Solution to Exercises
Chapter 2

2.1

```
n = 0:7;
a = 2*n-1;
b = 2*n+1;
aplusb = a+b
aminusb = a-b
atimesb = a'*b
detatimesb = det(atimesb)
atimesbtranspose = a*b'
```

Answers: aplusb = 0 4 8 12 16 20 24 28

aminusb = -2 -2 -2 -2 -2 -2 -2 -2

atimesb =

-1	-3	-5	-7	-9	-11	-13	-15
1	3	5	7	9	11	13	15
3	9	15	21	27	33	39	45
5	15	25	35	45	55	65	75
7	21	35	49	63	77	91	105
9	27	45	63	81	99	117	135
11	33	55	77	99	121	143	165
13	39	65	91	117	143	169	195

detatimesb = 0 atimesbtranspose = 552

2.2

```
x = sort( [17 -3 -47 5 29 -37 51 -7 19], 'descend');
xs = [x(find(sort(x, 'descend')<=0)), x(find(sort(x, 'descend')>0))]
```

Answer: w = -3 -7 -37 -47 51 29 19 17 5

2.3

```
y = [0, -0.2, 0.4, -0.6, 0.8, -1.0, -1.2, -1.4, 1.6];
sy = sin(y);
% (a)
mx = max(sy(find(sy<0)))
mn = min(sy(find(sy<0)))
% (b)
mp = sqrt(sy(find(sy>0)))
```

Answers: mx = -0.1987 mn = -0.9854 mp = 0.6240 0.8470 0.9998

2.4

```
v = logspace(log10(6), log10(106), 8)
v5 = v(5)
z = v(1:2:7)
```

Answers: v5 = 30.9607 z = 6.0000 13.6295 30.9607 70.3300

© 2011 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This publication is protected by Copyright and written permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or likewise. For information regarding permission(s), write to: Rights and Permissions Department, Pearson Education, Inc., Upper Saddle River, NJ 07458.

2.5

```
z = magic(5)
z(:,2) = z(:,2)/sqrt(3);
z(5,:) = z(5,:)+z(3,:);
z(:,1) = z(:,1).*z(:,4);
q = z-diag(diag(z))+diag([2 2 2 2 2]);
format long g
dq = diag(q*q')
format short
qmax = max(max(q))
qmin = min(min(q))
```

Answers: z =

```
    17    24     1     8    15
    23     5     7    14    16
     4     6    13    20    22
    10    12    19    21     3
    11    18    25     2     9
dq = [486    104189    7300    44522    111024]′
qmax = 330   qmin = 1
```

2.6

```
w = magic(2);
wa = repmat(w, 2, 2)
wb = repmat(w, 3, 1)
wc = [repmat(w, 3, 1), repmat(w', 3, 1)]
wad = [w, w; w, w]
wbd = [w; w; w]
wcd = [w, w'; w, w'; w, w']
```

Answers: wa = % or wad

```
     1     3     1     3
     4     2     4     2
     1     3     1     3
     4     2     4     2
wb = % or wbd
     1     3
     4     2
     1     3
     4     2
     1     3
     4     2
wc = % or wcd
     1     3     1     4
     4     2     3     2
     1     3     1     4
     4     2     3     2
     1     3     1     4
     4     2     3     2
```

2.7

© 2011 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This publication is protected by Copyright and written permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or likewise. For information regarding permission(s), write to: Rights and Permissions Department, Pearson Education, Inc., Upper Saddle River, NJ 07458.

(a)

```
x = magic(3);
t = x(1,:);
x(1:2,:) = x(2:3,:);
x(3,:) = t;
x
```

Answers: x =

```
3    5    7
4    9    2
8    1    6
```

(b)

```
x = magic(3)
t = x(:,3);
x(:,2:3) = x(:,1:2);
x(:,1) = t;
x
```

Answers: x =

```
6    8    1
7    3    5
2    4    9
```

2.8

```
x = magic(5);
xf = fliplr(x);
xf = fliplr(xf-diag(diag(xf)))
```

Answer: xf =

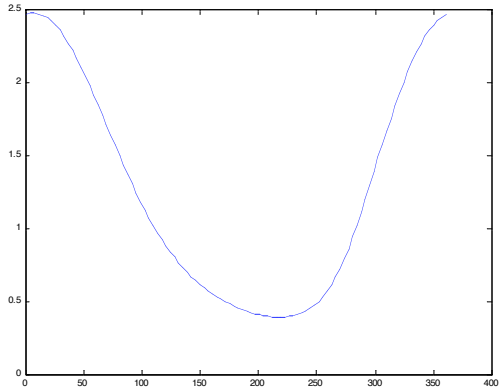
```
17   24    1    8    0
23    5    7    0   16
4     6    0   20   22
10    0   19   21    3
0    18   25    2    9
```

