Scilab Textbook Companion for Aircraft Structures For Engineering Students by T. H. G. Megson[1]

Created by
Mahesh Kumar
B. Tech.
Others
IIT Bombay
College Teacher
Madhu Belur
Cross-Checked by

August 17, 2013

[1]Funded by a grant from the National Mission on Education through ICT, http://spoken-tutorial.org/NMEICT-Intro. This Textbook Companion and Scilab codes written in it can be downloaded from the "Textbook Companion Project" section at the website http://scilab.in

Book Description

Title: Aircraft Structures For Engineering Students

Author: T. H. G. Megson

Publisher: Butterworth - Heinemann (Elsevier)

Edition: 4

Year: 2007

ISBN: 0-750-667397

Scilab numbering policy used in this document and the relation to the above book.

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

AP Appendix to Example(Scilab Code that is an Appednix to a particular Example of the above book)

For example, Exa 3.51 means solved example 3.51 of this book. Sec 2.3 means a scilab code whose theory is explained in Section 2.3 of the book.

Contents

List of Scilab Codes

List of Figures

Chapter 1

Basic Elasticity

check Appendix AP 100 for dependency:

`1_01data.sci`

Scilab code Exa 1.1 Example 1

```
pathname=get_absolute_file_path('1_01.sce')
filename=pathname+filesep()+'1_01data.sci'
exec(filename)
Sx1= p*d/(4*t);
Sy= p*d/(2*t);//  y
printf("\nLongitudnal stress produced by internal pressure: %f N/mm^2",Sx1);
printf("\nCircumferential stress produced by internal pressure (  y ): %f N/mm^2",Sy);
Sx2= Load/(%pi*d*t);
printf("\ndirect stress due to the axial load: %f N/mm^2",Sx2);
Sx= Sx1+Sx2;//  x
printf("\n  x  is: %f N/mm^2",Sx);
printf("\n  y  is: %f N/mm^2",Sy);
Sn=(Sx)*(cos(theta))^2 + Sy*(sin(theta))^2;//  n
T= (Sx-Sy)*sin(2*(theta)) /2;//
```

```
printf("\n n  is: %f N/mm^2",Sn);
printf("\n   is: %f N/mm^2",T);
Tmax= (Sx-Sy)/2;//   max
printf("\n max: %f N/mm^2",Tmax);
```

check Appendix AP 99 for dependency:

`1_02data.sci`

Scilab code Exa 1.2 Example 2

```
pathname=get_absolute_file_path('1_02.sce')
filename=pathname+filesep()+'1_02data.sci'
exec(filename)
printf("\nbending moment due to direct loading in a
    vertical plane: %f N/mm^2",Load*t);
Sx1= Load/(%pi*(d^2)/4);// x (axial load)
printf("\n x (axial load) is: %f N/mm^2",Sx1);
I= %pi*(d^4)/64;// moment of Inertia
Sx2= t*Load*(d/2)*(1/I);// x (bending moment)
printf("\n x (bending moment) is: %f N/mm^2",Sx2)
Sx=Sx1+Sx2;// x
J= %pi*(d^4)/32;//torsion constant
Txy=T*(d/2)*(1/J);// xy
printf("\nSince the element is positioned at the
    bottom of the beam\n xy:%fN/mm^2",-Txy);
printf("\n x: %f N/mm^2",-Sx);
Sn=(-Sx)*(cos(theta))^2 +(-Txy)*sin(2*theta);// n
T= (-Sx-0)*sin(2*theta)/2 -(-Txy)*cos(2*theta);//
printf("\n n: %f N/mm^2",Sn);
printf("\n  : %f N/mm^2)",T);
```

check Appendix AP 98 for dependency:

`1_03data.sci`

Scilab code Exa 1.3 Example 3

```
pathname=get_absolute_file_path('1_03.sce')
filename=pathname+filesep()+'1_03data.sci'
exec(filename)
Txy=((lLoad-Sx)*(lLoad-Sy))^0.5;
printf("\n xy:%f N/mm^2",Txy);
printf(",%f N/mm^2",-Txy);
S=poly(0,'S');
y=(S^2)-(S*(Sx+Sy))+(Sx*Sy)-(Txy^2);
m=roots(y);
printf("\n 1: %f N/mm^2",m(2,:));
printf("\n 2:%f N/mm^2",m(1,:));
Tmax=abs((m(2,:)-m(1,:))/2);
printf("\n max: %f N/mm^2",Tmax);
//plotting mohr circle
x=abs((m(2,:)+m(1,:))/2);//Centre of circle
plot2d(0,0,-1,"031"," ",[x-Tmax-50,-Tmax-50,x+Tmax
   +100,Tmax+50]);
xgrid(3);
xarc(x-Tmax,Tmax,2*Tmax,2*Tmax,0,360*64);
x1=[m(1,:),m(2,:)],y1=[0,0];
x2=[Sx,Sy],y2=[Txy,-Txy];
x3=[Sx,Sx],y3=[Txy,0];
x4=[Sy,Sy],y4=[-Txy,0];
x5=[x,x],y5=[Tmax,-Tmax];
plot(x1,y1,x2,y2,'--',x3,y3,'--',x4,y4,'--',x5,y5,'
   --');
datatipToggle();
printf("\n\nclick on the point to view its
   coordinate on the plot");
xtitle( 'Mohr s circle of stress', '    (N/mm^2)',
    '    (N/mm^2)', boxed = 1 );
```

check Appendix AP 97 for dependency:

`1_04data.sci`

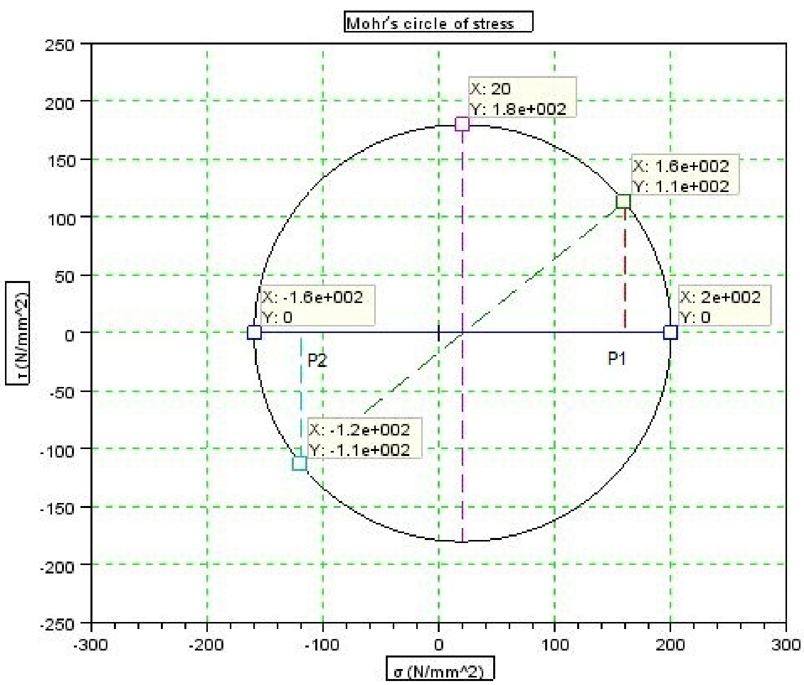

Figure 1.1: Example 3

Scilab code Exa 1.4 Example 4

```
pathname=get_absolute_file_path('1_04.sce')
filename=pathname+filesep()+'1_04data.sci'
exec(filename)
Ex= (1/E)*(Sx-v*Sy);//  x
Ey= (1/E)*(Sy-v*Sx);//  y
Ez= (1/E)*(0-v*(Sx+Sy));//  z
printf("\n  x : %f",Ex);
printf("\n  y : %f",Ey);
printf("\n  z : %f",Ez);
Tmax=(Sx-Sy)/2;// max
Gmax=2*(1+v)*Tmax/E;// max
printf("\n max: %f",Gmax);
printf("\n max: %f N/mm^2",Tmax);
```

check Appendix AP 96 for dependency:

`1_05data.sci`

Scilab code Exa 1.5 Example 5

```
pathname=get_absolute_file_path('1_05.sce')
filename=pathname+filesep()+'1_05data.sci'
exec(filename)
Ex= (1/E)*(Sx-v*Sy);//  x
Ey= (1/E)*(Sy-v*Sx);//  y
G=E/(2*(1+v));//shear modulus
Gxy=Txy/G;//  xy
printf("\n   x :  %f",Ex);
printf("\n   y : %f",Ey);
printf("\n G: %f",G);
```

```
printf("\n xy: %f",Gxy);
PE1=(Ex+Ey)/2 + 0.5*((Ex-Ey)^2 +Gxy^2)^0.5;// I
PE2=(Ex+Ey)/2 - 0.5*((Ex-Ey)^2 +Gxy^2)^0.5;// II
theta=0.5*atan(Gxy/(Ex-Ey)) *(180/%pi);// in degree
printf("\n I: %f",PE1);
printf("\n II: %f",PE2);
printf("\n : %f degree",theta);
printf("\n : %f degree",theta+90);
//plotting mohr circle
x=abs((PE1+PE2)/2);//Centre
r=(abs(PE1)+abs(PE2))/2;//radius
plot2d(0,0,-1,"031"," ",[x- 1.5*r,-1.5*r,x+ 1.5*r,1.5*r]);
xgrid(3);
xarc(x-r,r,2*r,2*r,0,360*64);
x1=[PE1,PE2],y1=[0,0];
x2=[Ex,Ey],y2=0.5*[Gxy,-Gxy];
theta1=atan(Gxy/(2*Ex)) *(180/%pi);
plot(x1,y1);
plot(x2,y2);
xarc(x-r/4,r/4,r/2,r/2,0,theta1*64);
xarc(x-r/2,r/2,r,r,180*64,(180+theta1)*64);
datatipToggle();
printf("\n\nclick on the point to view its coordinate on the plot");
xtitle( 'Mohr s circle of strain', ' ', ' (gamma)', boxed = 1 );
```

check Appendix AP 95 for dependency:

`1_07data.sci`

Scilab code Exa 1.7 Example 7

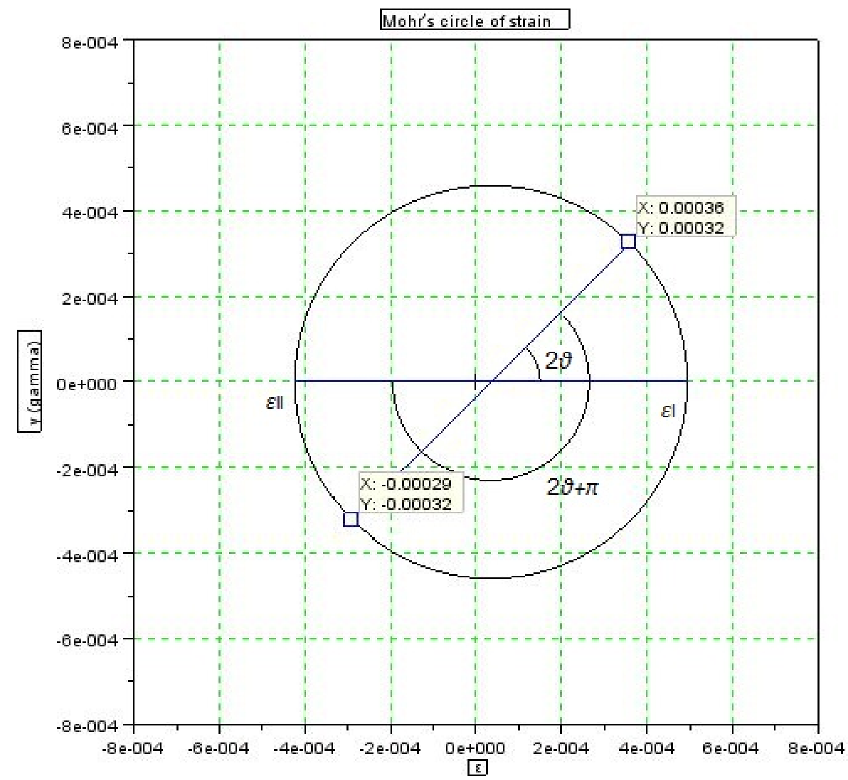

Figure 1.2: Example 5

```
pathname=get_absolute_file_path('1_07.sce')
filename=pathname+filesep()+'1_07data.sci'
exec(filename)
E1=0.5*(Ea+Ec) + (((Ea-Eb)^2 +(Ec-Eb)^2)/2)^0.5;
E2=0.5*(Ea+Ec) - (((Ea-Eb)^2 +(Ec-Eb)^2)/2)^0.5;
disp(E1,"  I=",E2,"  II=");
S1=E*(E1+ v*E2)/(1-v^2);//  I
S2=E*(E2+ v*E1)/(1-v^2);//  II
Sx=S1+S2;//  x
printf("\n  I: %f N/mm^2",S1);
printf("\n  II: %f N/mm^2",S2);
printf("\n  x: %f N/mm^2",Sx);
P=Sx*(%pi*d^2)/4;//axial tensile load
Txy=(((S1-S2)^2 -(S1+S2)^2)/4)^0.5;//  xy
printf("\n  xy: %f N/mm^2",Txy);
J=(%pi*d^4)/32;//torsion constant
T=2*Txy*J/d;//Torque
disp(p/10^3,"P in KN",P,"P(N)=");
disp(T/10^6,"T in KN.m",T,"T (N.mm)=");
```

Chapter 3

Torsion of Solid Section

check Appendix AP 94 for dependency:

`3_1data.sci`

Scilab code Exa 3.1 Example 1

```
pathname=get_absolute_file_path('3_1.sce')
filename=pathname+filesep()+'3_1data.sci'
exec(filename)
clear all
J= (%pi*R^4)/2;
x=poly(0,"x");
y=poly(0,"y");
t= T*R/J;//
twistrate= T/(G*J);//rate of twist
deff("[Tzy]=f(x)","Tzy=T*x/J");// z y
deff("[Tzx]=f1(y)","Tzx=-T*y/J");// z x
funcprot(0);
function sh=shear(x,y),
    sh=(T/J)*(x^2 +y^2)^0.5;
endfunction
t=linspace(-5,5,50);
clf();
```

```
sh=feval(t,t,shear);
plot3d1(t,t,sh);
xtitle('STRESS DISTRIBUTION','X','Y','  ');
x=[-R:0.01:R];
y=[-R:0.01:R];
xset('window',1)
subplot(2,1,1);
fplot2d(x,f);
xgrid(3);
xtitle( 'shear stress', ' -x- ', '  zy');
subplot(2,1,2);
fplot2d(y,f1,[2]);
xgrid(3);
xtitle( 'shear stress', ' -y-', '  zx');
datatipToggle();
printf("\nrate of twist: %f",twistrate);
printf("\n = %f n/mm^2",t);
printf("\n\nclick on the point to view its coordinate on the plot");
```

check Appendix AP 93 for dependency:

`3_2data.sci`

Scilab code Exa 3.2 Example 2

```
pathname=get_absolute_file_path('3_2.sce')
filename=pathname+filesep()+'3_2data.sci'
exec(filename)
clear all
J= (%pi*a^3 *b^3)/(a^2 +b^2);
twistrate= T/(G*J);//rate of twist
```

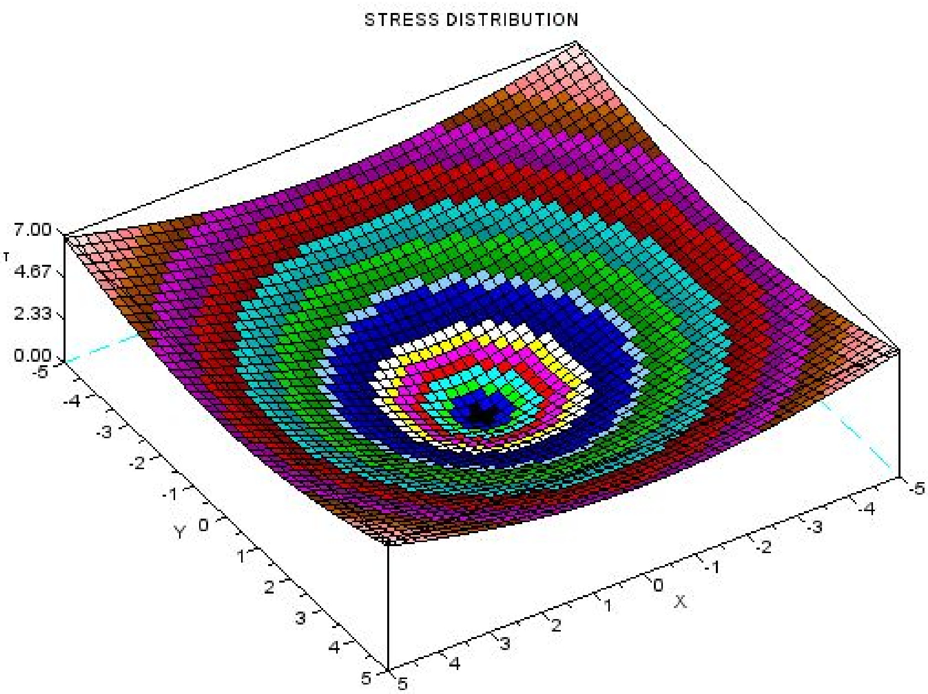

Figure 3.1: Example 1

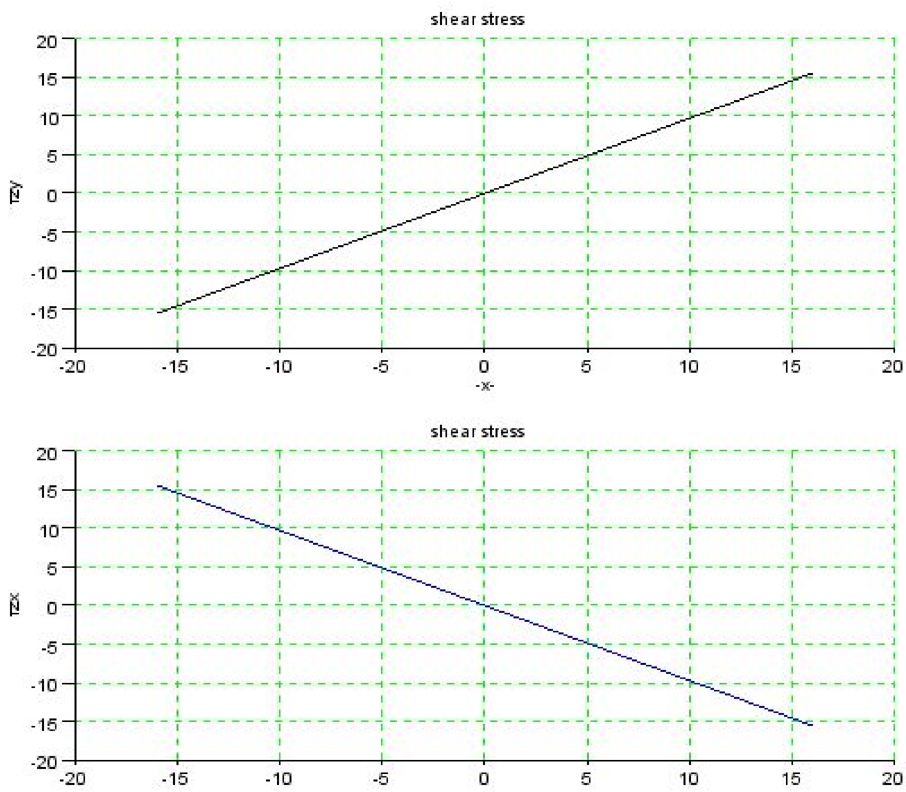

Figure 3.2: Example 1

```
x=poly(0,"x");
y=poly(0,"y");
deff("[Tzy]=f(x)","Tzy=2*T*x/(%pi*b*a^3)");// zy
deff("[Tzx]=f1(y)","Tzx=-2*T*y/(%pi*a*b^3)");// zx
function w=wrap(x,y),
    w=((T*(b^2 -a^2))/(%pi*a^3 *b^3 *G))*x*y*1000;//warping
endfunction
t=linspace(-a,a,10*a);
clf();
w=feval(t,t,wrap);
plot3d1(t,t,w);
xtitle('wraping of cross section','x','y','w * 10^3');
x=[-a:0.01:a];
y=[-b:0.01:b];
xset('window',1)
subplot(2,1,1);
fplot2d(x,f);
xgrid(3);
xtitle( 'shear stress', ' -x- ', '  zy ');
subplot(2,1,2);
fplot2d(y,f1,[2]);
xgrid(3);
xtitle( 'shear stress', ' -y-', '  zx ');
datatipToggle();
printf("\nrate of twist: %f",twistrate);
printf("\n\nclick on the point to view its coordinate on the plot");
```

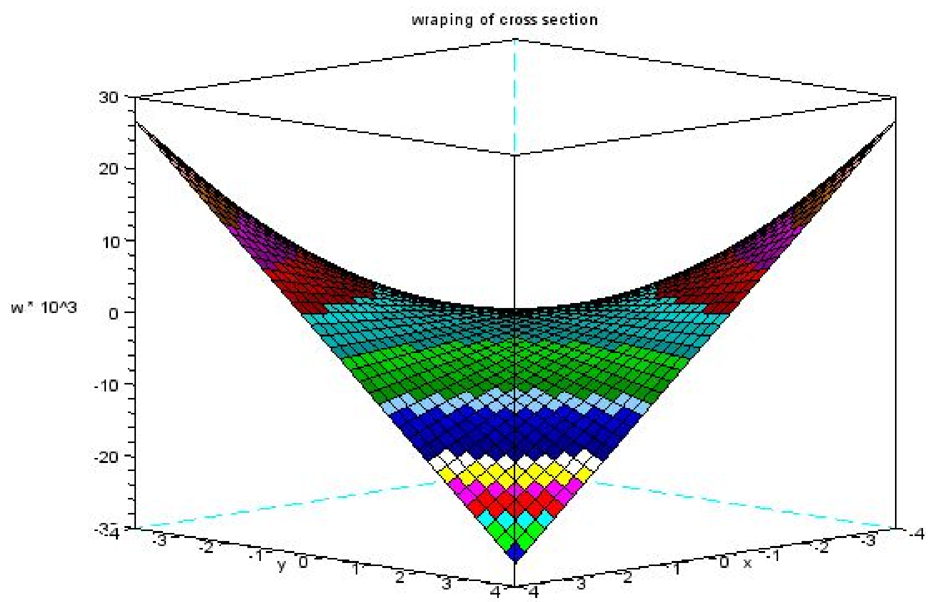

Figure 3.3: Example 2

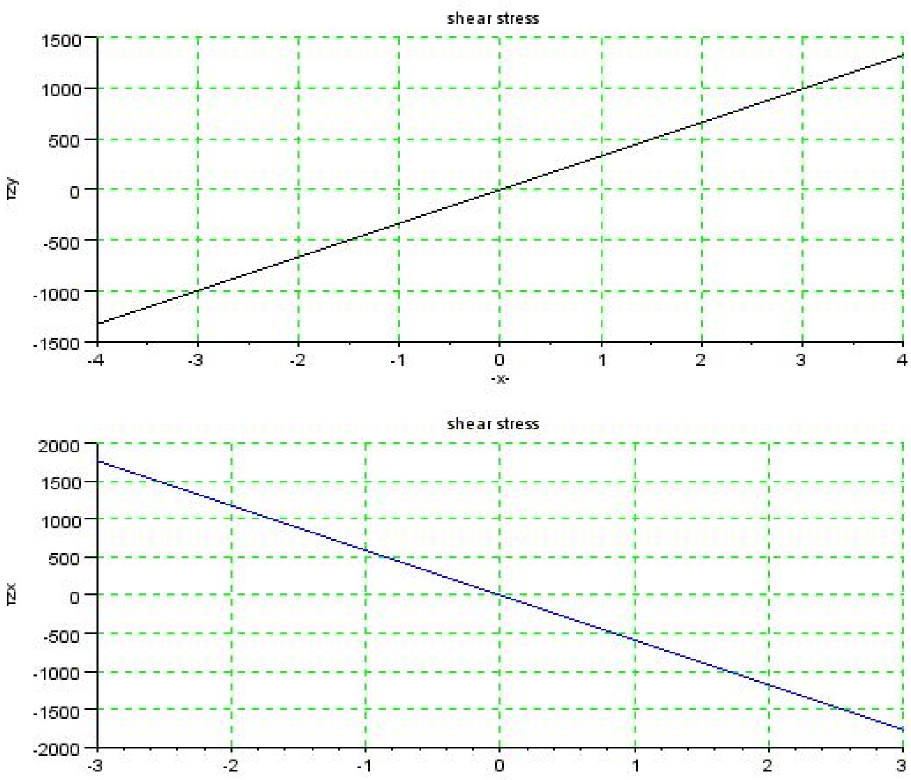

Figure 3.4: Example 2

Chapter 4

Virtual work and Energy methods

check Appendix AP 92 for dependency:

`4_1data.sci`

Scilab code Exa 4.1 Example 1

```
pathname=get_absolute_file_path('4_1.sce')
filename=pathname+filesep()+'4_1data.sci'
exec(filename)
Ra= W*(L-a)/L;
Rb= W*a/L;
printf("\nRA: %f N",Ra);
printf("\nRB: %f N",Rb);
```

---

check Appendix AP 91 for dependency:

`4_2data.sci`

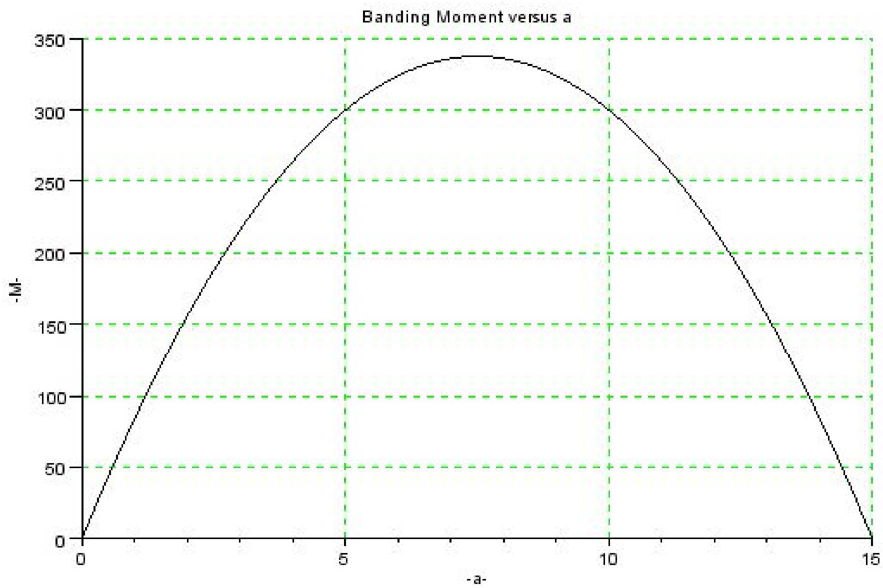

Figure 4.1: Example 2

Scilab code Exa 4.2 Example 2

```
pathname=get_absolute_file_path('4_2.sce')
filename=pathname+filesep()+'4_2data.sci'
exec(filename)
M=(W*a*(L-a))/(L);
deff("[y]=f(x)","y=(W*x*(L-x))/(L)")//manding moment
x=[0:0.05:L];
fplot2d(x,f);
xgrid(3);
datatipToggle();
xtitle( 'Banding Moment versus a', ' -a- ', '-M-');
printf("\nMB: %f N.m",M);
printf("\n\nclick on the point to view its
    coordinate on the plot");
```

check Appendix AP 90 for dependency:

`4_3data.sci`

Scilab code Exa 4.3 Example 3

```
pathname=get_absolute_file_path('4_3.sce')
filename=pathname+filesep()+'4_3data.sci'
exec(filename)
Fba=Loadc*(CD/BD);//FBA
printf("\nFBA: %f KN",Fba);
```

check Appendix AP 89 for dependency:

`4_4data.sci`

Scilab code Exa 4.4 Example 4

```
pathname=get_absolute_file_path('4_4.sce')
filename=pathname+filesep()+'4_4data.sci'
exec(filename)
clear all
Vb=(w*L^4)/(8*E*I);// B
deff("[y]=f(x)","y= -((w*x^2)/(24*E*I))*(6*L^2 -4*L*
    x +x^2)");//deflection
x=[0:0.05:L];
fplot2d(x,f);
xgrid(3);
datatipToggle();
xtitle( 'vertical deflection versus x', ' -x- ', '
    vertical deflection');
printf("\n B: %f m//",Vb);
printf("\n\nclick on the point to view its
    coordinate on the plot");
```

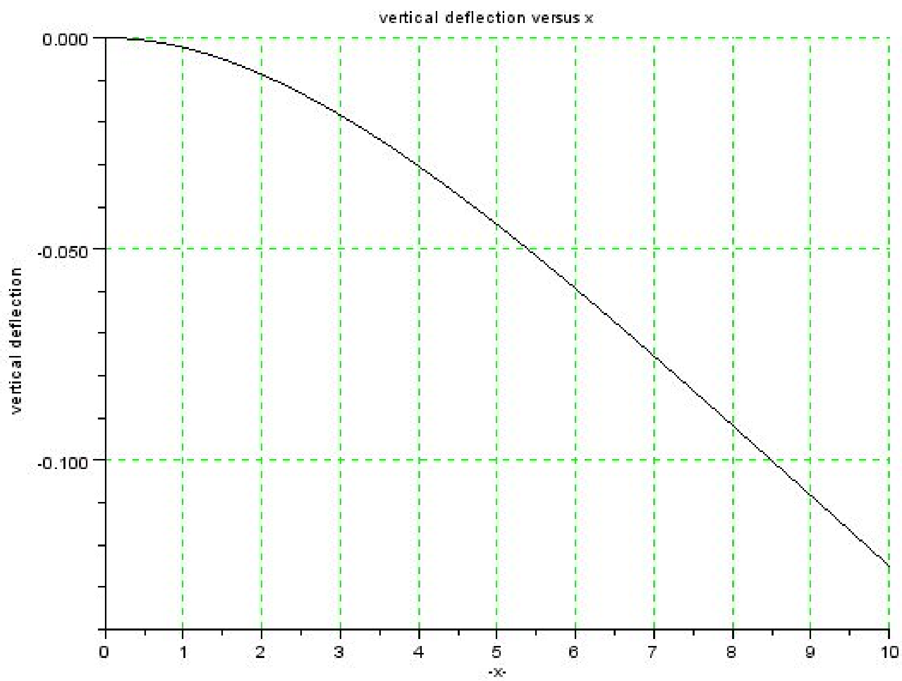

Figure 4.2: Example 4

check Appendix AP 88 for dependency:

```
4_5data.sci
```

Scilab code Exa 4.5 Example 5

```
pathname=get_absolute_file_path('4_5.sce')
filename=pathname+filesep()+'4_5data.sci'
exec(filename)
clear all
theta=(W*L^2)/(16*E*I);// A
printf("\n A: %f",theta);
```

check Appendix AP 87 for dependency:

```
4_6data.sci
```

Scilab code Exa 4.6 Example 6

```
pathname=get_absolute_file_path('4_6.sce')
filename=pathname+filesep()+'4_6data.sci'
exec(filename)
L=[(h^2 +AB^2)^0.5;BC;(h^2 +CD^2)^0.5;CD;BC;AB;h;(h^2 +BC^2)^0.5;h];//column 2
A=atan(h/AB),B=atan(h/BC),D=atan(h/CD);
lFC=Load2;
P=[
   0 0 sin(D) 0 0 0 0 sin(B);
   cos(A) 0 0 0 0 1 0 0;
   cos(A) -1 0 0 0 0 0 0;
   sin(A) 0 0 0 0 0 1 0;
   0 0 0 -1 1 0 0 0;
   0 0 0 0 1 -1 0 cos(B);
```

```
   0 0 0 0 0 0 1 -sin(B);
   0 1 -cos(D) 0 0 0 0 cos(B);];
X=[-Load2;0;0;-Load1;0;0;Load1;0];
D1=[0;0;0;1;1;1;0;0;0]; //F1,D
FC=0;
P1=[cos(A) 0 0 0 0 1 0 0;
    0 0 cos(D) 1 0 0 0 0;
    cos(A) -1 0 0 0 0 0 0;
    sin(A) 0 0 0 0 0 1 0;
    0 0 0 -1 1 0 0 0;
    0 0 0 0 1 -1 0 cos(B);
    0 0 0 0 0 0 1 sin(B);
    0 0 1 0 0 0 0 1]
X1=[0;0;0;0;0;0;1;0]
FA=[inv(P)*X;1FC]; //FA
B1=[inv(P1)*X1;FC]; //F1,B
for i=1:9
    K1(i)=FA(i)*B1(i)*L(i); //FA.F1,B.L
    K2(i)=FA(i)*D1(i)*L(i); //FA.F1,D.L
end
delB=(sum(K1)*10^3)/(E*CS);
delD=(sum(K2)*10^3)/(E*CS);
printf("\n B,v: %f mm",delB);
printf("\n D,h: %f mm",delD);
```

Chapter 5

Energy Methods

check Appendix AP 86 for dependency:

5_1data.sci

Scilab code Exa 5.1 Example 1

```
pathname=get_absolute_file_path('5_1.sce')
filename=pathname+filesep()+'5_1data.sci'
exec(filename)
L=[(h^2 +AB^2)^0.5;BC;(h^2 +CD^2)^0.5;CD;BC;AB;h;(h
    ^2 +BC^2)^0.5;h];
A=atan(h/AB),B=atan(h/BC),D=atan(h/CD);
lFC=Load2;
P=[
    0 0 sin(D) 0 0 0 0 sin(B);
    cos(A) 0 0 0 0 1 0 0;
    cos(A) -1 0 0 0 0 0 0;
    sin(A) 0 0 0 0 0 1 0;
    0 0 0 -1 1 0 0 0;
    0 0 0 0 1 -1 0 cos(B);
    0 0 0 0 0 0 1 -sin(B);
    0 1 -cos(D) 0 0 0 0 cos(B);];
X=[-Load2;0;0;-Load1;0;0;Load1;0];
```

```
D1=[0;0;0;1;1;1;0;0;0];
FC=0;
P1=[cos(A) 0 0 0 0 1 0 0;
    0 0 cos(D) 1 0 0 0 0;
    cos(A) -1 0 0 0 0 0 0;
    sin(A) 0 0 0 0 0 1 0;
    0 0 0 -1 1 0 0 0;
    0 0 0 0 1 -1 0 cos(B);
    0 0 0 0 0 0 1 sin(B);
    0 0 1 0 0 0 0 1]
X1=[0;0;0;0;0;0;1;0]
FA=[inv(P)*X;lFC];
B1=[inv(P1)*X1;FC];
for i=1:9
    K1(i)=FA(i)*B1(i)*L(i);
    K2(i)=FA(i)*D1(i)*L(i);
end
delB=(sum(K1)*10^3)/(E*CS);
delD=(sum(K2)*10^3)/(E*CS);
printf("\n B,v: %f mm",delB);
printf("\n D,h: %f mm",delD);
```

check Appendix AP 82 for dependency:

5_2data.sci

Scilab code Exa 5.2 Example 2

```
pathname=get_absolute_file_path('5_2.sce')
filename=pathname+filesep()+'5_2data.sci'
exec(filename)
delB=(119*w*L^4)/(24576*EI);
delC=(5*w*L^4)/(384*EI);
printf("\ndelB: %f m",delB);
printf("\ndelC: %f m",delC);
```

check Appendix AP 81 for dependency:

`5_3data.sci`

Scilab code Exa 5.3 Example 3

```
pathname=get_absolute_file_path('5_3.sce')
filename=pathname+filesep()+'5_3data.sci'
exec(filename)
clear all
L1=[L*tan(theta);L;L*tan(theta);L;L];
A=[AC;A;AC;A;A];
F1=[Load*cos(theta);Load*sin(theta);0;0;0];
F2=[-sin(theta);cos(theta);-sin(theta);1;cos(theta)
   ];
for i=1:5
    X(i)=L1(i)/A(i);
    X1(i)=F1(i)*F2(i)*X(i);
    X2(i)=F2(i)*F2(i)*X(i);
end
R=-sum(X1)/sum(X2);
F=F1+ R*F2;
disp("Force (AC,CB,BD,CD,AD):");
printf("\n %f N",F);
```

check Appendix AP 80 for dependency:

`5_4data.sci`

Scilab code Exa 5.4 Example 4

```
pathname=get_absolute_file_path('5_4.sce')
filename=pathname+filesep()+'5_4data.sci'
exec(filename)
```

```
clear all
AC=(AB^2 +BC^2)^0.5;
delBC=BC*delT*alpha;
F1=[AB/BC;1;AB/BC;1;-AC/BC;-AC/BC];
L=[AB;BC;AB;BC;AC;AC];
for i=1:6
    X(i)=L(i)*F1(i)*F1(i);
end
R=(-delBC*A*E)/sum(X);
F=R*F1;
disp("Force (AB,BC,CD,DA,AC,DB):");
printf("\n %f N",F);
```

check Appendix AP 79 for dependency:

`5_5data.sci`

Scilab code Exa 5.5 Example 5

```
pathname=get_absolute_file_path('5_5.sce')
filename=pathname+filesep()+'5_5data.sci'
exec(filename)
clear all
L1=0.5*L*ones(7,1);
A1=[Ab;Ab;A;A;A;A;A];
R=(11*3^0.5 *P*A*Ab*L^2)/(48*(L*L*A*Ab + 4*I*(A+ 10*
   Ab)));
delF=[-cos(theta);-cos(theta);1;1;-1;-1;1];
F=R*delF;
disp(R,"R:");
disp("Force (AB,BC,CD,DE,BD,EB,AE):");
printf("\n %f N",F)
```

check Appendix AP 78 for dependency:

`5_6data.sci`

Scilab code Exa 5.6 Example 6

```
pathname=get_absolute_file_path('5_6.sce')
filename=pathname+filesep()+'5_6data.sci'
exec(filename)
SA=0.187*M0/r;
SB=0.44*M0/r;
SC=0.373*M0/r;
printf("\nSA: %f N ",SA)
printf("\nSB: %f N",SB)
printf("\nSC:%f  N",SC)
printf("\nM1: %f N.mm",SA*r)
printf("\nM2: %f N.mm",SB*r)
printf("\nM3: %f N.mm",SC*r)
```

check Appendix AP 77 for dependency:

`5_7data.sci`

Scilab code Exa 5.7 Example 7

```
pathname=get_absolute_file_path('5_7.sce')
filename=pathname+filesep()+'5_7data.sci'
exec(filename)
clear all
delY=(W*L^4)*((11/(24*EI))+ 1/(2*GJ));
delZ=(W*L^4)*((1/(6*EI))+ 1/(2*GJ));
printf("\ndel Y %f mm",delY);
printf("\ndel Z %f mm",delZ);
```

check Appendix AP 76 for dependency:

`5_8data.sci`

Scilab code Exa 5.8 Example 8

```
pathname=get_absolute_file_path('5_8.sce')
filename=pathname+filesep()+'5_8data.sci'
exec(filename)
L1=[L;L;L;1.41*L;1.41*L;L];
F0=[0 0 -P 0 1.41*P 0];
F1=[-0.71;-0.71;-0.71;1;1;-0.71];
for i=1:6
    X(i)=F0(i)*F1(i)*L1(i);
    X1(i)=F1(i)*F1(i)*L1(i);
end
XBD= -sum(X)/sum(X1);
Fa=[-XBD/1.41;-XBD/1.41;((XBD/1.41)+1);XBD;-(((XBD
   /1.41)+1))*1.41;-XBD/1.41];
disp("Forces in the Mambrane are:");
printf("\n %f N",Fa)
```

---

check Appendix AP 75 for dependency:

`5_9data.sci`

Scilab code Exa 5.9 Example 9

```
pathname=get_absolute_file_path('5_9.sce')
filename=pathname+filesep()+'5_9data.sci'
exec(filename)
M=2^0.5;
L1=[L;M*L;L;L;M*L;M*L;L];
F0=[P;0;0;0;0;-M*P;0];
F1=[-0.71;0;0;-0.71;1;1;-0.71];
F1R2=[-2;-M;1;1;0;M;0];
```

```
for i=1:7
    X(i)=F0(i)*F1(i)*L1(i);
    X1(i)=F0(i)*F1R2(i)*L1(i);
    X2(i)=F1(i)*F1(i)*L1(i);
    X3(i)=F1R2(i)*F1R2(i)*L1(i);
    X4(i)=F1(i)*F1R2(i)*L1(i);
end
X5=[sum(X2) sum(X4);
    sum(X4) sum(X3)];
X6=-[sum(X);sum(X1)]
X7=inv(X5)*X6;
printf("\nX1: %f KN",X7(1,:));
printf("\nR2: %f KN",X7(2,:))
Fa=[X7(1,:)*M-X7(2,:)*(1+(1/M));-X7(2,:)*M;X7(2,:);
   X7(2,:)-X7(1,:)/M;X7(1,:);-X7(2,:)*(1+(1/M));-X7
   (1,:)/M]
disp("Forces in the Mambrane are:");
printf("\n %f KN",Fa);
```

check Appendix AP 85 for dependency:

`5_10data.sci`

Scilab code Exa 5.10 Example 10

```
pathname=get_absolute_file_path('5_10.sce')
filename=pathname+filesep()+'5_10data.sci'
exec(filename)
c=((a*a +b*b)^0.5);
L=[a;b;a;b;(a*a +b*b)^0.5;(a*a +b*b)^0.5];
F1=[a/b;1;a/b;1;-c/b;-c/b]
for i=1:6
    X(i)=F1(i)*F1(i)*L(i);
end
a11=sum(X)/(A*E);
X1=-alpha*b*T/a11;
```

```
Fa=[X1*a/b;X1;X1*a/b;X1;-X1*c/b;-X1*c/b]
printf("\nX1: %f N",X1);
disp("Forces in the Mambrane are (AB,BC,CD,DA,AC,DB):");
printf("\n %f KN",Fa);
```

check Appendix AP 84 for dependency:

`5_11data.sci`

Scilab code Exa 5.11 Example 11

```
pathname=get_absolute_file_path('5_11.sce')
filename=pathname+filesep()+'5_11data.sci'
exec(filename)
VB=(W*L^3)/(48*EI);
printf("\nVB: %f m",VB);
```

check Appendix AP 83 for dependency:

`5_12data.sci`

Scilab code Exa 5.12 Example 12

```
pathname=get_absolute_file_path('5_12.sce')
filename=pathname+filesep()+'5_12data.sci'
exec(filename)
v1= (L1/L0)*V(3);
v2= (L2/L0)*V(4);
v3= v1+v2;
theta=atan(v3/(D(9)-D(6)));
printf("\n B: %f rad",theta);
```

Chapter 6

Matrix Methods

check Appendix AP 74 for dependency:

`6_1data.sci`

Scilab code Exa 6.1 Example 1

```
pathname=get_absolute_file_path('6_1.sce')
filename=pathname+filesep()+'6_1data.sci'
exec(filename)
//theta=   ,lambda=   ,mu=
theta12=0,lambda12=cos(theta12),mu12=sin(theta12);
theta13=%pi/2,lambda13=cos(theta13),mu13=sin(theta13
    );
theta23=%pi/2 + atan(L13/L12);lambda23=cos(theta23),
    mu23=sin(theta23);
L23=(L12^2 +L13^2)^0.5;
LL12=lambda12^2,LM12=lambda12*mu12,MM12=mu12^2;
LL13=lambda13^2,LM13=lambda13*mu13,MM13=mu13^2;
LL23=lambda23^2,LM23=lambda23*mu23,MM23=mu23^2;
K220=[LL12 LM12;LM12 MM12];
K222=(L12/L23)*[LL23 LM23;LM23 MM23];
```

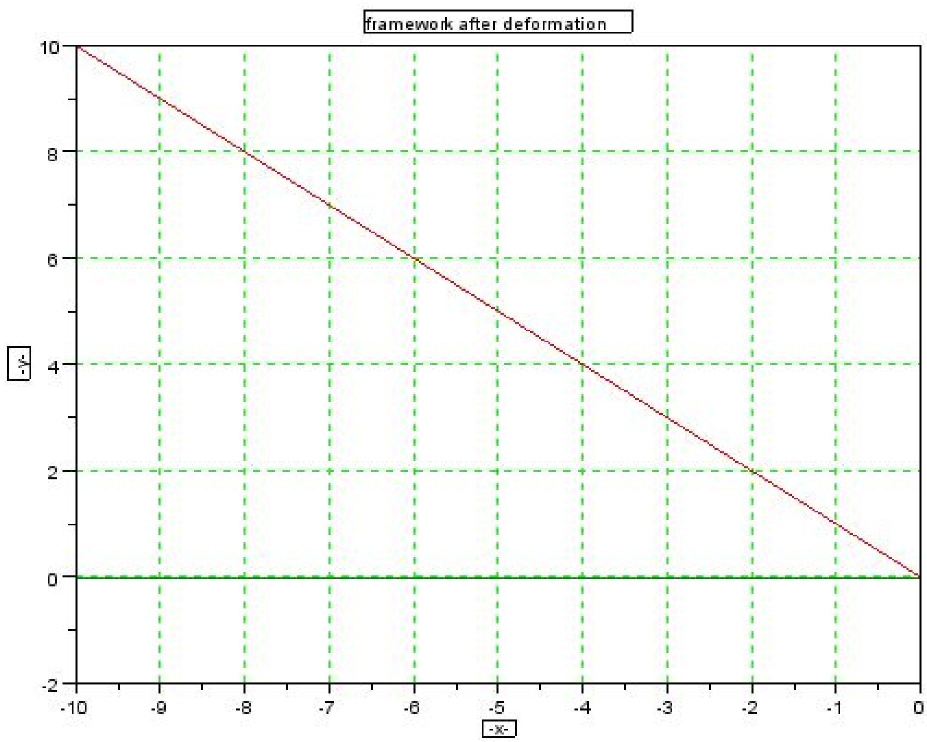

Figure 6.1: Example 1

```
K210=[-LL12 -LM12;-LM12 -MM12];
K232=(L12/L23)*[-LL23 -LM23;-LM23 -MM23];
K=K220+K222;
F=[FX2;FY2];
V=(L12/AE)*inv(K)*F;
u2=V(1,:),v2=V(2,:);
u1=0;v1=0;u3=0;v3=0;
F1=[K210';K232']*inv(K)*F;
S12=(AE/L12)*[lambda12 mu12]*[u2-u1;v2-v1];
S13=(AE/L13)*[lambda13 mu13]*[u3-u1;v3-v1];
S23=(AE/L23)*[lambda23 mu23]*[u3-u2;v3-v2];
x1=[-L12,-L12],y1=[0,L13];
x2=[-L12,u2],y2=[0,v2];
x3=[-L12,u2],y3=[L13,v2];
plot(x1,y1,x2,y2,x3,y3);
xgrid(3);
datatipToggle();
xtitle( 'framework after deformation', ' -x- ', ' -y- ',boxed = 1);
printf("\n\nu2: %f m",u2);
printf("\nv2: %f m",v2);
printf("\nFx,1: %f N",F1(1,:));
printf("\nFy,1: %f N",F1(2,:));
printf("\nFx,3: %f N",F1(3,:));
printf("\nFy,3: %f N",F1(4,:));
printf("\nS12: %f N",S12);
printf("\nS13: %f N",S13);
printf("\nS23: %f N",S23);
printf("\n\nclick on the point to view its coordinate on the plot");
```

check Appendix AP 73 for dependency:

`6_2data.sci`

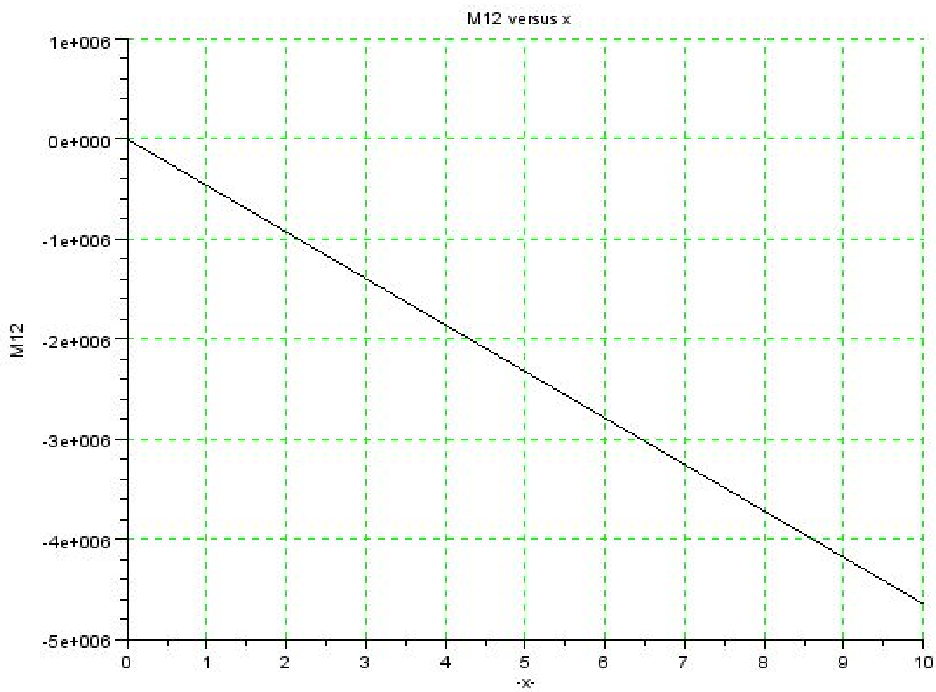

Figure 6.2: Example 2

Scilab code Exa 6.2 Example 2

```
pathname=get_absolute_file_path('6_2.sce')
filename=pathname+filesep()+'6_2data.sci'
exec(filename)
F=[-W;M;0;0];
P=EI*[(27/(2*L^3)) (9/(2*L^2)) (6/L^2) -(3/(2*L^2));
    (9/(2*L^2)) (6/L) (2/L) (1/L);
    (6/L^2) (2/L) (4/L) 0;
    -(3/(2*L^2)) (1/L) 0 (2/L)];
V=inv(P)*F;
Sy12= EI*(-(6*V(3)/(L^2))-(12*V(1)/(L^3)) -(6*V(2)/(L*L)));//Sy,12
deff("[M12]=f(x)","M12=EI*(((-6*x/L*L)+(4/L))*V(3) +((-12*x/L^3)+(6/L^2))*V(1) +((-6*x/L*L)+(2/L))*V(2))");
x=[0:0.05:L];
fplot2d(x,f);
xgrid(3);
xtitle( 'M12 versus x', ' -x- ', 'M12');
datatipToggle();
printf("\n 2: %f m",V(1));//v2
printf("\n 2: %f ",V(2));// 2
printf("\n 2: %f ",V(3));// 1
printf("\n 2: %f ",V(4));// 3
printf("\nSy,12: %f",Sy12);//Sy,12
```

---

check Appendix AP 72 for dependency:

`6_4data.sci`

Scilab code Exa 6.4 Example 4

```
pathname=get_absolute_file_path('6_4.sce')
filename=pathname+filesep()+'6_4data.sci'
exec(filename)
```

```
P=[1 P1(1) P1(2) P1(1)*P1(2);
   1 P2(1) P2(2) P2(1)*P2(2);
   1 P3(1) P3(2) P3(1)*P3(2);
   1 P4(1) P4(2) P4(1)*P4(2)];
alpha1=inv(P)*u;
alpha2=inv(P)*v;
alpha=[alpha1;alpha2];
deff("[Ex]=f(y)","Ex=alpha(2)+ y*alpha(4)");//  x
deff("[Ey]=f1(x)","Ey=alpha(7)+ x*alpha(8)");//  y
function[G]=Gxy(x,y)// xy
    G=x*alpha(4) +y*alpha(8) +alpha(3)+alpha(6);
endfunction
//at the centre
Pc(1)=(P1(1)+P3(1))/2;
Pc(2)=(P1(2)+P3(2))/2;
Sy=(E/(1-V^2))*(f1(Pc(2)) +V*f(Pc(1)));
Sx=(E/(1-V^2))*(f(Pc(1)) +V*f1(Pc(2)));
gxy=Gxy(0,0);
txy=(E/(1-V^2))*0.5*(1-V)*gxy;// xy
printf("\n x: %f N/mm^2",Sx);
printf("\n y: %f N/mm^2",Sy);
printf("\n xy: %f N/mm^2",txy);
```

Chapter 7

Bending of Thin plates

check Appendix AP 71 for dependency:

7_1data.sci

Scilab code Exa 7.1 Example 1

```
pathname=get_absolute_file_path('7_1.sce')
filename=pathname+filesep()+'7_1data.sci'
exec(filename)
D=(E*t^3)/(12*(1-v^2));
X=(16*q0/(D*%pi^6))/(((1/a^2)+(1/b^2))^2);
X1=(16*q0/%pi^4)*((1/a^2)+(v/b^2))/(((1/a^2)+(1/b^2)
    )^2);
X2=(16*q0/%pi^4)*((v/a^2)+(1/b^2))/(((1/a^2)+(1/b^2)
    )^2);
function[w]=f(x,y),//taking first term only
    w=X*(sin(%pi*x/a))*sin(%pi*y/b);
endfunction
x=linspace(0,a,10*a);
y=linspace(0,b,10*b);
w=feval(x,y,f);
```

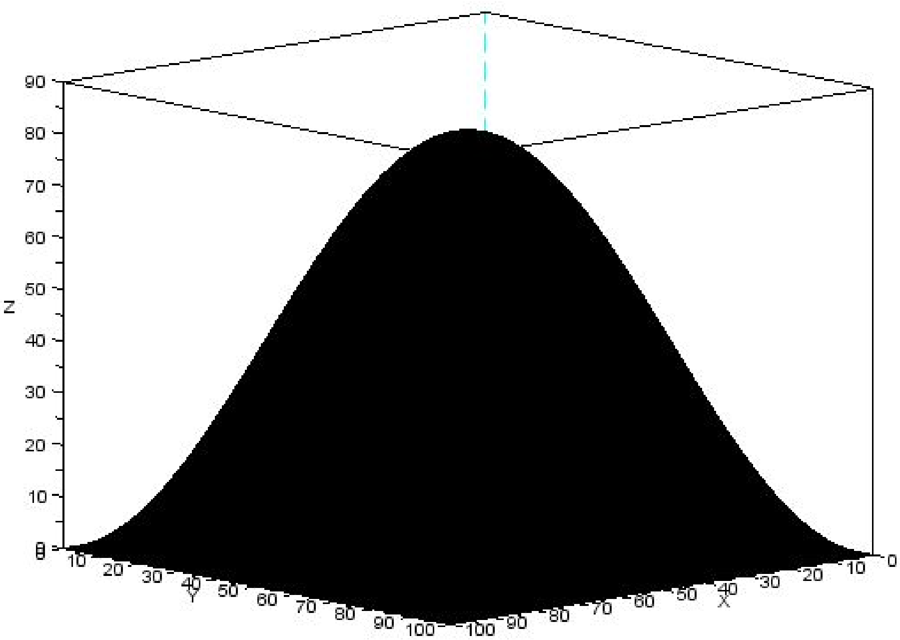

Figure 7.1: Example 1

```
plot3d1(x,y,w);
Wmax=(0.0443*q0*a^4)/(E*t^3);//from summation of
   first 4 terms
printf("\nWmax: %f mm",Wmax);
function[Mx,My]=f1(x,y)//taking first term only
    Mx=X1*(sin(%pi*x/a))*sin(%pi*y/b);
    My=X2*(sin(%pi*x/a))*sin(%pi*y/b);
endfunction
function[Sx,Sy]=f2(x,y,z)//taking first term only
    Sx=12*X1*(sin(%pi*x/a))*sin(%pi*y/b)*z/t^3;
    Sy=12*X2*(sin(%pi*x/a))*sin(%pi*y/b)*z/t^3;
endfunction
Mxmax=0.0479*q0*a^2;//from summation of first 5
   terms
printf("\nMx,max= My,max= %f N.mm",Mxmzx);
Sxmax=(0.287*q0*a^2)/t^2;
printf("\n x ,max=  y ,max= %f N.mm",Sxmax);
```

check Appendix AP 70 for dependency:

`7_3data.sci`

Scilab code Exa 7.3 Example 3

```
pathname=get_absolute_file_path('7_3.sce')
filename=pathname+filesep()+'7_3data.sci'
exec(filename)
D=(E*t^3)/(12*(1-v^2));
X=(16*q0/(D*%pi^6))/((((1/a^2)+(1/b^2))^2)+(Nx/(D*a*
   a*%pi^2)));
function[w]=f(x,y),//taking first term only
    w=X*(sin(%pi*x/a))*sin(%pi*y/b);
endfunction
x=linspace(0,a,10*a);
```

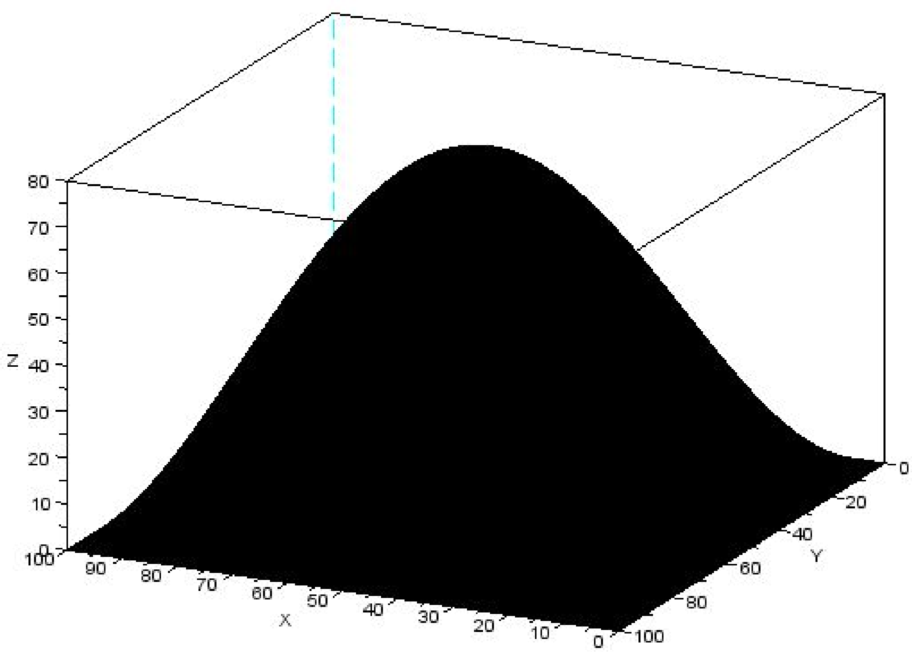

Figure 7.2: Example 3

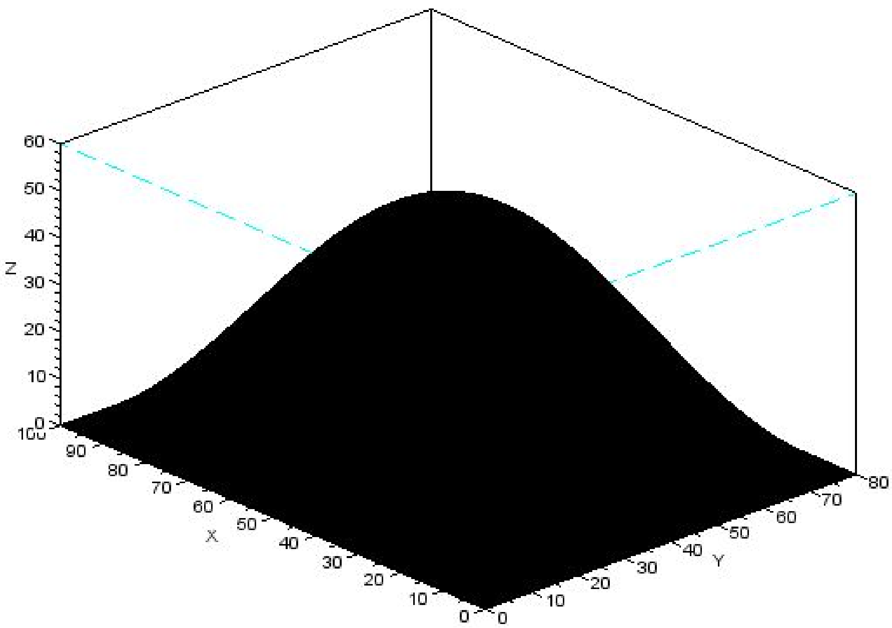

Figure 7.3: Example 4

```
y=linspace(0,b,10*b);
w=feval(x,y,f);
plot3d1(x,y,w);
datatipToggle();
printf("\nclick on the point to view its coordinate
    on the plot")
```

check Appendix AP 69 for dependency:

`7_4data.sci`

Scilab code Exa 7.4 Example 4

```
pathname=get_absolute_file_path('7_4.sce')
```

```
filename=pathname+filesep()+'7_4data.sci'
exec(filename)
clear all
D=(E*t^3)/(12*(1-v^3));
A11= (16*q0*(a^4)*(b^4))/((%pi^6)*D*((a*a +b*b)^2));
function[w]=f(x,y)
    w=A11*(sin(%pi*x/a))*(sin(%pi*y/b));
endfunction
funcprot()
x=linspace(0,a,10*a);
y=linspace(0,b,10*b);
clf();
w=feval(x,y,f);
plot3d1(x,y,w);
datatipToggle()
printf("\nA11= Wmax: %f mm",f(a/2,b/2));
```

Chapter 8

Columns

check Appendix AP 68 for dependency:

`8_2data.sci`

Scilab code Exa 8.2 Example 2

```
pathname=get_absolute_file_path('8_2.sce')
filename=pathname+filesep()+'8_2data.sci'
exec(filename)
mu=(P/(E*I))^0.5;//
deff("[v]=f(z)","v=e*((cos(mu*(z-L/2))/cos(mu*L/2))
    -1)");//v
deff("[m]=f1(z)","m=P*(e+e*((cos(mu*(z-L/2))/cos(mu*
    L/2))-1))");//M
funcprot(0);
z=[0:0.05:L];
subplot(2,1,1);
fplot2d(z,f);
xgrid(3);
xtitle( 'deflection', ' -z- ', '-v-');
subplot(2,1,2);
```

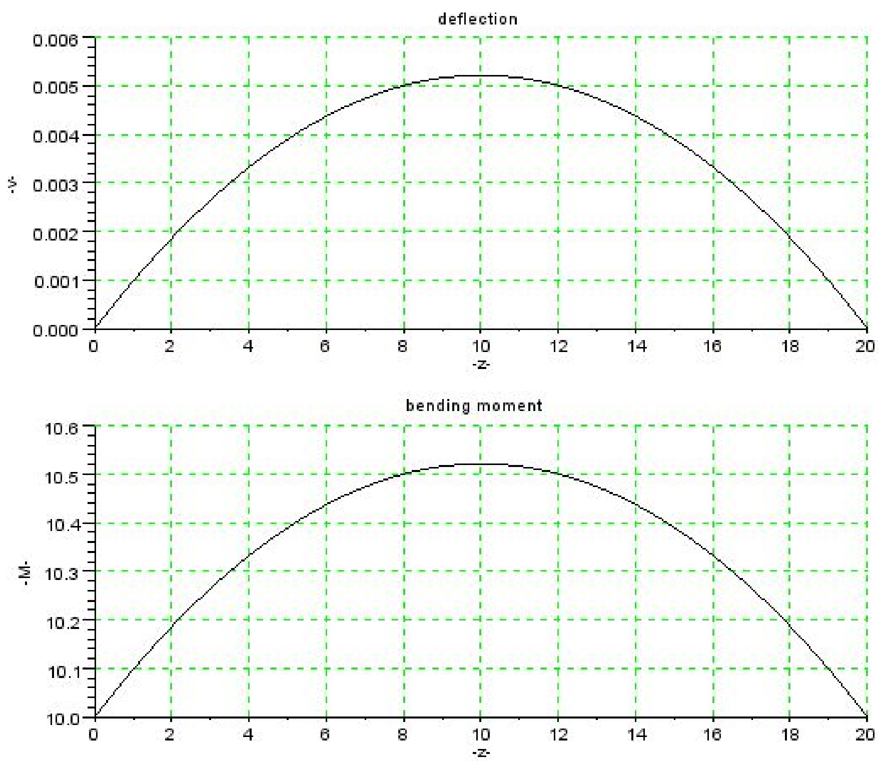

Figure 8.1: Example 2

```
fplot2d(z,f1);
xgrid(3);
xtitle( 'bending moment', ' -z- ', ' -M-');
datatipToggle();
printf("\nmaximum deflection: %f",f(L/2));
printf("\nM(max)= %f N.m",f1(L/2));
```

check Appendix AP 67 for dependency:

`8_3data.sci`

Scilab code Exa 8.3 Example 3

```
pathname=get_absolute_file_path('8_3.sce')
filename=pathname+filesep()+'8_3data.sci'
exec(filename)
A=t*(2*a +b);
Ixx=2*a*t*(b/2)^2 +(t*b^3)/12;
Iyy=(2*t*a^3)/12;
I0=Ixx+Iyy;
J=(2*a*t^3)/3 +(b*t^3)/3;
tau=(t*a^3 *b^2)/24;
Px=(%pi^2 *E*Ixx/L^2);//PCR(xx)
Py=(%pi^2 *E*Iyy/L^2);//PCR(yy)
Pth=(A/I0)*(G*J +(%pi^2 *E*tau)/L^2);//PCR(    )
P=poly(0,'P');
y=(I0/A)*(P^2 -(Px +Pth)*P +Px*Pth);
m=roots(y);
Ptb1=m(1,:)
Ptb2=m(2,:)
Load=[Px;Py;Pth];
printf("\nbuckling Load: %f N",min(Load));
printf("\nflexural-torsional buckling Load: %f N",
    roots(y));
```

check Appendix AP 66 for dependency:

8_4data.sci

Scilab code Exa 8.4 Example 4

```
pathname=get_absolute_file_path('8_4.sce')
filename=pathname+filesep()+'8_4data.sci'
exec(filename)
clear all
Xc=(a2^2)/(b+ 2*a2);//x bar
Xs=-(Xc+((3*a2^2)/(b*(1+ 6*a2/b))));
A= 2*a2*t + b*t;
Ixx=2*a2*t*(b/2)^2 +(t*b^3)/12;
Iyy=b*t*Xc^2 +(2*t/3)*((a2-Xc)^3 +Xc^3);
I0=Ixx+Iyy+ A*Xs^2;
J=(2*a2*t^3)/3 +(b*t^3)/3;
tau= 0.1244*t*a2^3 *b^2;
Px=((%pi^2)*E*Ixx/(L^2));//PCR(xx)
Py=((%pi^2)*E*Iyy/(L^2));//PCR(yy)
Pth=(A/I0)*(G*J +((%pi^2)*E*tau)/(L^2));//PCR(    )
a=(1-(A*Xs^2)/I0),b=-(Px +Pth),c=Px*Pth;
P1=(-b +(b*b -4*a*c)^0.5)/(2*a);
P2=(-b -(b*b -4*a*c)^0.5)/(2*a);
Load=[Px;Py;Pth;P1;P2];
minimum=Load(1);
for i=2:5
    if(Load(i)<Load(i-1)) then
        minimum=Load(i);
        a1=i;
    end
end
if(a1>3) then
    printf("\nflexural-torsional buckling will
       happen.\nand buckling load is: %f N",minimum)
       ;
else
```

```
    printf("\nuncoupled buckling will happen\nand buckling Load is %f N",minimum);
end
```

Chapter 9

Thin plates

check Appendix AP 65 for dependency:

`9_1data.sci`

Scilab code Exa 9.1 Example 1

```
pathname=get_absolute_file_path('9_1.sce')
filename=pathname+filesep()+'9_1data.sci'
exec(filename)
alpha= atan(((1+ t*d/(2*Af))/(1+ t*b/As))^0.25);//
Ft=(W*z/d)+(W/(2*tan(alpha)));//FT
printf("\nFT: %f N",Ft);
Mmax= (W*tan(alpha)*b^2)/(12*d);
Smax= (Mmax/ESM)+(Ft/Af);//    max
printf("\nMaximum Stress in Flange: %f N/mm^2",Smax)
    ;
P=(W*b*tan(alpha))/d;
if(b<1.5*d) then//le
    Le=d/((4-(2*b/d))^0.5);
else
    Le=d;
end
Pcr= ((%pi^2)*E*I)/(Le^2);
```

```
printf("\nPcr: %f KN",Pcr);
printf("\nP: %f KN",P);
if(P<Pcr) then
    printf("\nstiffener will not buckle")
else
    printf("\nstiffener will buckle")
end
```

Chapter 10

Oscillation of mass spring systems

check Appendix AP 64 for dependency:

`10_1data.sci`

Scilab code Exa 10.1 Example 1

```
pathname=get_absolute_file_path('10_1.sce')
filename=pathname+filesep()+'10_1data.sci'
exec(filename)
lambda=(m*l^3)/(3*48*EI);//
x=poly(0,'x');
y=21*x^2 -22*x +1;
m=roots(y);
omega1=(m(1,:)/lambda)^0.5;// 1
omega2=(m(1,:)/lambda)^0.5;// 2
f1=omega1/(2*%pi);
f2=omega2/(2*%pi);
printf("\nf1:%f",f1);
printf("\nf2:%f",f2);
```

check Appendix AP 63 for dependency:

10_2data.sci

Scilab code Exa 10.2 Example 2

```
pathname=get_absolute_file_path('10_2.sce')
filename=pathname+filesep()+'10_2data.sci'
exec(filename)
lambda=(m*l^3)/(6*EI);//
a=188,b=-44,c=1
m1=(-b+(b*b -4*a*c)^0.5)/(2*a);
m2=(-b-(b*b -4*a*c)^0.5)/(2*a);
omega1=(m1/lambda)^0.5;//  1
omega2=(m2/lambda)^0.5;//  2
f1=[omega1;omega2];
f=min(f1)/(2*%pi);
printf("\nlowest natural frequency is: %f",f);
```

check Appendix AP 62 for dependency:

10_4data.sci

Scilab code Exa 10.4 Example 4

```
pathname=get_absolute_file_path('10_4.sce')
filename=pathname+filesep()+'10_4data.sci'
exec(filename)
for i=1:3
    f(i)=(0.5*%pi*i/L)*(EI/(rho*A))^0.5;
end
printf("\nf1: %f",f(1));
printf("\nf2: %f",f(2));
printf("\nf3: %f",f(3));
```

check Appendix AP 61 for dependency:

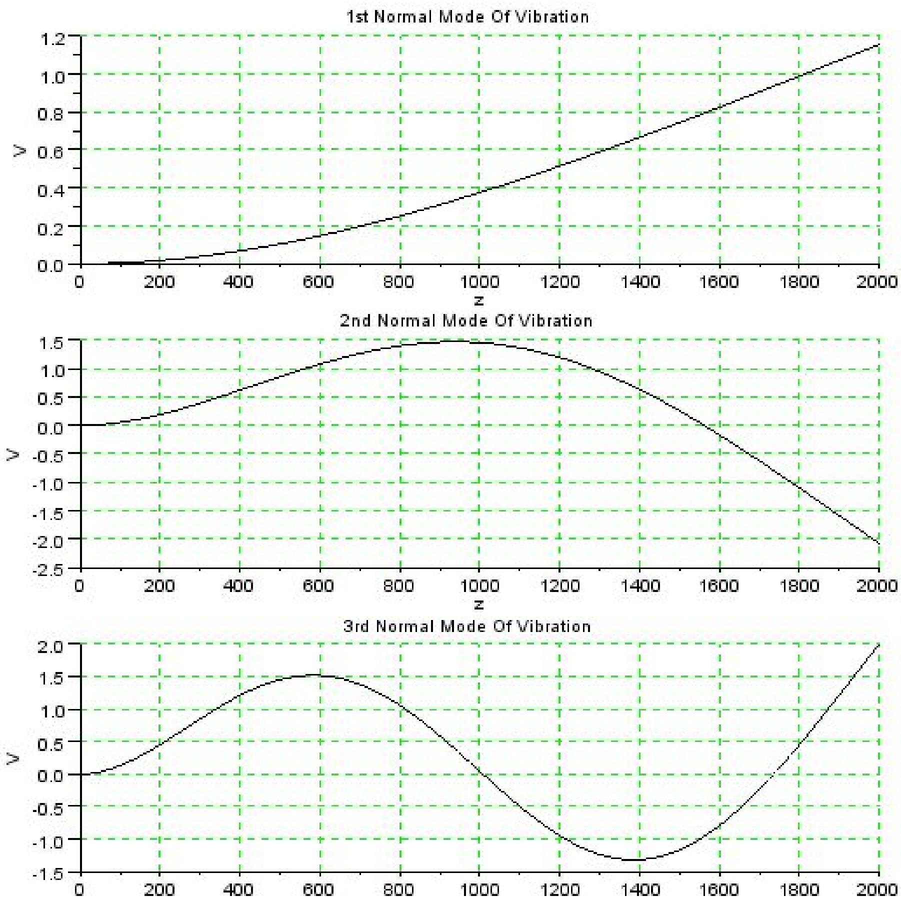

Figure 10.1: Example 5

`10_5data.sci`

Scilab code Exa 10.5 Example 5

```
pathname=get_absolute_file_path('10_5.sce')
filename=pathname+filesep()+'10_5data.sci'
exec(filename)
```

```
for i=1:3
    lambda(i)=(i-0.5)*%pi/L;
    omega(i)=(lambda(i)^2)*(EI/(rho*A))^0.5;
    fre(i)=omega(i)/(2*%pi);
    K(i)=(cos(L*lambda(i))+cosh(L*lambda(i)))/(sin(L*lambda(i))+sinh(L*lambda(i)));
end
function[V1]=f(z)
    V1=K(1)*(cosh(z*lambda(1))-cos(z*lambda(1))-K(1)*(sinh(z*lambda(1))-sin(z*lambda(1))));
endfunction
function[V2]=f1(z)
    V2=K(2)*(cosh(z*lambda(2))-cos(z*lambda(2))-K(2)*(sinh(z*lambda(2))-sin(z*lambda(2))));
endfunction
function[V3]=f2(z)
    V3=K(3)*(cosh(z*lambda(3))-cos(z*lambda(3))-K(3)*(sinh(z*lambda(3))-sin(z*lambda(3))));
endfunction
z=linspace(0,L,10*L);
subplot(3,1,1),xgrid(3),xtitle('1st Normal Mode Of Vibration','z','V')
V1=feval(z,f);
plot2d(z,V1);
subplot(3,1,2),xgrid(3),xtitle('2nd Normal Mode Of Vibration','z','V')
V2=feval(z,f1);
plot2d(z,V2);
subplot(3,1,3),xgrid(3),xtitle('3rd Normal Mode Of Vibration','z','V')
V3=feval(z,f2);
plot2d(z,V3);
printf("\nf1: %f ",fre(1));
printf("\nf2: %f ",fre(2));
printf("\nf3: %f ",fre(3));
```

check Appendix AP 60 for dependency:

`10_6data.sci`

Scilab code Exa 10.6 Example 6

```
pathname=get_absolute_file_path('10_6.sce')
filename=pathname+filesep()+'10_6data.sci'
exec(filename)
omega=1.1584*(EI/(m*l^3));
printf("\n 1: %f",omega)
```

Chapter 12

Structural components of aircraft

check Appendix AP 59 for dependency:

12_1data.sci

Scilab code Exa 12.1 Example 1

```
pathname=get_absolute_file_path('12_1.sce')
filename=pathname+filesep()+'12_1data.sci'
exec(filename)
clear all
Ar=(%pi*d^2)/4;
b=((2*Ar*Ls)/(t*Lt))+d;
printf("\nb: %f",b);
```

check Appendix AP 58 for dependency:

12_2data.sci

Scilab code Exa 12.2 Example 2

```
pathname=get_absolute_file_path('12_2.sce')
filename=pathname+filesep()+'12_2data.sci'
exec(filename)
clear all
Pe=Load*CL;
V=Load/6;
r=(DC^2 +AD^2)^0.5;
sumr=4*r^2 +2*DC^2;//sum(r^2)
S=(Pe/sumr)*r//shear on rivets A and B
printf("\nshear force on A & B (S): %f N",S);
thetaA=3*%pi/4;
thetaB= %pi/4;
RA=(S^2 + V^2 +2*S*V*cos(thetaA))^0.5;//resultent
    force on A
RB=(S^2 + V^2 +2*S*V*cos(thetaB))^0.5;//resultent
    force on B
printf("\nresultent force on A: %f N",RA);
printf("\nresultent force on B: %f N",RB);
```

Chapter 14

Airframe Loads

check Appendix AP 57 for dependency:

`14_1data.sci`

Scilab code Exa 14.1 Example 1

```
pathname=get_absolute_file_path('14_1.sce')
filename=pathname+filesep()+'14_1data.sci'
exec(filename)
T=((W/g)*a)/cos(10*%pi/180);
printf("\nT: %f N",T);
R=W+T*sin(10*%pi/180);
Ls=(R/2)/cos(20*%pi/180);//Load in each strut
printf("\nLoad in each strut: %f N",Ls);
Li=(Wa/g)*a;//inertial load at CG of fuselage aft of AA
N=T-Li*cos(10*%pi/180)+Wa*sin(10*%pi/180);
S=Li*sin(10*%pi/180)+Wa*cos(10*%pi/180);
s=v0^2/(2*a);
printf("\nN: %f N",N);
printf("\nS: %f N",S);
printf("\ns: %f m",s);
```

check Appendix AP 56 for dependency:

```
14_2data.sci
```

Scilab code Exa 14.2 Example 2

```
pathname=get_absolute_file_path('14_2.sce')
filename=pathname+filesep()+'14_2data.sci'
exec(filename)
clear all
ax=Rh/(W/g);//horizontal deceleration
ay=(Rv-W)/(W/g);//vertical deceleration
Ialpha=Rv*Sh +Rh*Sv;
alpha=(Ialpha*10^6)/Icg;
t=v0/ay;
omega=alpha*t;
printf("\nhorizontal reaction force: %f kN",W*ax/g);
printf("\nvertical reaction force: %f kN",W*ay/g);
printf("\n  : %f rad/s^2",alpha);
printf("\nt: %f s",t);
printf("\n  : %f rad/s",omega);
```

check Appendix AP 55 for dependency:

```
14_3data.sci
```

Scilab code Exa 14.3 Example 3

```
pathname=get_absolute_file_path('14_3.sce')
filename=pathname+filesep()+'14_3data.sci'
exec(filename)
clear all
L=n*W;
Cl1=(L/(0.5*S*rho*v^2));
```

```
l1=4.18*cos((alpha1-2)*%pi/180) +0.31*sin((alpha1-2)*%pi/180);
Cl2=(L/(0.5*S*rho*v^2))-((c/l1)*Cmcg1);
l2=4.18*cos((alpha2-2)*%pi/180) +0.31*sin((alpha2-2)*%pi/180);
Cl3=(L/(0.5*S*rho*v^2))-((c/l2)*Cmcg2);
//CD from Fig. 14.8(a)
CD=0.0875;
Lift=0.5*rho*v*v*S*(Cl1+Cl2+Cl3)/3;
Drag=0.5*rho*v*v*S*CD;
printf("\nLift: %f N",Lift);
printf("\nDrag: %f N",Drag);
```

Chapter 15

Fatigue

check Appendix AP 54 for dependency:

```
15_1data.sci
```

Scilab code Exa 15.1 Example 1

```
pathname=get_absolute_file_path('15_1.sce')
filename=pathname+filesep()+'15_1data.sci'
exec(filename)
clear all
af=(K^2)/(S^2 *alpha^2 *%pi);
Nf=(2/(C*(n-2)*((S*%pi^0.5)^n)))*((1/ai^((n-2)/2))
    -(1/af^((n-2)/2)));
printf("\naf: %f mm",af)
if(round(Nf)>Nf) then
    printf("\nNf: %f cycles",round(Nf));
else
    printf("\nNf: %f cycles",round(Nf)+1)
end
```

Chapter 16

Bending of open and closed thin walled beams

check Appendix AP 53 for dependency:

`16_1data.sci`

Scilab code Exa 16.1 Example 1

```
pathname=get_absolute_file_path('16_1.sce')
filename=pathname+filesep()+'16_1data.sci'
exec(filename)
Ixx=(a*b^3)/12 - ((a-tx)*(b-2*ty)^3)/12;
deff("[Sz]=f(y)","Sz=M*y/Ixx");
y=[-b/2:0.05:b/2];
fplot2d(y,f);
xgrid(3);
datatipToggle();
xtitle( 'Direct stress', ' -y- ', '- z -');
printf("\n z at the top of the beam: %f N/mm^2",f(b
   /2));
printf("\n z at the bottom of the beam: %f N/mm^2",
   f(-b/2));
```

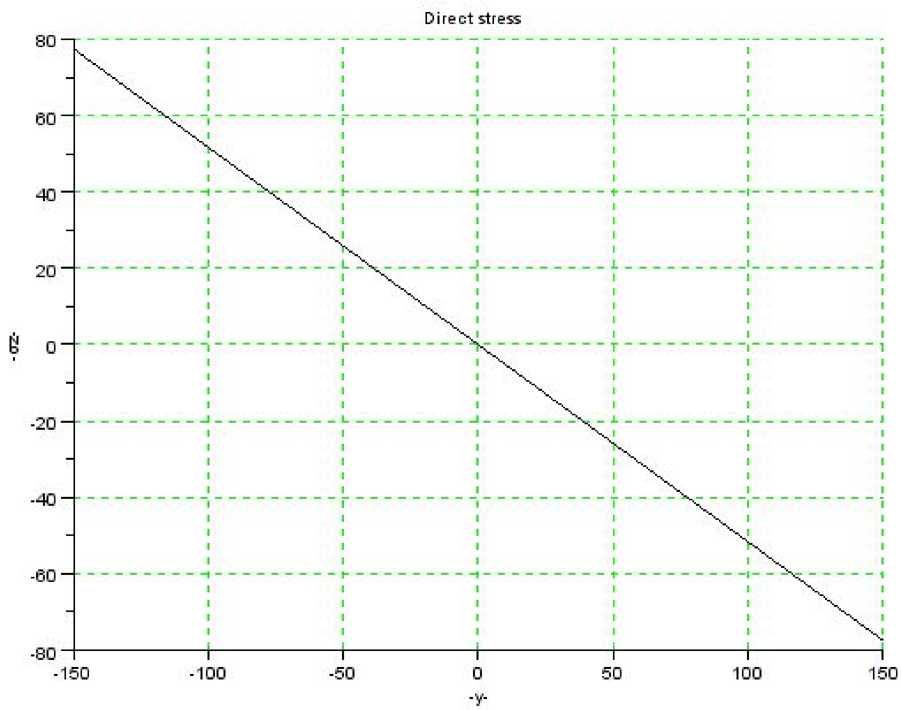

Figure 16.1: Example 1

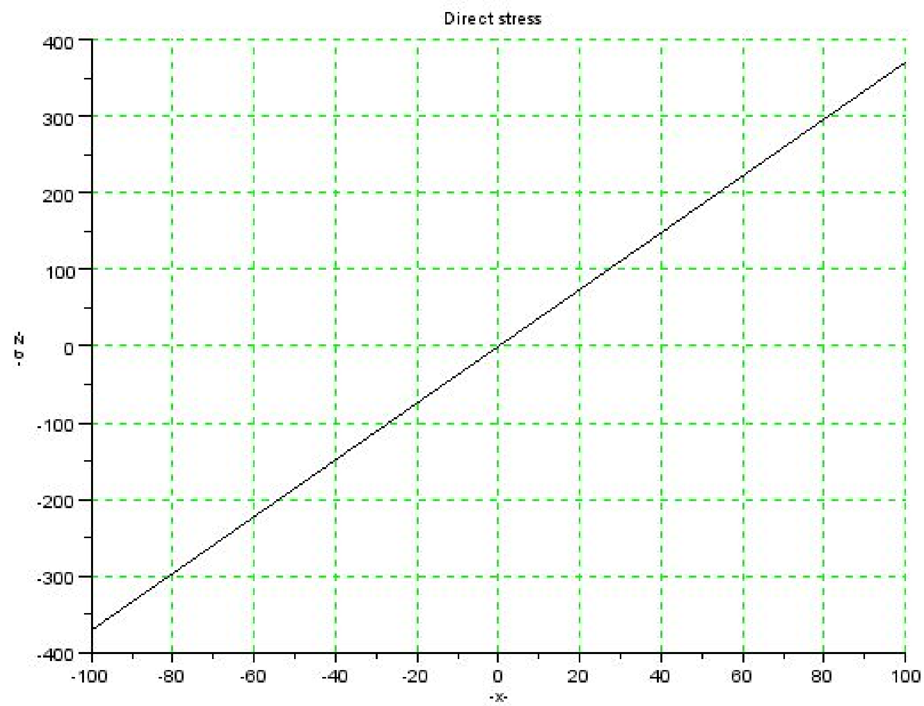

Figure 16.2: Example 2

---

check Appendix AP 45 for dependency:

`16_2data.sci`

Scilab code Exa 16.2 Example 2

```
pathname=get_absolute_file_path('16_2.sce')
filename=pathname+filesep()+'16_2data.sci'
exec(filename)
clear all
```

```
Iyy=2*(ty*a^3)/12 +((b- 2*ty)*tx^3)/12;
deff("[Sz]=f(x)","Sz=M*x/Iyy");
x=[-a/2:0.05:a/2];
fplot2d(x,f);
xgrid(3);
datatipToggle();
xtitle( 'Direct stress', ' -x- ', '-    z-');
printf("\n z at the left hand edges of flanges: %f
   N/mm^2",f(-a/2));
printf("\n z at the right hand edges of flanges: %f
    N/mm^2",f(a/2));
```

check Appendix AP 44 for dependency:

`16_3data.sci`

Scilab code Exa 16.3 Example 3

```
pathname=get_absolute_file_path('16_3.sce')
filename=pathname+filesep()+'16_3data.sci'
exec(filename)
clear all
Iyy=2*(ty*a^3)/12 +((b- 2*ty)*tx^3)/12;
Ixx=(a*b^3)/12 - ((a-tx)*(b-2*ty)^3)/12;
Mx=M*cos(theta),My=M*sin(theta);
alpha=(atan((My/Iyy)/(Mx/Ixx)))*180/%pi;
deff("[Sz1]=f(x)","Sz1=((Mx/Ixx)*(b/2))-((My/Iyy)*x)
   ");
deff("[Sz2]=f1(x)","Sz2=((Mx/Ixx)*(-b/2))-((My/Iyy)*
   x)");
deff("[Sz3]=f2(y)","Sz3=((Mx/Ixx)*y)");
deff("[Sz4]=f3(x)","Sz4=0*x");
deff("[Sz5]=f4(y)","Sz5=0*y");
funcprot();
```

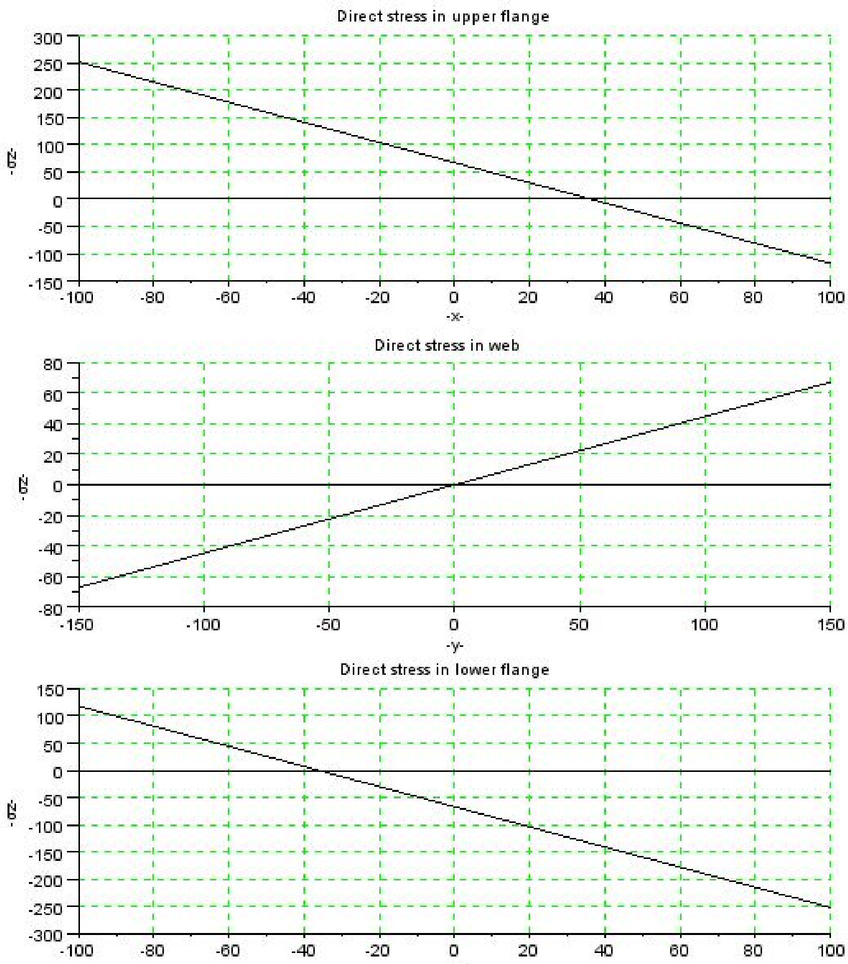

Figure 16.3: Example 3

```
y=[-b/2:0.05:b/2];
x=[-a/2:0.05:a/2];
funcprot(0);
subplot(3,1,1);
fplot2d(x,f);
fplot2d(x,f3);
xgrid(3);
xtitle( 'Direct stress in upper flange', ' -x- ', '-z -');
subplot(3,1,3);
fplot2d(x,f1);
fplot2d(x,f3);
xgrid(3);
xtitle( 'Direct stress in lower flange', ' -x- ', '-z -');
subplot(3,1,2);
fplot2d(y,f2);
fplot2d(y,f4);
xgrid(3);
xtitle( 'Direct stress in web', ' -y- ', '- z -');
datatipToggle();
printf("\nclick on the point on the plot to view its coordinates");
```

check Appendix AP 43 for dependency:

`16_4data.sci`

Scilab code Exa 16.4 Example 4

```
pathname=get_absolute_file_path('16_4.sce')
ilename=pathname+filesep()+'16_4data.sci'
exec(filename)
Yc=(b^2 -t^2 +a*t)/(2*(a+b-t));
Xc=((((a/2)-a1+ 0.5*t)*a) +((b-t)*t/2))/(a+b-t);
```

```
Ixx=(1/3)*((t*((Yc-t)^3 -(Yc-b)^3))+(a*((Yc)^3 -(Yc-
    t)^3)));
P=a1- 0.5*t +Xc;
Iyy=(1/3)*((t*(P^3 -(P-a)^3))+((b-t)*(Xc^3- (Xc-t)
    ^3)));
Ixy=a*t^2 *(Yc- t*0.5) + (b-t)*t*(Yc+ 0.5*t)*12;
M1=(1+round(100*Mx*Iyy/(Ixx*Iyy -Ixy^2)))/100,M2=(1+
    round(100*Mx*Ixy/(Ixx*Iyy -Ixy^2)))/100;
function[z]=Sz(x,y)
    z=M1*y -M2*x;
endfunction
Load=[Sz(-P,Yc);Sz(a-P,Yc);Sz(-P,Yc-t);Sz(a-P,Yc-t);
    Sz(-Xc,Yc-b);Sz(-Xc+t,Yc-b)];
Point1=[-P;a-P;-P;a-P;-Xc;-Xc+t];
Point2=[Yc;Yc;Yc-t;Yc-t;Yc-b;Yc-b];
maximum=Load(1);
for i=2:6
    if(abs(Load(i))>abs(Load(i-1))) then
        maximum=abs(Load(i));
        mm=i;
    end
end
printf("\n z ,max: %f N/mm^2",Load(mm));
disp("at point");
printf("\nX: %f ",Point1(mm));
printf("\nY: %f ",Point2(mm));
```

check Appendix AP 42 for dependency:

16_5data.sci

Scilab code Exa 16.5 Example 5

```
pathname=get_absolute_file_path('16_5.sce')
```

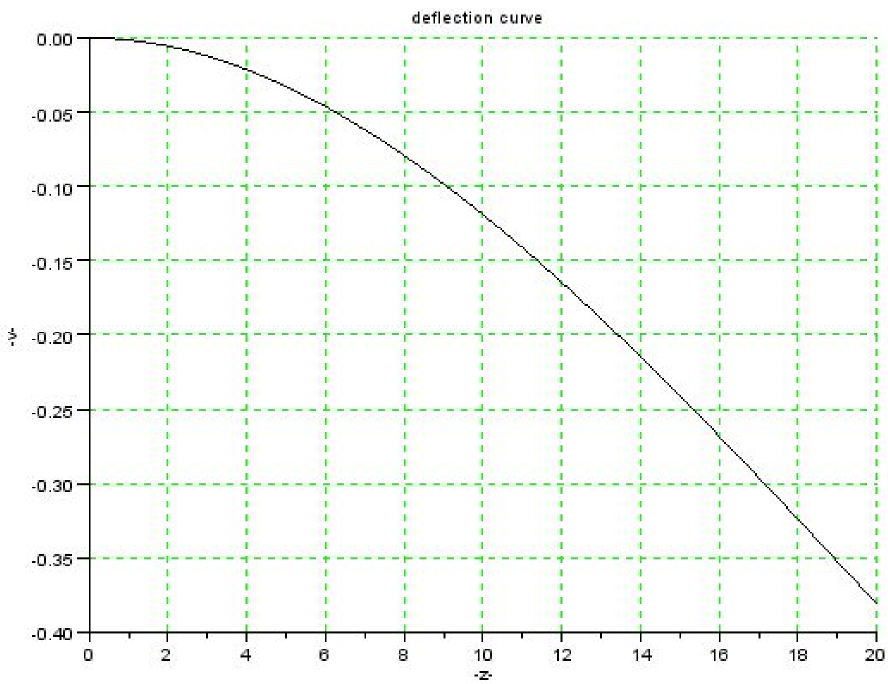

Figure 16.4: Example 5

```
filename=pathname+filesep()+'16_5data.sci'
exec(filename)
deff("[v]=f(z)","v=(-W/(6*EI))*(3*L*z^2 -z^3)");
funcprot();
z=[0:0.05:L];
fplot2d(z,f);
xgrid(3);
datatipToggle();
xtitle( 'deflection curve', ' -z- ', '-v-');
printf("\ntip deflection: %f m",f(L));
printf("\n\nclick on the point to view its
    coordinate on the plot");
```

check Appendix AP 41 for dependency:

`16_6data.sci`

Scilab code Exa 16.6 Example 6

```
pathname=get_absolute_file_path('16_6.sce')
filename=pathname+filesep()+'16_6data.sci'
exec(filename)
deff("[v]=f(z)","v=(-W/(24*EI))*(6*(L^2)*z^2 -4*L*z
    ^3 +z^4)");
funcprot();
z=[0:0.05:L];
fplot2d(z,f);
xgrid(3);
datatipToggle();
xtitle( 'deflection curve', ' -z- ', '-v-');
printf("\ntip deflection: %f m",f(L));
printf("\n\nclick on the point to view its
    coordinate on the plot");
```

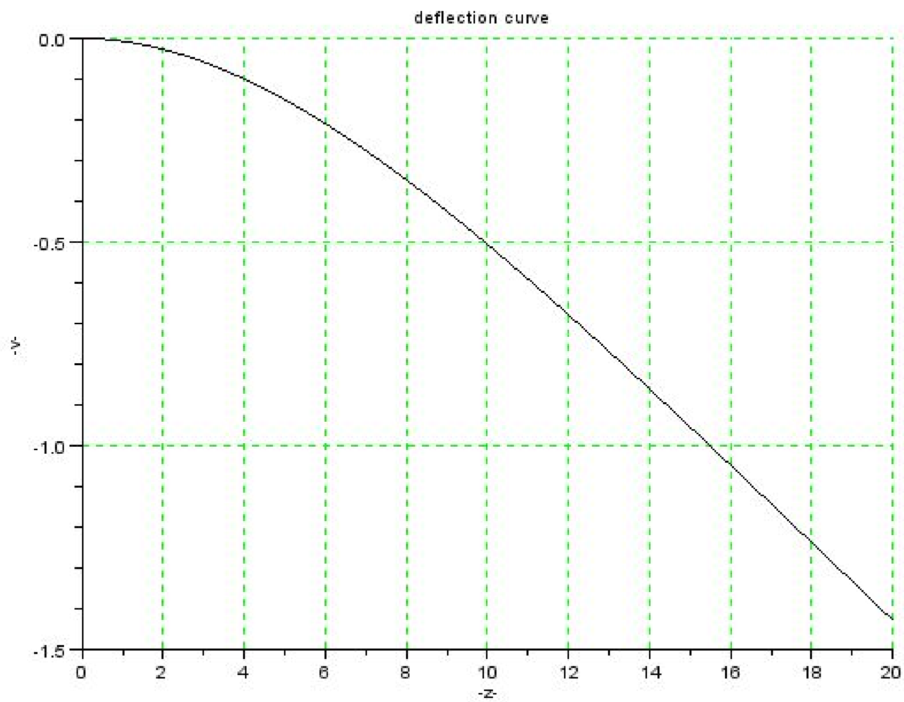

Figure 16.5: Example 6

Figure 16.6: Example 7

check Appendix AP 40 for dependency:

16_7data.sci

Scilab code Exa 16.7 Example 7

```
pathname=get_absolute_file_path('16_7.sce')
filename=pathname+filesep()+'16_7data.sci'
exec(filename)
deff("[v]=f(z)","v=(W/(24*EI))*(2*L*z^3 -z*L^3 -z^4)
    ");
funcprot();
z=[0:0.05:L];
```

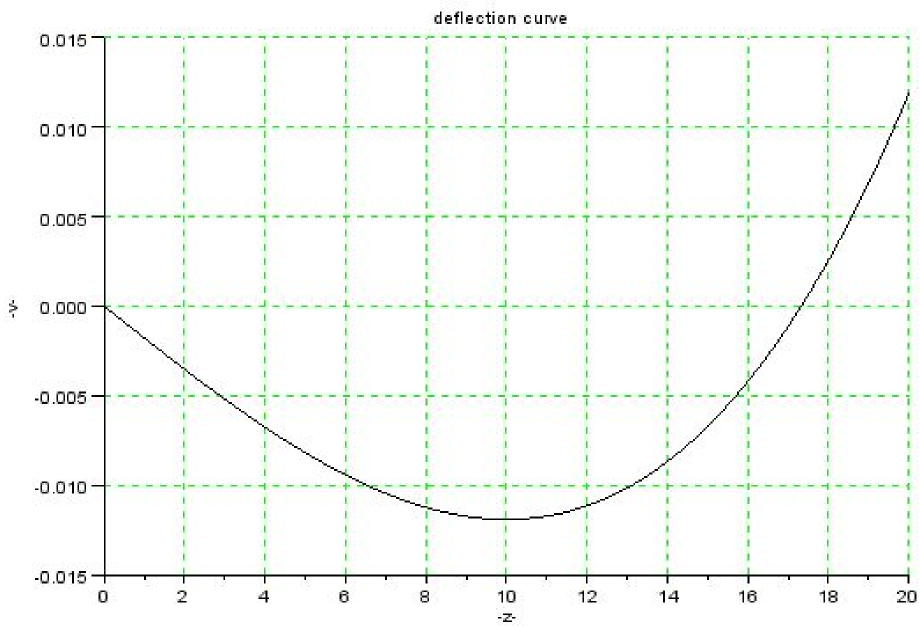

Figure 16.7: Example 8

```
fplot2d(z,f);
xgrid(3);
datatipToggle();
xtitle( 'deflection curve', ' -z- ', '-v-');
printf("\nmaximum deflection: %f m",f(L/2));
printf("\n\nclick on the point to view its
    coordinate on the plot");
```

---

check Appendix AP 39 for dependency:

`16_8data.sci`

Scilab code Exa 16.8 Example 8

```
pathname=get_absolute_file_path('16_8.sce')
filename=pathname+filesep()+'16_8data.sci'
exec(filename)
deff("[v]=f(z)","v=(W/(48*EI))*(4*z^3 -3*z*L^2)");
funcprot();
z=[0:0.05:L];
fplot2d(z,f);
xgrid(3);
datatipToggle();
xtitle( 'deflection curve', ' -z- ', '-v-');
printf("\nmaximum deflection: %f m",f(L/2));
printf("\n\nclick on the point to view its
    coordinate on the plot");
```

check Appendix AP 38 for dependency:

`16_9data.sci`

Scilab code Exa 16.9 Example 9

```
pathname=get_absolute_file_path('16_9.sce')
filename=pathname+filesep()+'16_9data.sci'
exec(filename)
clear all
function[si]=sing(a,b)
    if(a<b) then
        si=0;
    else
        si=(a-b);
    end
endfunction
deff("[v]=f(z)","v=(1/EI)*(((W*z^3)/8) -((W/6)*(sing
    (z,a))^3)-((W/6)*(sing(z,2*a))^3)+((W/3)*(sing(z
    ,3*a))^3)-((5*W*z*a^2)/8))");
```

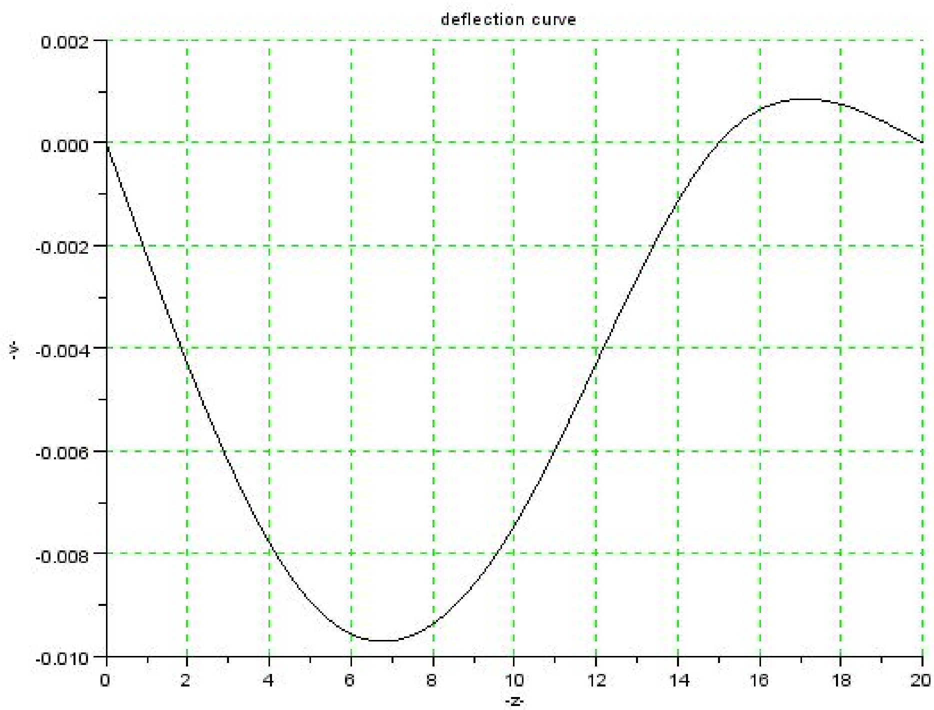

Figure 16.8: Example 9

```
for i=1:400*a
    x0=f((i-1)/100),x1=f(i/100),x2=f((i+1)/100);
    y1=(x0-x1),y2=(x1-x2);
    if(y1*y2<0) then
        if(y1<0) then
            P=i/100;
            P1=f(i/100);
        else
            Q=i/100;
            Q1=f(i/100);
        end
    end
end
z=[0:0.05:4*a];
fplot2d(z,f);
xgrid(3);
xtitle( 'deflection curve', ' -z- ', '-v-');
datatipToggle();
printf("\nmaximum positive deflection: %f m",P1);
printf("\nat z= %f m",P);
printf("\nmaximum negative deflection: %f m",Q1);
printf("\nat z= %f m",Q);
printf("\n\nclick on the point to view its
   coordinate on the plot");
```

check Appendix AP 52 for dependency:

`16_10data.sci`

Scilab code Exa 16.10 Example 10

```
pathname=get_absolute_file_path('16_10.sce')
filename=pathname+filesep()+'16_10data.sci'
exec(filename)
```

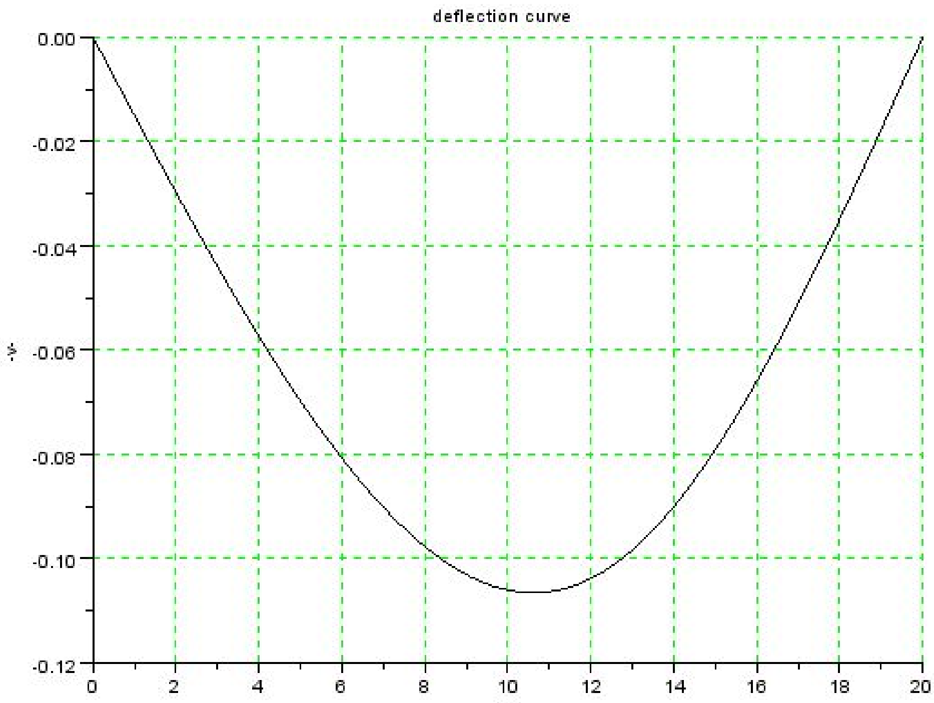

Figure 16.9: Example 10

```
clear all
function[si]=sing(a,b)
    if(a<b) then
        si=0;
    else
        si=(a-b);
    end
endfunction
deff("[v]=f(z)","v=(1/EI)*(((L*W*z^3)/64) -((W/24)*(
   sing(z,0.5*L))^4)+((W/24)*(sing(z,0.75*L))^4)
   -((27*W*z*L^3)/2048))");
funcprot();
for i=1:100*L
    x0=f((i-1)/100),x1=f(i/100),x2=f((i+1)/100);
    y1=(x0-x1),y2=(x1-x2);
    if(y1*y2<0) then
       P=i/100;
       P1=f(i/100);
       printf("\nmaximum deflection: %f m",P1);
       printf("\nat z= %f m",P);
    end
end

z=[0:0.05:L];
fplot2d(z,f);
xgrid(3);
datatipToggle();
xtitle('deflection curve', ' -z- ', '-v-');
printf("\n\nclick on the point to view its
   coordinate on the plot");
```

check Appendix AP 51 for dependency:

`16_11data.sci`

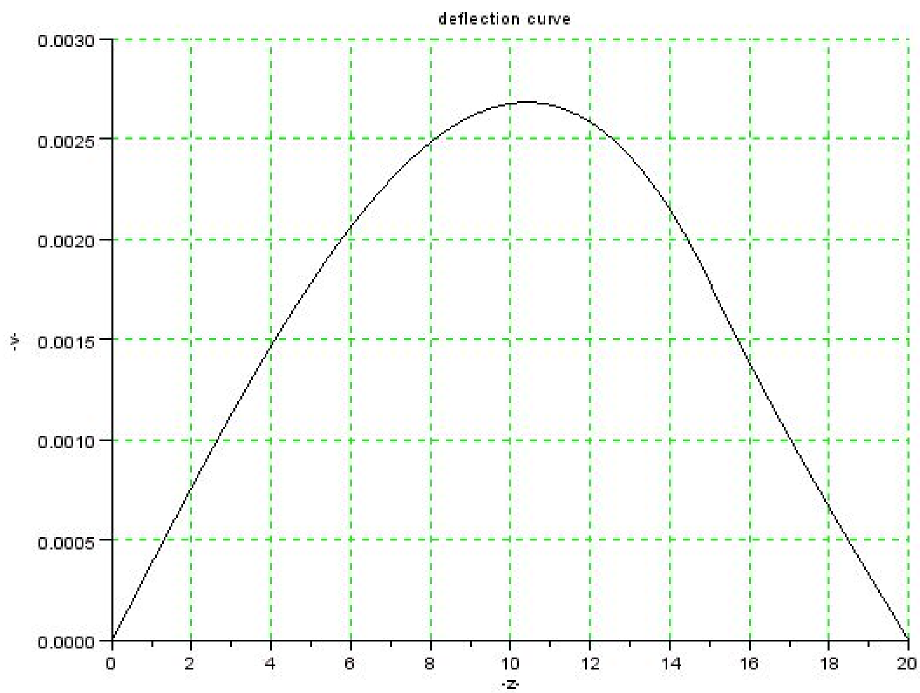

Figure 16.10: Example 11

Scilab code Exa 16.11 Example 11

```
pathname=get_absolute_file_path('16_11.sce')
filename=pathname+filesep()+'16_11data.sci'
exec(filename)
function[si]=sing(a,a1)
    if(a<a1) then
        si=0;
    else
        si=(a-a1);
    end
endfunction
deff("[v]=f(z)","v=(M0/(EI*6*L))*(-z^3 +(3*L*(sing(z
    ,b))^2)-(2*L^2 -6*L*b +3*b^2)*z)");
z=[0:0.05:L];
fplot2d(z,f);
xgrid(3);
datatipToggle();
xtitle( 'deflection curve', ' -z- ', '-v-');
printf("\n\nclick on the point to view its
    coordinate on the plot");
```

check Appendix AP 50 for dependency:

`16_12data.sci`

Scilab code Exa 16.12 Example 12

```
pathname=get_absolute_file_path('16_12.sce')
filename=pathname+filesep()+'16_12data.sci'
exec(filename)
P=(W*Ixy/(E*(Ixx*Iyy -Ixy^2)));
P1=-(W*Iyy/(E*(Ixx*Iyy -Ixy^2)));
deff("[u]=f(z)","u=P*(0.5*L*z^2 -(1/6)*z^3)");
```

