Scilab Textbook Companion for Strength Of Materials by B. K. Sarkar[1]

Created by
Nitin Kumar
B. Tech
Electronics Engineering
Uktu
College Teacher
None
Cross-Checked by
None

July 30, 2019

[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: Strength Of Materials

Author: B. K. Sarkar

Publisher: Tata McGraw-Hill Education, Delhi

Edition: 1

Year: 2003

ISBN: 0070494843

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 1

Bending Stresses in Beams

Scilab code Exa 1.1 centroid of the section

```
// Problem 1.1,Page No.8


clc;clear;
close;

//Rectangle-1
a_1=37.5 //cm**2
y_1=26.25 //cm

//Rectangle-2
a_2=50    //cm**2
y_2=15    //cm

//Rectangle-3
a_3=150   //cm**2
y_3=2.5   //cm


//Calculation

```

```
Y_bar=(a_1*y_1+a_2*y_2+a_3*y_3)*(a_1+a_2+a_3)**-1 //
    cm

//Result
printf("The centroid of the section is %.2f cm",
    Y_bar)
```

Scilab code Exa 1.2 centre of gravity

```
// Problem 1.2,Page No.9


clc;clear;
close;

//Area-1
a_1=6 //cm**2
x_1=3 //cm
y_1=0.5 //cm

//Area-2
a_2=6 //cm**2
x_2=2.671 //cm
y_2=3 //cm

//Area-3
a_3=16 //cm**2
x_3=1 //cm
y_3=5 //cm


//Calculation


```

```
X_bar=(a_1*x_1+a_2*x_2+a_3*x_3)*(a_1+a_2+a_3)**-1 //cm
Y_bar=(a_1*y_1+a_2*y_2+a_3*y_3)*(a_1+a_2+a_3)**-1 //cm


//Result
printf("The centre of gravity of section is %.2f cm",X_bar)
printf("\n The centre of gravity of section is %.2f cm",Y_bar)
```

Scilab code Exa 1.3 centre of gravity

```
// Problem 1.3,Page no.10

clc;clear;
close;

//Area-1
a_1=93.75 //cm**2
y_1=6.25 //cm

//Area-2
a_2=93.75 //cm**2
y_2=6.25 //cm

//Area-3
a_3=375 //cm**2
y_3=9.375 //cm

//Area-4
a_4=353.43 //cm**2
y_4=6.366 //cm

```

```
//Calculation

Y_bar=(a_1*y_1+a_2*y_2+a_3*y_3-a_4*y_4)*(a_1+a_2+a_3
   -a_4)**-1 //cm


//Result
printf("The centre of gravity lies at a distance of
   %.2f cm",Y_bar)
```

Scilab code Exa 1.4 centre of gravity

```
// Problem 1.4,Page no.10


clc;clear;
close;


a_1=36*%pi //cm**2  //Area of Quadrant of a circle
x_1=16/%pi //cm
y_1=16*%pi**-1 //cm


a_2=18*%pi //cm**2  //Area of the semicircle
x_2=6 //cm
y_2=8*%pi**-1 //cm


//Calculation -1

X_bar=(a_1*x_1-a_2*x_2)*(a_1-a_2)**-1 //cm

//Calculation -2
```

```
//To calculate Y_bar,taking AB as the Reference line

Y_bar=(a_1*y_1-a_2*y_2)*(a_1-a_2)**-1 //cm

//Result

printf("The centre of gravity is %.2f cm",X_bar)
printf("\n The centre of gravity is %.2f cm",Y_bar)
```

Scilab code Exa 1.5 centre of gravity

```
// Problem 1.5,Page no.11


clc;clear;
close;

//Circle-1
a_1=100*%pi //cm**2
x_1=10 //cm

//Square-2
a_2=50 //cm**2
x_2=15 //cm

//Calculation

X_bar=(a_1*x_1-a_2*x_2)*(a_1-a_2)**-1 //cm


//Result
printf("The centre of gravity is %.2f cm",X_bar)
```

Scilab code Exa 1.6 centroid of the given area

```
// Problem 1.6,Page no.12


clc;clear;close;

//Rectangle-1
a_1=51200 //mm**2
x_1=160 //mm
y_1=80 //mm

//Triangle-2
a_2=6400 //mm**2
x_2=80*3**-1 //mm
y_2=320*3**-1 //mm

//Semicircle-3
a_3=1250*%pi //mm**2
x_3=210 //mm
y_3=(160-(4*50-(3*%pi)**-1)) //mm


//Calculation

X_bar=(a_1*x_1-a_2*x_2-a_3*x_3)*(a_1-a_2-a_3)**-1 //
    mm
Y_bar=(a_1*y_1-a_2*y_2-a_3*y_3)*(a_1-a_2-a_3)**-1 //
    mm

//Result
printf("The centroid of the given area is %.2f mm",
    X_bar)
printf("\n The centroid of the given area is %.2f mm
    ",Y_bar)
//Answer given in the textbook is wrong.
```

Scilab code Exa 5.7 `Magnitude of Load`

```
// Problem 5.7,Page no.126

clc;clear;
close;

d=12 //m //depth of mast
D_1=20 //cm //diameter at the base
D_2=10 //cm //diameter at the top

//Calculations

//Consider section at a distance x cm below top of
    mast and y be the diameter at this section

//triangle OAB and ODC are similar,we get
//2*AB=x*120**-1
//EB=y=10+x*120**-1
//after simplifying we get, x=120*(y-10)

//Z=%pi*64**-1*y**4)*(y*32**-1)**-1 //Section
    modulus
//After simplifying we get
//Z=(%pi*y**3)*(32)**-1

//M=120*P(y-10) //bending moment at that section

//From flexural formula we get,
//sigma=M*Z**-1
//After substituting and simplifying above equation
    we get,
//sigma=3840*P*%pi**-1*(1*y**2-1-10*y**3-1)

```

```
//To find max value of sigma taking derivative of above equation we get
y=15 //cm

//Now substituting value of y in all equations with variable y
x=120*(y-10)
//sigma=3840*P*(15-10)*(%pi*15**3)**-1

//After implifying above equation we get

P=(3500*%pi*15**3)*(3840*5)**-1 //N //Magnitude of load causing failure

//Result
printf("The Magnitude of Load is %.2f N",P)
```

Scilab code Exa 1.8 centroid of the area

```
// Problem 1.8,Page no.12


clc;clear;
close;


alpha=%pi/2 //degree //In case of semicircle

//Semicircle-1
r_1=20 //cm //radius of semicircle
y_1=4*r_1*(3*%pi)**-1 //cm //distance from the base
a_1=(%pi*r_1**2)*2**-1 //cm**2 //area of semicircle

//Semicircle-2
r_2=16 //cm   //radius of semicircle
```

```
y_2=4*r_2*(3*%pi)**-1 //cm //distance from the base
a_2=(%pi*r_2**2)*2**-1 //cm**2 //area of semicircle

//Calculations


Y_bar=(a_1*y_1-a_2*y_2)*(a_1-a_2)**-1 //cm //centroid


//Result
printf("The centroid of the area is %.2f cm",Y_bar)
```

Scilab code Exa 1.12 `value of h`

```
// Problem no 1.12,Page no.16


clc;clear;
close;

//Right Circular Cyclinder
//m_1=(16*%pi*h*rho_1) //gm
//y_1=4+h*2**-1 //cm

//Hemisphere
//m_2=256*%pi*rho_1 //gm
y_2=2.5 //cm

Y_bar=4 //cm
r=4 //cm

//Calculation

//Y_bar=(m_1*y_1+m_2*y_2)*(m_1+m_2)**-1 //cm //
```

```
    Centroid
h=(402.114*25.132**-1)**0.5

//Result
printf("The value of h is %.2f cm",h)
```

Chapter 2

Moment of Inertia

Scilab code Exa 2.1 Moment of Inertia

```
// Problem no 2.1,Page no.29


clc;clear;
close;

//Rectangle-1
b_1=10 //cm //width of Rectangle-1
d_1=2 //cm //breadth of Rectangle-1
a_1=40 //cm**2 //Area of Rectangle-1
y_1=1 //cm //Distance of centroid-1

//Rectangle-2
b_2=2 //cm //width of Rectangle-2
d_2=10 //cm //breadth of Rectangle-2
a_2=20 //cm**2 //Area of rectangle-2
y_2=7 //cm //Distance of centroid-2

//Rectangle-3
b_3=20 //cm //width of Rectangle-3
d_3=2 //cm  //breadth of Rectangle-3
```

```
a_3=20 //cm**2 //Area of rectangle-3
y_3=13 //cm //Distance of centroid-3



//Calculation
Y_bar=((a_1*y_1+a_2*y_2+a_3*y_3)*(a_1+a_2+a_3)**-1)
    //cm //centre of gravity of section

Y_1=4.5 //cm //Distance of centroid of rectangle 1
    to C.G
Y_2=1.5 //cm //Distance of centroid of rectangle 2
    to C.G
Y_3=7.5 //cm //Distance of centroid of rectangle 3
    to C.G

I_x_x_1=b_1*d_1**3*12**-1+a_1*Y_1**2 //moment of
    inertia of rectangle 1 about centroidal x-x axis
    of the section
I_x_x_2=b_2*d_2**3*12**-1+a_2*Y_2**2 //moment of
    inertia of rectangle 2  about centroidal x-x axis
     of the section
I_x_x_3=b_3*d_3**3*12**-1+a_3*Y_3**2 //moment of
    inertia of rectangle 3 about centroidal x-x axis
    of the section
I_x_x=I_x_x_1+I_x_x_2+I_x_x_3 //cm**4

//Result
printf("Moment of Inertia of the section is %.2f cm
    ^4",I_x_x)
```

Scilab code Exa 2.2 Moment of Inertia

```
// Problem no 2.2,Page no.31

```

```

clc;clear;
close;

//Rectangle-1
b_1=2 //cm //width of Rectangle-1
d_1=12 //cm //breadth of Rectangle-1
a_1=24 //cm**2 //Area of Rectangle-1
y_1=6 //cm //Distance of centroid-1

//Rectangle-2
b_2=6 //cm //width of Rectangle-2
d_2=2 //cm //breadth of Rectangle-2
a_2=12 //cm**2 //Area of rectangle-2
y_2=1 //cm //Distance of centroid-2

//Rectangle-3
b_3=2 //cm //width of Rectangle-3
d_3=12 //cm  //breadth of Rectangle-3
a_3=24 //cm**2 //Area of rectangle-3
y_3=6 //cm //Distance of centroid-3

//Calculation
Y_bar=((a_1*y_1+a_2*y_2+a_3*y_3)*(a_1+a_2+a_3)**-1)
    //cm //centre of gravity of section

Y_1=6 //cm //Distance of centroid of rectangle 1 to
    base
Y_2=1 //cm //Distance of centroid of rectangle 2 to
    base
Y_3=6 //cm //Distance of centroid of rectangle 3 to
    base

I_x_x_1=b_1*d_1**3*12**-1+a_1*Y_1**2 //moment of
    inertia of rectangle 1 about centroidal x-x axis
    of the section
I_x_x_2=b_2*d_2**3*12**-1+a_2*Y_2**2 //moment of
    inertia of rectangle 2  about centroidal x-x axis
```

```
    of the section
I_x_x_3=b_3*d_3**3*12**-1+a_3*Y_3**2 //moment of
   inertia of rectangle 3 about centroidal x-x axis
   of the section
I_x_x=I_x_x_1+I_x_x_2+I_x_x_3 //cm**4


//Result
printf("Moment of Inertia of the section is %.2f cm
   ^4",I_x_x)
```

Scilab code Exa 2.3 Moment of Inertia

```
// Problem no 2.3,Page no.32


clc;clear;
close;

//Rectangle-1
b_1=12 //cm //width of Rectangle-1
d_1=2 //cm //breadth of Rectangle-1
a_1=24 //cm**2 //Area of Rectangle-1
y_1=1 //cm //Distance of centroid-1

//Rectangle-2
b_2=2 //cm //width of Rectangle-2
d_2=6 //cm //breadthof Rectangle-2
a_2=12 //cm**2 //Area of rectangle-2
y_2=5 //cm //Distance of centroid-2

//Rectangle-3
b_3=5 //cm //width of Rectangle-3
d_3=2 //cm  //breadth of Rectangle-3
a_3=10 //cm**2 //Area of rectangle-3
```

```
y_3=9 //cm //Distance of centroid-3

//Calculation
Y_bar=((a_1*y_1+a_2*y_2+a_3*y_3)*(a_1+a_2+a_3)**-1) //cm //centre of gravity of section

Y_1=2.78 //cm //Distance of centroid of rectangle 1 to C.G
Y_2=1.22 //cm //Distance of centroid of rectangle 2 to C.G
Y_3=5.22 //cm //Distance of centroid of rectangle 3 to C.G

I_x_x_1=b_1*d_1**3*12**-1+a_1*Y_1**2 //moment of inertia of rectangle 1 about centroidal x-x axis of the section
I_x_x_2=b_2*d_2**3*12**-1+a_2*Y_2**2 //moment of inertia of rectangle 2  about centroidal x-x axis  of the section
I_x_x_3=b_3*d_3**3*12**-1+a_3*Y_3**2 //moment of inertia of rectangle 3 about centroidal x-x axis of the section
I_x_x=I_x_x_1+I_x_x_2+I_x_x_3 //cm**4


//Result
printf("Moment of Inertia of the section is %.2f cm^4",I_x_x)
```

