Scilab Textbook Companion for Structural And Stress Analysis by T. H. G. Megson[1]

Created by
Kukkunuri Venkata Phani Pradeep
Solid Mechanics
Chemical Engineering
IIT Bombay
College Teacher
Rochish Thaokar
Cross-Checked by
Lavitha Pereira

February 19, 2014

[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: Structural And Stress Analysis

Author: T. H. G. Megson

Publisher: Elsevier, Great Britain

Edition: 2

Year: 2005

ISBN: 9780750662215

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

Chapter 2

Principles of Statics

Scilab code Exa 2.1 chapter 2 example 1

```
clc
//initialisation of variables
F1= -2.0 //KN
F2= 3.0 //KN
F3= -6.0 //KN
F4= -1.0 //KN
x1= 0 //m
x2= 0.6 //m
x3= 0.9 //m
x4= 1.2 //m
//CALCULATIONS
R= -(F1+F2+F3+F4)
x= -(x1*F1+x2*F2+x3*F3+x4*F4)/R
//RESULTS
printf ('R= %.2f kN',R)
printf (' \n x=%.2f m',x)
```

Scilab code Exa 2.2 chapter 2 example 2

```
clc
//initialisation of variables
F1= 5*cosd(60) //KN
F2= 5*sind(60) //KN
F3= -3 //KN
x1= 1.2 //m
x2= 0.9 //m
x3= 0.4 //m
//CALCULATIONS
Rah= F1
Rav= (-(F3*x2)+F2*x3)/1.2
Rd= -F3+F2-Rav
//RESULTS
printf ('Rah= %.1f kN',Rah)
printf (' \n Rav=%.1f KN',Rav)
printf (' \n Rd=%.1f KN',Rd)
```

Scilab code Exa 2.3 chapter 2 example 3

```
clc
//initialisation of variables
F1= -2*cosd(45) //KN
F2= -2*sind(45) //KN
F3= -5 //KN
x1= 0.4 //m
x2= 1.0 //m
Rc= 2.5 //m
Rd= 3.7 //m
//CALCULATIONS
Rah= -F1
Rav= -F3-F2
Ma= -F3*x1-F2*x2
Ra= sqrt(Rc^2+Rd^2)
theta= atan(Rc/Rd) *180/%pi
//RESULTS
```

```
printf ('Rah= %.1f kN',Rah)
printf (' \n Rav=%.1f KN',Rav)
printf (' \n Ma=%.1f KNm',Ma)
printf (' \n Ra=%.1f KN',Ra)
printf (' \n theta=%.1f degrees',theta)
```

Scilab code Exa 2.4 chapter 2 example 4

```
clc
//initialisation of variables
alpha= atand(2.4/3) //degrees
F1= 5*sind(alpha) //KN
F2= 10*sind(alpha) //KN
F3= 3 //KN
F4= 2 //KN
F5= -5*cosd(alpha) //KN
F6= 10*cosd(alpha) //KN
x1= 6 //m
x2= 4.5 //m
x3= 1.2 //m
x4= 1.5 //m
x5= 4 //m
x6= 2 //m
//CALCULATIONS
Rah= F1+F2
Rav= ((-F5)*x2-x3*F1-F6*x4-F2*x3+F3*x5+F4*x6)/6
Rb= F3+F4-F5-Rav-F6
//RESULTS
printf ('Rah= %.1f kN',Rah)
printf (' \n Rav=%.1f KN',Rav)
printf (' \n Rb=%.1f KN',Rb)
```

Chapter 3

Normal Force Shear Force Bending Moment and Torsion

Scilab code Exa 3.1 chapter 3 example 1

```
clc
//initialisation of variables
Rah= -10 //KN
F= 10 //KN
//CALCULATIONS
Nab= -Rah
//RESULTS
printf ('Nab= %.f kN',Nab)
```

Scilab code Exa 3.2 chapter 3 example 2

```
clc
//initialisation of variables
Rah= -10 //KN
Fb= 10 //KN
//CALCULATIONS
```

```
Nab= -Rah
Nbc= Rah+Fb
//RESULTS
printf ('Nab= %.3f KN (tension)',Nab)
printf (' \n Nbc= %.2f KN',Nbc)
```

Scilab code Exa 3.3 chapter 3 example 3

```
clc
//initialisation of variables
Fb= -2 //KN
Fc= 6//KN
Fd= 4 //KN
a1= 60 //degrees
a2= 60 //degrees
//CALCULATIONS
Rah= Fd*cosd(a2)-Fc*cosd(a1)
Nac= Rah
Ncd= Fd*cosd(a2)
//RESULTS
printf ('Rah= %.3f KN',Rah)
printf (' \n Nac=%.2f KN(compression)',Nac)
printf (' \n Ncd=%.3f KN(tension)',Ncd)
```

Scilab code Exa 3.12 chapter 3 example 12

```
clc
//initialisation of variables
Mb= 10 //KN
Mc= -8 //KN
x1= 1 //m
x2= 2 //m
//CALCULATIONS
```

```
Tab= Mb+Mc
Tbc= Mc
//RESULTS
printf ('Tab= %.f KN ',Tab)
printf (' \n Tbc= %.f KN',Tbc)
```

Chapter 4

Analysis of Pin jointed Trusses

Scilab code Exa 4.2 chapter 4 example 2

```
clc
//initialisation of variables
F1= -2 //KN
F2= -3 //KN
F3= -1 //KN
x1= 2 //m
x2= 1.5 //m
x3= 1 //m
x4= 0.5 //m
//CALCULATIONS
Ra= (-F2*x4-F3*x3-F1*x2)/x1
Rd= -F1-F2-F3-Ra
Fab= -2.75/sind(60)
Fae= -Fab*cosd(60)
Fba= Fab
Fbe= (-2-Fba*cosd(30))/cosd(30)
Fbc= Fba*cosd(60)-Fbe*cosd(60)
Fdc= -Rd/sind(60)
Fde= -Fdc*cosd(60)
Fce= (-3-Fdc*cosd(30))/cosd(30)
//RESULTS
```

```
printf ('Ra= %.2f KN',Ra)
printf (' \n Rd=%.2f KN',Rd)
printf (' \n Fab=%.2f KN(compression)',Fab)
printf (' \n Fae=%.2f KN(tension)',Fae)
printf (' \n Fbe=%.2f KN(tension)',Fbe)
printf (' \n Fbc=%.2f KN(compression)',Fbc)
printf (' \n Fdc=%.2f KN(compression)',Fdc)
printf (' \n Fde=%.2f KN(tension)',Fde)
printf (' \n Fce=%.2f KN(tension)',Fce)
```

Scilab code Exa 4.3 chapter 4 example 3

```
clc
//initialisation of variables
Re= -4 //KN
Rh= -6 //KN
Ro= 2 //KN
x1= 1 //m
x2= 3 //m
x3= 5 //m
x4= 4 //m
//CALCULATIONS
Rb= (Ro*x1-Re*x2-Rh*x3)/8
Rav= (-Ro*x1-Re*x3-Rh*x2)/8
Rah= Ro
Fcf= (Rav+Re)/cosd(45)
Fcd= (-Re*x1-Rav*x4-Ro*x1)/x1
Fef= (Rav*x2+Ro*x1)/x1
//RESULTS
printf ('Rb= %.1f KN',Rb)
printf (' \n Rav=%.1f KN',Rav)
printf (' \n Rah=%.f KN',Rah)
printf (' \n Fcf=%.2f KN',Fcf)
printf (' \n Fcd=%.f KN',Fcd)
printf (' \n Fef=%.1f KN',Fef)
```