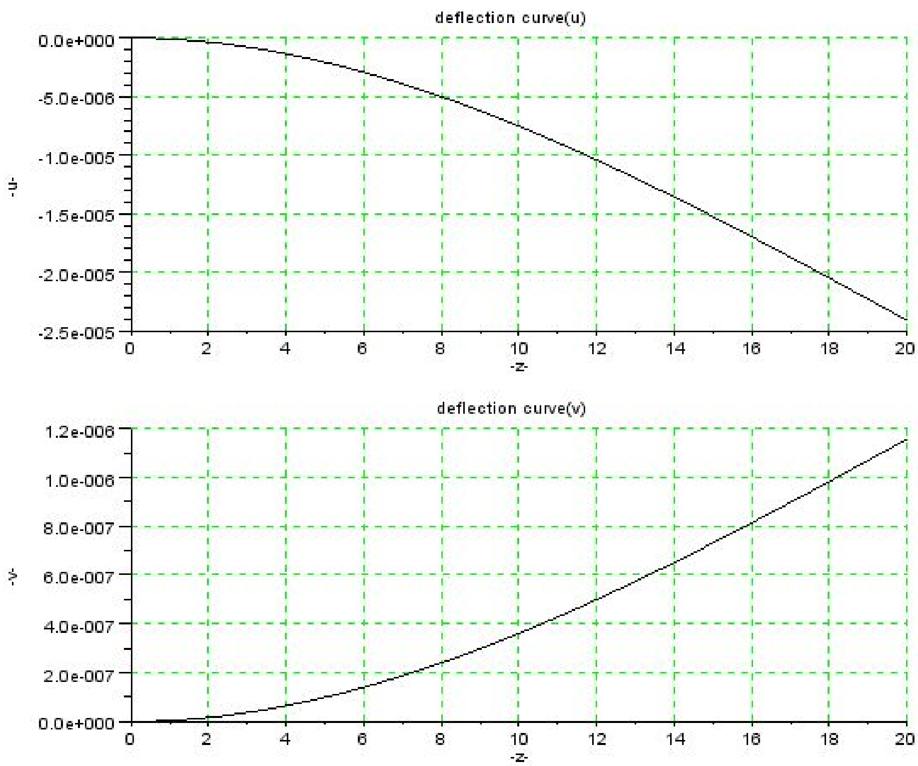

Figure 16.11: Example 12

```
deff("[v]=f1(z)","v=P1*(0.5*L*z^2 -(1/6)*z^3)");
funcprot();
z=[0:0.05:L];
subplot(2,1,1);
fplot2d(z,f);
xgrid(3);
xtitle( 'deflection curve(u)', ' -z- ', '-u-');
subplot(2,1,2);
fplot2d(z,f1);
xgrid(3);
xtitle( 'deflection curve(v)', ' -z- ', '-v-');
datatipToggle();
printf("\nmaximum value of u: %f",f(L));
printf("\nmaximum value of v: %f",f1(L));
printf("\n\nclick on the point to view its coordinate on the plot");
```

check Appendix AP 49 for dependency:

16_13data.sci

Scilab code Exa 16.13 Example 13

```
pathname=get_absolute_file_path('16_13.sce')
filename=pathname+filesep()+'16_13data.sci'
exec(filename)
dw=d- 2*tf;
Ixx=2*(((b*tf^3)/12)+ b*tf*((dw+tf)/2)^2) + (tw*dw^3)/12;
Iyy=(2*tf*b^3)/12 + (dw*dw^3)/12;
printf("\n Ixx= %f mm^4",Ixx);
printf("\n Iyy= %f mm^4",Iyy)
```

check Appendix AP 48 for dependency:

16_14data.sci

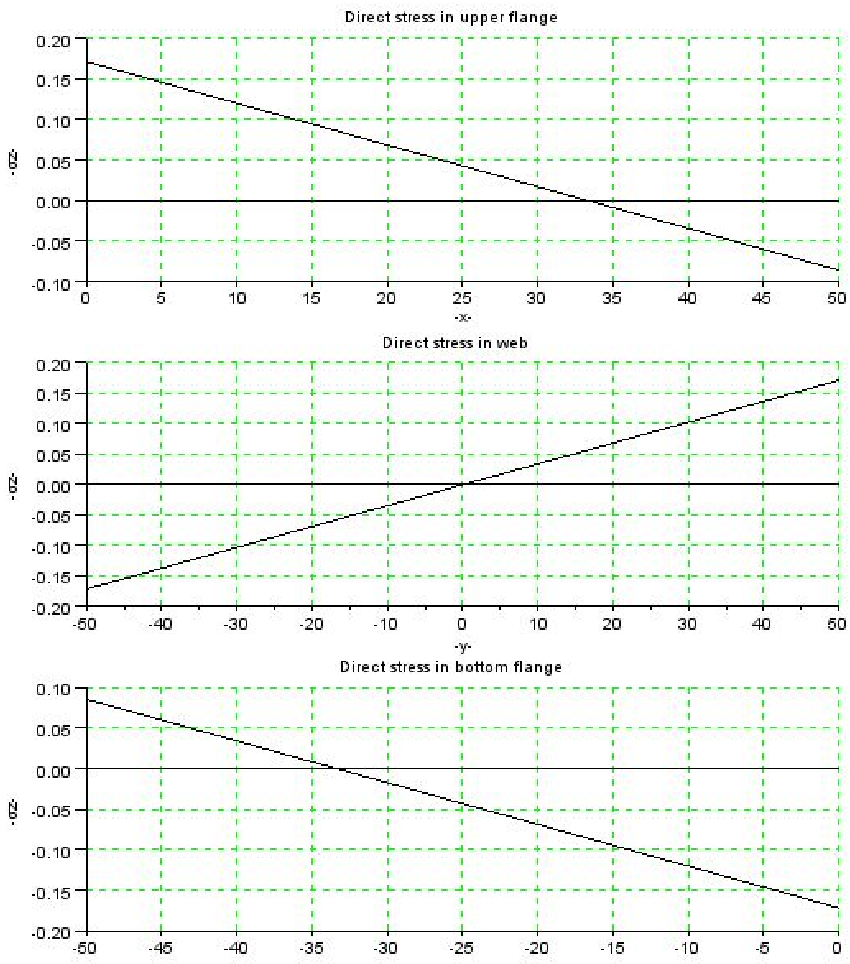

Figure 16.12: Example 14

Scilab code Exa 16.14 Example 14

```
pathname=get_absolute_file_path('16_14.sce')
filename=pathname+filesep()+'16_14data.sci'
exec(filename)
Ixx=(t*h^3)/3;
Iyy=(t*h^3)/12;
Ixy=(t*h^3)/8;
P=Mx/(Ixx*Iyy -Ixy*Ixy);
deff("[Sz1]=f(x)","Sz1=P*(Iyy*h*0.5 -Ixy*x)");//distribution of direct stress in top flange
deff("[Sz2]=f1(y)","Sz2=P*(Iyy*y)");//distribution of direct stress in web
deff("[Sz3]=f2(x1)","Sz3=P*(-Iyy*h*0.5 -Ixy*x1)");//distribution of direct stress in top flange
deff("[Sz4]=f3(x)","Sz4=0*x");
deff("[Sz5]=f4(y)","Sz5=0*y");
y=[-h/2:0.05:h/2];
x=[0:0.05:h/2];
x1=[-h/2:0.05:0];
funcprot(0);
subplot(3,1,1);
fplot2d(x,f);
fplot2d(x,f3);
xgrid(3);
xtitle( 'Direct stress in upper flange', ' -x- ', '-z -');
subplot(3,1,2);
fplot2d(y,f1);
fplot2d(y,f4);
xgrid(3);
xtitle( 'Direct stress in web', ' -y- ', '- z -');
```

```
subplot(3,1,3);
fplot2d(x1,f2);
fplot2d(x1,f3);
xgrid(3);
xtitle( 'Direct stress in bottom flange', ' -y- ', '
   - z -');
datatipToggle();
```

check Appendix AP 47 for dependency:

`16_15data.sci`

Scilab code Exa 16.15 Example 15

```
pathname=get_absolute_file_path('16_15.sce')
filename=pathname+filesep()+'16_15data.sci'
exec(filename)
Nt=4*E*alpha*a*t*T0;
Mxt=2*E*alpha*t*T0*a^2;
Myt=-E*alpha*t*T0*a^2;
printf("\nNt: %f ",Nt);
printf("\nMxt: %f ",Mxt);
printf("\nMyt: %f ",Myt);
```

check Appendix AP 46 for dependency:

`16_16data.sci`

Scilab code Exa 16.16 Example 16

```
pathname=get_absolute_file_path('16_16.sce')
filename=pathname+filesep()+'16_16data.sci'
exec(filename)
Nt=4*E*alpha*a*t*T0;
```

```
Mxt=(8/3)*E*alpha*t*T0*a^2;
Myt=-E*alpha*t*T0*a^2;
printf("\nNt: %f ",Nt);
printf("\nMxt: %f ",Mxt);
printf("\nMyt: %f ",Myt);
```

Chapter 17

Shear of beams

check Appendix AP 37 for dependency:

```
17_1data.sci
```

Scilab code Exa 17.1 Example 1

```
pathname=get_absolute_file_path('17_1.sce')
filename=pathname+filesep()+'17_1data.sci'
exec(filename)
Ixx=(t*h^3)/3,Iyy=(t*h^3)/12,Ixy=(t*h^3)/8;
A=0.5*(Sy/(Ixx*Iyy -Ixy^2));
function[q1]=q12(s1),
    q1=A*(((h*t*(Iyy-Ixy))*s1)+(Ixy*t*s1^2));
endfunction
s1=linspace(0,h/2,5*h);
q1=feval(s1,q12);
subplot(3,1,1)
plot2d(s1,q1);
xgrid(3);
xtitle( 'Direct stress in lower flange', ' -s1- ', '
  - z -');
```

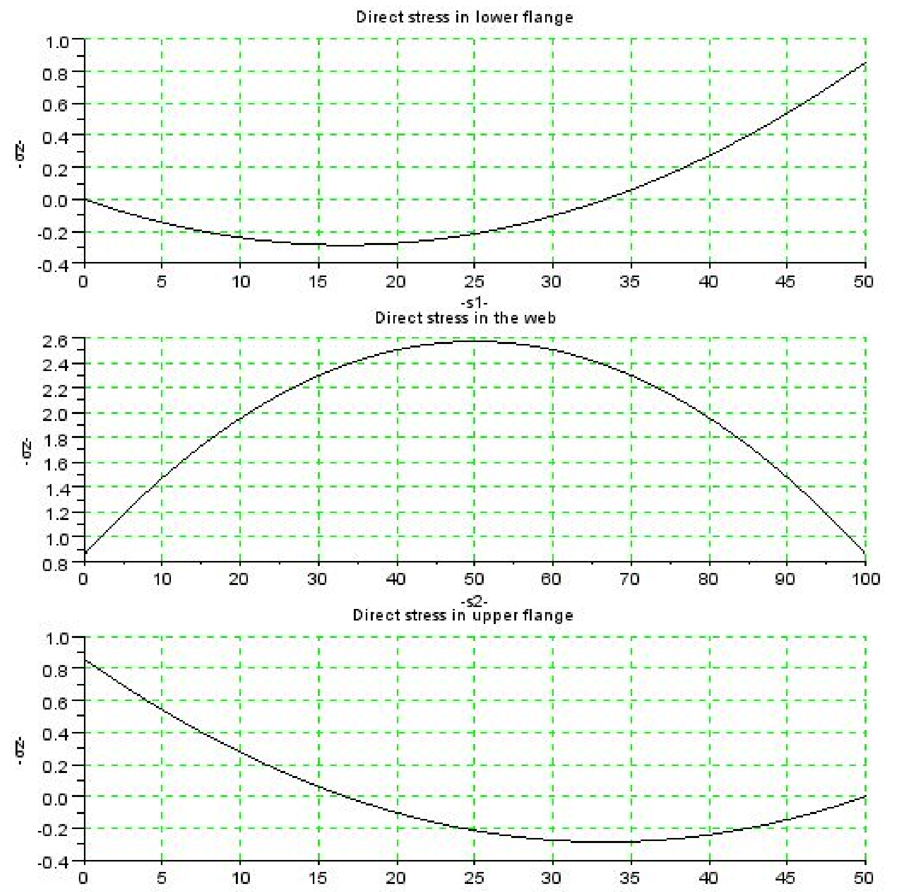

Figure 17.1: Example 1

```
function[q2]=q23(s2),
    q2=(A*((Iyy*t*h*s2)-(Iyy*t*s2^2)))+q12(h/2);
endfunction
s2=linspace(0,h,10*h);
q2=feval(s2,q23);
subplot(3,1,2)
plot2d(s2,q2);
xgrid(3);
xtitle( 'Direct stress in the web', ' -s2- ', '- z -');
function[q3]=q34(s3),
    q3=(A*((Ixy*t*s3*s3)-(Iyy*t*h*s3)))+q23(h);
endfunction
s3=linspace(0,h/2,5*h);
q3=feval(s3,q34);
subplot(3,1,3)
plot2d(s3,q3);
xgrid(3);
xtitle( 'Direct stress in upper flange', ' -s3- ', '- z -');
datatipToggle();
printf("\nclick on the point to view its coordinate on the plot")
```

check Appendix AP 36 for dependency:

`17_2data.sci`

Scilab code Exa 17.2 Example 2

```
pathname=get_absolute_file_path('17_2.sce')
filename=pathname+filesep()+'17_2data.sci'
exec(filename)
Es=(3*b*b)/(h*(1+ 6*b/h));
printf("\n  s : %f mm",Es);
```

check Appendix AP 35 for dependency:

17_3data.sci

Scilab code Exa 17.3 Example 3

```
pathname=get_absolute_file_path('17_3.sce')
filename=pathname+filesep()+'17_3data.sci'
exec(filename)
Es=-3.35*a;
printf("\n s: %f mm",Es);
```

Chapter 18

Torsion of beams

check Appendix AP 34 for dependency:

```
18_1data.sci
```

Scilab code Exa 18.1 Example 1

```
pathname=get_absolute_file_path('18_1.sce')
filename=pathname+filesep()+'18_1data.sci'
exec(filename)
clear all
A=%pi*d*d/4;
tmin1=Tmax/(2*A*Smax);
tmin2= (Tmax*%pi*d*0.5*L)/(4*A*A*G*angle);
if(tmin1<tmin2) then
    printf("\nminimum allowable thickness is: %f mm"
        ,tmin2);
else
    printf("\nminimum allowable thickness is: %f mm"
        ,tmin1);
end
```

check Appendix AP 33 for dependency:

```
18_2data.sci
```

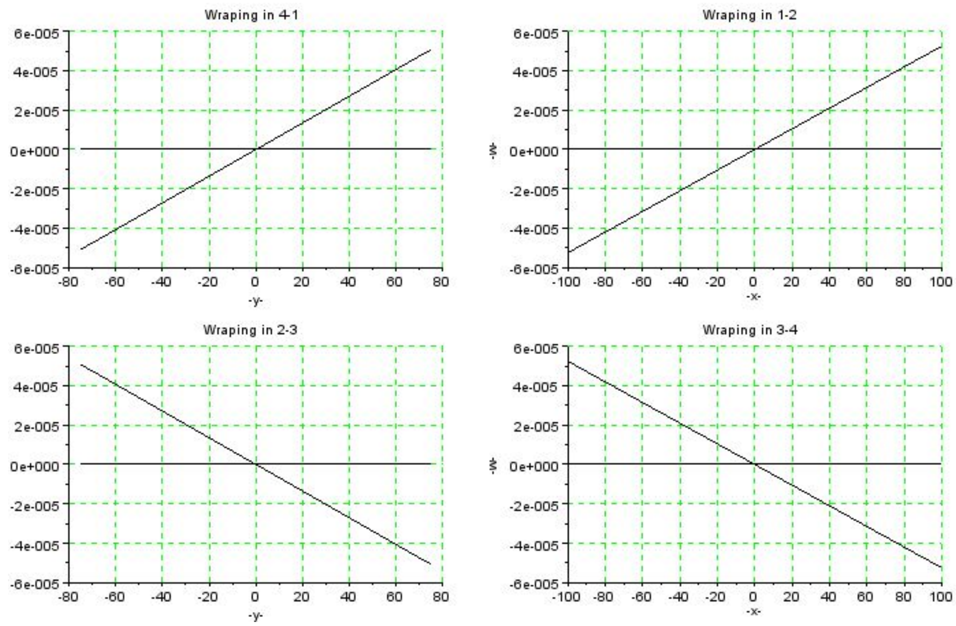

Figure 18.1: Example 2

Scilab code Exa 18.2 Example 2

```
pathname=get_absolute_file_path('18_2.sce')
filename=pathname+filesep()+'18_2data.sci'
exec(filename)
clear all
del=2*((b/tb)+(a/ta));//
A=a*b;
deff("[W41]=f(s1)","W41=(T/(2*A*G))*((s1/tb)+(del*a*
    s1/(4*A)))");
deff("[W12]=f1(s2)","W12=(T/(2*A*G))*((s2/ta)+(del*b
    *s2/(4*A)))");
```

```
deff("[W23]=f2(s1)","W23=-((T/(2*A*G))*((s1/tb)+(del
   *a*s1/(4*A))))");
deff("[W34]=f3(s2)","W34=-((T/(2*A*G))*((s2/ta)+(del
   *b*s2/(4*A))))");
deff("[Sz]=f4(s1)","Sz=0*s1");
deff("[Sz1]=f5(s2)","Sz1=0*s2");
funcprot(0);
s1=[-b/2:0.05:b/2];
s2=[-a/2:0.05:a/2];
subplot(2,2,1)
fplot2d(s1,f)
fplot2d(s1,f4)
xgrid(3);
xtitle( 'Wraping in 4-1', ' -y- ', '-w-');
subplot(2,2,2)
fplot2d(s2,f1)
fplot2d(s2,f5)
xgrid(3);
xtitle( 'Wraping in 1-2', ' -x- ', '-w-');
subplot(2,2,3)
fplot2d(s1,f2)
fplot2d(s1,f4)
xgrid(3);
xtitle( 'Wraping in 2-3', ' -y- ', '-w-');
subplot(2,2,4)
fplot2d(s2,f3)
fplot2d(s2,f5)
xgrid(3);
xtitle( 'Wraping in 3-4', ' -x- ', '-w-');
datatipToggle();
printf("\nclick on the point on the plot to view its
    coordinates")
```

check Appendix AP 32 for dependency:

`18_3data.sci`

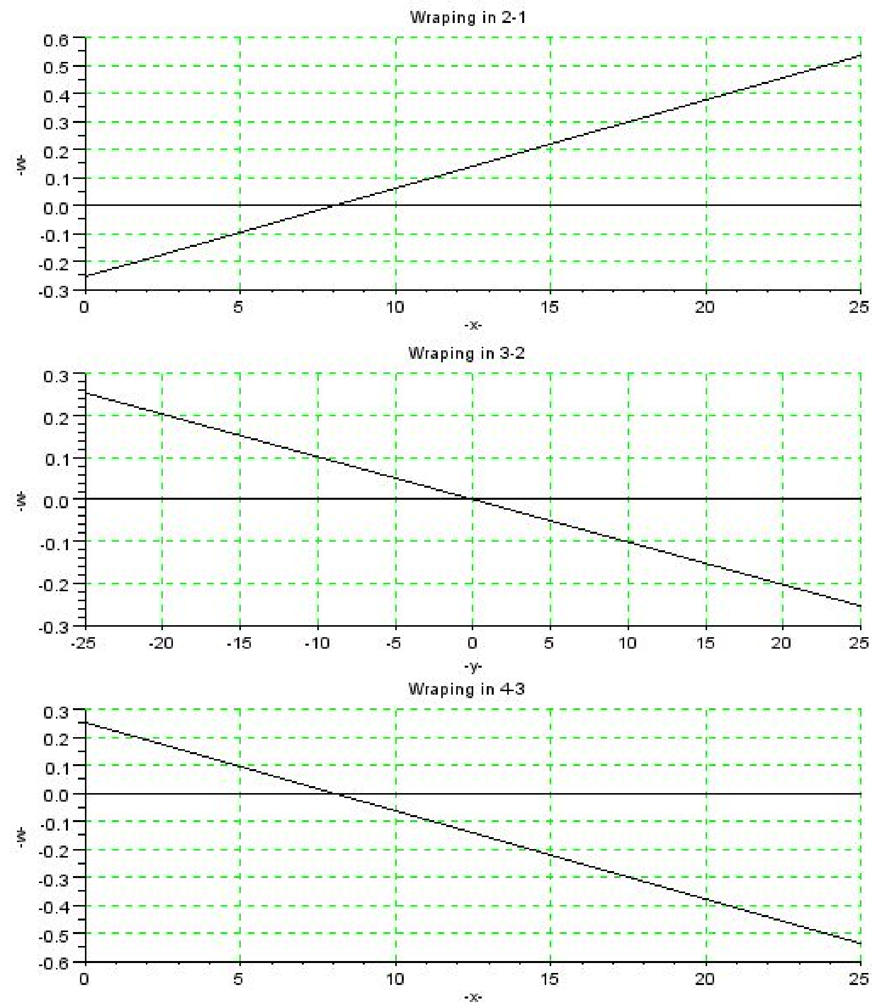

Figure 18.2: Example 3

Scilab code Exa 18.3 Example 3

```
pathname=get_absolute_file_path('18_3.sce')
filename=pathname+filesep()+'18_3data.sci'
exec(filename)
clear all
J=(2*a*ty^3 + b*tx^3)/3;
if(tx>ty) then
    tmax=tx*T/J;
else
    tmax=ty*T/J;
end
printf("\nmaximum shear stress: %f N/mm^2",tmax);
Ixx=a*ty*b*b/2 +(tx*b^3)/12;
Es=(ty*(a*b)^2)/(4*Ixx);
deff("[W32]=f(s1)","W32=-2*(T/(J*G))*(0.5*Es*s1)");
deff("[W21]=f1(s2)","W21=-2*(T/(J*G))*(0.5*Es*a
    -0.5*a*s2)");
deff("[W43]=f2(s2)","W43=2*(T/(J*G))*(0.5*Es*a -0.5*
    a*s2)");
deff("[Sz]=f3(s1)","Sz=0*s1");
deff("[Sz1]=f4(s2)","Sz1=0*s2");
s1=[-b/2:0.05:b/2];
s2=[0:0.05:a];
subplot(3,1,1)
fplot2d(s2,f1)
fplot2d(s2,f4)
xgrid(3);
xtitle( 'Wraping in 2-1', ' -x- ', '-w-');
subplot(3,1,2)
fplot2d(s1,f)
fplot2d(s1,f3)
xgrid(3);
xtitle( 'Wraping in 3-2', ' -y- ', '-w-');
```

```
subplot(3,1,3)
fplot2d(s2,f2)
fplot2d(s2,f4)
xgrid(3);
xtitle( 'Wraping in 4-3', ' -x- ', '-w-');
datatipToggle();
printf("\nclick on the point on the plot to view its
    coordinates")
```

Chapter 19

Combined open and closed section beams

check Appendix AP 31 for dependency:

19_1data.sci

Scilab code Exa 19.1 Example 1

```
pathname=get_absolute_file_path('19_1.sce')
filename=pathname+filesep()+'19_1data.sci'
exec(filename)
clear all
Yc=(2*L45^2 +L12^2)/(4*L12 +4*L45);
Ixx=((2*L12 +L45)*t*Yc^2) +(L45*t*(L45-Yc)^2)+ (2*t
   /3)*((2*Yc^3) -((Yc-L45)^3) -((Yc-L12)^3));
P=-Sy/Ixx;
function[q1]=q12(s1),
    q1=P*t*(Yc-L12)*s1 +P*t*0.5*s1^2;
endfunction
s1=linspace(0,L12,10*L12);
q1=feval(s1,q12);
```

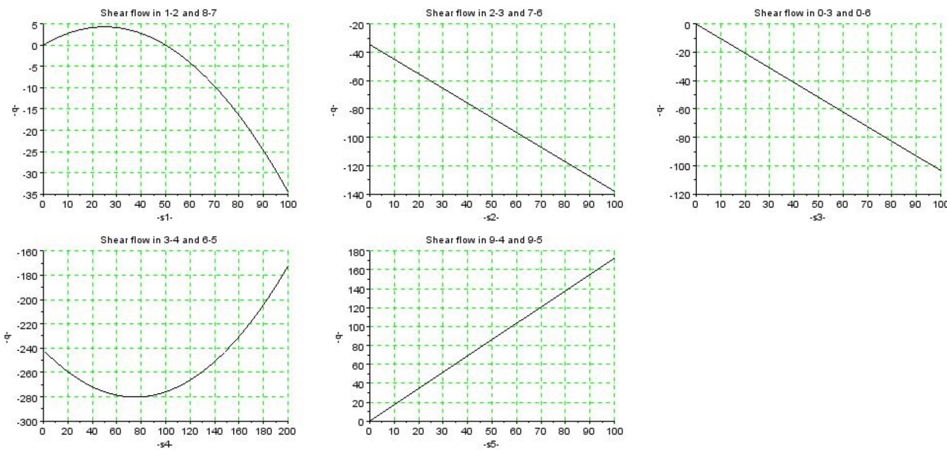

Figure 19.1: Example 1

```
subplot(2,3,1)
plot2d(s1,q1)
xgrid(3);
xtitle( 'Shear flow in 1-2 and 8-7', ' -s1- ', '-q-');
function[q2]=q23(s2),
    q2= P*t*Yc*s2+q12(L12);
endfunction
s2=linspace(0,L12,10*L12);
q2=feval(s2,q23);
subplot(2,3,2)
plot2d(s2,q2)
xgrid(3);
xtitle( 'Shear flow in 2-3 and 7-6', ' -s2- ', '-q-');
function[q3]=q03(s3),
    q3=P*t*Yc*s3;
endfunction
s3=linspace(0,L45/2,5*L45);
q3=feval(s3,q03);
subplot(2,3,3)
plot2d(s3,q3)
xgrid(3);
```

```
xtitle( 'Shear flow in 0−3 and 0−6', ' −s3− ', '−q−'
   );
function[q4]=q34(s4),
    q4=(P*t*Yc*s4 -0.5*P*t*s4^2)+q03(L45/2)+q23(L12)
       ;
endfunction
s4=linspace(0,L45,10*L45);
q4=feval(s4,q34);
subplot(2,3,4)
plot2d(s4,q4)
xgrid(3);
xtitle( 'Shear flow in 3−4 and 6−5', ' −s4− ', '−q−'
   );
function[q5]=q94(s5),
    q5=P*t*(Yc-L45)*s5;
endfunction
s5=linspace(0,L45/2,5*L45);
q5=feval(s5,q94);
subplot(2,3,5)
plot2d(s5,q5)
xgrid(3);
xtitle( 'Shear flow in 9−4 and 9−5', ' −s5− ', '−q−'
   );
datatipToggle();
printf("\nclick on the point on the plot to view its
    coordinates");
```

check Appendix AP 30 for dependency:

`19_2data.sci`

Scilab code Exa 19.2 Example 2

```
pathname=get_absolute_file_path('19_2.sce')
filename=pathname+filesep()+'19_2data.sci'
exec(filename)
```

```
GJcl=((4*A*A*G*t12)/(L12+L34));
GJo=((L34+L13)*G*t^3)/3
GJ=GJcl+GJo;
Dtheta=T/GJ;
qcl=GJcl*Dtheta/(2*A);
tmaxcl=qcl/t12;
tmaxo=G*t13*Dtheta;
printf("\n max,cl: %f N/mm^2",tmaxcl);
printf("\n max,op: %f N/mm^2",tmaxo);
```

Chapter 20

Structural idealization

check Appendix AP 29 for dependency:

`20_1data.sci`

Scilab code Exa 20.1 Example 1

```
pathname=get_absolute_file_path('20_1.sce')
filename=pathname+filesep()+'20_1data.sci'
exec(filename)
L25=(L16*L12+L34*L23)/(L12+L23);
B1=A+ (t16*L16/6) +(t12*L12/6)*(2+(L25/L16));
B6=B1;
B2= 2*A + (t12*L12/6)*(2+(L16/L25))+(t25*L25/6) +(
    t23*L23/6)*(2+(L34/L25));
B5=B2;
B3=A + (t23*L23/6)*(2+(L25/L34)) + (t34*L34/6);
B4=B3;
printf("\nB1 = B6 = %f mm^2",B1);
printf("\nB2 = B5 = %f mm^2",B2);
printf("\nB3 = B4 = %f mm^2",B3)
```

check Appendix AP 28 for dependency:

`20_2data.sci`

Scilab code Exa 20.2 Example 2

```
pathname=get_absolute_file_path('20_2.sce')
filename=pathname+filesep()+'20_2data.sci'
exec(filename)
clear all
Yc=(2*(B'*D) -B(1,:)*D(1,:))/((2*sum(B))-(B(1,:)+B
    (9,:)));
Y=D-Yc*ones(9,1);
for i=1:9
    Ixx(i)=B(i)*(Y(i))^2;
end
P=2*sum(Ixx)-Ixx(1)-Ixx(9);
for i=1:9
    Sz(i)=(Mx/P)*Y(i);//  z
end
printf("\n  z :  %f N/mm^2",Sz);
```

check Appendix AP 27 for dependency:

`20_3data.sci`

Scilab code Exa 20.3 Example 3

```
pathname=get_absolute_file_path('20_3.sce')
filename=pathname+filesep()+'20_3data.sci'
exec(filename)
clear all
Ixx=4*A*L^2;
B=[A;A;A;A];
Y=[L;L;-L;-L];
q(1)=(-Sy/Ixx)*B(1)*Y(1);
```

```
for i=2:4
    q(i)=((-Sy/Ixx)*B(i)*Y(i)) +q(i-1);
end
printf("\nq12: %f N/mm",q(1));
printf("\nq23: %f N/mm",q(2));
printf("\nq34: %f N/mm",q(3));
```

check Appendix AP 26 for dependency:

`20_4data.sci`

Scilab code Exa 20.4 Example 4

```
pathname=get_absolute_file_path('20_4.sce')
filename=pathname+filesep()+'20_4data.sci'
exec(filename)
clear all
for i=1:8
    I(i)=B(i)*y(i)*y(i);
end
Ixx=sum(I);
P=(-Sy/Ixx);
qb1(1)=0,qb2(1)=0;
for i=2:3
    qb1(i)=P*B(i+1)*y(i+1) +qb1(i-1);
    qb2(i)=(P*B(i+5)*y(i+5) +qb2(i-1));
end
qb1(4)=qb1(2);
qb2(4)=qb2(2);
qb=[qb1;-qb2];
A= (y(1)+y(2))*x(3) +(y(2)+y(3))*x(2) +(y(3)+y(4))*x(1);
qs0=(qb(7)*(x(2)+x(3))*(2*y(1)) +2*qb(6)*(x(3)*y(2)+x(3)*(y(2)-y(1))) + 2*qb(1)*x(2)*y(3) -2*qb(2)*x(1)*y(3) -qb(3)*2*y(4)*x(1))/(2*A);
q=[qb1+qs0*ones(4,1);qb2+qs0*ones(4,1);];
```

```
disp("shear flow(in order q23,q34,q45,q56,q67,q12,
    q78,q81)");
printf("\n q: %f N/mm",q)
```

Chapter 21

Wing spars and box beams

check Appendix AP 25 for dependency:

```
21_1data.sci
```

Scilab code Exa 21.1 Example 1

```
pathname=get_absolute_file_path('21_1.sce')
filename=pathname+filesep()+'21_1data.sci'
exec(filename)
Mx=-Sy*L1;//moment at section AA
Wa=(We*(L-L1)+ W*L1)/L;//width of section AA
Ixx=2*A*(Wa/2)^2 + (1/12)*t*Wa^3;
Sz1=Mx*(Wa/2)/Ixx;
Pz1=Sz1*A;
Syz=Sy +Pz1*((W-We)/L);
deff("[q12]=f(s)","q12=(-Syz/Ixx)*((-s^2 +Wa*s) +(A*
    Wa/2))");
s=[0:0.01:Wa];
fplot2d(s,f);
xgrid(3)
xtitle('shear flow','-s-','-q12-');
```

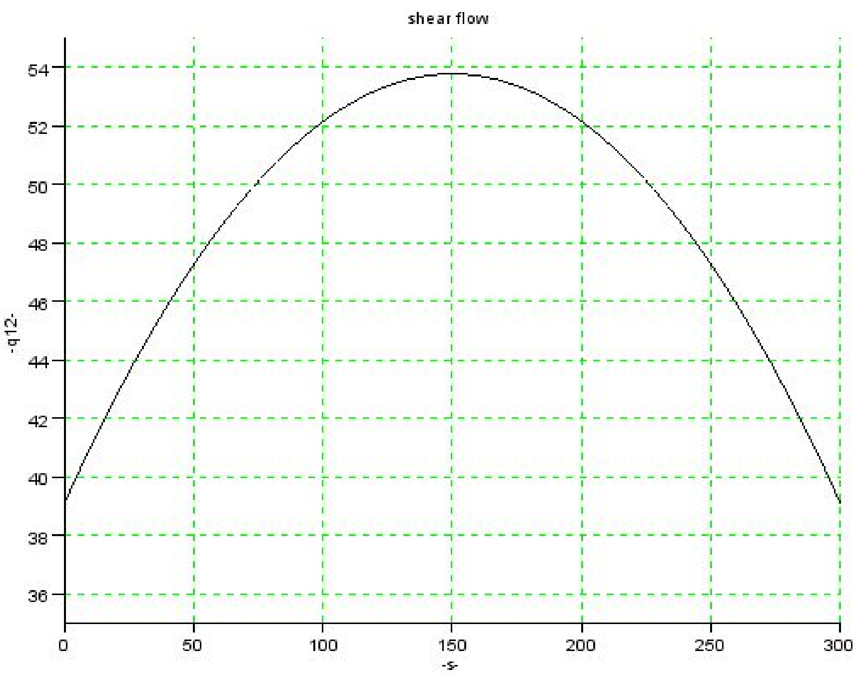

Figure 21.1: Example 1

```
datatipToggle();
```

check Appendix AP 24 for dependency:

21_2data.sci

Scilab code Exa 21.2 Example 2

```
pathname=get_absolute_file_path('21_2.sce')
filename=pathname+filesep()+'21_2data.sci'
exec(filename)
clear all
Mx=-Sy*(L-Lc);//moment at section
L3=(L1*(L-Lc)+ L2*Lc)/L;//leangth of CS
B3=(B1*(L-Lc)+ B2*Lc)/L;//breadth of CS
Ixx=4*Aco*(B3/2)^2 + 2*Ace*(B3/2)^2;
B=[Aco;Ace;Aco;Aco;Ace;Aco];
Y=[B3/2;B3/2;B3/2;-B3/2;-B3/2;-B3/2];
Dxr=[(L1-L2)/(2*L);0;-(L1-L2)/(2*L);-(L1-L2)/(2*L)
    ;0;(L1-L2)/(2*L)];
Dyr=[-(B1-B2)/(2*L);-(B1-B2)/(2*L);-(B1-B2)/(2*L);(
    B1-B2)/(2*L);(B1-B2)/(2*L);(B1-B2)/(2*L)];
for i=1:6
    Pz(i)=(Mx/Ixx)*Y(i)*B(i);
    Px(i)=Pz(i)*Dxr(i);
    Py(i)=Pz(i)*Dyr(i);
    P(i)=(((Px(i))^2 +(Py(i))^2 +(Pz(i))^2)^0.5)*((
        abs(Pz(i)))/Pz(i));
end
Syw=Sy-sum(Py);
qb(1)=0
for i=2:4
    qb(i)=qb(i-1)+(-Syw/Ixx)*B(i-1)*Y(i-1);
end
qb(5)= qb(3);
qb(6)= qb(2);
```

```
qs0=((-Sy*L3/2)+(qb(2)*L3*B3*0.5 +qb(3)*L3*B3*0.5 +
   qb(4)*B3*L3*0.5))/(2*L3*B3);
q=-qb+qs0*ones(6,1);
disp(q,"shear flow (61,12,23,34,45,56)")
```

check Appendix AP 23 for dependency:

`21_3data.sci`

Scilab code Exa 21.3 Example 3

```
pathname=get_absolute_file_path('21_3.sce')
filename=pathname+filesep()+'21_3data.sci'
exec(filename)
clear all
Lc1=Lc+ 0.1*10^3,Lc2=Lc- 0.1*10^3;
Mx1=-Sy*(L-Lc1);//moment at section1
L31=(L1*(L-Lc1)+ L2*Lc1)/L;//leangth of CS1
B31=(B1*(L-Lc1)+ B2*Lc1)/L;//breadth of CS1
Mx2=-Sy*(L-Lc2);//moment at section2
L32=(L1*(L-Lc2)+ L2*Lc2)/L;//leangth of CS2
B32=(B1*(L-Lc2)+ B2*Lc2)/L;//breadth of CS2
L3=(L31+L32)/2;
B3=(B31+B32)/2;
Ixx1=4*Aco*(B31/2)^2 + 2*Ace*(B31/2)^2;
Ixx2=4*Aco*(B32/2)^2 + 2*Ace*(B32/2)^2;
B=[Aco;Ace;Aco;Aco;Ace;Aco];
Y1=[B31/2;B31/2;B31/2;-B31/2;-B31/2;-B31/2];
Y2=[B32/2;B32/2;B32/2;-B32/2;-B32/2;-B32/2];
Dxr=[(L1-L2)/(2*L);0;-(L1-L2)/(2*L);-(L1-L2)/(2*L)
   ;0;(L1-L2)/(2*L)];
Dyr=[-(B1-B2)/(2*L);-(B1-B2)/(2*L);-(B1-B2)/(2*L);(
   B1-B2)/(2*L);(B1-B2)/(2*L);(B1-B2)/(2*L)];
for i=1:6
    Pz1(i)=(Mx1/Ixx1)*Y1(i)*B(i);
    Px1(i)=Pz1(i)*Dxr(i);
```

```
    Py1(i)=Pz1(i)*Dyr(i);
    P1(i)=(((Px1(i))^2 +(Py1(i))^2 +(Pz1(i))^2)^0.5)
        *((abs(Pz1(i)))/Pz1(i));
    Pz2(i)=(Mx2/Ixx2)*Y2(i)*B(i);
    Px2(i)=Pz2(i)*Dxr(i);
    Py2(i)=Pz2(i)*Dyr(i);
    P2(i)=(((Px2(i))^2 +(Py2(i))^2 +(Pz2(i))^2)^0.5)
        *((abs(Pz2(i)))/Pz2(i));
end
delP=(P1-P2)/200;
q12=(Sy*L3*0.5 +delP(2)*2*L3*B3*0.25 +(delP(2)+delP
    (3))*L3*B3*0.5 +delP(6)*L3*B3*0.5)/(2*L3*B3*0.25
    +2*L3*B3*0.25 +L3*B3*0.5 +L3*B3*0.5);
q23=q12-delP(2);
q34=q12-(delP(2)+delP(3));
q45=q12-(delP(2)+delP(3)+delP(4));
q56=q12;
q61=q12-delP(6);
q=[q12;q23;q34;q45;q56;q61];
disp("Shear flow(q12;q23;q34;q45;q56;q61):");
printf("\n %f N/mm",q);
```

Chapter 22

Fuselages

check Appendix AP 22 for dependency:

22_1data.sci

Scilab code Exa 22.1 Example 1

```
pathname=get_absolute_file_path('22_1.sce')
filename=pathname+filesep()+'22_1data.sci'
exec(filename)
b=(2*%pi*r)/16;
for i=1:16
    angle(i)=(2*%pi/16)*(i-1);
    y(i)=r*cos(angle(i));
end
B1=A+ 2*((t*b)/6)*(2 +y(2)/y(1));
for i=1:16
    B(i)=B1;
    I(i)=B(i)*y(i)*y(i);
end
Ixx=sum(I);
for i=1:16
    Sz(i)=(Mx*y(i))/Ixx;
    printf("\n z%f =",i);
```

```
    printf(" %f N/mm^2",Sz(i))
end
```

check Appendix AP 21 for dependency:

22_2data.sci

Scilab code Exa 22.2 Example 2

```
pathname=get_absolute_file_path('22_2.sce')
filename=pathname+filesep()+'22_2data.sci'
exec(filename)
b=(2*%pi*r)/16;
for i=1:16
    angle(i)=(2*%pi/16)*(i-1);
    y(i)=r*cos(angle(i));
end
B1=A+ 2*((t*b)/6)*(2 +y(2)/y(1));
for i=1:16
    B(i)=B1;
    I(i)=B(i)*y(i)*y(i);
end
Ixx=sum(I);
qs(1)=0;
qs(8)=qs(1);
for i=2:5
    qs(i)=((-Sy*B(i)*y(i))/Ixx)+qs(i-1);
    qs(9-i)=qs(i);
end
qs1(1)=((-Sy*B(1)*y(1))/Ixx);
qs1(8)=qs1(1);
for i=2:5
    qs1(i)=((-Sy*B(18-i)*y(18-i))/Ixx)+qs1(i-1);
    qs1(9-i)=qs1(i);
end
Ac=%pi*r*r/16;
```

```
qs0=-(((Sy*d)-2*Ac*(sum(qs1)-sum(qs)))/(2*Ac*16));
Q=[qs;-qs1];
for i=1:16
    q(i)=Q(i)+qs0;
    printf("\nq: %f N/mm",q(i))
end
```

Chapter 23

Wings

check Appendix AP 20 for dependency:

`23_1data.sci`

Scilab code Exa 23.1 Example 1

```
pathname=get_absolute_file_path('23_1.sce')
filename=pathname+filesep()+'23_1data.sci'
exec(filename)
clear all
for i=1:6
    I(i)=B(i)*y(i)*y(i);
end
Ixx=sum(I);
for i=1:6
    S(i)=(Mx/Ixx)*y(i);
end
printf("\n z : %f N/mm^2",S);
```

check Appendix AP 19 for dependency:

`23_2data.sci`

Scilab code Exa 23.2 Example 2

```
pathname=get_absolute_file_path('23_2.sce')
filename=pathname+filesep()+'23_2data.sci'
exec(filename)
clear all
for i=1:8
    ts(i)=(G(i)*t(i))/Gref;
    del(i)=L(i)/ts(i);
end
P=[(((del(1)+del(2))/A(1))+(del(2)/A(2))) -((del(2)/
   A(1))+((del(2)+del(3)+del(4)+del(5))/A(2))) (del
   (5)/A(2));
   ((del(1)+del(2))/A(1))  ((del(5)/A(3))-(del(2)/A
      (1)))  (-(del(5)+del(6)+del(7)+del(8))/A(3));
   2*A(1)  2*A(2)  2*A(3)];
X=[0;0;T]
q=inv(P)*X;
disp("shear flows are");
printf("\nqI: %f N/mm",q(1,:));
printf("\nqII: %f N/mm",q(2,:));
printf("\nqIII: %f N/mm\n",q(3,:));
disp("shear stress distribution is(in order 12o,12i
   ,13,24,34,35,46,56)");
X1=[q(1,:)/t(1);(q(1,:)-q(2,:))/t(2);q(2,:)/t(3);q
   (2,:)/t(4);(q(2,:)-q(3,:))/t(5);
    q(3,:)/t(6);q(3,:)/t(7);q(3,:)/t(8)]
printf("\n %f N/mm^2",X1)
```

check Appendix AP 18 for dependency:

23_3data.sci

Scilab code Exa 23.3 Example 3

```
pathname=get_absolute_file_path('23_3.sce')
```

```
filename=pathname+filesep()+'23_3data.sci'
exec(filename)
clear all
for i=1:10
    ts(i)=t(i)*G(i)/Gref;
    del(i)=L(i)/ts(i);
end
for i=1:6
    I(i)=B(i)*y(i)*y(i);
end
Ixx=sum(I);
for i=1:6
    q1(i)=(-Sy/Ixx)*B(i)*y(i);
end
q=[q1(2);q1(1);0;q1(5);q1(3);q1(4)]
P=[(((del(4)+del(5)+del(6))/A(1))+(del(6)/A(2)))
   -(((del(3)+del(6)+del(10)+del(8))/A(2))+(del(6)/A
   (1))) del(8)/A(2);
   ((del(4)+del(5)+del(6))/A(1)) -(((-del(8))/A(3))
      +(del(6)/A(1))) (-((del(2)+del(8)+del(7)+del
      (1)+del(9))/A(3)));
   2*A(1) 2*A(2) 2*A(3)]
X=[-((q(6)*del(5) +q(6)*del(6))/A(1))+((q(4)*del(8)
   +q(5)*del(6))/A(2));
   -((q(6)*del(5) +q(6)*del(6))/A(1))+((-q(2)*del(9)
       +q(1)*del(8)+q(1)*del(7))/A(3));
   -q(5)*L(10)*L(5)-q(5)*L(10)*L(6)+q(2)*L(1)*L(9)];
X1=inv(P)*X;
X2=[X1(1,:);X1(2,:);X1(2,:);X1(3,:);X1(3,:);-q(2)+X1
   (3,:);q(4)-X1(3,:);q(4)-X1(1,:);q(6)+X1(1,:);-q
   (5)-X1(1,:)];
dth=(1/(2*Gref))*((((del(4)+del(5)+del(6))/A(1))*X1
   (1,:))-(del(6)/A(1))*X1(2,:)+((q(6)*del(5) +q(6)*
   del(6))/A(1)));
printf("\n d /dz: %f rad/mm\n",dth);
disp("shear flow distribution is(in order q34,q23,
   q87,q12,q56,q61,q57,q72,q48,q83)");
printf("\n %f N/mm",X2)
```

check Appendix AP 17 for dependency:

23_4data.sci

Scilab code Exa 23.4 Example 4

```
pathname=get_absolute_file_path('23_4.sce')
filename=pathname+filesep()+'23_4data.sci'
exec(filename)
clear all
y1=0.5*[W1;W1;W1;-W1;-W1;-W1];
y2=0.5*[W2;W2;W2;-W2;-W2;-W2];
x1=[0;L12;L12+L11;L12+L11;L12;0];
x2=[0;L22;L22+L21;L22+L21;L22;0];
Li=[L12;L11;W1;L11;L12;W1;W1];
for i=1:6;
    I1(i)=B(i)*y1(i)*y1(i);
    del(i)=Li(i)/t(3);
end
del(7)=Li(7)/t(3);
Ixx=sum(I1);
dely=(y1-y2);
delx=(x1-x2);
epr=[L12;0;L11;L11;0;L12];
nr=abs(y1);
for i=1:6
    Pz(i)=(Mx/Ixx)*B(i)*y1(i);
    Py(i)=Pz(i)*dely(i)/L;
    Px(i)=Pz(i)*delx(i)/L;
    Pr(i)=((Px(i)^2 +Py(i)^2 +Pz(i)^2)^0.5)*(y1(i)/
       abs(y1(i)));
    Pxn(i)=-abs(Px(i)*nr(i));
    Pyep(i)=Py(i)*epr(i);
end
Pyep(6)=-Pyep(i);
```

```
Sxw=-sum(Px);
Syw=Sy-sum(Py);
qb=[0;0;(-Syw/Ixx)*(B(3)*y1(3));0;0;(-Syw/Ixx)*(B(6)*y1(6));(-Syw/Ixx)*B(5)*y1(5)];
qb1=0;
for i=1:7
    qb1=qb(i)*del(i) +qb1;
end
A1=L11*W1;
A2=L12*W1;
P=[((del(2)+del(3)+del(4)+del(7))/A1)+(del(7))/A2 -((del(7)/A1)+((del(1)+del(5)+del(6)+del(7))/A2));
   2*A1  2*A2];
X=[(qb1/(3*A1))+(qb1/(3*A2));-(qb(3)*W1*L12 +qb(6)*W1*L11)-sum(Pxn)+sum(Pyep)];
qs=inv(P)*X;
M1=-[qs(2);qs(1);qs(1);qs(1);qs(2);qs(2);qs(1)-qs(2)];
q=qb+M1;
disp("shear flow(q12;q23;q34;q45;q56;q61;q52):");
printf("\n %f N/mm",q)
```

check Appendix AP 16 for dependency:

`23_6data.sci`

Scilab code Exa 23.6 Example 6

```
pathname=get_absolute_file_path('23_6.sce')
filename=pathname+filesep()+'23_6data.sci'
exec(filename)
clear all
A=L1*B1;
```

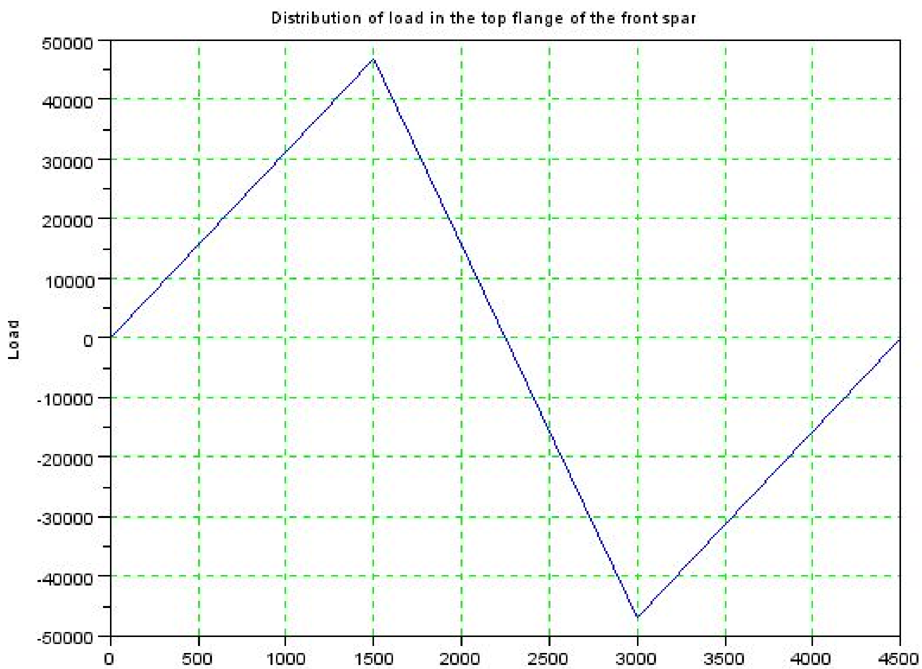

Figure 23.1: Example 6

```
q1=T/(2*A);
S=T/B1;
q1=S/L1;
P=S*(L/2)/L1;
X=[L -L;A A];
X1=[P;T];
q=[q1;inv(X)*X1];
X2=[0;L*q(2)-L*q(3);-L*q(2)+L*q(3);0];
Y=[0;1500;3000;4500];
plot(Y,X2);
xgrid(3);
xtitle('Distribution of load in the top flange of
   the front spar',' ','Load')
datatipToggle();
printf("\nq1: %f N/mm",q(1))
printf("\nq2: %f N/mm",q(2))
printf("\nq3: %f N/mm",q(3))
```

Chapter 24

Fuselage frames and wing ribs

check Appendix AP 15 for dependency:

```
24_1data.sci
```

Scilab code Exa 24.1 Example 1

```
pathname=get_absolute_file_path('24_1.sce')
filename=pathname+filesep()+'24_1data.sci'
exec(filename)
clear all
P=[GH -GH;DK KH],X=[L1*sin(theta);L1*cos(theta)];
q=inv(P)*X;
q(3)=L1*cos(theta)/(DK+KH);
q(4)=(L1*cos(theta)+L2)/(DK+KH);
PA=GH*q(1) +FG*q(3) +EF*q(4);
PE=-GH*q(2) -FG*q(3) -EF*q(4);
X1=[GH*q(1)+FG*q(3)+EF*q(4);GH*q(1)+FG*q(3);GH*q(1)
    ;0];
X2=[-GH*q(2)-FG*q(3)-EF*q(4);-GH*q(2)-FG*q(3);-GH*q
    (2);0];
Y=[0;EF;EF+FG;EF+FG+GH];
```

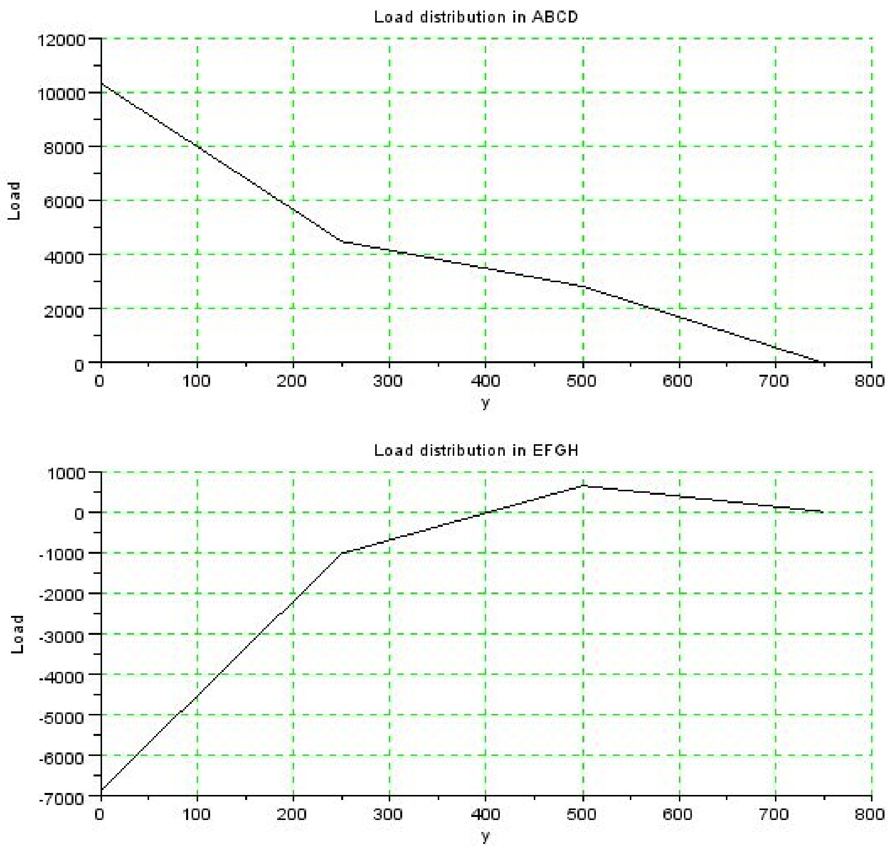

Figure 24.1: Example 1

```
subplot(2,1,1)
plot2d(Y,X1)
xgrid(3)
xtitle('Load distribution in ABCD','y','Load')
subplot(2,1,2)
plot2d(Y,X2)
xgrid(3)
xtitle('Load distribution in EFGH','y','Load')
datatipToggle();
printf("\nq1: %f N/mm",q(1));
printf("\nq2: %f N/mm",q(2));
printf("\nq3: %f N/mm",q(3));
printf("\nq4: %f N/mm",q(4));
printf("\nPA: %f N",PA);
printf("\nPE: %f N",PE);
printf("\nclick on the point to view its coordinate
    on the plot");
```

check Appendix AP 14 for dependency:

`24_2data.sci`

Scilab code Exa 24.2 Example 2

```
pathname=get_absolute_file_path('24_2.sce')
filename=pathname+filesep()+'24_2data.sci'
exec(filename)
clear all
P=[2*L11 -2*L11 0;0 -L11 L11;2*A2 2*(A1+A2) 0],X=[L1
    ;L2;440000];
q=inv(P)*X;
//actual X is X=[L1;L2;-L2*L11],it leads to wrong
    answers than book;
Sy1=-(q(2))*L11;
Px4= 2*A1*-(q(2))/L11;
Py2= Px4*tan(theta);
```

```
q1= (Sy1- 2*Py2)/L11;
P2= (Px4*Px4 +Py2*Py2)^0.5;
P5= 2*((A1+A22)*(-q(2)) - A21*q(1))/L12;
q2= ((-q(2))*L11 +(-q(2))*0.5*(L12-L11) -q(1)*0.5*(
    L12-L11))/L12;
q31= (q2*L12 +L2)/L12;
M3= 2*((A1+A2)*(-q(2)) -A2*q(1))+ L2*L11;
Px1=M3/L11;
Py1=Px1*tan(theta);
P1=(Px1*Px1+ Py1*Py1)^0.5;
q32=((L2+ L11*(-q(2))) -(2*Py1))/L11;
printf("\nq12: %f N/mm",q(1));
printf("\nq23: %f N/mm",q(2));
printf("\nq31: %f N/mm",q(3));
printf("\nP2= P4= %f N",P2);
printf("\nP5= P6= %f N",P5);
printf("\nP1= P3= %f N",P1);
printf("\nq1: %f N/mm",q1);
printf("\nq2: %f N/mm",q2);
printf("\nq3: %f N/mm",q31);
printf("\nshear flow q3 in the web: %f N/mm",q32)
```

Chapter 25

Laminated composites

check Appendix AP 13 for dependency:

```
25_1data.sci
```

Scilab code Exa 25.1 Example 1

```
pathname=get_absolute_file_path('25_1.sce')
filename=pathname+filesep()+'25_1data.sci'
exec(filename)
clear all
A=(L1*(Bc+Be1+Be2));
E1= ((Ec*L1*Bc)+(Ee*L1*(Be1+Be2)))/A;
S1=Load/A;
e1=S1/E1;
dell=e1*L;
v1= ((vc*L1*Bc)+(ve*L1*(Be1+Be2)))/A;
et=-e1*v1;
delt=-et*(Bc+Be1+Be2);
Se=e1*Ee;
Sc=e1*Ec;
printf("\nlengthening of the bar: %f mm",dell);
printf("\nreduction in thickness: %f mm",delt);
printf("\n m(epoxy):  %f N/mm^2",Se);
```

```
printf("\n f(carbon): %f N/mm^2",Sc);
```

check Appendix AP 12 for dependency:

`25_2data.sci`

Scilab code Exa 25.2 Example 2

```
pathname=get_absolute_file_path('25_2.sce')
filename=pathname+filesep()+'25_2data.sci'
exec(filename)
clear all
vtl=vlt*(Et/El);
e1=(S1/El)-(vtl*S2/Et);
e2=(S2/Et)-(vlt*S1/El);
gammalt=S3/Glt;// lt
printf("\n tl:%f ",vtl);
printf("\n l:%f ",e1);
printf("\n t:%f ",e2);
printf("\n lt:%f ",gammalt);
```

check Appendix AP 11 for dependency:

`25_3data.sci`

Scilab code Exa 25.3 Example 3

```
pathname=get_absolute_file_path('25_3.sce')
filename=pathname+filesep()+'25_3data.sci'
exec(filename)
clear all
s11=1/El;
s22=1/Et;
s12=-vlt/El;
```

```
s33=1/Glt;
m=cos(theta),n=sin(theta);
P=[(s11*m^4)+(s22*n^4)+(2*s12*m*m*n*n)+(s33*m*m*n*n)
     (m*m*n*n)*(s11+s22-s33)+(m^4 +n^4)*s12 0;
    (m*m*n*n)*(s11+s22-s33)+(m^4 +n^4)*s12 (s11*n^4)
       +(s22*m^4)+(2*s12*m*m*n*n)+(s33*m*m*n*n) 0;
    ((-n*m^3 +m*n^3)*(2*s12 +s33))-(2*s22*m*n^3)+(2*n
       *s11*m^3) ((n*m^3 -m*n^3)*(2*s12 +s33))+(2*s11
       *m*n^3)-(2*n*s22*m^3) 0];
X=[S1;S2;0];
E=P*X;
printf("\n x:  %f ",E(1));
printf("\n y: %f ",E(2));
printf("\n xy:%f ",E(3));
```

check Appendix AP 10 for dependency:

`25_4data.sci`

Scilab code Exa 25.4 Example 4

```
pathname=get_absolute_file_path('25_4.sce')
filename=pathname+filesep()+'25_4data.sci'
exec(filename)
clear all
X1=a*tb*Ez1;
X2=b*ta*Ez2;
ez=Load/(2*X1+X2);
P1=ez*X1;
P2=ez*X2;
printf("\nP(flanges) %f N",P1);
printf("\nP(web) %f N",P2);
```

check Appendix AP 9 for dependency:

`25_5data.sci`

Scilab code Exa 25.5 Example 5

```
pathname=get_absolute_file_path('25_5.sce')
filename=pathname+filesep()+'25_5data.sci'
exec(filename)
clear all
Ixx=(2*Ez1*a*tb*(b/2)^2) +(Ez2*ta*b^3)/12;
Iyy=(Ez1*tb*(2*a)^3)/12;
Ixy= Ez1*a*tb*a*(b/2) +Ez1*a*tb*(-a)*(-b/2);
P1=(-Mx*Ixy)/(Ixx*Iyy-Ixy*Ixy);
P2=(Mx*Iyy)/(Ixx*Iyy-Ixy*Ixy);
function[S1]=Sz1(x,y),//stress in flanges
    S1=Ez1*(P1*x+P2*y),
endfunction
function[S2]=Sz2(x,y),//stress in web
    S2=Ez2*(P1*x+P2*y),
endfunction
X=[Sz1(a,0.5*b);Sz1(0,0.5*b);Sz1(0,-0.5*b);Sz1(-a
    ,-0.5*b);Sz2(0,0.5*b);Sz2(0,-0.5*b)];
printf("\nmaximum direct stress in the beam cross-
    section is: %f N/mm^2",max(X));
```

check Appendix AP 8 for dependency:

`25_6data.sci`

Scilab code Exa 25.6 Example 6

```
pathname=get_absolute_file_path('25_6.sce')
filename=pathname+filesep()+'25_6data.sci'
```

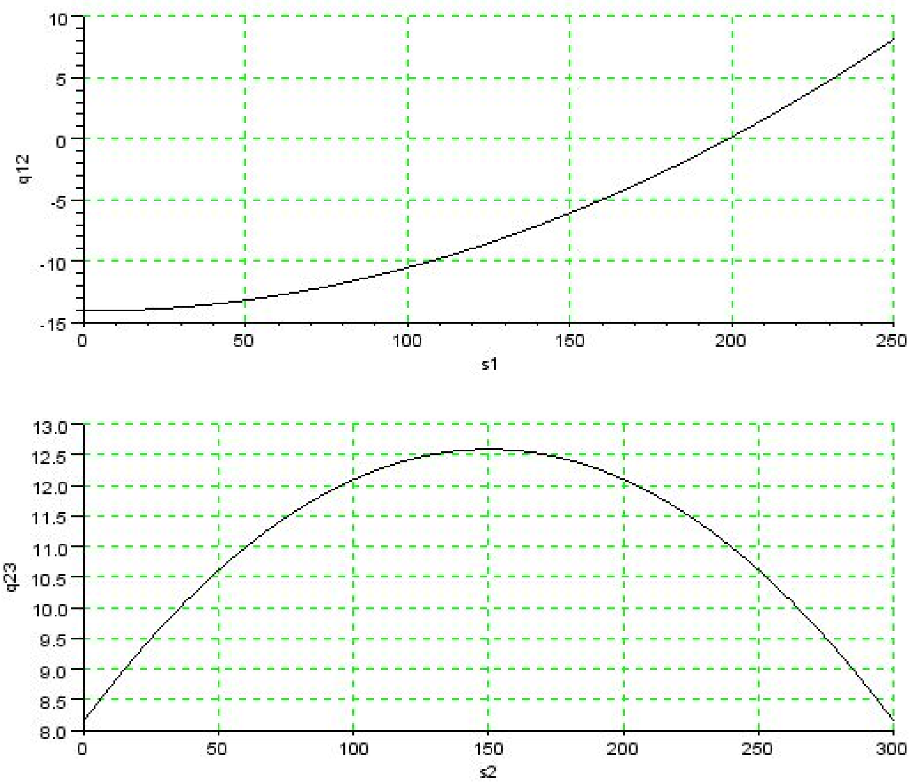

Figure 25.1: Example 6

```
exec(filename)
clear all
Ixx=((2*E12*t12*((L23/(2*L12))^2)*L12^3)+(E23*t23*
   L23^3))/12;
alpha=asin(L23*0.5/L12);
function[qb12]=qb12x(s1)
    qb12= 0.5*(t12*sin(alpha)*E12*Sy/Ixx)*s1^2;
endfunction
function[qb23]=qb23x(s2)
    qb23=((-E23*t23*Sy/Ixx)*(-0.5*L23*s2 +0.5*s2^2))
       +qb12x(L12);
endfunction
funcprot();
qs0=((Sy*L12)+(L23*L12*qb12x(L12)/3))/(L12*L23);
function[q12]=q12x(s1)
    q12=qb12x(s1)-qs0;
endfunction
function[q23]=q23x(s2)
    q23=qb23x(s2)-qs0;
endfunction
s1=linspace(0,L12,10*L12);
s2=linspace(0,L23,10*L23);
q12=feval(s1,q12x);
q23=feval(s2,q23x);
subplot(2,1,1)
plot2d(s1,q12);
xgrid(3)
xtitle('','s1','q12')
subplot(2,1,2)
plot2d(s2,q23);
xgrid(3)
xtitle('','s2','q23')
datatipToggle();
printf("\nclick on the point to view its coordinate
   on plot")
```

check Appendix AP 7 for dependency:

`25_7data.sci`

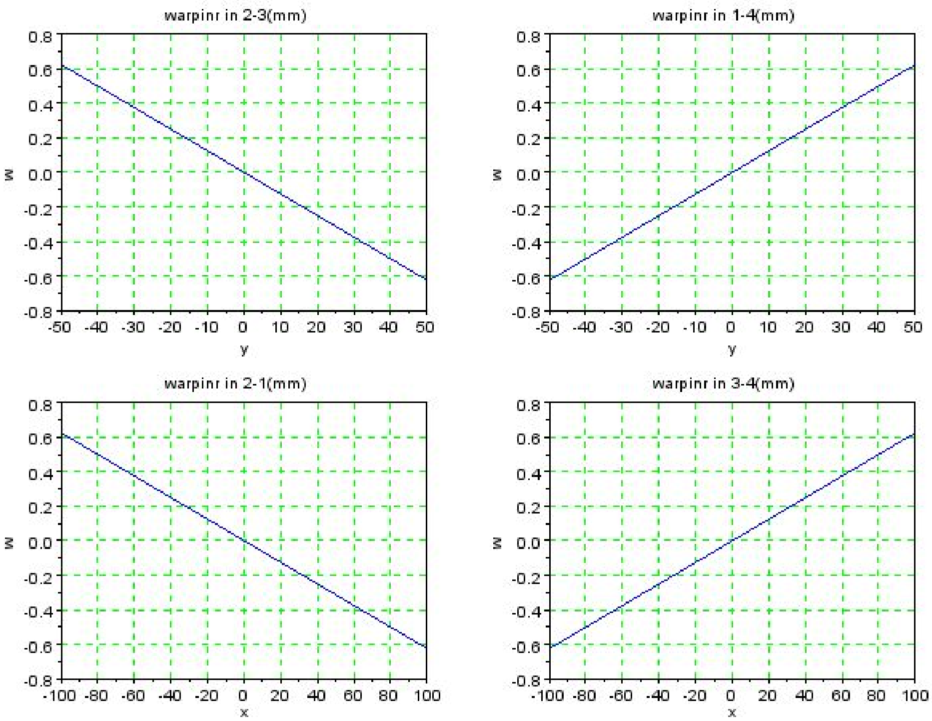

Figure 25.2: Example 7

Scilab code Exa 25.7 Example 7

```
pathname=get_absolute_file_path('25_7.sce')
filename=pathname+filesep()+'25_7data.sci'
exec(filename)
clear all
A=l*b;
q=T/(2*A);
P=(2*b/(t1*Gc))+(2*l/(t2*Gw));
w=q*((0.5*l/(Gw*t2))- 0.25*P);
```

```
X1=0.5*[l,-l],Y1=[w,-w];
X2=0.5*[l,-l],Y2=[-w,w];
X3=0.5*[b,-b],Y3=[w,-w];
X4=0.5*[b,-b],Y4=[-w,w];
subplot(2,2,1)
plot(X1,Y1),xgrid(3),xtitle('warpinr in 2-3(mm)','y','w')
subplot(2,2,2)
plot(X2,Y2),xgrid(3),xtitle('warpinr in 1-4(mm)','y','w')
subplot(2,2,3)
plot(X3,Y3),xgrid(3),xtitle('warpinr in 2-1(mm)','x','w')
subplot(2,2,4)
plot(X4,Y4),xgrid(3),xtitle('warpinr in 3-4(mm)','x','w')
datatipToggle();
printf("\nW1: %f mm",w);
printf("\nclick on the point to view its coordinate on plot")
```

check Appendix AP 6 for dependency:

`25_8data.sci`

Scilab code Exa 25.8 Example 8

```
pathname=get_absolute_file_path('25_8.sce')
filename=pathname+filesep()+'25_8data.sci'
exec(filename)
clear all
GJ=2*G1*a*(t1^3)/3 +G2*b*(t2^3)/3;
dtheta=T/GJ;
tmax12=2*G1*(t1/2)*dtheta;
```

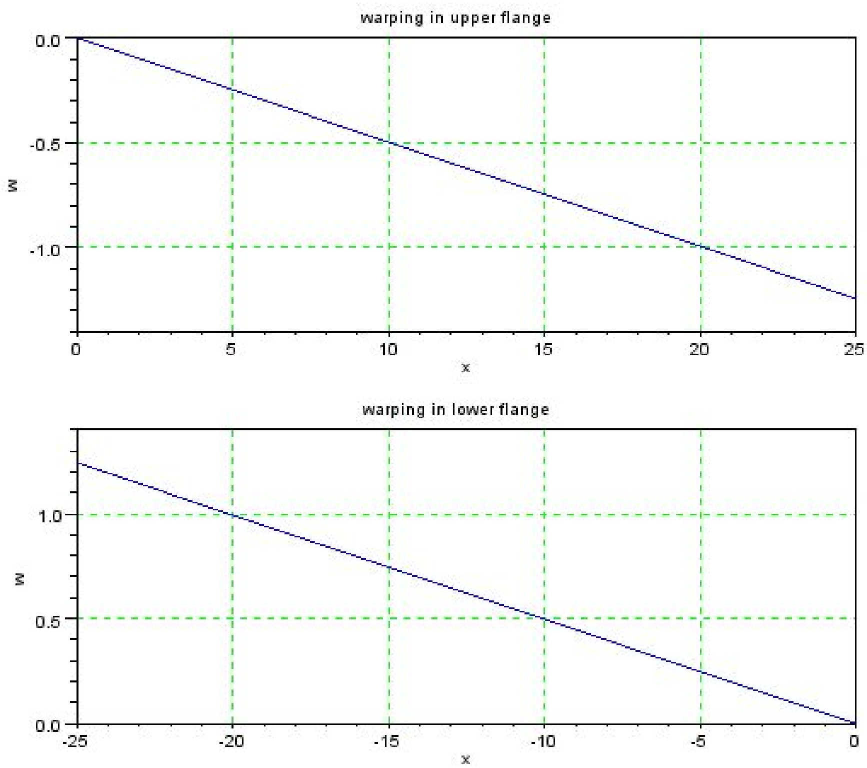

Figure 25.3: Example 8

```
tmax23=2*G2*(t2/2)*dtheta;
maximum=tmax23;
if(tmax12>tmax23) then
    maximum=tmax12;
end
printf("\nmaximum shear stress: %f N/mm^2",maximum);
w1=-2*(0.5*a*b/2)*dtheta;
printf("\nw1: %f mm",w1);
X=[0;a],Y=[0,w1],X1=-X,Y1=-Y;
subplot(2,1,1),plot(X,Y),xgrid(3),xtitle('warping in
    upper flange','x','w');
subplot(2,1,2),plot(X1,Y1),xgrid(3),xtitle('warping
   in lower flange','x','w');
datatipToggle();
printf("\nclick on the point to view its coordinate
   on plot");
```

Chapter 26

closed section beams

check Appendix AP 5 for dependency:

`26_1data.sci`

Scilab code Exa 26.1 Example 1

```
pathname=get_absolute_file_path('26_1.sce')
filename=pathname+filesep()+'26_1data.sci'
exec(filename)
clear all
L41=L23*cos(asin((L12-L34)/L23));
t41=t23;
C=[0;cos(asin((L12-L34)/L23));0;1];
S=[1;sin(asin((L12-L34)/L23));1;0];
P=[1 0 0 0 0 -t12*G 0;
    0 1 0 0 t23*G*cos(asin((L12-L34)/L23)) t23*G*sin(
        asin((L12-L34)/L23)) -t23*G*L12*cos(asin((L12-
        L34)/L23));
    0 0 1 0 0 t34*G -t34*G*L23*cos(asin((L12-L34)/L23
        ));
    0 0 0 1 -t41*G 0 0;
    0 1 0 -1 0 0 0;
    L12 -L23*sin(asin((L12-L34)/L23)) -L34 0 0 0 0;
```

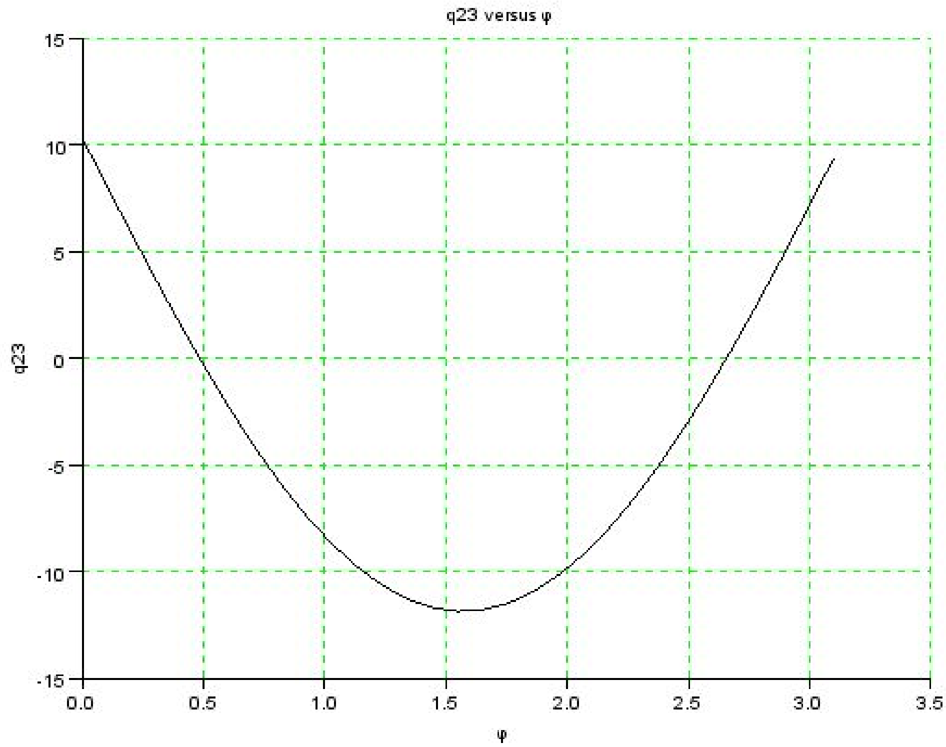

Figure 26.1: Example 2

```
    0 L23*L12*cos(asin((L12-L34)/L23)) L34*L23*cos(
        asin((L12-L34)/L23)) 0 0 0 0];
X=[0;0;0;0;0;Load;Load*x];
q=inv(P)*X;
printf("\n 12: %f N/mm^2",q(1)/t12);
printf("\n 23: %f N/mm^2",q(2)/t23);
printf("\n 34: %f N/mm^2",q(3)/t34);
printf("\n 41: %f N/mm^2",q(4)/t41);
```

check Appendix AP 4 for dependency:

`26_2data.sci`

Scilab code Exa 26.2 Example 2

```
pathname=get_absolute_file_path('26_2.sce')
filename=pathname+filesep()+'26_2data.sci'
exec(filename)
clear all
du=0;
P=[1 0 0 G*t*R;
   0 1 -G*t 2*R*G*t;
   0 0 1.79 -R
   0 0 -0.13 R];
X=[0;0;Load/(2*R*G*t);Load/((-0.5*%pi -6)*G*R*t)];
q=inv(P)*X;
printf("\nq12 = q34 = %f N/mm",q(1));
printf("\nq41= %f N/mm",q(2));
function[q23]=f(phi)
    q23=-R*G*t*q(4) -G*t*sin(phi)*q(3);
endfunction
phi=linspace(0,%pi,%pi*10);
q23=feval(phi,f);
plot2d(phi,q23);
xgrid(3),xtitle('q23 versus    ','   ','q23');
datatipToggle();
```

check Appendix AP 3 for dependency:

`26_3data.sci`

Scilab code Exa 26.3 Example 3

```
pathname=get_absolute_file_path('26_3.sce')
filename=pathname+filesep()+'26_3data.sci'
```

```
exec(filename)
clear all
Tr=T*L1/2;
mu=(8*G*t/(A*E*(b+a)))^0.5;
L=L1/2;
k1=((T*(b-a)*10^3)/(8*a*b*G*t));
k2=1/(mu*cosh(mu*L));
k3=((4*(b-a))/(a*b*(b+a)));
k4=(2*T*(10^3)/(a*b*G*t*(b+a)));
function[th]=f(z)
    w=(k1*((k2*sinh(mu*z))-z));
    F=((k1*k3 +k4)*L*L*0.5 -(k1*k2*k3/mu)*cosh(mu*L));
    th=(k1*k2*k3/mu)*cosh(mu*z) -(k1*k3 +k4)*z*z*0.5 + F;
endfunction
funcprot();
printf("\nangle of twist at mid-span   : %f rad",f(0));
```

check Appendix AP 2 for dependency:

26_4data.sci

Scilab code Exa 26.4 Example 4

```
pathname=get_absolute_file_path('26_4.sce')
filename=pathname+filesep()+'26_4data.sci'
exec(filename)
B=((a*t2)/6)+((b*t1)/18)*3;
A=((b*t1)/18)*6;
L1=Load/4;
x=L1/a;
d=b/3;
```

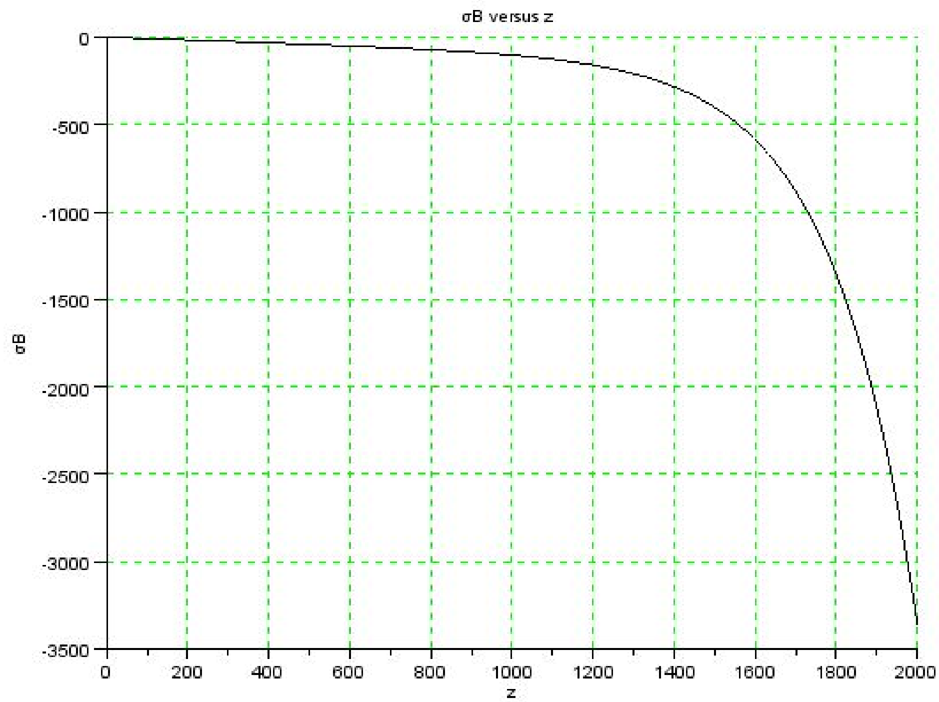

Figure 26.2: Example 4

```
E=1,G=GE;
mu=(((G*t1)/(d*E))*((A+B)/(A*B)))^0.5;
D=(-x*A)/((A+B)*mu*cosh(L*0.5*mu));
function [Sb]=f(z)
     Sb=((D/B)*sinh(mu*z)) -(x/(A+B))*z;
endfunction
funcprot()
z=linspace(0,L,10*L);
Sb=feval(z,f);
plot2d(z,Sb);
xgrid(3),xtitle(' B versus z','z',' B ');
datatipToggle()
printf("\nclick on the point to view its coordinate
   on the plot");
```

Chapter 27

Open section beams

check Appendix AP 1 for dependency:

```
27_2data.sci
```

Scilab code Exa 27.2 Example 2

```
pathname=get_absolute_file_path('27_2.sce')
filename=pathname+filesep()+'27_2data.sci'
exec(filename)
clear all
TR=((t*a^3 *b^2)*(2*b +a))/(12*(b+ 2*a));
J=(1/3)*(2*a +b)*t^3;
mu=((G*J)/(E*TR))^0.5;
Ar1=(-3/4)*(a*b/4);
Ar2=(1/4)*(a*b/4);
MT=P*2*Ar2;
X=-MT/(E*TR);
D=X/(mu*cosh(mu*L));
F=-D*cosh(0)/mu;
function [theta]=th(z)//
    theta=((D/mu)*cosh(mu*z))+F;
```

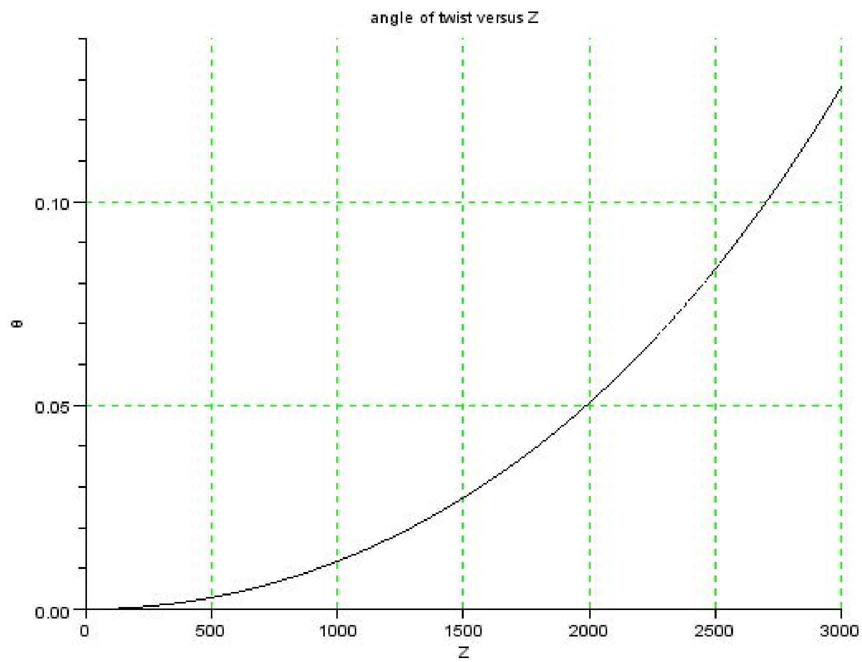

Figure 27.1: Example 2

```
endfunction
z=linspace(0,L,10*L);
theta=feval(z,th);
plot2d(z,theta);
xgrid(3)
xtitle('angle of twist versus Z','Z','  ')
datatipToggle();
printf("\n  (top): %f rad",th(L));
MT0=-E*TR*X/3;
A=(2*a +b)*t;
Sz1=(P/A)+(MT0/TR)*2*Ar1;//  z1
Sz2=(P/A)+(MT0/TR)*2*Ar2;//  z2
printf("\n z1=   z4= %f N/mm^2",Sz1)
printf("\n z3=   z2= %f N/mm^2",Sz2)
```