Scilab code Exa 2.4 Total Moment of Inertia

```
//  Problem no 2.4,Page no.33


clc;clear;
```

```
close;

D=10 //cm //diameter of circle
b=4 //cm //width of rectangle
d=4 //cm //breadth of rectangle
Y=1 //cm //Distance of centroid of rectangle 1 to C.
   G
a=16 //cm**2 //area of rectangle

//Calculations

I_x_x_1=%pi*64**-1*(D**4) //cm**4 //moment of
   inertia of circle about x-x axis
I_x_x_2=b*d**3*12**-1+a*Y**2 //cm**4 //moment of
   inertia of rectangle about x-x axis
I_x_x=I_x_x_1-I_x_x_2 //cm**4 //Total moment of
   inertia of the section

//Result
printf("Total moment of inertia of the section is %
   .2f cm^4",I_x_x)
```

Scilab code Exa 2.5 MI of whole section

```
// Problem no 2.5,Page no.33


clc;clear;
close;


//Notifications has been changed as per requirement


h=8 //cm //height of triangle
```

```
b=8 //cm //breadth of triangle or diameter
    semicircle
d=4 //cm //diameter of circle enclosed

//Calculations

I_1=b*h**3*12**-1 //cm //moment of inertia of the
    triangle ABC about the axis AB
I_2=%pi*b**4*128**-1 //cm ////moment of inertia of
    the semicircle about the axis AB
I_3=%pi*d**4*64**-1 //cm //moment of inertia of
    circle about the circle about the axis

I=I_1+I_2-I_3 //cm //Moment of Inertia of the shaded
     area about the axia AB

//Result
printf("Moment of Inertia of the shaded area is %.2f
     cm",I)
```

Scilab code Exa 2.6 Moment of Inertia

```
// Problem no 2.6,Page no.34

clc;clear;
close;

b_1=10 //cm //Breadth of the triangle
h=9 //cm //Height of triangle
b_2=2 //cm //width of rectangle
d=3 //cm //Depth of rectangle

//Triangle ABC-1
a_1=45 //cm**2 //Area of triangle
y_1=3 //cm //C.G of triangle
```

```
//Rectanglar hole-2
a_2=6 //cm**2 //Area of rectangle
y_2=4.5 //cm //C.G of rectangle

//Calculations

//Using relations
Y_bar=((a_1*y_1-a_2*y_2)*(a_1-a_2)**-1) //cm

I_1=b_1*h**3*36**-1+a_1*(y_1-Y_bar)**2 //cm**4 //M.I
    of triangle ABC about x-x passing through C.G of
    section
I_2=b_2*d**3*12**-1+a_2*(y_2-Y_bar)**2 //cm**4 //M.I
    of rectangular hole about x-x passing through C.
   G of section
I=I_1-I_2 //cm**4 //M.I of whole section about x-x
   passing through the C.G

I_3=b_1*h**3*12**-1 //cm**4 //M.I of triangle ABC
   about the base BC
I_4=b_2*d**3*12**-1+a_2*y_2**2 //cm**4 //M.I of
   Rectangular hole about the base BC

I_5=I_3-I_4 //cm**4 //M.I of the whole section about
    the base BC

//Result
printf("M.I of whole section about x-x passing
   through the C.G = %.2f cm^4",I)
printf("\n M.I of the whole section about the base
   BC is %.2f cm^4",I_5)
```

Scilab code Exa 2.12 `MI of the section`

```
// Problem no. 2.12,Page no.38


clc;clear;
close;

//Rectangle
a_1=600 //cm**2 //Area of the Rectangle
y_1=15 //cm //C.G of Rectangle
b=20 //cm //width of rectangle
d=30 //cm //depth of rectangle
D=15 //cm //Diameter of circle

//Circle
a_2=176.7 //cm**2 //Area of the circle
y_2=20 //cm //C.G of the circle

//Calculation

Y_bar=((a_1*y_1-a_2*y_2)*(a_1-a_2)**-1) //cm // Distance of C.G From the AB
Y_bar_1=2.1 //cm
Y_bar_2=7.1 //cm

I_1=b*d**3*12**-1 //cm**4 //M.I of the rectangle about its C.G and parallel to x-x axis
I_2=I_1+a_1*Y_bar_1**2
I_3=%pi*D**4*64**-1+a_2*Y_bar_2**2 //cm**4 //M.I of circular section about x-x axis

I=I_2-I_3 //cm**4 //M.I of the section about x-x axis

//Result
printf("M.I of the section about x-x axis = %.2f cm^4",I)
```

Scilab code Exa 2.13 Radius of gyration

```
// Problem no.2.13,Page no.38


clc;clear;
close;

d=90 //cm //Diameter of grindstone
t=10 //cm //thickness of grindstone
rho=0.0026 //Kg/cm**3 //Density

//calculations

//M=Mass of grindstone=Volume *Density=Area*
   Thickness*Density
M=%pi*4**-1*d**2*t*rho //Kg
R=d*2**-1 //cm //radius
I_g=M*R**2*2**-1 //Kg*m**2

k=R*(2**0.5)**-1 //cm //Radius of gyration

//Result
printf("Radius of gyration is %.2f cm",k)
```

Chapter 3

Stresses and Strain

Scilab code Exa 3.1 Elongation of steel

```
// Problem 3.1,Page no.54

clc;clear;
close;

P=40 //mm //Force applied to stretch a tape
L=30 //m //Length of steel tape
A=6*1 //mm //Cross section area
E=200*10**9*10**-6 //KN/m**2 //Modulus of Elasticity

//Calculations

sigma_L=(P*L*10**3)*(A*E)**-1 //mm

//Result
printf("The Elongation of steel tape is %.1f mm",
   sigma_L)
```

Scilab code Exa 3.2 outside Diameter of cyclinde

```
// Problem 3.2,Page no.54

clc;clear;
close;


//D=(D_0-2) //cm //Inside Diameter of cyclinder
//A=(%pi*(D_0-1)) //cm**2 //Area of cross-section
//L=(%pi*(D_0-1)*5400) //N //Crushing load for column
F=6 //Factor of safety
T=1 //cm //wall thickness of cyclinder

//S=L*F**-1
//After Simplifying,we get
S=600*10**3

//Calculations

D_0=(S*F)*(%pi*54000)**-1+1 //cm //Outside diameter of cyclinder

//Result
printf("The outside Diameter of cyclinder is %.2f cm ",D_0)
```

Scilab code Exa 3.3 Total Elongation of wire

```
// Problem 3.3,Page no.56

clc;clear;
close;

P=800 //N //force applied to steel wire
L=150 //m //Length of steel wire
```

```
E=200 //GN/m**2 //Modulus of Elasticity
d=10 //mm //Diameter of steel wire
W=7.8*10**4 //N/m**3 //Weight Density of steel
//A=(%pi*4**-1)*(d)**2 //m**2

//After simplifying Area,we get
A=7.85*10**-5 //m**2

//calculation (Part-1)

//Elongation Due to 800N Load
dell_L_1=(P*L*10**-3)*(A*E*10**9*10**-6)**-1 //mm

//calculation (Part-2)

//Elongation due to Weight of wire
dell_L_2=((%pi*4**-1)*150*W*L*10**-3)*(2*A*E*10**7)
    **-1 //mm

//calculation (Part-3)

//Total Elongation of wire
dell_L_3=dell_L_1+dell_L_2


//Result
printf("The Elongation due to 800N Load  = %.2f mm",
    dell_L_1)
printf("\n The Elongation due to Weight of wire  = %
    .2f mm",dell_L_2)
printf("\n Total Elongation of wire  = %.2f mm",
    dell_L_3)
```

Scilab code Exa 3.4 Compressive stress

```
// Problem 3.4,Page no.55

clc;clear;
close;

d=10 //mm //Diameter of Punching Hole
t=4 //mm //Thickness of Mild Steel Plate
tou=320 //N/mm**2 //Shear Strength of mild Steel

//Calculations

//Force Required for punching the hole
P=tou*%pi*d*t //N

//Area of punch in contact with the plate surface
A=(%pi*4**-1*d**2) //mm*2

//Compressive stress
sigma_c=P*A**-1 //N/mm*2

//Result
printf("Force Required for punching the hole is %.2f
    N",P)
printf("\n Compressive stress is %.f N/mm^2",sigma_c
   )
```

Scilab code Exa 3.6 Total Elongation of steel

```
// Problem 3.6,Page no.57

clc;clear;
close;

P=200*10**3 //N
L_1=0.10 //mm //Length of of portin AB
```

```
L_2=0.16 //mm //Length of of portin BC
L_3=0.12 //mm //Length of of portin CD
E=200*10**9 //N
d_1=0.1 //cm
d_2=0.08 //cm
d_3=0.06 //cm
A_1=(%pi*4**-1)*(0.1)**2 //mm**2
A_2=(%pi*4**-1)*(0.08)**2 //mm**2
A_3=(%pi*4**-1)*(0.06)**2 //mm**2

//Calculations

dell_L_1=(P*L_1*10**3)*(A_1*E)**-1 //mm
dell_L_2=(P*L_2*10**3)*(A_2*E)**-1 //mm
dell_L_3=(P*L_3*10**3)*(A_3*E)**-1 //mm
dell_L=dell_L_1+dell_L_2+dell_L_3 //mm

//Result
printf("Total Elongation of steel bar is %.3f mm",
   dell_L)
```

Scilab code Exa 3.7 Total Elongation of Steel

```
// Problem 3.7,Page no.57


clc;clear;
close;

//from F.B.D,we get
P_1=50 //KN
P_2=20 //KN
P_3=40 //KN

d=0.02 //mm //Diameter of steel bar
```

```
L_1=0.4 //mm
L_2=0.3 //mm
L_3=0.2 //mm
E=210*10**9 //N

//After simplifying Area,we get
A=%pi*10**-4 //m**2 //Area of cross section

//Calculations

sigma_AB=P_1*1000*A //N/m**2
sigma_BA=P_2*1000*A //N/m**2
sigma_CD=P_3*1000*A //N/m**2
dell_L=((P_1*L_1+P_2*L_2+P_3*L_3)*(A*E)**-1)*10**6
    //mm

//Result
printf("Total Elongation of Steel bar is %.3f mm",
    dell_L)
```

Scilab code Exa 3.8 reaction at support

```
// Problem 3.8,Page no.58

clc;clear;
close;

//R_a+R_c=25 //KN //R_a,R_b are reactions at
    supports A and C respectively
L_ab=2 //m
L_bc=3 //m

//Calculation

//From F.B.D,we get
```

```
//dell_L_AB=(R_a*L_AB)*(A*E)**-1 //Elongation of portion AB
//dell_L_BC=(R_c*L_BC)*(A*E)**-1 //Compression of portion BC

//After simplifying above equations we get,
//R_a=(1.5)*R_c //KN
//R_a+R_c=25 //KN
//Solving the above simultaneous equations using matrix method
A=[1 -1.5;1 1] //Here the coefficients of the first equations of unknowns are setup
B=[0;25] //Here the RHS of both equations are setup
C=A**-1*B

//print C[0] //Prints the first element in the vector C
//print C[1] //Prints the second element in the vector C

//Result
printf("The reaction at support A is %.2f kN",C(1))
printf("\n The reaction at support C is %.2f kN",C(2))
```

Scilab code Exa 3.9 `Stress in section`

```
// Problem 3.9,Page no.59

clc;clear;
close;

//P is the force acting on the bar BC compressive in nature and force on AB is (100-P) Tensile in nature
```

```
E=200*10*9 //N
A_1=3*10**-4 //cm**2 //Area of AB
A_2=4*10**-4 //cm**2 //Area of BC
L=1.5 //cm //Length of bar

//Calculations

//The total elongation of bar
//(((100-P)*10**3*1.5)*(3*10**-4*E)**-1)-((P
    *10**3*1.5)*(4*10**-4*E)**-1)=0

//The total elongation of bar is limited to 1
//(25-0.4375*P)*10**-4=1*10**-3

//After simplifying above equation we get,
P=-(10-25)*0.4375**-1 //KN //Total elongation of bar
F_AB=100-P //KN //force in AB
F_BC=P //KN //Force in BC
sigma_AB=(((F_AB)*(3*10**-4)**-1)*10**-3) //KN //
    Stress in AB
sigma_BC=((F_BC)*(4*10**-4)**-1*10**-3) //KN //
    Stress in Bc


//Result
printf("F_AB = %.2f kN",F_AB)
printf("\n F_BC = %.2f kN",F_BC)
printf("\n sigma_AB = %.2f kN",sigma_AB)
printf("\n sigma_BC = %.2f kN",sigma_BC)
```

Scilab code Exa 3.12 `cross sectional area of column`

```
// Problem 3.12,Page no.61

clc;clear;
```

```
close;

P=500 //KN //Safe Load
d=20 //mm //steel rod diameter
n=4 //number of steel rod
sigma_c=4 //N/mm**2 //stress in concrete
//E_S*E_c**-1=15


//Calculations

A_s=4*%pi*4**-1*d**2 //mm**2 //Area os steel rod
sigma_s=15*sigma_c //N/mm**2 //stress in steel

//P=sigma_s*A_s+sigma_c*A_c

//After substituting and simplifying above equation
    we get,

A_c=(P*10**3-sigma_s*1256)*(sigma_c)**-1 //mm**2 //
    Area of the concrete
X=(A_s+A_c)**0.5 //mm //Total cross sectional area
P_s=A_s*sigma_s*10**-3 //KN //Load carried by steel

//Result
printf("Load carried by steel is %.2f kN",P_s)
printf("\n stress induced in steel is %.2f kN",
    sigma_s)
printf("\n cross sectional area of column is %.2f mm
    ",X)
```