Scilab code Exa 4.4 chapter 4 example 4

```
clc
//initialisation of variables
Rav= 1 //KN
Re= 4 //KN
Xac= 1.5 //m
Xce= 1.5 //m
Fd= -5 //KN
Rah= -3 //KN
xa= 0 //m
ya= 0 //m
xc= 1.5 //m
yc= 0//m
xe= 3 //m
ye= 0 //m
xf= 3 //m
yf= 1.5 //m
xd= 1.5 //m
yd= 1.5 //m
xb= 0 //m
yb= 1.5 //m
Yef= 1.5 //m
Fb= 3 //KN
//CALCULATIONS
tac= -Rah/(xc-xa)
tab= -Rav/(yb-ya)
tba= tab
tbc= -tba*(ya-yb)/(yc-yb)
tbd= (-Fb-tbc*(xc-xb))/(xd-xb)
tdb= tbd
tdf= -tdb*(xb-xd)/(xf-xd)
tdc= (-Fd-tdb*(yb-yd))/(yc-yd)
tec= 0
```

```
tfe= -Re/(yf-ye)
tfc= (-tdf*(xd-xf)-tfe*(xe-xf))/(xc-xf)
Tab= tab*(yb-ya)
Tac= tac*(xc-xa)
Tbc= tbc*sqrt((xb-xc)^2+(yb-yc)^2)
Tbd= tbd*(xd-xb)
Tdf= tdf*(xf-xd)
Tdc= tdc*(yd-yc)
Tfc= tfc*sqrt((xf-xc)^2+(yf-yc)^2)
Tfe= tfe*(yf-ye)
Tec= tec*(xe-xc)
//RESULTS
printf ('Tab= %.2f KN(compression)',Tab)
printf (' \n Tac=%.2f KN(tension)',Tac)
printf (' \n Tbc=%.2f KN(tension)',Tbc)
printf (' \n Tbd=%.2f KN(compression)',Tbd)
printf (' \n Tdf=%.2f KN(compression)',Tdf)
printf (' \n Tdc=%.2f KN(compression)',Tdc)
printf (' \n Tfc=%.2f KN(tension)',Tfc)
printf (' \n Tfe=%.2f KN(compression)',Tfe)
printf (' \n Tec=%.2f KN(tension)',Tec)
```

Scilab code Exa 4.6 chapter 4 example 6

```
clc
//initialisation of variables
xa= -2
ya= -2
za= -4
xb= -2
yb= -2
zb= 2
xc= 2
yc= -2
zc= -4
```

```
xd= 2
yd= -2
zd= 2
xf= 0
yf= 0
zf= 0
xe= 0
ye= 0
ze= -2
Fe= -60 //KN
Ff= 40 //KN
//CALCULATIONS
A=[(xd-xf),(xb-xf),(xe-xf); (yd-yf),(yb-yf),(ye-yf);
    (zd-zf),(zb-zf),(ze-zf)]
b=[Ff;0;0]
c=A\b
tfd= c(1,1)
tfb= c(2,1)
tfe= c(3,1)
B=[(xb-xe),(xc-xe),(xa-xe); (yb-ye),(yc-ye),(ya-ye);
    (zb-ze),(zc-ze),(za-ze)]
e=[0-tfe*(xf-xe);-Fe-tfe*(yf-ye);-tfe*(zf-ze)]
f=B\e
teb= f(1,1)
tec= f(2,1)
tea= f(3,1)
Lfb= sqrt((xb-xf)^2+(yb-yf)^2+(zb-zf)^2)
Lfd= sqrt((xd-xf)^2+(yd-yf)^2+(zd-zf)^2)
Lfe= sqrt((xe-xf)^2+(ye-yf)^2+(ze-zf)^2)
Lec= sqrt((xc-xe)^2+(yc-ye)^2+(zc-ze)^2)
Lea= sqrt((xa-xe)^2+(ya-ye)^2+(za-ze)^2)
Leb= sqrt((xb-xe)^2+(yb-ye)^2+(zb-ze)^2)
Tfb= tfb*Lfb
Tfd= tfd*Lfd
Tfe= tfe*Lfe
Tec= tec*Lec
Tea= tea*Lea
Teb= teb*Leb
```

```
//RESULTS
printf ('Tfb= %.1f KN(compression)',Tfb)
printf (' \n Tfd=%.1f KN(tension)',Tfd)
printf (' \n Tfe=%.1f KN',Tfe)
printf (' \n Tec=%.1f KN(compression)',Tec)
printf (' \n Tea=%.1f KN(compression)',Tea)
printf (' \n Teb=%.1f KN(compression)',Teb)
```

Chapter 5

Cables

Scilab code Exa 5.1 chapter 5 example 1

```
clc
//initialisation of variables
F= -10 //KN
x1= 1 //m
x2= 2 //m
x3= 3 //m
//CALCULATIONS
alpha= atand(x1/x3)
beta= atand(x1/x2)
Tca= -F*cosd(beta)
Tcb= Tca*cosd(alpha)/cosd(beta)
Rav= -F*x2/(x2+x3)
Rbv= -F-Rav
Rah= Rav*x3/x1
Rbh= Rah
Tca= sqrt(Rav^2+Rah^2)
Tcb= sqrt(Rbv^2+Rbh^2)
//RESULTS
printf ('Tca= %.1f KN',Tca)
printf (' \n Tcb=%.1f KN',Tcb)
printf (' \n Rav=%.f KN',Rav)
```

```
printf (' \n Rbv=%.f KN',Rbv)
printf (' \n Rah=%.f KN',Rah)
printf (' \n Tca=%.1f KN',Tca)
printf (' \n Tcb=%.1f KN',Tcb)
```

Scilab code Exa 5.2 chapter 5 example 2

```
clc
//initialisation of variables
Fc= -10.0 //KN
Fd= -6.0 //KN
y= 0.5 //m
x1= 1.5 //m
x2= 2.0 //m
x3= 1.8 //m
//CALCULATIONS
//The values in the textbook are rounded off. hence,
    there is a small variation in the result of this
    code.
alpha= atand(y/x1)
Rav= (-Fd*x3-Fc*(x2+x3))/(x1+x2+x3)
Rah= Rav*x1/y
Tca= sqrt(Rah^2+Rav^2)
tanbeta= ((-Fc-Tca*sind(alpha)))/(Tca*cosd(alpha))
Tcd= Tca*cosd(alpha)/cosd(beta)
gama= atand((-Fd+Tcd*sind(beta)))/(Tcd*cosd(beta))
Tdb= (Tcd*cosd(beta))/cosd(gama)
//RESULTS
printf ('Tca= %.1f KN',Tca)
printf (' \n Tcd=%.1f KN',Tcd)
printf (' \n Tdb=%.2f KN',Tdb)
```

Scilab code Exa 5.4 chapter 5 example 4

```
clc
//initialisation of variables
L= 200 //m
D= 18 //m
h= 6 //m
w= 10 //KN/m
//CALCULATIONS
L2= L/(sqrt((D-h)/D)+1)
H= w*L2^2/(2*D)
Tmax= sqrt((w*L2)^2+H^2)
alphamax= atand(w*L2/H)
printf ('L2= %.1f m',L2)
printf (' \n H=%.1f KN',H)
printf (' \n Tmax=%.1f KN',Tmax)
printf (' \n alphamax=%.1f degrees',alphamax)
```

Scilab code Exa 5.5 chapter 5 example 5

```
clc
//initialisation of variables
w= 120 //KN
D= 30 //m
L= 300 //m
sigmamax= 600 //N/mm^2
h= 50 //m
beta= 45 //degrees
//CALCULATIONS
Tmax= ((w*L)/2)*(sqrt(1+(L/(4*D))^2))
d= sqrt((4*Tmax*10^3)/(sigmamax*%pi))
H= (w*L^2)/(8*D)
alpha= atand((w*L)/(2*H))
Mt= Tmax*(cosd(alpha)-cosd(beta))*h
Vt= Tmax*(sind(alpha)+sind(beta))
Wa= Tmax*cosd(beta)
//RESULTS
```

```
printf ('Tmax= %.1f KN',Tmax)
printf ('\n d=%.1f mm',d)
printf ('\n H=%.0f KN',H)
printf ('\n alpha=%.1f degrees',alpha)
printf ('\n Mt=%.0f KNm',Mt)
printf ('\n Vt=%.0f KN',Vt)
printf ('\n Wa=%.0f KN',Wa)
```