2.9

```
a = 1;   b = 1.5;   e = 0.3;
phi = linspace(0, 2*pi);
s = a*cos(phi)+sqrt(b^2-(a*sin(phi)-e).^2);
plot(phi*180/pi, s)
```

Answer:

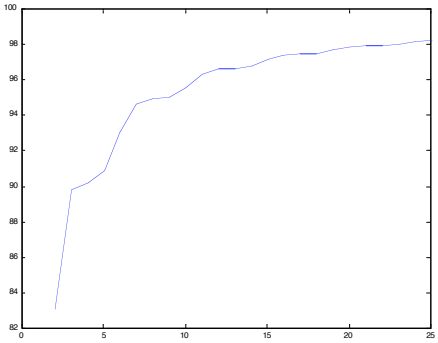
© 2011 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This publication is protected by Copyright and written permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or likewise. For information regarding permission(s), write to: Rights and Permissions Department, Pearson Education, Inc., Upper Saddle River, NJ 07458.



2.10

```
n = 1:25;
a = n*pi/sqrt(19);
P = 100*(1+2*cumsum((sin(a)./a).^2))/4.3589;
plot(n(2:25), P(2:25))
```

Answer:



2.11

```
a = sqrt(2.8);
n = 1:100;      % (1x100)
x = 1:0.5:5;    % (1x9)
exact = a./sqrt(a^2+x.^2).*sin(pi*sqrt(a^2+x.^2))/sin(pi*a);
e = 100*(prod(1-(1./(n.^2-a^2))'*x.^2)-exact)./exact   % prod works on columns
```

Answer: e = 1.0001 2.2643 4.0610 6.4176 9.3707 12.9670 17.2642 22.3330 28.2588

2.12

```
x = [72, 82, 97, 103, 113, 117, 126, 127, 127, 139, 154, 159, 199, 207];
beta = 3.644;
delta = (sum(x.^beta)/length(x))^(1/beta)
```

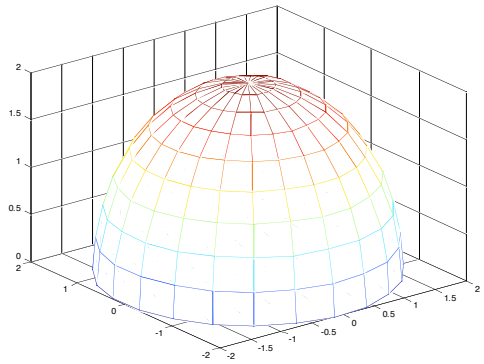
Answer: delta = 144.2741

© 2011 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This publication is protected by Copyright and written permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or likewise. For information regarding permission(s), write to: Rights and Permissions Department, Pearson Education, Inc., Upper Saddle River, NJ 07458.

2.13

```
b = 2;
phi = linspace(0, pi/2, 10);
the = linspace(0, 2*pi, 24);
[p, t] = meshgrid(phi, the);
mesh(b*sin(p).*cos(t), b*sin(p).*sin(t), b*cos(p))
```

Answer:



2.14

```
x = linspace(0.1, 1, 5);
n = -25:25;
y = pi*x*sqrt(2);
exact = 2*pi^4./y.^3.*(sinh(y)+sin(y))./(cosh(y)-cos(y));
[xx, nn] = meshgrid(x, n);
apx = sum(1./(nn.^4+xx.^4));
format long g
comp = [apx' exact']
format short
```

Answer: comp =

10002.1644054971	10002.1644456719
91.7751642291914	91.7752044040698
12.9244097924593	12.9244499673344
4.40350416999114	4.40354434485533
2.15691498449604	2.15695515933427

2.15

```
k = 0:25;  n = 2;
x = linspace(1, 6, 6);
[xx, kk] = meshgrid(x, k);
Jn = sum((-1).^kk.*(xx/2).^(2*kk+n)./factorial(kk)./gamma(kk+1+n));
format long g
Comp = [Jn' besselj(n, x)']
format short
```

Answer: Comp =

0.1149034849319	0.114903484931901
0.352834028615638	0.352834028615638

© 2011 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This publication is protected by Copyright and written permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or likewise. For information regarding permission(s), write to: Rights and Permissions Department, Pearson Education, Inc., Upper Saddle River, NJ 07458.