Scilab code Exa 3.13 Compressive stress in Aluminium

```
// Problem 3.13,Page no.62

```

```
clc;clear;
close;

A_s=500 //mm**2
E_s=200000
E_al=80000
A_al=1000


//Calculations

//(P_al*L_al)*(A_al*E_al)**-1+(P_s*L_s)*(A_s*E_s)
    **-1=1*2**-1

P=1*1000**-1*((A_s*E_s*A_al*E_al)*(A_s*E_s+A_al*E_al
    )**-1) //N
P_s=P;//N
P_al=P //N
sigma_t=P_s*A_s**-1 //N/mm**2 //Tensile stress in
    bolt
sigma_c=P_al*A_al**-1 //N/mm**2 //Compressive stress
     in Aluminium tube

//result
printf("Tensile stress in bolt is %.2f N/mm^2",
    sigma_t)
printf("\n Compressive stress in Aluminium tube is %
    .2f N/mm^2",sigma_c)
```

Scilab code Exa 3.14 value of Poissoins ratio

```
// Problem 3.14,Page no.63

clc;clear;
close;
```

```

A=1600 //mm**2 //Area of the Bar
P=480*10**3 //N //Load
dell_L=0.4 //mm //Contraction of metal bar
L=200 //mm //Length of metal bar
sigma_t=0.04 //mm //Guage Length
t=40

//Calculations

sigma_L=dell_L*L**-1
E=((P*L)*(A*dell_L)**-1*10**-3) //N/mm**2 //Young's
    Modulus
m=t*sigma_t**-1*sigma_L


//Result
printf("The value of Young''s Modulus  is %.2f N/mm
    ^2",E)
printf("\n The value of Poissoin''s ratio is %.2f",m
    )
```

Scilab code Exa 3.15 stress developed in aluminium bar

```
// Problem 3.15,Page no.63

clc;clear;
close;

A_s=0.003848 //m**2 //Area of steel bar
A_al=0.003436 //m**2 //Area of Aluminium tube
E=220*10*9 //N //Young's modulus of steel
E=70*10*9 //N //Young's modulus of aluminium
P=600*10**3 //N //Load applied to the bar
//dell_L_al-dell_L_s=0.00015 //mm //difference
```

```
    between strain in aluminium bar and steel bar

//Calculations


//Let the aluminium tube be compressed by dell_L_al
    and steel bar by by dellL_s
//dell_L_al=sigma_al*E_al**-1*L_al
//dell_L_s=sigma_s*E_s**-1*L_s

//After substituting and simplifying above equation
    we get,
//((sigma_al*70**-1)-(sigma_s*220**-1))=300000
                    //(equation 1)

//After simplifying above equation we get,
//sigma_al=17462.165*10**4-1.1199*sigma_s
                          //(equation 2)

//Now substituting sigma_al in equation(1)
//((17462.165*10**4-1.1199*sigma_s)*(70)**-1)-(
    sigma_s*220**-1)=300000

//After simplifying above equation we get,

sigma_s=-((300000-249.4594*10**4)*0.0205444**-1)
    *10**-6 //MN/m**2 //stress developed in steel bar
//sigma_al=17462.165*10**4-1.1199*sigma_s
sigma_al=(17462.165*10**4-1.1199*106822005.02)
    *10**-6


//Result
printf("stress developed in steel bar is %.2f MN/m^2
    ",sigma_s)
printf("\n stress developed in aluminium bar is %.2f
     MN/M^2",sigma_al)
```

Scilab code Exa 3.16 Pull Exerted by the rod

```
// Problem 3.16,Page no.64

clc;clear;
close;

E=200 //GN/m**2 //Modulus of elasticity
alpha=11*10**-6 //per degree celsius //coeffecient o
    flinear expansion of steel bar
L=6 //m //Length of rod


//Calculations

//(Part-1) //IF the walls do not yield

t=58 //degree celsius //Fall in temperature //(t
   =80-22)
dell=alpha*t //strain
sigma=E*10**9*dell*10**-6 //MN/m**2 //Stress
A=%pi*4**-1*6.25*10**-4 //mm**2 //Area of wall and
   rod
P=sigma*10**6*A*10**-3 //KN //Pull Exerted

//(Part-2) //IF the walls yield together at the two
   ends is 1.15 mm

L_2=L*(1-alpha*t) //m //Length of rod at 22 degree
   celsius
L_3=L-L_2 //m //Decrease in Length

//As the walls yield by 1.5 mm, actual decrease in
   length is
```

```
L_4=L_3-0.0015 //m
dell_2=L_4*L**-1 //strain
P_2=E*10**9*dell_2*A*10**-3 //KN

//Result
printf("Pull Exerted by the rod:when walls do not
   yield %.2f kN",P)
printf("\n                              :when total yield
   together at two ends is 1.5 mm = %.2f kN",P_2)
```

Scilab code Exa 3.17 Increase in Length of bar

```
// Problem 3.17,Page no.65

clc;clear;
close;

D=4.5 //cm //External Diameter of tube
d=3 //cm //Internal diameter of tube
t=3 //mm //thickness of tube
t_1=30 //degree celsius
t_2=180 //degree celsius //when metal heated
L=30 //cm //Original LEngth
alpha_s=1.08*10**-5 //Per degree celsius //
   coefficient of Linear expansion of steel tube
alpha_c=1.7*10**-5 //Per degree celsius //
   coefficient of Linear expansion of copper tube
E_s=210 //GPa //Modulus of Elasticity of steel
E_c=110 //GPA //Modulus of Elasticity of copper

//Calculation

//For Equilibrium of the system, Total tension in
   steel=Total tension in copper

```

```
//sigma_s*A_s=sigma_c*A_c (equation 1)

A_c=%pi*4**-1*d**2 //cm**2 //Area of copper
A_s=%pi*4**-1*(D**2-d**2) //cm**2 //Area of steel

//simplifying equation 1
//sigma_s=1.785*sigma_c

T=t_2-t_1 //change in temperature

//Actual expansion of steel=Actual expansion of copper
//alpha_s*T*L+sigma_s*E_s**-1*L=alpha_c*T*L-sigma_c*E_c**-1*L

//After substituting values in above equation and simplifying we get

sigma_c=(930*10**5*1.7591**-1)*10**-6 //MN/m**2 //Stress in copper
sigma_s=1.785*sigma_c //MN/m**2 //Stress in steel

//Increase in Length of either component
L_2=(alpha_s*T+sigma_s*10**6*(E_s*10**9)**-1)*L

//Result
printf("stress in copper bar is %.2f MN/m^2",sigma_c)
printf("\n stress in steel bar is %.2f MN/m^2",sigma_s)
printf("\n Increase in Length is %.3f cm",L_2)
```

Scilab code Exa 3.18 `Original Length of bar`

```
// Problem 3.18,Page no.66
```

```

clc;clear;
close;

t_1=15 //degree celsius //temperature of steel bar
t_2=315 //degree celsius //raised temperature
E_s=210 //GPa //Modulus of Elasticity of steel bar
E_c=100 //GPa //Modulus of Elasticity of copper bar
dell_L=0.15 //cm //Increase in Length of bar

//Calculation

//For Equilibrium of the system, Tension in steel
   bar = Tension in copper bar
//sigma_s*A_s = sigma_c*2*A_c
//sigma_S=2*sigma_c

//Actual expansion of steel = Actual expansion of
   copper
//L*alpha_s*T+sigma_s*E_s**-1*L = L*alpha_c*T-
   sigma_c*E_c**-1*L (Equation 1)

T=t_2-t_1 //per degree celsius //change in
   temperature

//After substituting values in above equation and
   simplifying we get
sigma_c=(1650*10**5*1.9524**-1)*10**-6 //MN/m**2 //
   Stress in copper
sigma_s=2*sigma_c //MN/m**2 //Stress in steel

//Actual Expansion of steel bar
//L*alpha_s*T+sigma_s*E_s**-1*L = L*alpha_c*T-
   sigma_c*E_c**-1*L
//After substituting values in above equation and
   simplifying we get
L=0.15*10**-2*0.0044048**-1 //m

```

```
//Result
printf("Stress in copper bar is %.2f MN/m^2",sigma_c
    )
printf("\n Stress in steel bar is %.2f MN/m^2",
    sigma_s)
printf("\n Original Length of bar is %.2f m",L)
```

Scilab code Exa 3.19 Compressive stress in bar

```
// Problem 3.19,Page no.67

clc;clear;
close;

L=100 //m //Length of rod
A=2 //cm**2 //cross sectional area
rho=80 //KN/m**3

//Calculatiom
W=A*10**-4*L*rho //KN

sigma_s=10+1.6 //KN //Rod experiencing max tensile
    stress when it is at top performing upstroke
sigma_s_2=sigma_s*10**3*200**-1 //N/mm**2 //
    corresponding stress at this moment

sigma_c=1 //KN ////Rod experiencing max compressive
    stress at its lower end,free from its own weight
sigma_c_2=sigma_c*10**3*200**-1 //corresponding
    stress at this moment

//Result
printf("Tensile stress in bar = %.2f N/mm^2",
    sigma_s_2)
printf("\n Compressive stress in bar = %.2f N/mm^2",
```

```
sigma_c_2)
```

Scilab code Exa 3.20 Longer dimension of post

```
// Problem 3.20,Page no.68

clc;clear;
close;

sigma=0.012 //strain
P=150 //KN   //Total Load on the Post
E=1.4*10**4 //N/mm**2 //modulus of elasticity
//b be the width of the post in mm
//2b is the longer dimension of the post in mm

//Calculations

//We know,
//sigma=(P*(A*E)**-1)

//After substituting values and simplifying, we get
b=((150*10**3)*(0.012*1.4*2*10**4)**-1)**0.5
q=2*b //mm //Longer dimension of post

//Result
printf("Width of post is %.2f mm",b)
printf("\n Longer dimension of post is %.2f mm",q)
```

Chapter 4

Shearing Force and Bending Moment

Scilab code Exa 4.1 Bending Moment Diagram

```
// Problem no 4.4.1,Page No.89

clc;clear;
close;

F_B=-10 //KN //Force at pt B
F_D=-20 //KN //Force at pt D
w_CB=5 //KN/m //u.d.l at CB
w_AE=40 //KN/m //u.d.l at AE
L_ED=2;L_CB=2 //m //Length of ED & CB
L_CD=1;L_DC=1 //m //Length of CD
L_AE=3 //m //Length of AE
L=8 //m //span of beam


//Calculations

//Shear Force Calculations

```

```
//Shear Force at B
V_B=F_B //KN

//Shear Force at C
V_C=F_B-(w_CB*L_CB)

//Shear Force at D
V_D1=V_C
V_D2=V_C+F_D

//Shear Force at E
V_E=V_D2

//Shear Force at A
V_A=V_D2-(w_AE*L_AE)

//Bending Moment Calculations

//Bending Moment at B
M_B=0

//Bending Moment at C
M_C=F_B*L_CB-w_CB*L_CB**2*2**-1

//Bending Moment at D
M_D=F_B*(L_CB+L_CD)-w_CB*L_CB*(L_CB*2**-1+L_CD)

//Bending Moment at E
M_E=F_B*(L_CB+L_CD+L_ED)-w_CB*L_CB*(L_CB*2**-1+L_CD+
    L_ED)+F_D*L_ED

//Bending Moment at A
M_A=F_B*L-w_CB*L_CB*(L_CB*2**-1+L_CD+L_ED+L_AE)+F_D
    *(L_AE+L_ED)-w_AE*(L_AE**2*2**-1)

//Result
printf("The Shear Force and Bending Moment Diagrams
    are the results")
```

```
//Plotting the Shear Force Diagram
subplot(2,1,1)
X1=[0,L_CB,L_CB+L_DC,L_CB+L_DC,L_CB+L_DC+L_ED,L_CB+
    L_DC+L_ED+L_AE,L_CB+L_DC+L_ED+L_AE]
Y1=[V_B,V_C,V_D1,V_D2,V_E,V_A,0]
Z1=[0,0,0,0,0,0,0]
plot(X1,Y1,X1,Z1)
xlabel("Length x in m")
ylabel("Shear Force in kN")
title("the Shear Force Diagram")

subplot(2,1,2)
//Plotting the Bending Moment Diagram

Y2=[M_B,M_C,M_D,M_E,M_A]
X2=[0,L_CB,L_CB+L_DC,L_CB+L_DC+L_ED,L_CB+L_DC+L_ED+
    L_AE]
Z2=[0,0,0,0,0]
plot(X2,Y2)
xlabel("Lenght in m")
ylabel("Bending Moment in kN.m")
title("the Bending Moment Diagram")
```

Scilab code Exa 4.2 the Bending Moment Diagram

```
// Problem no 4.4.2,Page No.90

clc;clear;
close;
w_CB=1 //KN/m //u.d.l on Length CB
F_D=2 //KN //Pt Load at D
L_AD=1;L_DC=1 //m //Length of AD & DC
L_CB=2 //m //Length of CB