Chapter 6

Arches

Scilab code Exa 6.1 chapter 6 example 1

```
clc
//initialisation of variables
F1= -60 //KN
F2= -100 //KN
r= 6 //m
alpha1= 30 //degrees
alpha2= 45 //degrees
//CALCULATIONS
Rav= (-F1*(r*cosd(alpha1)+r)-F2*(r*sind(alpha1)+r) )
    /(2*r)
Rbv= -F1-F2-Rav
Rbh= Rbv
Rah= Rbh
Nx= -Rav*cosd(alpha2)-Rah*cosd(alpha2)-F1*cosd(
    alpha2)
Sx= -Rav*sind(alpha2)+Rah*cosd(alpha2)-F1*sind(
    alpha2)
Mx= Rav*(r-r*cosd(alpha2))-Rah*r*sind(alpha2)+F1*(r*
    cosd(alpha1)-r*cosd(alpha2))
//RESULTS
printf ('Normal force= %.1f KN',Nx)
```

```
printf ('\n  Shear force=%.1f KN',Sx)
printf (' \n Bending moment=%.1f KNm',Mx)
```

Scilab code Exa 6.2 chapter 6 example 2

```
clc
//initialisation of variables
W= -10 //KN/m
Yac= 7 //m
xad= -7.5 //m
xac= -15 //m
xcb= 10 //m
//CALCULATIONS
k= Yac/((xac)^2)
yb= k*(xcb)^2
hb= Yac-yb
yd= k*(xad)^2
hd= Yac-yd
A=[(xcb-xac),(hb);(xcb),(-yb)]
b=[-W*(-xac)*(-xad);0]
c= A\b
Rbv= c(1,1)
Rbh= c(2,1)
Rah= Rbh
Rav= -Rbv-W*(-xac)
dybydx= 2*k*xad
alpha= atand(-2*k*xad)
Nd= -Rav*sind(alpha)-Rah*cosd(alpha)+((-W)*(-xad)*
    sind(alpha))
Sd= -Rav*cosd(alpha)+Rah*sind(alpha)+((-W)*(-xad)*
    cosd(alpha))
Md= Rav*(-xad)-Rah*hd+W*(-xad)*(-xad/2)
//RESULTS
printf ('Normal force= %.2f kN',Nd)
printf ('\n  Shear force=%.2f KN',Sd)
```

```
printf('\n Bending moment=%.1f KNm',Md)
```

Chapter 7

Stress and Strain

Scilab code Exa 7.1 chapter 7 example 1

```
clc
//initialisation of variables
P= 800*10^3
sigmamax= 400
//CALCULATIONS
Amin= P/sigmamax
B= sqrt(Amin/2)
//RESULTS
printf ('Amin= %.2f mm^2',Amin)
printf (' \n B=%.2f mm(Therefore the min dimensions
    of the column cross section are 31.6mm*63.2mm)',B
    )
```

Scilab code Exa 7.2 chapter 7 example 2

```
clc
//initialisation of variables
x1= %pi/4
```

```
y= 350^2-300^2
W= 2000*10^3
E= 200000
h= 5*10^3
//CALCULATIONS
A= x1*y
sigma= -(W/A)
epsilon= (sigma/E)
delta= -(epsilon*h)
//RESULTS
printf ('A= %.2f mm^2',A)
printf (' \n sigma=%.2f N/mm^2',sigma)
printf (' \n epsilon=%.5f ',epsilon)
printf (' \n delta=%.2f mm',delta)
```

Scilab code Exa 7.3 chapter 7 example 3

```
clc
//initialisation of variables
W= 10*10^3 //KN
L= 500 //mm
D= 200 //mm
T= 2 //mm
G= 25000 //N/mm^2
//CALCULATIONS
Tav= W/(D*T)
gama= Tav/G
deltas= gama*L
//RESULTS
printf ('Tav= %.2f N/mm^2',Tav)
printf (' \n gama=%.3f rad',gama)
printf (' \n deltas=%.2f mm',deltas)
```

Scilab code Exa 7.4 chapter 7 example 4

```
clc
//initialisation of variables
mu= 0.3
E= 200000 //N/mm^2
R= 0.1*10^-2
//CALCULATIONS
K= E/(3*(1-2*mu))
sigma= R*K
linearstrain= R/3
//RESULTS
printf ('K= %.f N/mm^2',K)
printf (' \n sigma=%.f N/mm^2',sigma)
printf (' \n linearstarin=%.5f ',linearstrain)
```

Scilab code Exa 7.5 chapter 7 example 5

```
clc
//initialisation of variables
x1= 4
x2= %pi/x1
L= 400 //mm
h= 5 //m
d=20 //mm
W= 1000*10^3 //KN
Ys= 200000 //N/mm^2
Yc= 15000 //N/mm^2
//CALCULATIONS
As= x1*x2*(d^2)
Ac= L^2-As
sigmas= (Ys*W)/(Ac*Yc+As*Ys)
sigmac= (Yc*W)/(Ac*Yc+As*Ys)
delta= (sigmac*h*10^3)/(Yc)
//RESULTS
```

```
printf ('As= %.f mm^2',As)
printf (' \n Ac=% f mm^2',Ac)
printf (' \n sigmas=%.f N/mm^2(stress in the steel)'
    ,sigmas)
printf (' \n sigmac=%.1f N/mm^2(stress in the
    concrete)',sigmac)
printf (' \n delta;=%.1f mm(shortening of the column
    )',delta)
```

Scilab code Exa 7.6 chapter 7 example 6

```
clc
//initialisation of variables
Ao= 2*300 //mm^2
Eo= 80000 //N/mm^2
Ei= 200000 //N/mm^2
Ai= 300 //mm^2
P= 100*10^3 //KN
deltaT= 100 //degrees
alphai= 1.2*10^-5 ///degreesc
alphao= 1.85*10^-5 ///degreesc
L= 4*10^3 //mm
//CALCULATIONS
sigmaiload= (Ei*P)/(Ao*Eo+Ai*Ei)
sigmaoload= (Eo*P)/(Ao*Eo+Ai*Ei)
sigmaotemp= (deltaT*(alphai-alphao)*Eo*Ai*Ei)/(Ao*Eo
    +Ai*Ei)
sigmaitemp= (deltaT*(alphai-alphao)*Eo*Ao*Ei)/(Ao*Eo
    +Ai*Ei)
sigmai= sigmaiload+sigmaitemp
sigmao= sigmaoload-sigmaotemp
deltaload= (P*L)/(Ao*Eo+Ai*Ei)
deltatemp= (L*deltaT)*(alphao*Ao*Eo+alphai*Ai*Ei)/(
    Ao*Eo+Ai*Ei)
displacement= deltatemp-deltaload
```

```
//RESULTS
printf ('sigmai= %.2f N/mm^2(stress in the column)',
    sigmai)
printf (' \n sigmao=% f N/mm^2(stress in the column)
    ',sigmao)
printf (' \n displacement=% f mm(elongation)',
    displacement)
```

Scilab code Exa 7.7 chapter 7 example 7

```
clc
//initialisation of variables
A= 120*300 //mm^2
At= 6*300 //mm^2
Ec= 150 //N/mm^2
Et= 150*15 //N/mm^2
P= 150*10^3 //N
//CALCULATIONS
Ac= A-At
sigmaci= (Ec*At)/Ac
F= Ac*sigmaci
stressintheconcrete= (sigmaci)-((Ec*P)/(Ac*Ec+At*Et)
    )
stressinthesteel= (F/At)+((Et*P)/(Ac*Ec+At*Et))
printf ('stressintheconcrete= %.1f N/mm^2(
    compression)',stressintheconcrete)
printf (' \n stressinthesteel=% f N/mm^2(tension)',
    stressinthesteel)
```

Scilab code Exa 7.8 chapter 7 example 8

```
clc
//initialisation of variables
```

```
sigmac= 400 //N/mm^2
fs= 6
d= 2*10^3 //mm
t= 20 //mm
E= 200000 //N/mm^2
mu= 0.3
//CALCULATIONS
p= (sigmac*2*t)/(d*6)
volumestrain= (p*d)*((5/4)-mu)/(t*E)
//RESULTS
printf ('p= %.2f N/mm^2',p)
printf (' \n volumestrain=% f percent',volumestrain)
```