0.486091260585891	0.486091260585891
0.364128145852073	0.364128145852073
0.0465651162777518	0.0465651162777523
-0.242873209960186	-0.242873209960185

2.16

```
n = 7;  k = 1:(2*n-1);
ser = sum(cos(k*pi/n))
```

Answer: ser = -1.0000

2.17

```
n = 6;   k = 1:n;
N1 = n*(2*n^2+3*n+1)/6
S1 = sum(k.^2)
N2 = n*(6*n^4+15*n^3+10*n^2-1)/30
S2 = sum(k.^4)
N3 = n^2*(2*n^4+6*n^3+5*n^2-1)/12
S3 = sum(k.^5)
```

Answers: N1 = 91 S1 = 91 N2 = 2275 S2 = 2275 N3 = 12201 S3 = 12201

2.18

```
N = 10;   n = 0:N;
PieDiff = sum((4./(8*n+1)-2./(8*n+4)-1./(8*n+5)-1./(8*n+6)).*(1/16).^n) -pi
```

Answer: PieDiff = 0

2.19

```
k=1:300;
dn=0.5*cumsum(1./k);
On = find(dn>1);
d1 = On(1)
tw = find(dn>2);
d2 = tw(1)
th = find(dn>3);
d3 = th(1)
```

Answer: d1 = 4 d2 = 31 d3 = 227

2.20

```
N = 10;  k = 0:N;
e = sum(1./factorial(k))-exp(1)
Jo = sum((-1).^k./factorial(k).^2)-besselj(0,2)
co = sum((-1).^k./factorial(2*k))-cos(1)
```

Answers: e = -2.7313e-008 Jo = 6.3838e-016 co = -1.1102e-016

© 2011 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This publication is protected by Copyright and written permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or likewise. For information regarding permission(s), write to: Rights and Permissions Department, Pearson Education, Inc., Upper Saddle River, NJ 07458.

2.21

```
K = 41;   k = 1:2:K;   y = pi/3;   x = 0.75;
SKdiff = sum(exp(-k*x).*sin(k*y)./k)-0.5*atan(sin(y)/sinh(x))
```

Answer: SKdiff = -2.2204e-016

2.22

```
K = 14;   k = 0:K;  a = 3;  x = -2;
axdiff = sum((x*log(a)).^k./factorial(k))-a^x
```

Answer: axdiff = 9.0230e-008

2.23

```
N = 500;   k = 1:N;   z = 10;
c = pi*coth(pi*z)/(2*z)-1/(2*z^2)
S1 = cumsum(1./(k.^2+z^2));
K = find(abs(S1-c)<3e-3);
N =K(1)
```

Answer: N = 333

2.24

```
w = [-1 -1;1 -1;-1 1;1 1]/2;
orthw = w'*w
q = [1 -1 -1 1;1 1 -1 -1;1 -1 1 -1;1 1 1 1]/2;
orthq = q'*q
```

Answer: orthw =

```
     1     0
     0     1
```

orthq =

```
     1     0     0     0
     0     1     0     0
     0     0     1     0
     0     0     0     1
```

2.25

```
A = [2 -2 -4; -1 3 4; 1 -2 -3];
T = A*A-A
```

Answer: T =

```
     0     0     0
     0     0     0
     0     0     0
```

2.26

© 2011 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This publication is protected by Copyright and written permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or likewise. For information regarding permission(s), write to: Rights and Permissions Department, Pearson Education, Inc., Upper Saddle River, NJ 07458.

```
A = [1 2 2; 2 1 2; 2 2 1];
T = A*A-4*A-5*eye(3)
```