```

```
//Calculations

//Shear Force at B
V_B=0 //KN

//Shear Force at C
V_C=-(w_CB*L_CB)

//Shear Force at D
V_D1=V_C
V_D2=V_C-F_D

//Shear Force at A
V_A=V_D2

//Bending Moment Calculations

//Bending Moment at B
M_B=0

//Bending Moment at C
M_C=-w_CB*L_CB**2*2**-1

//Bending Moment at D
M_D=-w_CB*L_CB*(L_CB*2**-1+L_DC)

//Bending Moment at A
M_A=-w_CB*L_CB*(L_CB*2**-1+L_DC+L_AD)-F_D*L_AD

//Result
printf("The Shear Force and Bending Moment Diagrams
    are the results")

//Plotting the Shear Force Diagram
subplot(2,1,1)
X1=[0,L_CB,L_CB+L_DC,L_CB+L_DC,L_CB+L_DC+L_AD,L_CB+
    L_DC+L_AD]
Y1=[0,V_C,V_D1,V_D2,V_A,0]
```

```
Z1=[0,0,0,0,0,0]
plot(X1,Y1,X1,Z1)
xlabel("Length x in m")
ylabel("Shear Force in kN")
title("the Shear Force Diagram")


//Plotting the Bending Moment Diagram
subplot(2,1,2)
Y2=[M_B,M_C,M_D,M_A]
X2=[0,L_CB,L_CB+L_DC,L_CB+L_DC+L_AD]
Z2=[0,0,0,0]
plot(X2,Y2)
xlabel("Length in m")
ylabel("Bending Moment in kN.m")
title("the Bending Moment Diagram")
```

Scilab code Exa 4.3 `the Bending Moment Diagram`

```
// Problem no 4.4.3,Page No.91

clc;clear;
close;
AC=5000 //N/m //u.v.l
L_AB=4 //m //Length of AB

//Calculations

//Consider a section at Distance x from B
//DB=x
//By similar triangles (triangle ABC and BDE) we get

//Shear Force at x
//F_x=-DB*DE*2**-1
//After substituting values in above equation we get
```

```
//F_x=625*x**2

//shear Force at B where x=0
V_B=0

//shear Force at A where x=L_AB=4
V_A=625*L_AB**2

//Bending Moment Calculation

//M_x=DB*DE*DB*3**-1*2**-1
//Substituting values in above equation we get
//M_x=-625*x**3*3**-1

//Bending Moment at B where x=0
M_B=0

//Bending Moment at A where x=L_AB=4
M_A=-625*L_AB**3*3**-1

//Result
printf("The Shear Force and Bending Moment Diagrams are the results")

//Plotting the Shear Force Diagram
subplot(2,1,1)
X1=[0,L_AB]
Y1=[V_B,V_A]
Z1=[0,0]
plot(X1,Y1,X1,Z1)
xlabel("Length x in m")
ylabel("Shear Force in kN")
title("the Shear Force Diagram")

//Plotting the Bending Moment Diagram
subplot(2,1,2)
Y2=[M_B,M_A]
X2=[0,L_AB]
```

```
Z2=[0,0]
plot(X2,Y2)
xlabel("Length in m")
ylabel("Bending Moment in kN.m")
title("the Bending Moment Diagram")
```

Scilab code Exa 4.4 Bending moment and shear force diagram

```
// Problem no 4.4.4,Page No.92

clc;clear;
close;
F_C=30;F_D=30;F_E=30 //KN //Pt Load at C,D,E
    respectively
L_AE=1.5;L_ED=1.5;L_DC=1.5 //m //Length of AE,ED,DC
    respectively
L_CB=0.5 //m //Length of CB
L_AC=4.5 //m //Length of AC
L_AD=3 //m //Length of AD
w=10 //KN/m //u.d.l
L=5 //m //Length of beam

//Calculations

//Shear Force Calculations

//Shear Force at B
V_B=0 //KN

//Shear Force at C
V_C1=-w*L_CB
V_C2=-w*L_CB-F_C //KN

//Shear Force at D
V_D1=-w*(L_DC+L_CB)-F_C*L_DC
```

```
V_D2=-w*(L_DC+L_CB)-F_C-F_D //KN

//Shear Force at E
V_E1=-w*(L_DC+L_CB+L_ED)-F_C*(L_DC+L_ED)
V_E2=-F_C-F_D-F_E-w*(2*L_ED+L_CB)

//Shear Force at A
V_A=-w*L-F_C-F_D-F_E

//Bending Moment Calculations

//Bending Moment at B
M_B=0

//Bending Moment at C
M_C=-w*L_CB**2*2**-1

//Bending Moment at D
M_D=-w*(L_DC+L_CB)**2*2**-1-F_C*L_DC

//Bending Moment at E
M_E=-w*(L_DC+L_CB+L_ED)**2*2**-1-F_C*(L_ED+L_DC)-F_D
    *L_ED

//Bending Moment at A
M_A=-w*L**2*2**-1-F_C*L_AC-F_D*L_AD-F_E*L_AE

//Result
printf("The Shear Force and Bending Moment Diagrams
    are the results")

//Plotting the Shear Force Diagram
subplot(2,1,1)
X1=[0,L_CB,L_CB,L_CB+L_DC,L_CB+L_DC,L_CB+L_DC+L_ED,
    L_CB+L_DC+L_ED,L_CB+L_DC+L_ED+L_AE,L_CB+L_DC+L_ED
    +L_AE]
Y1=[V_B,V_C1,V_C2,V_D1,V_D2,V_E1,V_E2,V_A,0]
Z1=[0,0,0,0,0,0,0,0,0]
```

```
plot(X1,Y1,X1,Z1)
xlabel("Length x in m")
ylabel("Shear Force in kN")
title("the Shear Force Diagram")

//Plotting the Bending Moment Diagram
subplot(2,1,2)
X2=[0,L_CB,L_CB+L_DC,L_CB+L_DC+L_ED,L_CB+L_DC+L_ED+
   L_AE,L_CB+L_DC+L_ED+L_AE]
Y2=[M_B,M_C,M_D,M_E,M_A,0]
Z2=[0,0,0,0,0,0]
plot(X2,Y2)
xlabel("Length in m")
ylabel("Bending Moment in kN.m")
title("the Bending Moment Diagram")
```

Scilab code Exa 4.5 Bending moment and shear force diagram

```
// Problem no 4.4.5,Page No.93

clc;clear;
close;

w1=30 //KN/m //u.d.l on L_CB
F_C=120 //KN //Pt Load at C
w2=50 //KN/m //u.d.l on L_AD
L_DC=2;L_CB=2 //m //Length of DC and CB respectively
L_AD=4 //m //Length of AD
L_AB=8;L=8 //m //Length of beam


//Calculations

//Let R_A & R_B be the reactions at A & B
//R_A+R_B=380
```

```
//Taking Moment at A
//M_A=-R_B*L+F_C(L_DC+L_AD)+w1*L_CB*(L_CB*2**-1+L_DC
    +L_AD)+w2*L_AD**2*2**-1=0

//After Rearranging the terms we get
R_B=(F_C*(L_DC+L_AD)+w1*L_CB*(L_CB*2**-1+L_DC+L_AD)+
    w2*L_AD**2*2**-1)*L**-1
R_A=380-R_B

//Shear Force Calculations

//Shear Force at B
V_B=R_B

//Shear Force at C
V_C1=-w1*L_CB+R_B
V_C2=R_B-w1*L_CB-F_C

//Shear Force at D
V_D=V_C2

//Shear Force at A
V_A=V_D-w2*L_AD

//Point of contraflexure
//Let E be the point EB=x
//Shear Force at E
//V_E=0=R_B-F_C-w1*L_CB-w2*(L_EB-L_DC-L_CB)
L_EB=-((-R_B+F_C+w1*L_CB)*w2**-1-L_DC-L_CB)
V_E=0

//Bending Moment Calculations

//Bending Moment at B
M_B=0

//Bending Moment at C
```

```
M_C=R_B*L_CB-w1*L_CB**2*2**-1

//Bending Moment at D
M_D=R_B*(L_CB+L_DC)-w1*L_CB*(L_CB*2**-1+L_DC)-F_C*
    L_DC

//Bending Moment at A
M_A=0

//Bending Moment at E
L_ED=L_EB-(L_DC+L_CB) //m //Length of ED
M_E=-w1*L_CB*(L_ED+L_DC+L_CB*2**-1)-F_C*(L_DC+L_ED)+
    R_B*L_EB

//Result
printf("The Shear Force and Bending Moment Diagrams
    are the results")

//Plotting the Shear Force Diagram
subplot(2,1,2)
X1=[0,L_CB,L_CB,L_CB+L_DC,L_CB+L_DC+L_AD,L_CB+L_DC+
    L_AD]
Y1=[V_B,V_C1,V_C2,V_D,V_A,0]
Z1=[0,0,0,0,0,0]
plot(X1,Y1,X1,Z1)
xlabel("Length x in m")
ylabel("Shear Force in kN")
title("the Shear Force Diagram")

//Plotting the Bending Moment Diagram
subplot(2,1,1)
X2=[0,L_CB,L_CB+L_DC,L_CB+L_DC+L_ED,L_CB+L_DC+L_AD]
Y2=[M_B,M_C,M_D,M_E,M_A]
Z2=[0,0,0,0,0]
plot(X2,Y2)
xlabel("Length in m")
ylabel("Bending Moment in kN.m")
title("the Bending Moment Diagram")
```

Scilab code Exa 4.6 Bending moment and shear force diagram

```
// Problem no 4.4.6,Page No.95

clc;clear;
close;
F_C=100 //KN //Pt Load at C
F_E=50 //KN //Pt Load at E
w=20 //KN/m
L_AE=2;L_ED=2;L_DC=2;L_CB=2 //m //Length of AE,ED,DC,CB respectively
L=8 //m //Length of Beam

//Calculations

//Let R_A & R_B be the reactions at A & B
//R_A+R_B=190

//Taking Moment at A
//M_A=-R_B*L+F_C*(3*L_AE)+w*L_DC*(L_DC*2**-1+2*L_ED)+F_E*L_AE=0
R_B=(F_C*(3*L_AE)+w*L_DC*(L_DC*2**-1+2*L_ED)+F_E*L_AE)*L**-1
R_A=190-R_B

//Shear Force Calculations

//Shear Force at B
V_B=R_B

//Shear Force at C
V_C1=R_B
V_C2=R_B-F_C

```

```
//Shear Force at D
V_D=V_C2-w*L_DC

//Shear Force at E
V_E1=V_D
V_E2=V_D-F_E

//Shear Force at A
V_A=V_E2

//Point of contraflexure
//Let F be the point BF=x
//Shear Force at F
//V_F=R_B-F_C-w*(L_BF-L_CB)
L_FB=-((-R_B+F_C)*w**-1-L_CB)
V_F=0

//Bending Moment Calculations

//Bending Moment at B
M_B=0

//Bending Moment at C
M_C=R_B*L_CB

//Bending Moment at D
M_D=R_B*(L_CB+L_DC)-F_C*L_DC-w*L_DC**2*2**-1

//Bending Moment at E
M_E=R_B*(L_CB+L_DC+L_ED)-F_C*(L_ED+L_DC)-w*L_DC*(
    L_DC*2**-1+L_ED)

//Bending Moment at A
M_A=R_B*(L_ED+L_DC+L_AE+L_CB)-F_C*(L_ED+L_DC+L_AE)-w
    *L_DC*(L_DC*2**-1+L_ED+L_AE)-F_E*L_AE

//Bending Moment at F
L_FC=L_CB-L_CB
```

```
M_F=R_B*L_FB-F_C*L_FC-w*L_FC**2*2**-1
L_DF=L_DC-L_FC

//Result
printf("The Shear Force and Bending Moment Diagrams
    are the results")

//Plotting the Shear Force Diagram
subplot(2,1,1)
X1=[0,L_CB,L_CB,L_CB+L_DC,L_CB+L_DC+L_ED,L_CB+L_DC+
    L_ED,L_CB+L_DC+L_ED+L_AE]
Y1=[V_B,V_C1,V_C2,V_D,V_E1,V_E2,V_A]
Z1=[0,0,0,0,0,0,0,]
plot(X1,Y1,X1,Z1)
xlabel("Length x in m")
ylabel("Shear Force in kN")
title("the Shear Force Diagram")

//Plotting the Bending Moment Diagram
subplot(2,1,2)
X2=[0,L_CB,L_CB+L_FC,L_CB+L_DC,L_CB+L_DC+L_ED,L_CB+
    L_DC+L_ED]
Y2=[M_B,M_C,M_F,M_D,M_E,M_A]
Z2=[0,0,0,0,0,0]
plot(X2,Y2)
xlabel("Length in m")
ylabel("Bending Moment in kN.m")
title("the Bending Moment Diagram")
```