Chapter 9

Bending of Beams

Scilab code Exa 9.1 chapter 9 example 1

```
clc
//initialisation of variables
w= 10 //KN/m
L= 6 //m
sigmaxallowable= 155 //N/mm^2
Modulusofuniversalbeam= 307600 //mm^3
Satisfactorybeam= 254*102*28
//CALCULATIONS
Mmaxnormal= (w*L^2)/8
Zemin= (Mmaxnormal)/sigmaxallowable
Totalload= w+((28*9.81)/10^3)
Mmaxload= (Totalload*L^2)/8
Allowablestress= (Mmaxload*10^3*10^3)/
   Modulusofuniversalbeam
//RESULTS
printf ('Satisafactorybeam=% 2f (254*102*28)',
   Satisfactorybeam)
```

Scilab code Exa 9.2 chapter 9 example 2

```
clc
//initialisation of variables
M= 100*10^6 //Nmm
BeamB= 300 //mm
BeamL= 200 //mm
BeamT= 25 //mm
BeamT2= 20 //mm
//CALCULATIONS
Iz= ((BeamL*BeamB^3)/12)-((BeamL-BeamT)*(BeamB-2*
    BeamT2)^3)/12
sigmaxbyY= -M/Iz
SB= sigmaxbyY*(BeamB/2)
ST= sigmaxbyY*(-BeamB/2)
//RESULTS
printf ('Stress at top of the beam= %.2fN/mm^2(
    Tension)',ST)
printf ('\n Stress at bottom of the beam= %.2fN/mm
    ^2(compression)',SB)
```

Scilab code Exa 9.3 chapter 9 example 3

```
clc
//initialisation of variables
M= 100*10^6 //Nmm
BeamB= 300 //mm
BeamH= 200 //mm
BeamT= 25 //mm
BeamT2= 20 //mm
//CALCULATIONS
Iy= (2*BeamT2*BeamH^3/12)+((BeamB-2*BeamT2)*BeamT
    ^3/12)
alphabyz=-M/Iy
//RESULTS
printf ('sigmax= %.2f *z',alphabyz)
```

Scilab code Exa 9.4 chapter 9 example 4

```
clc
//initialisation of variables
BeamB= 300 //mm
BeamL= 200 //mm
BeamT= 25 //mm
BeamT2= 20 //mm
alpha= 30 //degrees
Mz= 100*10^6*cosd(alpha)//Nmm
My= 100*10^6*sind(alpha)//Nmm
//CALCULATIONS
Iz= ((BeamL*BeamB^3)/12)-((BeamL-BeamT)*(BeamB-2*
    BeamT2)^3)/12
Iy= (2*BeamT2*BeamL^3/12)+((BeamB-2*BeamT2)*BeamT
    ^3/12)
sigmaxtl= (+Mz/Iz)*(BeamB/2)+(My/Iy)*(BeamH/2)
sigmaxtr= (+Mz/Iz)*(BeamB/2)+(My/Iy)*(-BeamH/2)
inclination= atand((My*Iz)/(Mz*Iy))
//RESULTS
printf ('Stress at top left of the beam= %.2fN/mm^2(
    Tension)',sigmaxtl)
printf ('\n Stress at top right of the beam= %.2fN/
    mm^2(compression)',sigmaxtr)
printf ('\n Incination= %.2fdegrees',inclination)
```

Scilab code Exa 9.5 chapter 9 example 5

```
clc
//initialisation of variables
BeamB= 200 //mm
BeamH= 200 //mm
```

```
BeamT= 20 //mm
BeamT2= 20 //mm
sigmaxtop= 150 //N/mm^2
sigmaxbottom= -150 //N/mm^2
//CALCULATIONS
y= ((BeamB*BeamT*BeamT/2)+(BeamH*BeamT2*((BeamH/2)+
   BeamT)))/(BeamB*BeamT+BeamH*BeamT2)
Iz= ((BeamB*(y^3))/3)-(((BeamB-BeamT2)*(y-BeamT)^3)
   /3)+(BeamT2*((BeamH+BeamT-y)^3)/3)
P1= sigmaxtop/((1/(BeamB*BeamT+BeamH*BeamT2))+((y-
   BeamT/2)*y/Iz))
P2= (sigmaxbottom/((1/(BeamB*BeamT+BeamH*BeamT2))+((
   y-BeamT/2)*(-(BeamH+BeamT-y))/Iz)))
if(P1>P2)
    disp(P2)
else
    disp(P1)
end
```

Scilab code Exa 9.6 chapter 9 example 6

```
clc
//initialisation of variables
Height= 7 //m
Thickness= 0.6 //m
density= 2000 //Kg/m^3
//CALCULATIONS
W= density*9.81*Thickness*Height
p= 0.1*W*2/(Height*Height)
//RESULTS
printf ('p= %.2f N/m^1',p)
```

Scilab code Exa 9.8 chapter 9 example 8

```
clc
//initialisation of variables
M= 1500 //Nm
x1= 40 //mm
x2= 80 //mm
x3= 8 //mm
y1= 8 //mm
y2= 80 //mm
//CALCULATIONS
Ycentroid= (((x1+x2)*y1*y1/2)+(y2*x3*((y2/2)+y1)))
    /((x1+x2)*y1+y2*x3)
Zcentroid= (((y2*x3*y1/2)+((x1+x2)*x3*((y2/2)+y1)/2)
    )/((x1+x2)*y1+y2*x3))
Iz= (((x1+x2)*(y1)^3)/12)+(x1+x2)*y1*((Ycentroid-(y1
    /2))^2)+(x3/12)*(y2^3)+y2*x3*((y2/2)-(Ycentroid-
    y1))^2
Iy= (y1*(((x1+x2)^3)/12))+(x1+x2)*y1*(y1^2)+((x3^3)
    /12)*(y2)+y2*x3*((Zcentroid-(x3/2))^2)
Izy= (x1+x2)*y1*(-y1)*(Ycentroid-(y1/2))+y2*x3*(
    Zcentroid-(x3/2))*(-(y2/2)+(Ycentroid-y1))
sigmax= ((-M*10^3*Izy*x3)+(-M*10^3*Iy*(y2-Ycentroid+
    y1)))/((Iz*Iy)-(Izy)^2)
//RESULTS
printf ('Maximum direct stress= %.2f N/mm^2',sigmax)
```

Chapter 11

Torsion of Beams

Scilab code Exa 11.1 chapter 11 example 1

```
clc
//initialisation of variables
Lab= 2 //m
Lbc= 0.5 //m
Dab= 200 //mm
Dbc= 100 //mm
T= 50 //KNm
G= 80000 //N/mm^2
//CALCULATIONS
Jab= %pi*Dab^4/32
Jbc= %pi*Dbc^4/32
Tc= T/((Lbc*Jab)/(Lab*Jbc)+1)
Ta= T-Tc
if(Dab<Dbc)
    Dbc=Dab;Tc=Ta;
else
    Dab=Dab;Tc=Tc
end
Stressmax= (Tc*10^6*Dbc*32)/(2*%pi*Dbc^4)
angleoftwist= Ta*10^6*Lab*32*10^3*180/(G*%pi*Dab^4*
   %pi)
```

```
//RESULTS
printf ('Stress max= %.1f N/mm^2',Stressmax)
printf (' \n Anlge of twist=% 2f degrees',
    angleoftwist)
```

Scilab code Exa 11.2 chapter 11 example 2

```
clc
//initialisation of variables
d= 200 //mm
l= 2 //m
Shearstressmax= 200 //N/mm^2
Maximumangleoftwist= 2 //degrees
Maxtorque= 30/2 //KNm
G= 25000 //N/mm^2
//CALCULATIONS
tmin= (Maxtorque*10^6*4)/(2*%pi*d^2*Shearstressmax)
x1=l/2
c=0
dtbydx= (Maxtorque*%pi*200*16)/(4*%pi^2*d^4*G*tmin)
theta= (Maxtorque*%pi*200*16)/(4*%pi^2*d^4*G*tmin)*
    x1+c
tminimum= (Maxtorque*%pi*200*10^9*180*16)/(4*%pi^2*d
    ^4*G*Maximumangleoftwist*%pi)*x1
//RESULTS
printf ('minimum allowable thickness= %.1f mm',
    tminimum)
```

Scilab code Exa 12.8 chapter 12 example 8

```
clc
b=250 //mm
BM=350*10^3 //Nm
```

```
SigmaCu=30 //N/mm^2
SigmaY=400 //N/mm^2
d1=sqrt(BM*10^3 /(0.15*SigmaCu*b))
lever=3*d1/4
As=BM*10^3/(0.87*SigmaY*lever)
printf("As=%f mmm^2",As)
```