Answer: T =

```
     0     0     0
     0     0     0
     0     0     0
```

2.27

```
A = [1 -1; 2 -1];   B = [1 1; 4 -1];
T = (A+B)^2-A^2-B^2
```

Answer: T =

```
     0     0
     0     0
```

2.28

```
A = [7 -2 1; -2 10 -2; 1 -2 7];
P = [1/sqrt(2) 1/sqrt(3) 1/sqrt(6); 0 1/sqrt(3) -2/sqrt(6); -1/sqrt(2) 1/sqrt(3) 1/sqrt(6)];
L = eig(A)
LL = diag(inv(P)*A*P)
```

Answers: L =

```
    6.0000
    6.0000
   12.0000
```

LL =

```
    6.0000
    6.0000
   12.0000
```

2.29

```
c = pi/180;
th1 = 30*c;   th2 = 30*c;   th3 = 30*c;
a1 = 1;   a2 = 2;   a3= 3;
a01 = [cos(th1) -sin(th1) 0 a1*cos(th1); sin(th1) cos(th1) 0 a1*sin(th1);0 0 1 0; 0 0 0 1];
a12 = [cos(th2) -sin(th2) 0 a2*cos(th2); sin(th2) cos(th2) 0 a2*sin(th2);0 0 1 0; 0 0 0 1];
a23 = [cos(th3) -sin(th3) 0 a3*cos(th3); sin(th3) cos(th3) 0 a3*sin(th3);0 0 1 0; 0 0 0 1];
t = a01*a12*a23;
thx3 = atan2(t(2,1), t(1,1))/c
thy3 = atan2(t(2,2), t(1,2))/c
qx = t(1,4)
qy = t(2,4)
```

Answers: thx3 = 90.0000   thy3 = 180   qx = 1.8660   qy = 5.2321

2.30

```
c = pi/180;
th1 = 15*c;   th2 = 105*c;   th3 = 145*c;
```

© 2011 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This publication is protected by Copyright and written permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or likewise. For information regarding permission(s), write to: Rights and Permissions Department, Pearson Education, Inc., Upper Saddle River, NJ 07458.

```
th4 = 0;   th5 = 215*c;   th6 = 55*c;
a2 = 0.431;   a3 = 0.019;  r4 = a2;  r3 = 0.125;
T12 = [cos(th1) 0 sin(th1) 0 ; sin(th1) 0 -cos(th1) 0 ; 0 1 0 0; 0 0 0 1];
T23 = [cos(th2) -sin(th2) 0 a2*cos(th2); sin(th2) cos(th2) 0  a2*sin(th2); 0 0 1 0; 0 0 0 1];
T34 = [cos(th3) 0 sin(th3)  a3*cos(th3); sin(th3) 0 -cos(th3)  a3*sin(th3); 0 1 0 r3; 0 0 0 1];
T45 = [cos(th4) 0 sin(th4) 0; sin(th4) 0 -cos(th4)  0; 0 1 0 r4; 0 0 0 1];
T56 = [cos(th5) 0 sin(th5) 0; sin(th5) 0 -cos(th5)  0; 0 1 0 0; 0 0 0 1];
T67 = [cos(th6) 0 sin(th6) 0; sin(th6) 0 -cos(th6)  0; 0 1 0 0; 0 0 0 1];
T17 =T12*T23*T34*T45*T56*T67
```

Answer: T17 =

```
    0.2418   -0.5540    0.7966   -0.4729
    0.9128   -0.1485   -0.3804   -0.2561
    0.3290    0.8192    0.4698    0.5459
    0         0         0    1.0000
```