Scilab code Exa 4.7 Bending moment and shear force diagram

```
// Problem no 4.4.7,Page No.96

clc;clear;
close;
```

```
w=20 //KN/m //u.d.l on Length  CB
F_D= 50 //KN //Pt Load at D
L_CB=5 //m //Length of CB
L_DC=3 //M //Length of DC
L_AD=2 //m //Length of AD
L=10 //m //Length of Beam

//Calculations

theta=atan(4*3**-1)*(180*%pi**-1)
F_DV=F_D*sin(theta*%pi*180**-1) //Force at Pt D vertically
F_DH=F_D*cos(theta*%pi*180**-1) //Force at pt D horizontally

//Let R_A & R_B be the reactions at A & B
//R_A+R_B=140

//Taking Moment at A
//M_A=0=-R_B*L+w*L_CB*(L_CB*2**-1+L_DC+L_AD)+F_DV*L_AD
R_B=(w*L_CB*(L_CB*2**-1+L_DC+L_AD)+F_DV*L_AD)*L**-1
R_A=140-R_B

//Shear Force Calculations

//Shear Force at B
V_B=R_B

//Shear Force at C
V_C=V_B-w*L_CB

//Shear Force at D
V_D1=V_C
V_D2=V_C-F_DV

//Shear Force at A
V_A=V_D2
```

```
//Pt of Contraflexure
//Let E be the pt And BE=x
//V_E=0=R_B-w*x
x=R_B*w**-1;
L_BE=R_B*w**-1

//Bending Moment Calculations

//Bending Moment at B
M_B=0

//Bending Moment at C
M_C=R_B*L_CB-w*L_CB**2*2**-1

//Bending Moment at D
M_D=R_B*(L_CB+L_DC)-w*L_CB*(L_CB*2**-1+L_DC)

//Bending Moment at A
M_A=R_B*L-w*L_CB*(L_CB*2**-1+L_DC+L_AD)-F_DV*L_AD

//Bending Moment at E
M_E=R_B*L_BE-w*L_BE**2*2**-1

//Result
printf("The Shear Force and Bending Moment Diagrams
    are the results")

//Plotting the Shear Force Diagram
subplot(2,1,1)
X1=[0,L_CB,L_CB+L_DC,L_CB+L_DC,L_CB+L_DC+L_AD]
Y1=[V_B,V_C,V_D1,V_D2,V_A]
Z1=[0,0,0,0,0]
plot(X1,Y1,X1,Z1)
xlabel("Length x in m")
ylabel("Shear Force in kN")
title("the Shear Force Diagram")

```

```
//Plotting the Bending Moment Diagram
subplot(2,1,2)
X2=[0,L_BE,L_CB,L_CB+L_DC,L_CB+L_DC+L_AD]
Y2=[M_B,M_E,M_C,M_D,M_A]
Z2=[0,0,0,0,0,0]
plot(X2,Y2)
xlabel("Length in m")
ylabel("Bending Moment in kN.m")
title("the Bending Moment Diagram")
```

Scilab code Exa 4.8 Bending moment and shear force diagram

```
// Problem no 4.4.8,Page No.97

clc;clear;
close;
F_C=150 //KN //Pt LOad at C
w=300 //KN //u.v.l
L=6 //m //Length of beam
L_AE=1;L_DC=2;L_CB=1;L_CD=1 //m //Lengthof AE,DC,CB
L_ED=3 //m //Length of ED
L_Ed=2 //m
L_dD=1 //m

//Calculations

//Let R_A & R_B be the reactions at A & B
//R_A+R_B=450

//Taking Moment at A
//M_A=0=R_B*L-F_C*(L_CD+L_ED+L_AE)-w*(2*3**-1*L_ED+L_AE)
R_B=(F_C*(L_DC+L_ED+L_AE)+w*(2*3**-1*L_ED+L_AE))*L**-1
R_A=450-R_B
```

```

//Shear Force Calculations

//Shear Force at B
V_B=R_B

//Shear Force at C
V_C1=R_B
V_C2=R_B-F_C

//Shear Force at D
V_D=V_C2

//Shear Force at E
V_E=V_D-w

//Shear Force at A
V_A=V_E

//Pt of contraflexure
//Let F be the pt and EF=x
//Let w1 be the rate of Loading at D we get
w1=w*2*3**-1
//The rate of Loading at distance x is200*x*3**-1

//V_F=0=-R_B+200*x*3**-1*x*2**-1
//After substituting values and simplifying further
    we get
L_EF=(R_A*3*100**-1)**0.5
x=(R_A*3*100**-1)**0.5;
//Bending Moment Calculations

//Bending Moment at B
M_B=0

//Bending Moment at C
M_C=R_B*L_CB

```

```
//Bending Moment at D
M_D=R_B*(L_CB+L_DC)-F_C*L_DC

//Bending Moment at E
M_E=R_B*(L_CB+L_DC+L_ED)-F_C*(L_DC+L_ED)-w*L_Ed

//Bending Moment at A
M_A=0

//Bending Moment at F
M_F=R_A*(L_AE+L_EF)-200*x*3**-1*x*2**-1*x*3**-1

L_FD=L_ED-L_EF


//Result
printf("The Shear Force and Bending Moment Diagrams are the results")

//Plotting the Shear Force Diagram
subplot(2,1,1)
X1=[0,L_CB,L_CB,L_CB+L_CD,L_CB+L_CD+L_ED,L_CB+L_CD+L_ED+L_AE,L_CB+L_CD+L_ED+L_AE]
Y1=[V_B,V_C1,V_C2,V_D,V_E,V_A,0]
Z1=[0,0,0,0,0,0,0]
plot(X1,Y1,X1,Z1)
xlabel("Length x in m")
ylabel("Shear Force in kN")
title("the Shear Force Diagram")

//Plotting the Bending Moment Diagram
subplot(2,1,2)
X2=[0,L_CB,L_CB+L_DC,L_FD+L_DC+L_CB,L_CB+L_DC+L_ED,L_CB+L_DC+L_ED+L_AE]
Y2=[M_B,M_C,M_D,M_F,M_E,M_A]
Z2=[0,0,0,0,0,0]
plot(X2,Y2)
xlabel("Length in m")
```

```
ylabel("Bending Moment in kN.m")
title("the Bending Moment Diagram")
```

Scilab code Exa 4.9 Bending moment and shear force diagram

```
// Problem no 4.4.9,Page No.99

clc;clear;
close;
M_C=40 //KNM //Moment at Pt C
w=20 //KNm //u.d.l on L_AD
L=10 //m //Length of beam
L_CB=5 //m //Length of CB
L_DC=1 //m //Length of DC
L_AD=4 //m //Length of AD

//Calculations

//Let R_A & R_B be the reactions at A & B
//R_A+R_B=80

//Taking Moment at A
//M_A=0=R_B*L-M-w*L_AD**2*2**-1
R_B=(w*L_AD**2*2**-1+M_C)*L**-1
R_A=80-R_B

//Shear Force Calculations

//Shear Force at B
V_B=R_B

//Shear Force at C
V_C=V_B

//Shear Force at D
```

```
V_D=V_C

//Shear Force at A
V_A=V_D-w*L_AD

//Pt of contraflexure
//Let E be the pt and BE=x
//V_E=0=R_B-w*(L_BE-L_DC-L_CB)
L_BE=R_B*w**-1+L_DC+L_CB;
x=L_BE

//Bending Moment Calculations

//Bending Moment at B
M_B=0

//Bending Moment at C
M_C1=R_B*L_CB
M_C2=M_C1-M_C

//Bending Moment at D
M_D=R_B*(L_CB+L_DC)-M_C

//Bending Moment at A
M_A=R_B*L-M_C-w*L_AD**2*2**-1

//Bending Moment at E
L_ED=L_BE-(L_DC+L_CB)
M_E=R_B*L_BE-M_C-w*L_ED**2*2**-1

//Result
printf("The Shear Force and Bending Moment Diagrams
   are the results")

//Plotting the Shear Force Diagram
subplot(2,1,1)
X1=[0,L_CB,L_CB+L_DC,L_CB+L_DC+L_AD,L_CB+L_DC+L_AD]
Y1=[V_B,V_C,V_D,V_A,0]
```

```
Z1=[0,0,0,0,0]
plot(X1,Y1,X1,Z1)
xlabel("Length x in m")
ylabel("Shear Force in kN")
title("the Shear Force Diagram")

//Plotting the Bending Moment Diagram
subplot(2,1,2)
X2=[0,L_CB,L_CB,L_CB+L_DC,L_CB+L_DC+L_ED,L_CB+L_DC+
    L_AD]
Y2=[M_B,M_C1,M_C2,M_D,M_E,M_A]
Z2=[0,0,0,0,0,0]
plot(X2,Y2,X2,Z2)
xlabel("Length in m")
ylabel("Bending Moment in kN.m")
title("the Bending Moment Diagram")
```

Scilab code Exa 4.10 Bending moment and shear force diagram

```
// Problem no 4.4.10,Page No.100

clc;clear;
close;
w=10 //KNm //u.d.l on L_AD
F_D=20 //KN //Pt Load at D
M_C=240 //KNm //moment at Pt C
L_DC=2;L_CB=2 //m //Length of DC and CB
L_AD=4 //m //Length of AD
L=8 //m //Length of Beam

//Calculations

//Calculations

//Let R_A & R_B be the reactions at A & B
```

```
//R_A+R_B=60

//Taking Moment at A
//M_A=0=-R_B*L-M_C+F_D*L_AD+w*L_AD**2*2**-1
R_B=-(M_C-F_D*L_AD-w*L_AD**2*2**-1)*L**-1
R_A=60-R_B

//Shear Force Calculations

//Shear Force at B
V_B=R_B

//Shear Force at C
V_C=V_B

//Shear Force at D
V_D1=V_B
V_D2=V_D1-F_D

//Shear Force at A
V_A=V_D2-w*L_AD

//Bending Moment Calculations

//Bending Moment at B
M_B=0

//Bending Moment at C
M_C1=R_B*L_CB
M_C2=M_C+R_B*L_CB

//Bending Moment at D
M_D=R_B*(L_DC+L_CB)+M_C

//Bending Moment at A
M_A=R_B*L+M_C-w*L_AD**2*2**-1-F_D*L_AD

//Result
```

```
printf("The Shear Force and Bending Moment Diagrams
    are the results")

//Plotting the Shear Force Diagram
subplot(2,1,1)
X1=[0,L_CB,L_CB+L_DC,L_CB+L_DC,L_CB+L_DC+L_AD]
Y1=[V_B,V_C,V_D1,V_D2,V_A]
Z1=[0,0,0,0,0]
plot(X1,Y1,X1,Z1)
xlabel("Length x in m")
ylabel("Shear Force in kN")
title("the Shear Force Diagram")

//Plotting the Bending Moment Diagram
subplot(2,1,2)
X2=[0,L_CB,L_CB,L_CB+L_DC,L_CB+L_DC+L_AD,L_CB+L_DC+
    L_AD]
Y2=[M_B,M_C1,M_C2,M_D,M_A,0]
Z2=[0,0,0,0,0,0]
plot(X2,Y2,X2,Z2)
xlabel("Length in m")
ylabel("Bending Moment in kN.m")
title("the Bending Moment Diagram")
```

Scilab code Exa 4.11 Bending moment and shear force diagram

```
// Problem no 4.4.11,Page No.101

clc;clear;
close;
F_C=5 //KN //Force at C
w=2 //KNm //u.d.l on beam
L_BC=3 //m //Length of BC
L_AB=6 //m //Length of AB
L=9 //m //Length of Beam
```

```

//Calculations

//Let R_A & R_B be the reactions at A & B
//R_A+R_B=23

//Taking Moment at A
//M_A=0=F_C*L-R_B*L_AB+w*L**2*2**-1
R_B=-(-F_C*L-w*L**2*2**-1)*L_AB**-1
R_A=23-R_B

//Shear Force Calculations

//Shear Force at C
V_C1=0
V_C2=-F_C

//Shear Force at B
V_B=V_C2-w*L_BC**2*2**-1

//Shear Force at A
V_A=F_C*L+R_B*L_AB-w*L**2*2**-1

//Pt of contraflexure
//Let D be the pt And L_AD=x
//V_D=0=R_A+w*L_AD
L_AD=R_A*w**-1
x=L_AD
//Bending Moment Calculations

//Bending Moment at C
M_C=0

//Bending Moment at B
M_B=-F_C*L_BC-w*L_BC**2*2**-1

//Bending Moment at A
M_A=-F_C*L-w*L**2*2**-1+R_B*L_AB
```

```
//Bending Moment at D
L_DC=L-L_AD
L_DB=L_DC-L_BC
M_D=-R_A*L_AD+w*L_AD**2*2**-1

//Result
printf("The Shear Force and Bending Moment Diagrams are the results")

//Plotting the Shear Force Diagram
subplot(2,1,1)
X1=[0,L_BC,L_BC+L_AB,L_BC+L_AB]
Y1=[V_C2,V_B,V_A,0]
Z1=[0,0,0,0]
plot(X1,Y1,X1,Z1)
xlabel("Length x in m")
ylabel("Shear Force in kN")
title("the Shear Force Diagram")

//Plotting the Bending Moment Diagram
subplot(2,1,2)
X2=[0,L_BC,L_BC+L_DB,L_BC+L_AB]
Y2=[M_C,M_B,M_D,M_A]
Z2=[0,0,0,0]
plot(X2,Y2,X2,Z2)
xlabel("Length in m")
ylabel("Bending Moment in kN.m")
title("the Bending Moment Diagram")

//The Bending moment in book is incorrect
```