Chapter 12

Composite Beams

Scilab code Exa 12.1 chapter 12 example 1

```
clc
//initialisation of variables
TimberB= 100 //mm
TimberH= 400 //mm
SteelB= 12 //mm
SteelH= 300 //mm
Bm= 50 //KNm
ratio= 12
//CALCULATIONS
It= 2*TimberB*TimberH^3/12
Is= ratio*SteelH^3/12
sigmat= -(Bm*10^6*TimberH/2)/(It+ratio*Is)
sigmas= -(Bm*10^6*SteelH/2)/(Is+It/ratio)
//RESULTS
printf ('Maximum stress in timber= %.1f mm^2 (+ or
    -)',sigmat)
printf (' \n Maximum stress in steel=%.1f N/mm^2 (+
    or -)',sigmas)
```

Scilab code Exa 12.2 chapter 12 example 2

```
clc
TimberB=100 //mm
TimberH=200 //mm
It=TimberB*TimberH^3 /12
SteelB=15 //mm
SteelH=100 //mm
ratio=15
Is=2*SteelB*SteelH*(SteelH+SteelB/2)^2
Load=10 //KN/m
Span=4 //m
Mmax=Load*Span^2 *10^6 /8 //Nm
sigmaT=Mmax*TimberH/2/(It+ratio*Is)
sigmaS=Mmax*(SteelH+SteelB)/(Is+It/ratio)
printf("The maximum stress in Timber=%f N/mm^2",
    sigmaT)
printf(" \n The maximum stress in Steel=%f N/mm^2",
    sigmaS)
Shear=Load*Span/2
printf("Max. Shear force in beam at the supports =
    %f kN", Shear)
Tav=Mmax/(TimberH*TimberB)
ShearPerlength=Tav*TimberB
printf("\n Shear force per unit length in timber/
    steel connection= %f N/m",ShearPerlength)
```

Scilab code Exa 12.3 chapter 12 example 3

```
clc
b=200 //mm
d=350 //mm
dia=20 //mm
BM=30*10^3 //Nm
m=15
```

```
As=2*%pi*dia^2 /4
n=m*As*(sqrt(1+ 2*b*d/(m*As))-1)/b
Ic=b*n^3 /3 + m*As*(d-n)^2
SigmaC=-BM*n*10^3/Ic
printf("Stress in concrete=%f N/mm^2 compression",
   SigmaC)
SigmaS=m*BM*10^3*(d-n)/Ic
printf("\n Stress in Steel=%f N/mm^2 tension",SigmaS
   )
```

Scilab code Exa 12.4 chapter 12 example 4

```
clc
b=250 //mm
d=400 //mm
dia=20 //mm
n=3
SigmaC=7 //N/mm^2
SigmaS=140 //N/mm^2
m=15
As=n*%pi*dia^2 /4
n=m*As*(sqrt(1+ 2*b*d/(m*As))-1)/b
BMC=SigmaC*b*n*(d-n/3)*10^(-6) /2
BMS=SigmaS*As*(d-n/3)*10^(-6)
if BMC>=BMS then
    printf("Limiting material is Steel and moment of
        resistance of the beam is %f",BMS)
else
    printf("Limiting material is Concrete and moment
        of resistance of the beam is %f",BMC)
end
```

Scilab code Exa 12.5 chapter 12 example 5

```
clc
d=400 //mm
m=15
ASs=120 //N/mm^2
ASc=6.5 //N/mm^2
BM=40*10^3 //Nm
n=d/(ASs/(ASc*m) +1 )
As=BM*10^3/(ASs*(d-n/3))
printf("required area= %f mm^2",As)
```

Scilab code Exa 12.6 chapter 12 example 6

```
clc
b=180 //mm
d=360 //mm
m=15
BM=45*10^3 //Nm
depth=40 //mm
Sc=8.5 //N/mm^2
Ss=140 //N/mm^2
n=d/(Ss/(Sc*m) +1 )
Ast=(BM*10^3 - Sc*b*n*(n/3 - depth)/2)/(Ss*(d-depth)
   )
Asc=(m*Ast*(d-n) - b*n^2 /2 )/((m-1)*(n-depth))
SigmaSC=-m*(n-depth)*Sc/n
printf("Area of reinforcement steel = %f mm^2",Ast)
printf("\n Area of reinforcement concrete= %f mm^2",
   Asc)
printf("\n Stress in compresson steel=%f N/mm^2
   compression",SigmaSC)
```

Scilab code Exa 12.7 chapter 12 example 7

```
//CLC
d= 600 //mm
b= 250 //mm
BM= 350 //KNm
t= 28
Sc= 30 //N/mm^2
T= 400 //N/mm^2
//CALCULATIONS
Mu= 0.15*Sc*b*d^2*10^-6
n= d-sqrt(d^2-(2*BM*10^6/(0.4*Sc*b)))
l= d-(n/2)
As= BM*10^6/(l*T*0.87)
//RESULTS
printf("As(mm^2) = %.2f",As)
```

Scilab code Exa 12.8 chapter 12 example 8

```
clc
b=250 //mm
BM=350*10^3 //Nm
SigmaCu=30 //N/mm^2
SigmaY=400 //N/mm^2
d1=sqrt(BM*10^3 /(0.15*SigmaCu*b))
lever=3*d1/4
As=BM*10^3/(0.87*SigmaY*lever)
printf("As=%f mmm^2",As)
```

Scilab code Exa 12.9 chapter 12 example 9

```
clc
b=300 //mm
d=618 //mm
depth=60 //mm
```

```
SigmaCu=30 //N/mm^2
SigmaY=410 //N/mm^2
BM=650 //Nm
Mu=0.15*SigmaCu*b*d^2 *10^(-6)
Asc=(BM-Mu)*10^6 /((d-depth)*0.72*SigmaY)
Ast=Mu*10^6/(0.75*d*SigmaY*0.87) + (BM-Mu)*10^6/((d-
    depth)*0.87*SigmaY)
printf("Asc=%f mm^2",Asc)
printf("\n  Ast=%f mm^2",Ast)
```

Scilab code Exa 12.10 chapter 12 example 10

```
//CLC
w= 1200 //mm
d= 618 //mm
t= 150 //mm
BM= 500 //KNm
Scu= 30 //N/mm^2
Sy= 410 //mm^2
//CALCULATIONS
Mu= 0.4*Scu*w*t*(d-(t/2))*10^-6
n= d-sqrt(d^2-(2*BM*10^6/(0.4*Scu*w)))
l= d-(n/2)
As= BM*10^6/(0.87*Sy*l)
//RESULTS
printf("As(mm^2)  = %.2f",As)
```

Scilab code Exa 12.11 chapter 12 example 11

```
clc
thick=150 //mm
width=1.8 //m
depth=562 //mm
```

```
SigmaCu=30 //N/mm^2
SigmaY=350 //N/mm^2
BM=709 //KNm
As=2*BM*10^6 /(0.87*SigmaY*depth)
Tensile=0.87*SigmaY*As
disp(Tensile)
Compressive=0.4*width*thick*SigmaCu*10^3
disp(Compressive)
n1=0.87*SigmaY*8530/(0.4*SigmaCu*width*10^3)
disp(n1)
Mu=0.87*SigmaY*8530*(SigmaY+6-n1/2)*10^(-6)
printf("Mu=%f KNm",Mu)
printf("\n This is greater than applied moment.
   hence it is satisfactory")
```

Chapter 14

Complex stress and Strain

Scilab code Exa 14.1 chapter 14 example 1

```
clc
//initialisation of variables
d= 2 //m
t= 20 //mm
p= 1.5 //N/mm^2
load= 2500 //KN
alpha= 60 //degrees
//CALCULATIONS
Cs= (p*d*10^3)/(2*t)
Ls= (p*d*10^3)/(4*t)
Ds= (load*10^3)/(%pi*d*t*10^3)
Ts= Ls+Ds
sigman= (Ts*t*(cosd(90-alpha))^2+Cs*t*(cosd(alpha))
    ^2)/t
tab= Ts*sind(alpha)*cosd(alpha)-Cs*sind(alpha)*cosd(
    alpha)
tmax= (Ts-Cs)/2
//RESULTS
printf ('direct stress= %.1f N/mm^2',sigman)
printf (' \n Shear stress=%.1f N/mm^2',tab)
printf (' \n maximum Shear stress=%.1f N/mm^2',tmax)
```