2.31

```
x = [17 31 5;6 5 4;19 28 9;12 11 10];
H = diag(x*inv(x'*x)*x')'
```

Answer: H = 0.7294 0.9041 0.4477 0.9188

2.32

```
% square
   n = 1:2:401;
   tau = linspace(-0.5, 0.5, 200);
   plot(tau, 4/pi*(1./n)*sin(2*pi*n'*tau))
% sawtooth
   n = 1:200;
   tau = linspace(-1, 1, 200);
   plot(tau, 0.5+1/pi*(1./n)*sin(2*pi*n'*tau))
% sawtooth
   n = 1:200;
   tau = linspace(-1, 1, 200);
   plot(tau, 0.5-1/pi*(1./n)*sin(2*pi*n'*tau))
% triangular
   n = 1:200;
   tau = linspace(-1, 1, 200);
   plot(tau, 0.5*pi-4/pi*((1./(2*n-1).^2)*cos(pi*(2*n'-1)*tau)))
% recitified sine wave
   n = 1:200;
   tau = linspace(-1, 1, 200);
   plot(tau, 2/pi+4/pi*((1./(1-4*n.^2))*cos(2*pi*n'*tau)))
% half sine wave
   n = 2:2:106;
   tau = linspace(-2, 2, 200);
   plot(tau, 1/pi+.5*sin(pi*tau)-2/pi*(1./(n.^2-1)*cos(pi*n'*tau)))
% exponential
   n = 1:250;
   tau = linspace(0, 4*pi, 350);
   plot(tau, (exp(2*pi)-1)/pi*(0.5+((1./(1+n.^2))*cos(n'*tau)-(n./(1+n.^2))*sin(n'*tau))))
% trapezoidal
   n = 1:2:105;
```

© 2011 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This publication is protected by Copyright and written permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or likewise. For information regarding permission(s), write to: Rights and Permissions Department, Pearson Education, Inc., Upper Saddle River, NJ 07458.

```
tau = linspace(-2, 2, 200);
plot(tau, 64*((sin(n*pi/4)./(pi*n).^2)*sin(pi*n'*tau)))
```

2.33

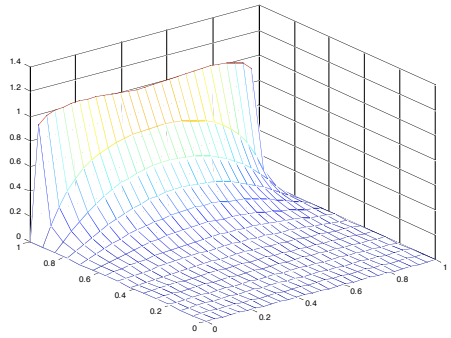
```
a = sqrt(3);   n = 1:25;
t = (10:10:80)*pi/180;
c = pi/sinh(pi*a)/2;
b = 1./(n.^2+a^2);
e1 = 100*(b*cos(n'*t)./(c*cosh(a*(pi-t))/a-0.5/a^2)-1)
e2 = 100*(n.*b*sin(n'*t)./(c*sinh(a*(pi-t)))-1)
```

Answers: e1 = -1.2435 0.8565 0.8728 -1.9417 -0.9579 -8.1206 0.7239 1.1661
e2 = 8.0538 10.4192 -8.9135 -5.4994 12.9734 -0.5090 -17.2259 11.2961

2.34

```
n = (1:2:51)*pi;   a = 2;
eta = 0:1/14:1;   xi = 0:1/14:1;
temp = meshgrid(1./(n.*sinh(n*a)), eta);
z = 4*(temp.*sinh(a*n'*eta)')*sin(n'*xi);
mesh(xi, eta, z)
```

Answer:

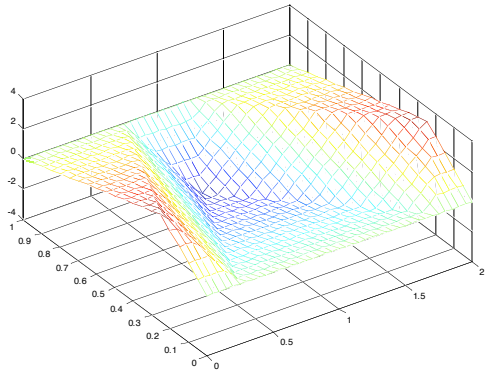


2.35

```
n = (1:50)*pi;  eta = 0:0.05:1;
tau = 0:0.05:2;  a = 0.25;
temp = meshgrid(sin(a*n)./n.^2, eta);
z = 2*pi/a/(1-a)*temp.*sin(n'*eta)'*cos(n'*tau);
mesh(tau, eta, z)
```

Answers:

© 2011 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This publication is protected by Copyright and written permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or likewise. For information regarding permission(s), write to: Rights and Permissions Department, Pearson Education, Inc., Upper Saddle River, NJ 07458.