Scilab code Exa 4.12 Bending moment and shear force diagram

```
// Problem no 4.4.12,Page No.102
```

```

clc;clear;
close;
F_C=5 //KN //Pt Load at C
F_D=4 //KN //Pt Load at D
L_BC=1.25 //m //Length of BC
L_DB=1 //m //Length of DB
L_AD=3 //m //Length of AD
w=2 //KN/m //u.d.l
L=5.25 //m //Length of beam

//Calculations

//Let R_A & R_B be the reactions at A & B
//R_A+R_B=15

//Taking Moment at A
//M_A=0=F_C*L-R_B*(L_DB+L_AD)+F_D*L_AD+w*L_AD
    **2*2**-1
R_B=-(-F_C*L-F_D*L_AD-w*L_AD**2*2**-1)*(L_DB+L_AD)
    **-1
R_A=15-R_B

//Shear Force Calculations

//Shear Force at C
V_C=-F_C

//Shear Force at B
V_B1=V_C
V_B2=V_C+R_B

//Shear Force at D
V_D1=V_B2
V_D2=V_B2-F_D

//Shear Force at A
V_A=-(w*L_AD)-F_D-F_C+R_B
```

```
//Pt of contraflexure
//Let E be the pt and BE=x
//V_E=0=-F_C+R_B-F_D-w*(L_BE-L_DB)
L_BE=-((F_C-R_B+F_D)*w**-1-L_DB);
x=L_BE;
//Bending Moment Calculations

//Bending Moment at C
M_C=0

//Bending Moment at B
M_B=-F_C*L_BC

//Bending Moment at D
M_D=-F_C*(L_DB+L_BC)-R_B*L_DB

//Bending Moment at A
M_A=-F_C*L+R_B*(L_DB+L_AD)-F_D*L_AD-w*L_AD**2*2**-1

//Bending Moment at E
L_ED=L_BE-L_DB
M_E=-F_C*(L_BC+L_BE)+R_B*L_BE-F_D*(L_BE-L_DB)-w*(
    L_BE-L_DB)**2*2**-1

//Result
printf("The Shear Force and Bending Moment Diagrams
    are the results")

//Plotting the Shear Force Diagram
subplot(2,1,1)
X1=[0,L_BC,L_BC,L_BC+L_DB,L_BC+L_DB,L_BC+L_DB+L_AD,
    L_BC+L_DB+L_AD]
Y1=[V_C,V_B1,V_B2,V_D1,V_D2,V_A,0]
Z1=[0,0,0,0,0,0,0]
plot(X1,Y1,X1,Z1)
xlabel("Length x in m")
ylabel("Shear Force in kN")
```

```
title("the Shear Force Diagram")

//Plotting the Bending Moment Diagram
subplot(2,1,2)
X2=[0,L_BC,L_BC+L_DB,L_BC+L_DB+L_ED,L_BC+L_DB+L_AD]
Y2=[M_C,M_B,M_D,M_E,M_A]
Z2=[0,0,0,0,0]
plot(X2,Y2,X2,Z2)
xlabel("Length in m")
ylabel("Bending Moment in kN.m")
title("the Bending Moment Diagram")
```

Scilab code Exa 4.13 Bending moment and shear force diagram

```
// Problem no 4.4.13,Page No.103

clc;clear;
close;
F_E=20 //KN //Pt Load at E
F_C=30 //KN //Pt Load at C
F_B=60 //KN //Pt Load at B
L_AB=1.5;L_BC=1.5;L_CD=1.5 //m //Length of AB,BC,CD
    respectively
L_DE=2.5 //m //Length od DE
L_AD=4.5 //m //Length of AD
L=7 //m //Length of beam
w=30 //KN/m

//Calculations

//LEt R_A and R_D be the reactions at A and D
//R_A+R_D=245

//Taking moment at A
//M_A=0=-R_D*(L_BC+L_AB+L_CD)+F_E*L+w*L_Ad**2*2**-1+
```

```
    F_C*(L_AB+L_BC)+F_B*L_AB
R_D=-(-(F_E*L)-(w*L_AD**2*2**-1)-F_C*(L_AB+L_BC)-F_B
    *L_AB)*(L_BC+L_AB+L_CD)**-1
R_A=245-R_D

//Shear Force Calculations

//Shear Force at C
V_E1=0
V_E2=-F_E

//Shear Force at D
V_D1=V_E2
V_D2=V_E2+R_D

//Shear Force at C
V_C1=V_D2
V_C2=V_D2-F_C-w*L_CD

//Shear Force at B
V_B1=V_C2
V_B2=-F_E+R_D-F_C-w*(L_BC+L_CD)-F_B

//Shear Force at A
V_A=-F_E-F_C-F_B-w*L_AD+R_D

//Pt of contraflexure
//Let F be the pt and EF=x
//V_F=-F_E-F_C+R_D-w*L_FE+w*L_DE
L_FE=-(F_E+F_C-R_D-w*L_DE)*w**-1
L_FD=L_FE-L_DE
L_FC=L_FE-L_CD-L_DE

//Bending Moment Calculations

//Bending Moment at E
M_E=0

```

```
//Bending Moment at D
M_D=-F_E*L_DE

//Bending Moment at C
M_C=-F_E*(L_CD+L_DE)+R_D*L_CD-w*L_CD**2*2**-1

//Bending Moment at F
M_F=-w*L_FD**2*2**-1-F_C*L_FC+R_D*L_FD-F_E*L_FE

//Bending Moment at B
M_B=-F_E*(L_DE+L_CD+L_BC)-F_C*L_BC+R_D*(L_CD+L_BC)-w*(L_BC+L_CD)**2*2**-1

//Bending Moment at A
M_A=-F_E*L+R_D*(L_AD)-F_C*(L_BC+L_AB)-F_B*L_AB-w*(L_AD)**2*2**-1

//Bending Moment at F
M_F=-F_E*L_FE+R_D*L_FD-F_C*L_FC-w*L_FD**2*2**-1

//Pt of contraflexure
//Let G be the pt and GE=y
//M_G=-F_E*L_GE+R_D*(L_GE-L_DE)-F_C*(L_GE-L_DE)**2*2**-1
//After substituting values and further simplifying we get
//y**2-12.9+29.35=0
a=1
b=-12.9
c=29.35

X=b**2-4*a*c

y1=(-b+X**0.5)*(2*a)**-1
y2=(-b-X**0.5)*(2*a)**-1

//Result
printf("The Shear Force and Bending Moment Diagrams
```

```
   are the results")

//Plotting the Shear Force Diagram
subplot(2,1,1)
X1=[0,0,L_DE,L_DE,L_DE+L_CD,L_DE+L_CD,L_DE+L_CD+L_BC
   ,L_DE+L_CD+L_BC,L_DE+L_CD+L_BC+L_AB,L_DE+L_CD+
   L_BC+L_AB]
Y1=[V_E1,V_E2,V_D1,V_D2,V_C1,V_C2,V_B1,V_B2,V_A,0]
Z1=[0,0,0,0,0,0,0,0,0,0]
plot(X1,Y1,X1,Z1)
xlabel("Length x in m")
ylabel("Shear Force in kN")
title("the Shear Force Diagram")

//Plotting the Bending Moment Diagram
subplot(2,1,2)
X2=[0,L_DE,L_DE+L_CD,L_DE+L_CD+L_FC,L_DE+L_CD+L_BC,
   L_DE+L_CD+L_BC+L_AB]
Y2=[M_E,M_D,M_C,M_F,M_B,M_A]
Z2=[0,0,0,0,0,0]
plot(X2,Y2,X2,Z2)
xlabel("Length in m")
ylabel("Bending Moment in kN.m")
title("the Bending Moment Diagram")
```

Scilab code Exa 4.14 `the Bending Moment Diagram`

```
// Problem no 4.4.14,Page No.105


clc;clear;
close;
L_DE=2.5;L_BC=2.5 //m //Length of DE & BC
L_CD=5;L_FE=5;L_AB=5 //m //Length of CD & AB
F_C=80;F_B=80 //KN //Pt Load at C & B
```

```
w1=16 //KN/m //u.d.l on L_DE
w2=10 //KN/m //u.d.l on L_AB
L=10 //m //Length of beam

//Calculations

//LEt R_A and R_D be the reactions at A and D
//R_A+R_D=250

//Taking moment at A
//M_A=0=w1*L_DE*(L_DE*2**-1+L_CD+L_BC+L_AB)-R_D*(L_CD+L_BC+L_AB)+F_C*(L_BC+L_AB)+F_C*(L_BC+L_AB)+F_B*L_AB+w2*L_AB**2*2**-1
R_D=-(-w1*L_DE*(L_DE*2**-1+L_CD+L_BC+L_AB)-F_C*(L_BC+L_AB)-F_B*(L_AB)-w2*L_AB**2*2**-1)*(L_CD+L_BC+L_AB)**-1
R_A=250-R_D

//Shear Force Calculations

//Shear Force at E
V_E=0

//Shear Force at D
V_D1=-w1*L_DE
V_D2=-w1*L_DE+R_D

//Shear Force at C
V_C1=V_D2
V_C2=V_D2-F_C

//Shear Force at B
V_B1=V_C2
V_B2=V_C2-F_B

//Shear Force at A
V_A1=V_B2-w2*L_AB
V_A2=0
```

```
//Bending Moment Calculations

//Bending Moment at E
M_E=0

//Bending Moment at D
M_D=-w1*L_DE**2*2**-1

//Bending Moment at C
M_C=R_D*L_CD-w1*L_DE*(L_DE*2**-1+L_CD)

//Bending Moment at B
M_B=-w1*L_DE*(L_DE*2**-1+L_CD+L_BC)+R_D*(L_CD+L_BC)-
    F_C*L_BC

//Bending Moment at A
M_A=-w1*L_DE*(L_DE*2**-1+L_CD+L_BC+L_AB)+R_D*(L_CD+
    L_BC+L_AB)-F_C*(L_BC+L_AB)-F_B*L_AB-w2*L_AB
    **2*2**-1

//Result
printf("The Shear Force and Bending Moment Diagrams
    are the results")

//Plotting the Shear Force Diagram
subplot(2,1,1)
X1=[0,L_FE,L_FE,L_DE+L_CD,L_DE+L_CD,L_DE+L_CD+L_BC,
    L_DE+L_CD+L_BC,L_DE+L_CD+L_BC+L_AB,L_DE+L_CD+L_BC
    +L_AB]
Y1=[V_E,V_D1,V_D2,V_C1,V_C2,V_B1,V_B2,V_A1,V_A2]
Z1=[0,0,0,0,0,0,0,0,0]
plot(X1,Y1,X1,Z1)
xlabel("Length x in m")
ylabel("Shear Force in kN")
title("the Shear Force Diagram")

//Plotting the Bending Moment Diagram
```

```
subplot(2,1,2)
X2=[0,L_DE,L_DE+L_CD,L_DE+L_CD+L_BC,L]
Y2=[M_E,M_D,M_C,M_B,M_A]
Z2=[0,0,0,0,0]
plot(X2,Y2,X2,Z2)
xlabel("Length in m")
ylabel("Bending Moment in kN.m")
title("the Bending Moment Diagram")
```

Scilab code Exa 4.15 Bending moment and shear force diagram

```
// Problem no 4.4.15,Page No.105

clc;clear;
close;
L=8 //m //Length of beam
L_AD=4 //m //Length of AD
w=300 //KN //u.d.l

//Calculations

//Let R_A and R_C be the reactions at A and C
//R_A+R_C=300

//Taking moment at A
//LEt x be the distance from Pt B L_CB=x
//R_C*(L-L_CB)=300*L*2**-1
//R_C=1200*(8-x)**-1
//After substituting values and further simplifying we get
//R_A=300-R_C
//R_A=1200-300*x*(8-x)**-1

//B.M at D
//M_D=R_A*L_AD-w*2**-1*2=0
```

```

//Now substituting value of R_A we get
//M_D=4*1200-300*x*(8-x)**-1-300=0

//Further on simplification we get
L_CB=600*225**-1
x=L_CB;
R_C=1200*(8-x)**-1
R_A=(1200-300*x)*(8-x)**-1

//Pt of contraflexure
//Let E be the pt and BE=y
//V_E=0=-R_A*2**-1*L_BE+R_C
L_BE=R_C*(R_A*2**-1)**-1
L_AE=L-L_BE
L_AC=L-L_CB
L_EC=L_BE-L_CB

//Shear Force at B
V_B=0

//Shear Force at C
V_C1=-w
V_C2=-V_C1+R_C

//Shear Force at A
V_A=-w+R_C

//B.M at C
M_C=-w*L_CB

//B.M at E
M_E=-R_A*L_AE+w*L_AE

//B.M at A
M_A=0

//B.M at B
```

```
M_B=0

//Result
printf("The Shear Force and Bending Moment Diagrams
    are the results")

//Plotting the Shear Force Diagram
subplot(2,1,1)
X1=[0,L_CB,L_CB,L_CB+L_AC,L_CB+L_AC]
Y1=[V_B,V_C1,V_C2,V_A,0]
Z1=[0,0,0,0,0]
plot(X1,Y1,X1,Z1)
xlabel("Length x in m")
ylabel("Shear Force in kN")
title("the Shear Force Diagram")

//Plotting the Bending Moment Diagram
subplot(2,1,2)
X2=[0,L_CB,L_CB+L_EC,L_CB+L_AC]
Y2=[M_B,M_C,M_E,M_A]
Z2=[0,0,0,0]
plot(X2,Y2,X2,Z2)
xlabel("Length in m")
ylabel("Bending Moment in kN.m")
title("the Bending Moment Diagram")
```