Scilab code Exa 14.2 chapter 14 example 2

```
clc
//initialisation of variables
load= 50000 //N
torque= 1200 //Nm
d= 60//mm
t= 1.5 //mm
alpha= 60 //degrees
//CALCULATIONS
BM= load*t
axialload= (load*4)/(%pi*d^2)
bendingmoment= (BM*d*64)/(%pi*d^4*2)
Ts= axialload+bendingmoment
shearstress= (torque*10^3*d*32)/(2*%pi*d^4)
sigman= -Ts*(cosd(alpha-30))^2+shearstress*cosd(alpha-30)*sind(alpha-30)+shearstress*cosd(alpha-30)*sind(alpha-30)
T= -Ts*sind(alpha)*cosd(alpha)-shearstress*(sind(alpha))^2+shearstress*(cosd(alpha)^2)
//RESULTS
printf ('direct stress= %.1f N/mm^2',sigman)
printf (' \n Shear stress=%.1f N/mm^2',T)
```

Scilab code Exa 14.3 chapter 14 example 3

```
clc
//initialisation of variables
directstress= 80 //N.mm^2
shearstress= 45 //N/mm^2
//CALCULATIONS
```

```
Sx= directstress
Sy= 0
Txy= shearstress
sigma1= ((Sx+Sy)/2)+(sqrt((Sx-Sy)^2+4*Txy^2))/2
sigma2= ((Sx+Sy)/2)-(sqrt((Sx-Sy)^2+4*Txy^2))/2
theta= (atand(-((2*Txy)/(Sx-Sy))))/2
direction1= theta
direction2= theta-90
Tmax= (sigma1-sigma2) /2
theta1= direction1-45
theta2= direction2-45
//RESULTS
printf ('principal stress1= %.1f N/mm^2',sigma1)
printf (' \n principal stress2=%.1f N/mm^2',sigma2)
printf (' \n direction of principal stress1=%.1f degrees',direction1)
printf (' \n.direction of principal stress2=%.1f degrees',direction2)
printf (' \n.maximum shear stress=%.1f N/mm^2',Tmax)
printf (' \n.derection of plane1=%.1f degrees',theta1)
printf (' \n.derection of plane2=%.1f degrees',theta2)
```

Scilab code Exa 14.5 chapter 14 example 5

```
clc
//initialisation of variables
sigmax= 60 //N/mm^2
sigmay= -40 //N/mm^2
Txy= 50 //N/mm^2
E= 200000 //N/mm^2
mu= 0.3
//CALCULATIONS
Sx= (sigmax-mu*sigmay)/E
```

```
Sy= (sigmay-mu*sigmax)/E
G= E/(2*(1+mu))
gamaxy= Txy/G
e1= ((Sx+Sy)/2+(sqrt((Sx-Sy)^2+(gamaxy)^2))/2)
e2= ((Sx+Sy)-(sqrt((Sx-Sy)^2+gamaxy^2)))/2
theta= atand(-gamaxy/(Sx-Sy))/2
theta1= -90+theta
//RESULTS
printf ('direct strain in x direction= %.2e ',Sx)
printf (' \n direct strain in y direction=%.2e ',Sy)
printf (' \n Gamaxy=%.2e ',gamaxy)
printf (' \n.principal strain1=%.9e ',e1)
printf (' \n.principal strain2=%.9e ',e2)
printf (' \n.direction of plane1=%.1f degrees',theta
   )
printf (' \n.direction of plane2=%.1f degrees',
   theta1)
```

Scilab code Exa 14.6 chapter 14 example 6

```
clc
//initialisation of variables
ea= 1000*10^-6
eb= -200*10^-6
ec= -300*10^-6
sigmay= 0 //N/mm^2
E= 70000 //N/mm^2
mu= 0.3
d= 50 //mm
//CALCULATIONS
e1= ((ea+ec)/2)+sqrt(((ea-eb)^2+(ec-eb)^2)/2)
e2= ((ea+ec)/2)-sqrt(((ea-eb)^2+(ec-eb)^2)/2)
sigma1= (E*(e1+mu*e2))/(1-mu^2)
sigma2= (E*(e2+mu*e1))/(1-mu^2)
sigmax= sigma1+sigma2
```

```
Txy= sqrt((((sigma1*2)-(sigmax))^2-(sigmax^2)))/2
P= sigmax*((%pi/4)*(d^2))
T= Txy*((%pi/32)*(50^4)/25)
//RESULTS
printf ('T= %.2fNm',T)
printf ('\n P= %.2fN',P)
```

Scilab code Exa 14.7 chapter 14 example 7

```
clc
//initialisation of variables
sigmax= 140 //N/mm^2
sigmay= -70 //N/mm^2
Txy= 60 //N/mm^2
T= 225 //N/mm^2
//CALCULATIONS
sigma1= (sigmax+sigmay)/2+(sqrt((sigmax-sigmay)^2+4*(Txy^2)))/2
sigma2= (sigmax+sigmay)/2-(sqrt((sigmax-sigmay)^2+4*(Txy^2)))/2
sigmaY= sigma1-sigma2
sigmaY1= sqrt(sigma1^2+sigma2^2-sigma1*sigma2)
if(sigmaY>T)
    disp("Tresca theory failure has ocurred")
else
    disp("Tresca theory failed")
end
if(sigmaY1<T)
    disp("According to Von Mises theory material has not failed")
else
    disp("According to Von Mises theory material has failed")
end
```

Scilab code Exa 14.8 chapter 14 example 8

```
clc
//initialisation of variables
M= 250 //KNm
Torquemax= 200 //KNm
allowablestress= 180 //N/mm^2
L=250 //mm
B= 500 //mm
t= 10 //mm
t1= 12 //mm
//CALCULATIONS
Stressmax= (Torquemax*10^6)/(2*B*L*t)
I= (2*t1*L*L^2)+((2*t*B^3)/12)
sigma= (M*10^6*B)/(2*I)
Stressallowable= sqrt(sigma^2+3*(Stressmax^2))
if(Stressallowable<allowablestress)
    disp("Box grider section is satisfactory")
else
    disp("Box grider section is  not satisfactory")
end
```

Scilab code Exa 14.9 chapter 14 example 9

```
clc
//initialisation of variables
BeamL= 60 //mm
BeamB= 100 //mm
Load= 60000 //N
Stress=  150 //N/mm^2
//CALCULATIONS
sigmax= Load/(BeamL*BeamB)
```

```
stressmax1= sqrt((Stress/2)^2-(sigmax^2/4))
Sy1= (2*stressmax1*BeamL*BeamB)/3
stressmax2= sqrt((Stress^2-(sigmax^2/4))/3-(sigmax
    ^2/4))
Sy2= (2*stressmax2*BeamL*BeamB)/3
//RESULTS
printf ('Shear force using Tresca= %.2e N',Sy1)
printf (' \n Shear force using Von Misses=%.2e N',
    Sy2)
```

Scilab code Exa 14.10 chapter 14 example 10

```
clc
//initialisation of variables
BeamL= 250 //mm
BeamH= 500 //mm
spanlength= 4 //m
Failurestress= 1.5 //N/mm^2
//CALCULATIONS
W1= (Failurestress*BeamL*BeamH^3)/(10^3*BeamL*12)
W2= (4*Failurestress*BeamL*BeamH)/3
if(W1>W2)
    printf ("W2= %.2e kN",W2)
else
    printf ("W2= %.2e kN",W1)
```

Chapter 15

Virtual Work and Energy Methods

Scilab code Exa 15.3 chapter 15 example 3

```
clc
//initialisation of variables
Xae= 3 //m
Ycd= 4 //m
Yde= 4 //m
Fc= 30 //KN
//CALCULATIONS
Fba= Fc*Ycd/Xae
//RESULTS
printf ('Fba= %.2fKN',Fba)
```