Appendix

Scilab code AP 1 Example 27.2 data

```
a=100;//cross section dimention,given,in mm
b=200;//cross section dimention,given,in mm
t=5;//thickness,given,in mm
L=3000;//length,given,in mm
E=200000;//given,in N/mm^2
G=0.36*200000;//given,in N/mm^2
P=-100*10^3;//load,given,in N
```

Scilab code AP 2 Example 26.4 data

```
t1=2;
t2=3;
a=100;
b=600;
L=2000;//length
Load=20*10^3;//given in N
GE=0.36;//  G/E
```

Scilab code AP 3 Example 26.3 data

```
L1=5000;//given,in mm
A=800;//booms area,given,in mm^2
G=20000;//given,in N/mm^2
E=G/0.36;//given
T=20;//torque loading,given,in N.m/mm
t=1;//wall thickness,given,in mm
```

```
a=500;
b=200;
```

Scilab code AP 4 Example 26.2 data

```
R=200;//given,in mm
Load=20000;//given,in N
G=70000;//in N/mm^2
t=2;//thickness in mm
```

Scilab code AP 5 Example 26.1 data

```
L12=375;//given,in mm
L23=500;//given,in mm
L34=125;//given,in mm
t12=1.6;//given,in mm
t23=1;//given,in mm
t34=1.2;//given,in mm
x=100;//given,in mm
Load=22000;//given,in mm
G=70000;//in N/mm^2
```

Scilab code AP 6 Example 25.8 data

```
T=10*10^3;//given,in N.mm
G1=20000;//laminate shear modulus of flanges,given,
    in N/mm^2
G2=15000;//laminate shear modulus of web,given,in N/
    mm^2
a=25;
b=50;
t1=1.5;
t2=2.5;
```

Scilab code AP 7 Example 25.7 data

```
T=10*10^6;//Torque,given,in N.mm
```

```
l=100;//given ,in mm
b=200;//given ,in mm
t1=2;//given ,in mm
t2=1;//given ,in mm
Gw=35000;//given ,in N/mm^2
Gc=20000;//given ,in N/mm^2
```

Scilab code AP 8 Example 25.6 data

```
E23=20000;//laminate Young s modulus of 23,given ,
    in N/mm^2
E12=45000;//laminate Young s modulus of 12,given ,
    in N/mm^2
L12=250;//langth of 12,given ,in mm
L23=300;//langth of 23,given ,in mm
t12=2;//thickness of 12,given ,in mm
t23=1.5;//thickness of 23,given ,in mm
Sy=2*10^3;//load
```

Scilab code AP 9 Example 25.5 data

```
a=50;//cross section dimension ,given ,in mm
b=100;//cross section dimension ,given ,in mm
ta=1;//thickness ,given ,in mm
tb=2;//thickness ,given ,in mm
Ez1=50000;// Young s modulus for the flange ,given ,
    in N/mm^2
Ez2=15000;// Young s modulus for the web,given ,in N
    /mm^2
Mx=1*10^6;
```

Scilab code AP 10 Example 25.4 data

```
a=100;
b=150;
ta=1;
tb=2;
```

```
Ez1=60000;
Ez2=20000;
Load=40*10^3;
```

Scilab code AP 11 Example 25.3 data

```
S1=60;//stress parallel to the x reference axis, given, in N/mm^2
S2=40;//stress perpendicular to the x reference axis, given, in N/mm^2
theta=45*(%pi/180);//given
El=150000;//given, in N/mm^2
Et=90000;//given, in N/mm^2
Glt=5000;//given, in N/mm^2
vlt=0.3;//given
```

Scilab code AP 12 Example 25.2 data

```
S1=50;//longitudnal direct stress, given, in N/mm^2
S2=25;//transverse direct stress, given, in N/mm^2
S3=40;//shear stress, given, in N/mm^2
El=120000;//given, in N/mm^2
Et=80000;//given, in N/mm^2
Glt=5000;//given, in N/mm^2
vlt=0.3;//given
```

Scilab code AP 13 Example 25.1 data

```
Ee=5000;//modulus of epoxy, given, in N/mm^2
Ec=200000;//modulus of carbon, given, in N/mm^2
ve=0.2;//poission's ratio of epoxy
vc=0.3;//poission's ratio of carbon
L=500;//langth of bar, given, in mm
L1=80;//langth of cross section , given, in mm
Be1=20;//width of first section of epoxy, given, in mm
Be2=20;//width of other section of epoxy, given, in mm
Bc=10;//width of section of carbon, given, in mm
Load=100*10^3;//axial tensile load, given, in N
```

Scilab code AP 14 Example 24.2 data

```
L11=300;
L12=320;
L1=12000;
L2=15000;
A1=50000;
A2=95000;
A21=49000;
A22=A2-A21;
theta=15*(%pi/180);
```

Scilab code AP 15 Example 24.1 data

```
GH=250;//given in mm
DK=200;//given in mm
KH=100;//given in mm
FG=250;//given in mm
EF=250;//given in mm
L1=4000;//given in N
L2=5000;//given in N
theta=60*(%pi/180);//given
```

Scilab code AP 16 Example 23.6 data

```
T=10*10^6;//given, in N.mm
L1=200;//Cross section dimention,given,in mm
B1=800;//Cross section dimention,given,in mm
L=1500;//in mm
```

Scilab code AP 17 Example 23.4 data

```
B=[600;900;600;600;900;600];//matrix having the
    values of B
t=[0.8;0.8;1;0.8;0.8;1;1];//thickness,in order
    -12,23,34,45,56,61,25;
```

```
L11=200;//leangth 1 of built in end,given in mm
L12=400;//leangth 2 of built in end,given in mm
W1=180;//breadth of built in end,given in mm
L21=150;//leangth 1 of open end,given in mm
L22=300;//leangth 2 of open end,given in mm
W2=80;//breadth of open end,given in mm
L=1.2*10^3;//leangth of Beam,given in mm
Mx=1.65*10^6;//given,in N.mm
Sy=10*10^3;//given,in N
G=27600;//in N/mm^2
```

Scilab code AP 18 Example 23.3 data

```
//in order 12,56,26,34,48,83,57,72,61,78
L=[1023;1023;1274;2200;250;150;280;180;330;1270];//
    length
t
    =[1.22;1.22;1.63;2.03;2.64;2.64;2.64;2.64;1.63;1.22];
    //thickness
A=[265000;213000;413000];//cell area
Gref=27600;
G=[27600*ones(9,1);3*27600];
B=[2580;3880;3230;3230;3880;2580];//boom areas
y=[165;230;200;-200;-230;-165];
Sy=86.8*10^3;//shear load
```

Scilab code AP 19 Example 23.2 data

```
//matrices are in the order[120;12i
    ;13;24;34;35;46;56]
L=[1650;508;775;775;380;508;508;254];//length,given
    in mm
t=[1.22;2.03;1.22;1.22;1.63;0.92;0.92;0.92];//
    thickness,given in mm
G=[24200;27600;24200;24200;27600;20700;20700;20700];
    //given in N.mm^2
Gref=27600;//given in N^mm^2
A=[258000;355000;161000];//cell area,given in mm^2
```

```
T=11.3*10^6;//torque,given in N.mm
```

Scilab code AP 20 Example 23.1 data

```
B=[2580;3880;3230;3230;3880;2580];//values of boom
    area,given in mm^2
y=[165;230;200;-200;-230;-165];//values of y,given
    in mm
Mx=300*10^6;//given in N.mm
```

Scilab code AP 21 Example 22.2 data

```
A=100;//cross sectional area of a stringer
r=381;//radius of the fuselage,given in mm
t=0.8;//thickness,given in mm
Sy=100*10^3;//given in N
d=150;//distence of action of load from center,given
     in mm
```

Scilab code AP 22 Example 22.1 data

```
A=100;//cross sectional area of a stringer
r=381;//radius of the fuselage,given in mm
t=0.8;//thickness,given in mm
Mx=200*10^6;
```

Scilab code AP 23 Example 21.3 data

```
Sy=100*10^3;//given in N
Aco=900;//area of corner booms,given in mm^2
Ace=1200;//area of central booms,given in mm^2
tl=2;//thickness,given in mm
tb=3;//thickness,given in mm
L1=1.6*10^3;//leangth of built in end,given in mm
L2=0.8*10^3;//leangth of open end,given in mm
B1=0.8*10^3;//breadth of built in end,given in mm
B2=0.4*10^3;//breadth of open end,given in mm
```

```
Lc=2*10^3;//distence of the section from the built
    in end,given in mm
L=4*10^3;//leangth of Beam,given in mm
```

Scilab code AP 24 Example 21.2 data

```
Sy=100*10^3;//given in N
Aco=900;//area of corner booms,given in mm^2
Ace=1200;//area of central booms,given in mm^2
tl=2;//thickness,given in mm
tb=3;//thickness,given in mm
L1=1.6*10^3;//leangth of built in end,given in mm
L2=0.8*10^3;//leangth of open end,given in mm
B1=0.8*10^3;//breadth of built in end,given in mm
B2=0.4*10^3;//breadth of open end,given in mm
Lc=2*10^3;//distence of the section from the built
    in end,given in mm
L=4*10^3;//leangth of Beam,given in mm
```

Scilab code AP 25 Example 21.1 data

```
Sy=-20*10^3;//given in N
A=400;//given in mm^2
t=2;//thickness,given in mm
L=2*10^3;//leangth ,given in mm
L1=1*10^3;//distence of section AA from the end
We=200;//width at the end,given in mm
W=400;//width at the joint,given in mm
```

Scilab code AP 26 Example 20.4 data

```
Sy=10*10^3;//vertical load,given,in N
B=[200;250;400;100;100;400;250;200];//boom area,
    given
y=[30;100;100;50;-50;-100;-100;-30];//x-coordinate
    of each boom
x=[120;240;240];//distences along x-axis between
    booms
```

Scilab code AP 27 Example 20.3 data

```
Sy=4.8*10^3; //shear load , given , in N
A=300; //Boom area , given , in mm^2
L=200; //leangth , given , in mm
```

Scilab code AP 28 Example 20.2 data

```
Mx=100*10^6;
B=[640;600;600;600;620;640;640;850;640]; //matrix
    having the values of B
D=[1200;1140;960;768;565;336;144;38;0]; //matrix
    having the distence of all booms from boom 9
```

Scilab code AP 29 Example 20.1

```
L16=400; //given in mm
L34=200; //given in mm
L12=600; //given in mm
L23=600; //given in mm
t12=2; //given in mm
t23=1.5; //given in mm
t34=2; //given in mm
t25=2.5; //given in mm
t16=3; //given in mm
A=300; //given in mm^2
```

Scilab code AP 30 Example 19.2 data

```
L12=900; //leangth of section 1-2(outer),given in mm
L34=300; //leangth of section 3-4,given in mm
L13=600; //leangth of section 1-3,given in mm
t13=2; //thickness of section 1-3,given in mm
t12=1.5; //thickness of section 1-2,given in mm
T=10*10^6; //given in N.mm
A=20000; //given in N.mm^2
G=25000; //given in N.mm^2
```

Scilab code AP 31 Example 19.1 data

```
L12=100;//leangth of 1-2,given in mm
L45=200;//leangth of 4-5(3-4-5-6 is a square),given in mm
t=2;//thickness,given in mm
Sy=100*10^3;//in N
G=25000;//given in N/mm^2
```

Scilab code AP 32 Example 18.3 data

```
a=25;//leangth along x-axis,given in mm
b=50;//leangth along y-axis,given in mm
tx=2.5;//in mm
ty=1.5;//in mm
T=10*10^3;//in N.mm
G=25000;//given in N/mm^2
```

Scilab code AP 33 Example 18.2 data

```
a=200;//in mm
b=150;//in mm
ta=2.5;//in mm
tb=2;//in mm
T=1000;//in N.mm
G=25000;//given in N/mm^2
```

Scilab code AP 34 Example 18.1 data

```
d=200;//given, in mm
L=2000;//given,2m in mm
T=30*10^6;//given, in N.mm
Tmax=15*10^6;//given
Smax=200;//maximum allowable shear stress,given,in N/mm^2
```

```
angle=2*%pi/180;//maximum angle of twist,given,in degrees
G=25000;//given, in N/mm^2
```

Scilab code AP 35 Example 17.3 data

```
a=10;//in mm
```

Scilab code AP 36 Example 17.2 data

```
h=50;//in mm
t=1.5;//in mm
b=25;//in mm
```

Scilab code AP 37 Example 17.1 data

```
h=100;//in mm
t=2;//in mm
Sy=200;//in N/mm^2
```

Scilab code AP 38 Example 16.9 data

```
W=10;//load in N/m
a=5;//L/4, in m
EI=70000;//flexural rigidity,in N.m^2
```

Scilab code AP 39 Example 16.8 data

```
W=5;//load in N/m
L=20;//leanth in m
EI=70000;//flexural rigidity,in N.m^2
```

Scilab code AP 40 Example 16.7 data

```
W=5;//load in N/m
L=20;//leanth in m
EI=70000;//flexural rigidity,in N.m^2
```

Scilab code AP 41 Example 16.6 data

```
W=5;//load in N/m
L=20;//leanth in m
EI=70000;//flexural rigidity ,in N.m^2
```

Scilab code AP 42 Example 16.5 data

```
W=10;//load in N
L=20;//leanth in m
EI=70000;//flexural rigidity ,in N.m^2
```

Scilab code AP 43 Example 16.4 data

```
a=120;//leangth of cross section along x-axis ,given
    in mm
a1=40;//leangth AE
b=88;//leangth of cross section along y-axis ,given
    in mm
t=8;//thickness ,given in mm
Mx=1500*10^3;//given in N.mm
```

Scilab code AP 44 Example 16.3 data

```
a=200;//leangth of cross section along x-axis ,given
    in mm
b=300;//leangth of cross section along y-axis ,given
    in mm
tx=25;//thickness along x-axis ,given in mm
ty=20;//thickness along y-axis ,given in mm
M=100*10^6;//bending moment ,given in N.mm
th=30;//inclination of plane of bending moment ,given
     in degrees
theta=th*%pi/180;//th in radians
```

Scilab code AP 45 Example 16.2 data

```
a=200;//leangth of cross section along x-axis,given
    in mm
b=300;//leangth of cross section along y-axis,given
    in mm
tx=25;//thickness along x-axis,given in mm
ty=20;//thickness along y-axis,given in mm
M=100*10^6;//bending moment,given in N.mm
```

Scilab code AP 46 Example 16.16 data

```
a=100;//in mm
t=2;//in mm
E=70000;//N/mm^2
T0=10;//in K
alpha=0.01;//mm/k
```

Scilab code AP 47 Example 16.15 data

```
a=100;//in mm
t=2;//in mm
E=70000;//N/mm^2
T0=10;//in K
alpha=0.01;//mm/k
```

Scilab code AP 48 Example 16.14 data

```
h=100;//in mm
t=2;//in mm
Mx=1000;//N.mm
```

Scilab code AP 49 Example 16.13 data

```
b=100;//in mm
tf=2;//in mm
tw=2.5;//in mm
d=150;//in mm
```

Scilab code AP 50 Example 16.12 data

```
Ixx=1.937D+08;
Iyy=27005208;
Ixy=562584521;
E=20000;
L=20;
W=100000
```

Scilab code AP 51 Example 16.11 data

```
M0=10;//load in N/m
L=20;//L in m
b=15;//b in m
EI=70000;//flexural rigidity ,in N.m^2
```

Scilab code AP 52 Example 16.10 data

```
W=10;//load in N/m
L=20;//L in m
EI=70000;//flexural rigidity ,in N.m^2
```

Scilab code AP 53 Example 16.1 data

```
a=200;//leangth of cross section along x-axis,given
    in mm
b=300;//leangth of cross section along y-axis,given
    in mm
tx=25;//thickness along x-axis,given in mm
ty=20;//thickness along y-axis,given in mm
M=-100*10^6;//bending moment,given in N.mm
```

Scilab code AP 54 Example 15.1 data

```
K=1708;//fracture toughness, given in N/mm^2
S=175;//given in N/mm^2
alpha=1;///given
```

```
C=40/10^15;//rete of crack growth, given in mm/cycle
n=4;//given
ai=0.2;//initial leangth of crack,given in mm
```

Scilab code AP 55 Example 14.3 dqta

```
W=8000;//given in N
S=14.5;//wing area,given in m^2
c=1.35;//mean chord,given in m
n=4.5;
v=60;//speed,given in m/s
rho=1.223;//air density,given in kg/m^3
alpha1=13.75;//from fig. 14.8(a),in degree
Cmcg1=0.075;//Cm,cg from fig. 14.8(a)
alpha2=13.3;//given in degree
Cmcg2=0.073;//given
```

Scilab code AP 56 Example 14.2 data

```
W=250;//given in kN
Rh=400;//horizontal reaction,given in kN
Rv=1200;//vertical reaction,given in kN
Icg=5.65*10^8;//given in N.s^2
Sh=1;//horizontal distence of CG from main wheels,
    given in m
Sv=2.5;//vertical distence of CG from main wheels,
    given in m
v0=3.7;//initial vertical velocity,given in m/s
g=9.81;//in m/s^2;
```

Scilab code AP 57 Example 14.1 data

```
W=45;//given in kN
Wa=4.5;//wight of aircraft aft,given in kN
v0=25;//given in m/s
g=9.81;//in m/s^2;
a=3*g;//given
```

Scilab code AP 58 Example 12.2 data

```
AD=25;//distence between point A and D,given in mm
DC=20;//distence between point D and centroid ,given
    in mm
DG=25;//distence between point G and D,given in mm
CF=25;//distence between point F and centroid ,given
    in mm
Load=5000;//load ,given(5kN in N)
CL=75;//distence between the centroid and load
```

Scilab code AP 59 Example 12.1 data

```
t=2.5;//skin thickness ,given in mm
St=1.2;//straps thickness ,given in mm
d=4;//rivets diameter ,given in mm
Lt=125;//limit tensile stress
Ls=120;//limit shear stress
```

Scilab code AP 60 Example 10.6 data

```
m=1;//in Kg
EI=70000*2000;//given in N.mm^2
l=2000;//in mm
```

Scilab code AP 61 Example 10.5 data

```
EI=70000*2000;//given in N.mm^2
L=2000;//in mm
rho=1;//in Kg/mm^3
A=1;//in mm^2
```

Scilab code AP 62 Example 10.4 data

```
m=1;//in Kg
EI=70000*2000;//given in N.mm^2
L=2000;//in mm
```

```
rho=1;//in Kg/mm^3
A=1;//in mm^2
```

Scilab code AP 63 Example 10.2 data

```
m=1;//in Kg
EI=70000*2000;//given in N.mm^2
l=2000;//in mm
```

Scilab code AP 64 Example 10.1 data

```
m=1;//in Kg
EI=70000*2000;//given in N.mm^2
l=2000;//in mm
```

Scilab code AP 65 Example 9.1 data

```
Af=350;//cross sectional area of flanges,given in mm
    ^2
As=300;//Cross sectional area of stiffners,given in
    mm^2
ESM=750;//elastic section modulus,given in mm^3
t=2;//thickness of web,given in mm
MA=2000;//2nd moment of area of a stiffner,given in
    mm^4
E=70000;//given in N/mm^2
I=2000;//moment of inertia
d=400;//given in mm
b=300;//given in mm
W=5000;//given (5 KN in N)
z=1200;//given in mm
```

Scilab code AP 66 Example 8.4 data

```
L=1000;//given (1m in mm)
a2=100;//width of cross section(along x axis),given
    in mm
```

```
b=100;//leanght of cross section(along y axis),given
    in mm
t=2;//thickness
E=70000;//given in N/mm^2
G=30000;//given in N/mm^2
```

Scilab code AP 67 Example 8.3 data

```
L=2000;//given (2m in mm)
a=37.5;//width of cross section(along x axis),given
    in mm
b=75;//leanght of cross section(along y axis),given
    in mm
t=2.5;//thickness
E=75000;//given in N/mm^2
G=21000;//given in N/mm^2
```

Scilab code AP 68 Example 8.2 data

```
L=20;//in mm
P=100;//in N
e=0.1;//in m
E=200000;//in N/^2
I=0.5// moment of Inertia of cross section , in m^4
```

Scilab code AP 69 Example 7.4 data

```
a=100;//in mm
b=80;//in mm
t=2;//in mm
E=70000;//in N/mm^2
v=0.3;
q0=10;//in N/mm^2
```

Scilab code AP 70 Example 7.3 data

```
t=2;//in mm
```

```
E=70000;//in N/mm^2
v=0.3;
a=100;//in mm
b=100;//in mm
q0=10;//in N/mm^2
Nx=10;//in n/mm
```

Scilab code AP 71 Example 7.1 data

```
t=2;//in mm
E=70000;//in N/mm^2
v=0.3;
a=100;//in mm
b=100;//in mm
q0=10;//in N/mm^2
```

Scilab code AP 72 Example 6.4 data

```
P1=[-2;-1];
P2=[2;-1];
P3=[2;1];
P4=[-2;1];
u=[0.001;0.003;-0.003;0];//given in m
v=[-0.004;-0.002;0.001;0.001];//given in m
E=200000;//given in N/mm^2
V=0.3;//poission's ratio,given
```

Scilab code AP 73 Example 6.2 data

```
L=10;//in m
W=1000;//FORCE ON POINT 2
M=100;//MOMENT ON POINT 2
EI=20000;
```

Scilab code AP 74 Example 6.1 data

```
L12=10;//in m
```

```
L13=10;//in m
AE=200000;//in N
FX2=0;//FORCE ON POINT 2 IN X DIRECTION
FY2=-10;//-W,FORCE ON POINT 2 IN Y DIRECTION
```

Scilab code AP 75 Example 5.9 data

```
L=1;//000;//langth,given,in mm
P=10;//*10^3;//load,given,in N
```

Scilab code AP 76 Example 5.8 data

```
L=1000;//langth in mm
P=1;//Load in N
```

Scilab code AP 77 Example 5.7 data

```
L=2000;//langth.in mm
EI=2*10^10;
GJ=5*10^10;
W=0.1;//in N/mm
```

Scilab code AP 78 Example 5.6 data

```
r=1000;//in mm
M0=1000;//in N.mm
```

Scilab code AP 79 Example 5.5 data

```
L=2000;//langth.in mm
Ab=200;//in mm^2
A=180;//area of bar,in mm^2
P=1000;//in N
theta=60*(%pi/180);
E=200000;//in N/mm^2
I=100000;//in mm^4
```

Scilab code AP 80 Example 5.4 data

```
clear all
AB=4000;//langth AB, given , in mm
BC=3000;//langth BC, given , in mm
A=200;//area of bar , given , in mm^2
delT=30;//change in temprature , given , in celcius ;
alpha=7/10^6;//coefficient of linear expansion , given
    , in 1/celcius
E=200000;//given in N/mm^2
```

Scilab code AP 81 Example 5.3 data

```
AC=30;//C.S. area of AC, given , in mm^2
A=20;//C.S. areaa of other elements , given , in mm^2
L=800;//langth , given in mm
E=200000;//given in N/mm^2
theta=60*(%pi/180);
Load=100;//given , in N
```

Scilab code AP 82 Example 5.2 data

```
clear all
w=5;//in N/m
L=20;//in m
EI=70000;//in N.m^2
```

Scilab code AP 83 Example 5.12 data

```
D=[0;100;200;300;400;500;600;700;800];
V=[0;-0.3;-1.4;-2.5;-1.9;0;2.3;4.8;10.6];
L0=40;
L1=30;
L2=10;
```

Scilab code AP 84 Example 5.11 data

```
EI=70000;//in N.mm^2
W=10;//in N
L=20;//in m
```

Scilab code AP 85 Example 5.10 data

```
a=4000;//langth,given,in mm
b=3000;//breadth,given,in mm
T=30;//change in temprature,given,in degrees
A=200;//given,in mm^2
alpha=7/10^6;//given,in 1/C;
E=200000;//given,in N/mm^2
```

Scilab code AP 86 Example 5.1 data

```
CS=1800;//cross-section area,given in mm^2
E=200000;//given in N/mm^2
h=4;//height, given in m
AB=4;//given in m
BC=4;//given in m
CD=4;//given in m
Load1=40*10^3;//load at point E,given in N
Load2=100*10^3;//load at point C,given in N
```

Scilab code AP 87 Example 4.6 data

```
CS=1800;//cross-section area,given in mm^2
E=200000;//given in N/mm^2
h=4;//height, given in m
AB=4;//given in m
BC=4;//given in m
CD=4;//given in m
Load1=40*10^3;//load at point E,given in N
Load2=100*10^3;//load at point C,given in N
```

Scilab code AP 88 Example 4.5 data

```
W=100;//in N
L=20;//in m
E=200000;//in N/mm^2
I=0.5// moment of Inertia of cross section, in m^4
```

Scilab code AP 89 Example 4.4 data

```
w=10;//intensity of distributed load, in N/m
L=10;//leangth in m
E=200000;//in N/mm^2
I=0.5;// moment of Inertia of cross section, in m^4
```

Scilab code AP 90 Example 4.3 data

```
CD=4;//given in m
BD=3;//given in m
Loadc=30;//given in KN
```

Scilab code AP 91 Example 4.2 data

```
W=90;//in Newton
a=10;//in m
L=15;//(a+b),in m
```

Scilab code AP 92 Example 4.1 data

```
W=100;//in N
L=20;//in m
a=14;//in m
```

Scilab code AP 93 Example 3.2 data

```
a=4;//major axis,in mm
b=3;//minor axis of bar,in mm
T=100000;//applied torque,in N.mm
G=76923;//shear modulus,in N/mm^2
```

Scilab code AP 94 Example 3.1 data

```
R=16;//radius of bar,in mm
T=100000;//applied torque,in N.mm
G=76923;//shear modulus,in N/mm^2
```

Scilab code AP 95 Example 1.7 data

```
d=50;//given (in mm)
Ea=1000/10^6;
Eb=-200/10^6;
Ec=-300/10^6;
v=0.3;
E=70000;//given (in N/mm^2)
```

Scilab code AP 96 Example 1.5 data

```
Sx=60;// x , given(in N/mm^2)
Sy=-40;//- y , given(in N/mm^2)
Txy=50;// xy ,given(in N/mm^2)
E=200000;//given(in N/mm^2)
v=0.3;
```

Scilab code AP 97 Example 1.4 data

```
Sx=83;// x , given (in N/mm^2)
Sy=65;// y , given (in N/mm^2)
E=200000;// given (in N/mm^2)
v=0.3;
```

Scilab code AP 98 Example 1.3 data

```
Sx=160;// x , tension stress , given in N/mm^2
Sy=-120;// y , compression stress , given in N/mm^2
lLoad=200;//limit load , given in N/mm^2
```

Scilab code AP 99 Example 1.2 data

```
t=1.5;//given(in mm)
d=60;//given(in mm)
T=1200*10^3;//in N.mm, given(in N.m)
Load=50*10^3;//Compressive load(N)
angle= %pi/3;//angle of plane with axis(radian)
theta=%pi/2 - angle;
```

Scilab code AP 100 Example 1.1 data

```
d=2000;//given(2m in mm)
t=20;//given(in mm)
p=1.5;//pressure inside the vessel(N/mm^2)
Load=2500*10^3;//axial tensile load(N)
angle= %pi/3;//angle of plane with axis(radian)
theta=%pi/2 -angle;
```