Scilab code Exa 4.16 Bending moment and shear force diagram

```
// Problem no 4.4.16,Page No.107

clc;clear;
close;
F_C=250 //KN //Pt LOad at C
M_D=120 //KNM //moment at Pt D
w=50 //KN/m //u.d.l 0n L_AD
```

```
L_DB=2;L_BC=2 //m //Length of DB & BC
L_AD=4 //m //Length of AD
L=8 //m //Length of beam

//Calculations

//LEt R_A and R_D be the reactions at A and D
//R_A+R_D=450

//Taking moment at A
//M_A=0=-R_B*(L_DB+L_AD)+M_D+F_C*L+w*L_AD**2*2**-1
R_B=-(-M_D-F_C*L-w*L_AD**2*2**-1)*(L_DB+L_AD)**-1
R_D=450-R_B

//Shear Force Calculations

//Shear Force at C
V_C=-F_C

//Shear Force at B
V_B1=V_C
V_B2=R_B-F_C

//Shear Force at D
V_D=V_B2

//Shear Force at A
V_A=-F_C+R_B-w*L_AD

//Pt of contralfexure
//Let E be the pt and CE=x
//V_E=0=-F_C+R_B-w*(L_EC-L_DB-L_BC)
L_EC=-((+F_C-R_B)*w**-1-L_DB-  L_BC)
L_ED=L_EC-L_DB-L_BC

//Bending Moment Calculations

//Bending Moment at C
```

```
M_C=0

//Bending Moment at B
M_B=-F_C*L_BC

//Bending Moment at D
M_D1=-F_C*(L_BC+L_DB)+R_B*L_DB
M_D2=M_D1-M_D

//Bending Moment at E
M_E=-F_C*L_EC+R_B*(L_ED+L_DB)-w*L_ED**2*2**-1-M_D

//Bending Moment at A
M_A=0

//Pt of contraflexure
//Let F be the pt and CF=y
//M_F=0=- F_C*L_FC+R_B*(L_FC-L_BC)-M_D-w*(L_FC-L_DB-
    L_BC)
//After substituting values and further simplifying
    we get equation as
//y**2-14.8*y+54.5=0

a=1
b=-14.8
c=54.4

X=b**2-4*a*c

y1=(-b+X**0.5)*(2*a)**-1
y2=(-b-X**0.5)*(2*a)**-1

//From above two equations y2 is taken into
    consideration

//Result
printf("The Shear Force and Bending Moment Diagrams
    are the results")
```

```
//Plotting the Shear Force Diagram
subplot(2,1,1)
X1=[0,L_BC,L_BC,L_BC+L_DB,L_BC+L_DB+L_AD,L_BC+L_DB+
    L_AD]
Y1=[V_C,V_B1,V_B2,V_D,V_A,0]
Z1=[0,0,0,0,0,0]
plot(X1,Y1,X1,Z1)
xlabel("Length x in m")
ylabel("Shear Force in kN")
title("the Shear Force Diagram")

//Plotting the Bending Moment Diagram
subplot(2,1,2)
X2=[0,L_BC,L_BC+L_DB,L_BC+L_DB,L_BC+L_DB+L_ED,L_BC+
    L_DB+L_AD,]
Y2=[M_C,M_B,M_D1,M_D2,M_E,M_A]
Z2=[0,0,0,0,0,0]
plot(X2,Y2,X2,Z2)
xlabel("Length in m")
ylabel("Bending Moment in kN.m")
title("the Bending Moment Diagram")
```

Chapter 5

Bending Stresses in Beams

Scilab code Exa 5.1 `Max value of Load applied`

```
// Problem 5.1,Page no.121

clc;clear;
close;

b=100 //mm //width of timber joist
d=200 //mm //depth of joist
L=3 //m //Length of beam
sigma=7 //KN/mm**2 //bending stress
w_1=5 //KN/mm**2 //unit weight of timber

//Calculations
w=0.1*0.2*1*5*100 //N/m //self weight of the joist
I_xx=1*12**-1*100*200**3 //mm**4 //M.I of section about N.A

//M=W*L+w*L**2*2**-1 //Max Bending moment
//Therefore,M=(3*W+450)

//using the relation M*I**-1=sigma*y**-1,we get
W=(((7*2*10**8)*(100*10**3*3)**-1)-450)*3**-1 //N //
```

```
Max Load applied

//Result
printf("The Max value of Load applied is %.2f N",W)
```

Scilab code Exa 5.2 Max Bending Moment

```

// Problem 5.2,Page no.122

clc;clear;
close;

D=160 //mm //Overall Depth
B=150 //mm //Width of Flange
f_t=40 //mm //Flange thickness
W_t=50 //mm //Web thickness
sigma_t=20 //N/mm**2 //tension stress
sigma_c=75 //N/mm**2 //compression stress

//Calculations

//Rectangle-1
a_1=150*40 //mm**2 //Area of Rectangle-1
y_1=40*2**-1 //mm //C.G of Rectangle-1

//Rectangle-2
a_2=120*50 //mm**2 //Area of Rectangle-2
y_2=40+120*2**-1 //mm //C.G of Rectangle-2

Y_bar=(a_1*y_1+a_2*y_2)*(a_1+a_2)**-1 //mm //Distance of C.G from the bottom flange
I=1*12**-1*150*40**3+150*40*(60-40)**2+1*12**-1*50*120**3+50*120*(100-60)**2 //mm**4 //M.I of section about N.A
```

```
y_t=60 //mm //Permissible tensile stress at the
    bottom face of flange from N.A
y_c=100 //mm //Permissible tensile stress at the top
    face of flange from N.A

//M=W*L*4**-1 //Max bending mooment at the centre

//Using the relation M*I**-1=sigma_t*y_t**-1 we get
W=(0.333*4*272*10**5)*(2.5*1000)**-1 //N //MAx
    central load

//Result
printf("The Max Bending Moment at the centre is %.2f
    N",W)
//Answer is wrong in the textbook.
```

Scilab code Exa 5.3 Max Bending stress

```
// Problem 5.3,Page no.123

clc;clear;
close;

b=10 //cm //width of beam
d=20 //cm depth of beam

//Calculations

//R_a and R_b are the reactions at A and B
    respectively.
//Moment of all forces about A

R_b=(4*4*4*2**-1-2*1.5)*(2)**-1 //KN
//R_a+R_b=18
R_a=18-R_b
```

```

//Consider a section at a distance x from A
//M_x=9.25*x-2(x-1.5)-4*x*x*2**-1=7.25*x+3-2*x**2

//Taking derivative of above equation to find max
    value of M_x we get
x=1.81 //m

M=7.25*x+3-2*x**2 //kN*m
I=b*d**3*12**-1 //cm**4 //M.I of the section
y=10
sigma=M*I**-1*y*10**8*(10**2)**-1 //Max bending
    stress

//Result
printf("The Max Bending stress is %.2f kN/m^2",sigma
    )
```

Scilab code Exa 5.4 Max Bending Moment

```
// Problem 5.4,Page no.124

clc;clear;
close;

b=10 //cm //width of beam
d=20 //cm depth of beam

sigma=8 //N/mm**2 //Max bending stress
W=5000 //N/m**2 //Load of floor
A=450 //cm**2 //Area of joist
L=5 //m //span of floor

//Calculations
//Let x be the centre to centre spacingof the joists
```

```
//A_1=5*x**2 //m**2 //Area  of floor between any two joists
//W_1=5*x*W //N //total load supported by one interior joist
//M=W_1*L*8**-1 //Max bending moment
I=1*12**-1*b*(d*10**-2)**3*10**-2 //m**4 //M.I of joist
y=0.15 //cm //Distance of of farthest fibre
M=I*y**-1*sigma //N*m

//Now equating to max bending moment we get
x=(18000*8)*(25000*5)**-1

//Result
printf("The Max Bending Moment is %.2f m",x)
```

Scilab code Exa 5.8 The shear force at half length

```
// Problem 5.8,Page no.127

clc;clear;
close;

L=3 //m //span of beam
t=20 //mm //Thickness of steel
D=200 //mm //overall depth
B=140 //mm //overall width
b=100 //mm //width of inner rectangle
d=160 //mm //depth of inner rectangle
w=77 //KN/mm**2
sigma=100 //N/mm**2 //Bending stress
//Calculations
V=((D*10**-3*B*10**-3)-(d*10**-3*b*10**-3)) //m**3 //Volume of rectangular box
```

```
W=V*3*w //KN //Weight of Beam
I=(B*D**3-b*d**3)*12**-1 //mm**4 //M.I of beam
    section

//Now using the relation ,M*I**-1=sigma*y**-1

y=200 //mm //distance from farthest fibre
M=I*sigma*2*y**-1 //N*mm

//M=3000*W+2772*3000*2**-1
//After sub values in above equation we get

W=((59.2*10**6-2772*3000*2**-1)*(3000)**-1)*10**-3
    //KN //Max concentrated Load at free end

F=W+2.772*2**-1 //KN //shear force at half length

//Result
printf("The shear force at half length is %.2f kN",F
    )
```

Scilab code Exa 5.9 Safe value of Load

```
// Problem 5.9,Page no.128

clc;clear;
close;

B=24 //mm //width of beam section
D=21.7 //mm //depth of beam section
E_1=11440 //MN/m**2 //Modulus of Elasticity parallel
     grain
E_2=2860 //MN/m**2 ////Modulus of Elasticity
    perpendicular grain
sigma_1=8.57 //MN/m**2
```

```
sigma_2=2.14 //MN/m**2
L=1.2 //m //span of beam

//Calculations

//Ratio of smaller modulus to larger modulus is E_2:
    E_1=1:4
//Dimension of transformed Beam section
b=18 //mm //width of Beam section
d=3.1 //mm //depth of beam section

I=(1*12**-1*B*10**-3*(D*10**-3)**3)-(3*(1*12**-1*b
    *10**-3*(d*10**-3)**3)) //m**4 //M.I of
    transformed section
y=21.7*10**-3*2**-1
M=I*sigma_1*10**6*y**-1 //N*m //Safe B.M
P=4*M*L**-1 //N

//Result
printf("Safe value of Load is %.2f N",P)
```

Scilab code Exa 5.11 Max central load

```
// Problem 5.11,Page no.131

clc;clear;
close;

D=4 //cm //Outside diameter
d=3 //cm //inside diamter
L=2 //m //span of beam
W=1000 //N //Max safe Load

//Calculations

```

```
I=%pi*64**-1*(D**4-d**4) //cm**4 //M.I
A=%pi*4**-1*(D**2-d**2) //cm**2 //Area
y=2
Z=I*y**-1 //cm**3 //Section modulus

M=W*L*4**-1 //N*cm //Max bending moment

//From Flexural Formula
sigma=M*Z**-1 //N/cm**2

//For Tubes
//M.I about x-x axis
I_1=4*(8.59+5.492*2**2) //cm**4

Z_1=122.32*4**-1 //cm**3

//M=W_1*200*4**-1 //N*cm
//After substituting values we get
//M=50*W_1 (equation 1)

//Again from Flexural Formula
M=sigma*Z_1

//substitute value of M in equation 1

W=11640*30.58*50**-1 //N

//Result
printf("Max central load is %.2f N",W)
```

Scilab code Exa 5.12 Allowable safe Load

```
// Problem 5.12,Page no.133

clc;clear;
```

```
close;

b=200 //mm //width of beam
d=300 //mm //depth of beam
t=12 //mm //thickness of beam
E_s=220 //KN/m**2 //modulus of elasticity of steel
E_w=11 //KN/m**2 //modulus of elasticity of timber
sigma_s=115 //MN/m**2 //stress of steel
sigma_w=9.2 //MN/m**2 //stress of timber
L=2 //m //Span of beam

//Calculations

//E_w*E_s**-1=1*20**-1 //ratio of Modulus of elasticity of timber to steel


//(Part-1)
b_1=b*20**-1 //mm //web thickness of transformed section
stress=20*sigma_w //MN/m**2 //Allowable stress in web of equivalen beam
//But allowable stress in flanges is sigma_s is 115 KN/m**2 and therefore taken into consideration


d_1=324 //mm //depth of beam with thickness in consideration
I=1*12**-1*0.2*0.324**3-2*1*12**-1*0.095*0.3**3 //m**4 //M.I of transformed section

//Using Relation , M*I**-1=sigma*y**-1 we get

//Part-2
M_max=I*(324*10**-3*2**-1)**-1*sigma_s*10**6 //N*m //Max allowable Bending moment for steel section

//Part-3
```

```
//As beam is simply supported at the ends and the
   load is applied at the centre of beam
//M_max=W*L*4**-1 //Max Bending moment
W=M_max*4*L**-1 //N //Allowable stress Load

//Result
printf("Web thickness of Equivalent steel section is
    %.2f mm",b_1)
printf("\n Max Allowable bending moment for section
   is %.2f N-m",M_max)
printf("\n Allowable safe Load is %.2f N",W)
```

