807
0	0.40264	0.900589110503988	1.58769746866683
0	0.445290826950534	0.985237873831325	1.71125801516862

Columns 5 through 8

1.024	2	3.456	5.488
1.19584	2.2148	3.71376	5.78872
1.36768	2.4296	3.97152	6.08944
1.53952	2.6444	4.22928	6.39016
1.71136	2.8592	4.48704	6.6523815369625
1.8832	3.074	4.72757193779072	6.90247605806819
2.05504	3.28109044216135	4.96086808945354	7.12689523232798
2.2234299728672	3.4841333664574	5.1784647387266	7.33872618515917
2.38964642864074	3.67818188691625	5.38696844691471	7.53276705664664
2.55091877990629	3.86624425493727	5.58253133917044	7.71564769479202

```
           2.708485393203                4.04567457505525                5.76906243811675
7.88538387001003

  Columns 9 through 11

                   8.192                   11.664                       16
                 8.53568                 12.05064                       16
                 8.87936                12.245034                       16
             9.137009915               12.41924217                      16
            9.37659351215          12.5528323648125                      16
         9.57887553982006          12.6740729949924                      16
         9.76628763292574          12.7773244685437                      16
         9.93259851759727          12.8720327849314                      16
         10.0872374834632          12.9564012790426                      16
         10.2280627659846          13.0344609081493                      16
         10.3596201902446          13.1056764831338                      16


ans =

  Columns 1 through 4
```

	0	0.02	0.13
0.43			
	0	0.06	0.21
0.56			
	0	0.1	0.3
0.69			
	0	0.14	0.39
0.82			
	0	0.19	0.47
0.95			
	0	0.23	0.56
1.08			
	0	0.27	0.64
1.21			
	0	0.32	0.73
1.33			
	0	0.36	0.82
1.46			
	0	0.4	0.9
1.59			
	0	0.45	0.99
1.71			

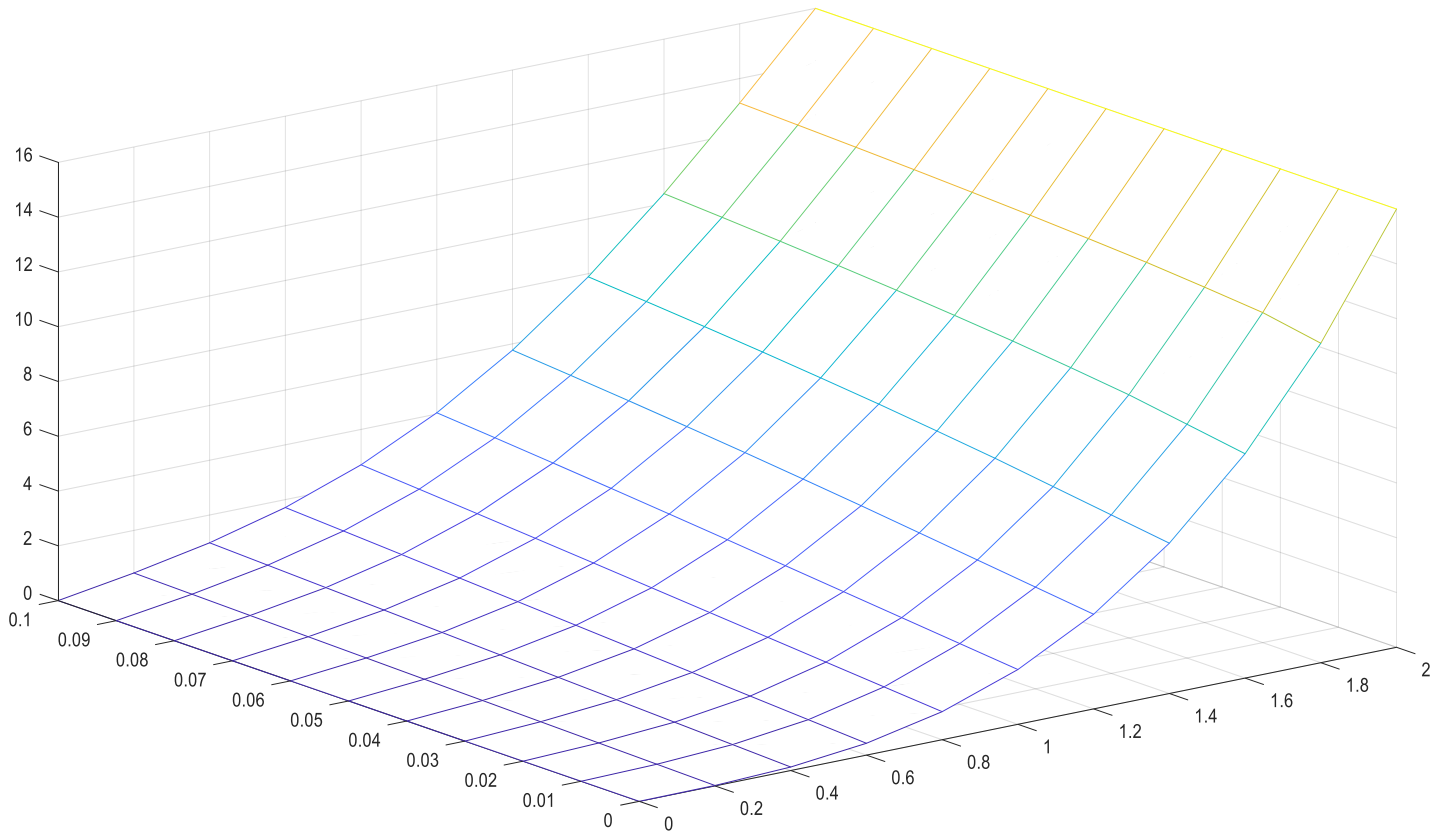
Columns 5 through 8

1.02	2	3.46	5.49
1.2	2.21	3.71	5.79
1.37	2.43	3.97	6.09
1.54	2.64	4.23	6.39
1.71	2.86	4.49	6.65
1.88	3.07	4.73	6.9
2.06	3.28	4.96	7.13
2.22	3.48	5.18	7.34
2.39	3.68	5.39	7.53
2.55	3.87	5.58	7.72

2.71 4.05 5.77
7.89

Columns 9 through 11

8.19	11.66	16
8.54	12.05	16
8.88	12.25	16
9.14	12.42	16
9.38	12.55	16
9.58	12.67	16
9.77	12.78	16
9.93	12.87	16
10.09	12.96	16
10.23	13.03	16
10.36	13.11	16


16
14
12
10
8
6
4
2
0
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2