Chapter 16

Analysis of Statically Indeterminate Structures

Scilab code Exa 16.1 chapter 16 example 1

```
clc
//initialisation of variables
M= 4
N= 3
r= 5
//CALCULATIONS
Ns= 3*(M-N+1)-r
nk= 3*N-M
//RESULTS
printf ('Ns= %.f ',Ns)
printf (' \n Nk= %.f ',nk)
```

Scilab code Exa 16.2 chapter 16 example 2

```
clc
//initialisation of variables
```

```
M= 17
N= 8
r= 27
st= 3
pt= 2
n= 8
//CALCULATIONS
ns= 3*(M-N+1)-r
nk= n*pt-st
//RESULTS
printf ('Ns= %.f ',ns)
printf (' \n Nk= %.f ',nk)
```

Scilab code Exa 16.3 chapter 16 example 3

```
clc
//initialisation of variables
M= 7
N= 6
r= 3
n= 6
df= 3
//CALCULATIONS
ns= 3*(M-N+1)-r
nk= n*df-r
//RESULTS
printf ('Ns= %.f ',ns)
printf (' \n Nk= %.f ',nk)
```

Scilab code Exa 16.4 chapter 16 example 4

```
clc
//initialisation of variables
```

```
M= 19
N= 13
r= 0
n= 6
no= 13
c= 24
//CALCULATIONS
ns= n*(M-N+1)-r
nk= n*no-c
//RESULTS
printf ('Ns= %.f ',ns)
printf (' \n Nk= %.f ',nk)
```

Scilab code Exa 16.7 chapter 16 example 7

```
clc
//initialisation of variables
F1= -6 //KN
F2= -10 //KN
W= -12 //KN/m
E= 200000 //N/mm^2
I= 12000 //mm^4
x1= 0.5 //m
x2= 0.5 //m
x3= 0.5 //m
x4= 0.5 //m
x5= 1.0 //m
//CALCULATIONS
vb0= 8.88/(E*I)
vc0= 9.089/(E*I)
a11= 0.45/(E*I)
a21= 0.39/(E*I)
a22= a11
a12= a21
A=[0.45 0.39;0.39 0.45]
```

```
b=[8.88;9.08]
c=A\b
R1=c(1,1)
R2=c(2,1)
Ra= -((F1*(x2+x3+x4+x5)+R1*(x3+x4+x5)+F2*(x4+x5)+R2
   *(x5)+(W*x5)*(x5/2)))/(x1+x2+x3+x4+x5)
Rd= -F1-F2-W*x5-R1-R2-Ra
//RESULTS
printf ('R1= %.2f KN',R1)
printf (' \n R2=%.2f KN',R2)
printf (' \n Ra=%.2f KN',Ra)
printf (' \n Rd=%.2f KN',Rd)
```

Scilab code Exa 16.13 chapter 16 example 13

```
clc
//initialisation of variables
W= -10 //KN/m
r= 5 //m
//CALCULATIONS
Rav= -W*2*r/2
Rbv= Rav
function[y]=conv(x)
    y=125*(sin(x))^2*5*(sin(x))*5
endfunction
v=intg(0,%pi,conv)
function[y]=conk(x)
    y=25*(sin(x))^2*5
endfunction
k=intg(0,%pi,conk)
Rbh= v/k
Rah= Rbh
//RESULTS
printf ('Rav= %.2f KN',Rav)
printf (' \n Rbv=%.2f KN',Rbv)
```

```
printf (' \n Rah=%.2f KN',Rah)
printf (' \n Rbh=%.2f KN',Rbh)
```

Scilab code Exa 16.18 chapter 16 example 18

```
//CLC
x1= 7 //m
x2= 7 //m
x3= 4 //m
x4= 4 //m
x5= 4 //m
x6= 12 //m
x7= 4 //m
Fab= 12 //KN
Fbc1= 7 //KN
Fbc2= 7 //KN
Fcd= 22 //KN
Fe= 5 //KN
//CALCULATIONS
MfAB= -Fab*(x1+x2)/(x3+x4)
MfBC= -(Fbc1*x3*(x4+x5)^2/(x6)^2)-(Fbc2*x3^2*(x4+x5)
   /(x6)^2)
MfCD= -Fcd*x6/x6
MfDE= -Fe*x7
DFba= (3/(x1+x2))/((3/(x1+x2))+(4/(x3+x4+x5)))
DFbc= 1-DFba
DFcb= (4/(x3+x4+x5))/((3/(x6))+(4/(x3+x4+x5)))
DFcd= 1-DFcb
//RESULTS
printf("DFba = %.2f",DFba)
printf("DFbc = %.2f",DFbc)
printf("DFcb = %.2f",DFcb)
printf("DFcd = %.2f",DFcd)
```

Scilab code Exa 16.19 chapter 16 example 19

```
clc
//initialisation of variables
W1= 5 //KN/m
W2= 5 //KN/m
F= -40 //KN
l1= 6 //m
l2= 5 //m
l3= 5 //m
l4= 6 //m
//CALCULATIONS
Mfab= -W1*l1^2/12
Mfbc= F*l2/8
DFab= (3/l1)/((3/l1)+(2/(l2+l3)))
DFbc= 1-DFab
//RESULTS
printf ('MFab= %.f KN m',Mfab)
printf (' \n MFbc= %.f KN m',Mfbc)
printf (' \n DFab= %.2f ',DFab)
printf (' \n DFbc= %.2f.',DFbc)
```

Scilab code Exa 16.20 chapter 16 example 20

```
clc
//initialisation of variables
W= 6 //KN/m
F= 40 //KN
l1= 5 //m
l2= 3 //m
l3= 3 //m
l= 12 //mm
```

```
Smab= 9*10^6 //mm^4
Smbc= 12*10^6 //mm^4
E= 200000 //N/mm^2
//CALCULATIONS
MFab= (-W*l1^2/12)+((-W*Smab*E*l))/((l1*10^3)^2*10^6)
MFba= (W*l1^2/12)+((-W*Smab*E*l))/((l1*10^3)^2*10^6)
MFbc= -(F*(l2+l3)/8)+(3*E*Smbc*l)/(((l2+l3)*10^3)^2*10^6)
MFcb= (F*(l2+l3)/8)
DFba= ((4*E*Smab)/l1)/((((4*E*Smab)/l1)+((3*E*Smbc)/(l2+l3)))
DFbc= 1-DFba
//RESULTS
printf ('MFab= %.1f KN m',MFab)
printf (' \n MFbc= %.1f KN m',MFba)
printf (' \n MFbc= %.1f KN m',MFbc)
printf (' \n MFbc= %.1f KN m',MFcb)
printf (' \n DFab= %.2f ',DFba)
printf (' \n DFbc= %.2f. ',DFbc)
```

Scilab code Exa 16.21 chapter 16 example 21

```
//CLC
x1= 4 //m
x2= 4 //m
x3= 4 //m
x4= 16 //m
F1= 12 //KN
F2= 12 //KN
F3= 1 //KNm
y= 12 //m
//CALCULATIONS
MFab= -(F1*x1*(x2+x3)^2/(y)^2)-(F2*x3^2*(x1+x2)/(y)^2)
```

```
MFbc= -F3*x4^2/y
DFad= (4/y)/((4/(x1+x2+x3))+(4/y))
DFab= 1-DFad
DFba=  (4/(x1+x2+x3))/((4/x4)+(3/y)+(4/(x1+x2+x3)))
DFbc= (4/x4)/((4/x4)+(3/y)+(4/(x1+x2+x3)))
DFbe= 1-DFba-DFbc
//RESULTS
printf("DFab = %.2f",DFab)
printf("DFbc = %.2f",DFbc)
printf("DFba = %.2f",DFba)
printf("DFad = %.2f",DFad)
```

Scilab code Exa 16.22 chapter 16 example 22

```
//CLC
x1= 5 //m
x2= 10 //m
y= 10 //m
Fb= 2 //KN
Fbc= 4 //KN
Rbc= 2
//CALCULATIONS
MFbc= -Fbc*x1*x2^2/(x1+x2)^2
MFcb= Fbc*x2*x1^2/(x1+x2)^2
DFba= (4/y)/((4/y)+(4*Rbc/(x1+x2)))
DFbc= 1-DFba
//RESULTS
printf("DFba = %.2f",DFba)
printf("DFbc = %.2f",DFbc)
```