2.36

```
A = [1 3 4; 31 67 9; 7 5 9];
B = [11 34 6; 7 13 8; 43 10 53];
DADB = det(A)*det(B)
DAB = det(A*B)
```

Answer: DADB = -3832062 DAB = -3832062

2.37

```
syms x y
x1 = -1;  y1 = 1;  x2 = 0;  y2 = 0;  x3 = 1;  y3 = 1;
p = det([x^2+y^2 x y 1; x1^2+y1^2 x1 y1 1; x2^2+y2^2 x2 y2 1; x3^2+y3^2 x3 y3 1]);
p = factor(p)
```

Answer: p = 2*(x^2 + y^2 - 2*y)

2.38

```
syms x y
x1 = -1;  y1 = 1;  x2 = 1;  y2 = 1;  x3 = 2;  y3 = 2;
p = det([x^2 x y 1; x1^2 x1 y1 1; x2^2 x2 y2 1; x3^2 x3 y3 1]);
p = factor(p)
```

Answer: p = 2*(x^2 - 3*y + 2)

2.39

```
A = [16, 32, 33, 13; 5, 11, 10, 8; 9, 7, 6, 12; 34, 14, 15, 1];
c = [91, 16, 5, 43];
supw = A\c'  % or supw = linsolve(A, c')
determin = det(A)
invA = inv(A)
```

Answers: supw = [-0.1258 -8.7133 11.2875 -0.0500]′

determin = 7680

invA =

```
   -0.0177   -0.0023    0.0180    0.0333
   -0.3344    1.2352   -0.4695    0.1000
```

© 2011 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This publication is protected by Copyright and written permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or likewise. For information regarding permission(s), write to: Rights and Permissions Department, Pearson Education, Inc., Upper Saddle River, NJ 07458.

```
0.3500   -1.1375    0.3875   -0.1000
0.0333   -0.1500    0.1500   -0.0333
```

2.40

```
a = 0.005;   b = 0.0064;   c = 0.008;
E1 = 2.1e9;  E2 = 0.21e9;
nu1 = 0.4;  nu2 = 0.4;  Uo = 0.00025;
Matrix = [1, a^2, 0, 0; 1, b^2, -1, -b^2; ...
          -(1+nu1), (1-nu1)*b^2, (1+nu2)*E1/E2, -(1-nu2)*b^2*E1/E2;...
          0, 0, -(1+nu2), (1-nu2)*c^2];
y = [0, 0, 0, -Uo*E2*c]';
AB = Matrix\y;
hoop1 = -AB(1)/b^2+AB(2)
hoop2 = -AB(3)/b^2+AB(4)
% check
urc = -(1+nu2)*AB(3)/E2/c+(1-nu2)*c*AB(4)/E2
```

Answers: hoop1 = -6.3013e+007   hoop2 = -1.1790e+007   urc = -2.5000e-004

2.41

```
syms i1 i2 i3 R V1 V2 V3
Q1 = 'V1-6*R*i1+4*R*(i2-i1)=0,';
Q2 = 'V2+2*R*(i3-i2)-3*R*i2-4*R*(i2-i1)=0,';
Q3 = '-V3-R*i3-2*R*(i3-i2y)=0';
[i1 i2 i3] = solve([Q1 Q2 Q3])
```

Answer: i1 = 1/182/R*(23*V1 + 12*V2 - 8*V3)
i2 = 1/91/R*(6*V1 + 15*V2 - 10*V3)
i3 = 1/91/R*(4*V1 + 10*V2 - 37*V3)

2.42

Either

```
syms s t V1 V2 V3 U real
A = [2*s+t -s 0; -s 2*s+t -s; 0 -s s+t];
B = [s*U 0 0]';
V=inv(A)*B
```

or

```
syms s t V1 V2 V3 U real
[V1 V2 V3] = solve((2*s+t)*V1-s*V2-s*U, -s*V1+(2*s+t)*V2-s*V3, -s*V2+(s+t)*V3, V1, V2, V3);
V1 = factor(V1)
V2 = factor(V2)
V3 = factor(V3)
```

gives

Answer: V1 = (U*s*(s^2 + 3*s*t + t^2))/(s^3 + 6*s^2*t + 5*s*t^2 + t^3)
V2 = (U*s^2*(s + t))/(s^3 + 6*s^2*t + 5*s*t^2 + t^3)
V3 = (U*s^3)/(s^3 + 6*s^2*t + 5*s*t^2 + t^3)

© 2011 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This publication is protected by Copyright and written permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or likewise. For information regarding permission(s), write to: Rights and Permissions Department, Pearson Education, Inc., Upper Saddle River, NJ 07458.