Scilab code Exa 16.23 chapter 16 example 23

```
//CLC
```

```
x1= 6 //m
x2= 4.5 //m
y1= 3 //m
y2= 3 //m
Fba= 40 //KN
Fbc= 20 //KNm
//CALCULATIONS
MFba= -Fba*(y1+y2)/8
MFbc= Fbc*x1^2/12
x= sqrt(x1^2+x2^2)
DFba= (4/(y1+y2))/((4/(y1+y2))+(4/(x1)))
DFbc= 1-DFba
DFcb= (4/x1)/((4/x1)+(3/x))
DFcd= 1-DFcb
//RESULTS
printf("DFba = %.2f",DFba)
printf("DFbc = %.2f",DFbc)
printf("DFcb = %.3f",DFcb)
printf("DFcd = %.3f",DFcd)
```

Chapter 18

Plastic Analysis of Beams and Frames

Scilab code Exa 18.1 chapter 18 example 1

```
clc
//initialisation of variables
sigmay= 100 //N/mm^2
b= 10 //mm
d= 12 //mm
//CALCULATIONS
My= sigmay*b*d^3*2/(d*12)
Mp= sigmay*b*(d/2)*(d/2)
f= Mp/My
//RESULTS
printf ('f= %.1f',f)
```

Scilab code Exa 18.2 chapter 18 example 2

```
clc
//initialisation of variables
```

```
d= 300 //mm
b= 150 //mm
tw= 8 //mm
tf= 12 //mm
//CALCULATIONS
Zp= b*tf*(d-tf)+(tw*((d-2*tf)^2))/4
Ze= (2/d)*((b*d^3)/12-((b-tw)*(d-2*tf)^3)/12)
f= Zp/Ze
//RESULTS
printf ('f= %.2f',f)
```

Scilab code Exa 18.3 chapter 18 example 3

```
clc
//initialisation of variables
d= 200 //mm
b= 150 //mm
tw= 7 //mm
tf= 10 //mm
//CALCULATIONS
ye= (b*tf*(tf/2)+(d-tf)*tw*((d+tf)/2))/(b*tf+(d-tf)*
    tw)
I= ((b*ye^3)/3)-(b-tw)*(((ye-tf)^3)/3)+(tw*((d-ye)
    ^3)/3)
Ze= I/(d-ye)
yp= (b*tf+(d-tf)*tw)/(2*b)
Zp= b*yp*yp/2+b*(tf-yp)*(tf-yp)/2+(d-tf)*tw*((d-tf)
    /2+(tf-yp))
f= Zp/Ze
//RESULTS
printf ('fie= %.2f',f)
```

Scilab code Exa 18.7 chapter 18 example 7

```
clc
//initialisation of variables
Load= 100 //KN
Length= 10 //m
yieldstress= 300 //N/mm^2
loadfactor= 1.5
//CALCULATIONS
requiredultimateload= loadfactor*Load
Mp= requiredultimateload*Length/6
Zp= Mp/yieldstress
//RESULTS
printf ('Zp= %.1e mm^3',Zp)
disp("The appropriate beam for this is 406*140*49")
```

Chapter 20

Influenece Lines

Scilab code Exa 20.1 chapter 20 example 1

```
clc
//initialisation of variables
Xac= 2 //m
Xcb= 4 //m
Xbd= 2 //m
Wa= 1 //N
Wc= 1 //N
Wd= 1 //N
//CALCULATIONS
Rb= Wa*Xac/(Xac+Xcb)
Sc= Rb
Ra= Wc*Xcb/(Xac+Xcb)
Sc1= -Ra
Ra1=-Wd*Xbd/(Xac+Xcb)
Mc= Ra*Xac
Mc1= Ra1*Xac
//RESULTS
printf ('Rb= %.2f KN',Rb)
printf (' \n Ra= %.2f KN ',Ra)
printf (' \n Ra= %.2f KN ',Ra1)
printf (' \n Mc= %.2f KN m',Mc1)
```

Scilab code Exa 20.2 chapter 20 example 2

```
clc
//initialisation of variables
xac= 2 //m
xcb= 4 //m
xbd= 2 //m
//CALCULATIONS
C1e= xac/((xac)+(xcb))
C1f= xcb/ ((xac)+(xcb))
C2h= 1/((1/xac)+(1/xcb))
//RESULTS
printf ('C1e= %.2f m',C1e)
printf (' \n C1f= %.2f m',C1f)
printf (' \n C2h= %.2f m',C2h)
```

Scilab code Exa 20.3 chapter 20 example 3

```
clc
//initialisation of variables
W1= 3 //KN
W2= 4 //KN
W3= 5 //KN
x1= 0.3 //m
x2= 0.1 //m
x3= 0.5 //m
x4= 0.7 //m
//CALCULATIONS
Skmax= W3*x1+W2*x2
Sk1= W1*(-x4)+W2*(-x3)+W3*(-x1)
Sk2= W1*(x2)+W2*(-x4)+W3*(-x3)
```

```
//RESULTS
printf ('Sk(max)= %.2f KN',Skmax)
printf (' \n Sk= %.2f KN',Sk1)
printf (' \n Sk= %.2f KN',Sk2)
```

Scilab code Exa 20.4 chapter 20 example 4

```
clc
//initialisation of variables
W= 2 //KN/m
l= 2 //m
x1= 0.05
x2= 0.25
x3= 0.75
x4= 0.55
x5= 1.5
x6= 1.875
l1= 0.5 //m
l2= 1.5 //m
//CALCULATIONS
Sk= W*l*(1/2)*(x1+x2)
Sk1= -W*l*(1/2)*(x3+x4)
Mk= W*((1/2)*(x5+x6)*l1+(1/2)*(x5+x6)*l2)
//RESULTS
printf ('Sk(max +)= %.2f KN',Sk)
printf (' \n Sk(max -)= %.2f KN',Sk1)
printf (' \n Mk(max)= %.2f KN m',Mk)
```

Scilab code Exa 20.6 chapter 20 example 6

```
clc
//initialisation of variables
W1= 9 //KN
```

```
W2= 15 //KN
W3= 15 //KN
W4= 8 //KN
W5= 8 //KN
x1= 2 //m
x2= 2.3 //m
x3= 2.7 //m
x4= 2.3 //m
l= 20 //m
l1= 10.105 //m
//CALCULATIONS
x= (W2*x1+W3*(x1+x2)+W4*(x1+x2+x3)+W5*(x1+x2+x3+x4))/(W1+W2+W3+W4)
Ra= (W1+W2+W3+W4+W5)*l1/l
Mk= ((W1+W2+W3+W4+W5)/l)*l1*l1-W1*(x1+x2)-W2*x2
//RESULTS
printf ('Ra= %.1f KN',Ra)
printf (' \n Mk= %.1f KN',Mk)
```

Scilab code Exa 20.7 chapter 20 example 7

```
clc
//initialisation of variables
W= 2.5 //KN/m
n= 8
x= 1.4 //m
y= 1.4 //m
l= 4 //m
x1= 2.5
x2= 3.2
x3= 0.25
x4= 0.3125
x5= 0.625
x6= 0.5
x7= 3.5
```

```
a= 45 //degrees
//CALCULATIONS
Fec= x1*x2*x3*(1/2)/sind(a)
Scd= W*(0.5*(x4+x5)*x6+0.5*(x5+x4)*x7)
Fec1= Scd/sind(a)
//RESULTS
printf ('Maximum compressive force= %.2f KN',Fec)
printf (' \n Maximum tensile force= %.2f KN',Fec1)
```

Scilab code Exa 20.8 chapter 20 example 8

```
clc
//initialisation of variables
W= 1.5 //KN/m
W1= 1 //KN/m
n=10
x= 0.9 //m
y= 1.2 //m
x1= 5
x2= 0.5
x3= 4
x4= 0.4
x5= 6
x6= 0.6
x7= 3
x8= 0.3
//CALCULATIONS
S5= -1*0.5*x1*x2+2.5*0.5*x3*x4
S51= -1*0.5*x5*x6+2.5*0.5*x7*x8
//RESULTS
printf ('S5= %.2f KN',S5)
printf (' \n S4= %.2f KN',S51)
```