Scilab code Exa 5.13 Max uniform distributed Load

```
// Problem 5.13,Page no.135

clc;clear;
close;

d=10 //cm //distance between joists
t=2 //cm //thickness of steel plate
d_2=20 //cm //depth of beam
sigma_t=8.5 //N/mm**2 //stress in timber
E_s=2*10**5 //N/mm**2 //Modulus of elasticity of
   steel
E_t=10**4 //N/mm**2 ////Modulus of elasticity of
   timber
L=5 //cm //span of beam

//calculation
sigma=10*15**-1*sigma_t //stress in timber at
   distance of 10 cm from XX (N/mm**2)

dell=sigma*E_t**-1 //strain in timber at 10 cm from
   XX (N/mm**2)
```

```
sigma_s=dell*E_s //N/mm**2 //Max stress

//For Timber
Z_w=1*6**-1*10*30**2*2 //cm**3 //section modulus of timber
M_w=sigma_t*100*Z_w //moment of resistance of timber (N-cm)

//For steel
Z_s=1*6**-1*2*20**2 //cm**3 //section modulus of steel
M_s=sigma_s*Z_s*100  //moment of resistance of steel (N-cm)

M=(M_w+M_s)*10**-5 //total moment of resistance(N-cm)

//M=w*L**2*8**-1 //N*cm //Max bending moment
w=8*M*(L**2)**-1 //kN/m //Max uniform distributed Load

//Result kN/m
printf("Moment of resistance is %.3f N-cm",M)
printf("\n Max uniform distributed Load = %.3f kN/m",w)
// answer in the textbook is not accurate.
```

Scilab code Exa 5.14 Max Stress in timbe

```
// Problem 5.14,Page no.136

clc;clear;
close;

```

```
B=10 //cm //width of timber section
D=15 //cm //depth of timber section
b=10 //cm //width of steel plate
t=12 //mm //thickness
w=3 //KN/m //Uniformly distributed Load
L=4 //m //Span of beam
m=20 //Ratio of modulus of elasticity of steel to timber
W=3 //KN/m //Load

//Calculations

y_1=15*2**-1 //C.G of timber
y_2=1.2*2**-1 //C.G of steel plate
b_s=10*m**-1 //cm //Equivalent width of steel
Y_bar=(10*1.2*0.6+15*0.5*8.7)*(10*1.2+15*0.5)**-1 //cm //distance of C.G from bottom edge

I=1*12**-1*10*(1.2)**3+10*1.2*(3.72-0.6)**2+1*12**-1*0.5*(15)**3+0.5*15*(7.5-3.72)**2
M=W*10**5*L**2*8**-1 //N*m

Y_bar_1=3.72 //cm //C.G from bottom edge
Y_bar_2=16.2-Y_bar //cm //C.G from top edge

sigma_1=(M*I**-1*Y_bar_1)*10**-2 //N/mm**2 //stress at bottom

sigma_2=(M*I**-1*Y_bar_2)*10**-2 //N/mm**2 //stress at top

sigma_max=sigma_2*m**-1

//The Answers in book for Moment of Inertia about x-x axis onwards are incorrect

//Result
printf("Moment of Inertia = %.f N-m",M)
```

```
printf("\n The Max Stress in steel is %.2f N/mm^2",
   sigma_1)
printf("\n The Max Stress in timber is %.2f N/mm**2"
   ,sigma_max)
```

Scilab code Exa 5.15 Moment of Resistance of beam

```
// Problem 5.15,Page no.137

clc;clear;
close;

B=20 //cm //width of timber
D=30 //cm //depth of timber
d=25 //cm //depth of steel plate
b=1.2 //cm //width of steel plate
sigma_s=90 //N/mm**2 //Bending stress in steel
sigma_t=6 //N/mm**2 //Bending stress in timber
m=20 //Ratio of modulus of elasticity of of steel to
    timber

//Calculation

//Equivalent width of wood section,when 1.2 cm wide
   steel plate is replaced by steel plate is
b_1=1.2*20 //cm
d_1=25 //cm //depth of wood section
y_1=d*2**-1 //cm //C.G of timber section
y_2=D*2**-1 //cm //C.G of steel section

Y_bar=(2*d*b_1*y_1+D*B*y_2)*(2*d*b_1+D*B)**-1 //cm
   //Distance of C.G from Bottom edge
I=B*D**3*12**-1+B*D*(y_2-Y_bar)**2+2*(b_1*d_1
   **3*12**-1+b_1*d_1*(Y_bar-y_1)**2) //M.I of
   equivalent timber section about N.A
```

```
Y=30-Y_bar //distance of C.G from top of equivalent
    wood section

//Thus max stress will occur at top and that in
    steel will occur at bottom
//sigma_s=m*Y_bar*Y**-1*sigma_t

//After simplifying we get
//sigma_s=15.99*sigma_t

sigma_t=sigma_s*15.99**-1 //N/mm**2 //Max stress in
    Equivalent timber section

Z_t=I*Y**-1 //Section modulus of equivalent section
M=sigma_t*Z_t*10**-5*100 //Moment of resistance of
    beam

//Result
printf("Position of N.A is %.2f cm",Y_bar)
printf("\n Moment of Resistance of beam is %.2f kN-m
    ",M)
```

Chapter 6

Slope and Deflection

Scilab code Exa 6.1 Concentrated Load at free end

```
// Problem no 6.1,Page No.154

clc;clear;
close;

b=0.12 //m //Width of beam
d=0.2  //m //Depth of beam
dell=0.005 //m //Deflection
E=2*10**5*10**6 //N/m**2
L=2.5 //m //Length of beam

//Calculations

I=b*d**3*12**-1 //m**4 //M.I of rectangular section
w=8*E*I*dell*(L**4)**-1 //N/m //U.d.l

//Let slope at free end be theta
theta=w*L**3*(6*E*I)**-1 //Radian

W=dell*3*E*I*(L**3)**-1*10**-3 //kN //Concentrated
    Load
```

```
theta_2=W*L**2*(2*E*I)**-1 //Slope at free end

//Result
printf("Uniformly distributed Load beam should carry
    is %.2f N/m",w)
printf("\n Concentrated Load at free end is %.2f kN"
   ,W)

//Answer is wrong in the textbook.
```

Scilab code Exa 6.2 Dimension of Beam

```
// Problem no 6.2,Page No.155

clc;clear;
close;

L=6 //m //Length of beam
y_b=1.5*10**-2 //m //Deflection
E=2*10**7*10**4
sigma=10*10**3*10**4
//d=2*b

//Calculations

//Let w*I**-1=X    //From Deflection at the free end
    Equation
X=y_b*8*E*(L**4)**-1*10**-3    //Equation 1

//Let w*b*I**-1=Y     //From Max bending stress at
   the extreme fibre From N.A
Y=sigma*2*(L**2)**-1           //Equation 2

b=Y*X**-1  //width of beam //mm
```

```
d=2*b        //depth of beam //mm

//Result
printf("The Dimension of Beam are:\n\t\t\t  b=%.2f
   mm (width)\n\t\t\t  d=%.2f mm (depth)",b,d)
```

Scilab code Exa 6.3 Deflection at the free end

```
// Problem no 6.3,Page No.156

clc;clear;
close;

L=3 //m //Length of beam
L_1=1.2 //m //Distance from fixed end
d=0.25 //m //Depth of beam
w=15*10**3 //N //U.d.L
W=40*10**3 //N //Point Load
E=2*10*10**4 //N/m**2
I=13500*10**-4 //M.I

//Calculations

y_b=W*L_1**3*(3*E*I)**-1+W*L_1**2*(2*E*I)**-1*(L-L_1
   )+w*L**4*(8*E*I)**-1 //Deflection at free end

M=W*L_1+w*L*L*2**-1 //Max Bending moment at the
   fixed end A //Nm
y=d*2**-1
sigma_max=M*y*I**-1  //N/cm**2 //Max Bending stress
   at extreme fibre

//Result
printf("Deflection at the free end is %.4f cm",y_b)
printf("\n Max stress due to bending is %.2f N/cm^2"
```

```
,sigma_max)
```

Scilab code Exa 6.4 The slope at Point B

```
// Problem no 6.4,Page No.156

clc;clear;
close;

M=100*10**3 //N //Moment
L=3 //m //Length
d=0.15 //m //Width
b=0.1 //m //width
E=2.1*10**7*10**4 //N/cm**2

//Calculations

I=b*d**3*12**-1 //cm**4 //M.I of beam section
B_1=M*L*(E*I)**-1 //radian //Slope at B
B_2=M*L**2*(2*E*I)**-1*10**2 //cm //Deflection at point B

//Result
printf("The slope at Point B is %.2f radian",B_1)
printf("\n The Deflection at point B is %.2f cm",B_2)
```

Scilab code Exa 6.5 The slope at free end

```
// Problem no 6.5,Page No.157

clc;clear;
close;
```

```

b=0.1 //m //width
d=0.2 //m //depth
L=2 //m //Length of beam
L_1=1 //m //Length from free end
E=210*10**9
W=1*10**3 //N //Concentrated Load
w=2*10**3 //N/m

//Calculations

I=b*d**3*12**-1 //m**4 //M.I of the beam section

//Slope at free end
theta=W*L**2*(2*E*I)**-1+w*L**3*(6*E*I)**-1-w*(L-L_1
   )**3*(6*E*I)**-1

//Deflection at free end
y_b=(W*L**3*(3*E*I)**-1+w*L**4*(8*E*I)**-1-w*(L-L_1)
   **4*(8*E*I)**-1-w*(L-L_1)**3*L_1*(6*E*I)**-1)
   *10**3

//Result
printf("Slope at free end is %.5f radian",theta)
printf("\n Deflection at free end is %.2f mm",y_b)
```

Scilab code Exa 6.6 slope at left end

```
// Problem no 6.6,Page No.158

clc;clear;
close;

L=10 //m //span of beam
W=10*10**3 //N //Point Load
```

```
a=6 //m //Distance from left end of beam to point Load
b=4 //m ////Distance from right end of beam to point Load
E=210*10**9
I=10**-4 //m //M.I of beam

//Calculation

//slope at left end is given by
theta_A=W*b*(L**2-b**2)*(6*E*I*L)**-1 //radian

//Deflection under Load is
y_c=W*a*b*(L**2-a**2-b**2)*(6*E*I*L)**-1*10**3 //mm

//Maximum Deflection of the beam is
y_max=W*a*(L**2-a**2)**1.5*(15.588457*E*I*L)**-1*10**3 //mm

//Result
printf("slope at left end is %.5f radian",theta_A)
printf("\n Deflection under Load is %.2f mm",y_c)
printf("\n #Maximum Deflection of the beam is %.2f mm",y_max)
```

Scilab code Exa 6.7 Minimum value of Depth

```
// Problem no 6.7,Page No.158

clc;clear;
close;

L=5 //m //Length of beam
w=40*10**3 //N //U.d.L
y_max=0.01 //Deflection
```

```
sigma_s=7*10**6 //Bending stress
E=10.5*10**9

//Calculation

M=w*L*8**-1 //N*m //Max Bending moment

//From equation of max deflection
I=5*w*L**3*(y_max*384*E)**-1 //m**4

d=sigma_s*2*I*M**-1*10**2 //cm
b=12*I*((d*10**-2)**3)**-1*10**2 //cm //Breadth

//Result
printf("Minimum value of breadth is %.2f cm",b)
printf("\n Minimum value of Depth is %.2f cm",d)
```

Scilab code Exa 6.8 Slope at supports

```
// Problem no 6.8,Page No.159

clc;clear;
close;

L=6 //m //Length of beam
d=0.15 //m //diameter
y_max=1.035*10**-2 //m //Deflection
E=210*10**9

//Calculations

I=%pi*64**-1*d**4 //M.I of Beam
W=y_max*48*E*(L**3)**-1 //Point Load
theta_A=3*y_max*L**-1
theta_B=-theta_A
```

```

//Result
printf("The Heaviest central Point Load placed is %.2f N",W)
printf("\n Slope at supports are:theta_A = %.5f radian",theta_A)
printf("\n                         :theta_B = %.5f radian",theta_B)
```

Scilab code Exa 6.9 `Deflection under points`

```
// Problem no 6.9,Page No.160

clc;clear;
close;

L=14 //m //Lenth of steel girder
E=210*10**9 //modulus of Elasticity of steel
I=16*10**4*10**-8 //M.I of girder section

//Calculations

//R_a+R_b=200  //R_a & R_b are the Reactions at supports A & B respectively

//After taking moment at B We get
R_a=(120*11+80*4.5)*14**-1 //KN
R_b=200-R_a

//After considering section at X-X at a distance x from left end A and taking B.M at X-X
//M=120*x-120(x-3)-80*(x-9.5)

//After Integrating twice we get
//EI*dy*dx**-1=-60*x**2*+60(x-3)**2+40(x-9.5)**2+C_1
```

```
      //slope

//Again on Integrating we get
//EI*y=-20*x**3+20(x-3)**3+40*3**-1*(x-9.5)**3+C_1*x +C_2 //Deflection

//At A deflection is zero,i.e at x=0,y=0
//At B deflection is zero,i.e at x=14,y=0 So C_2=0

C_1=-(-20*(14)**3+20*(11)**3+40*3**-1*(14-9.5)**3) *14**-1 //constant

//Now Deflection at D i.e at x=3 m
x=3
y_D=1*(E*I)**-1*(-20*x**3+20*(x-3)**3+C_1*x)*10**3

//Now Deflection at D i.e at x=9.5 m
x=9.5
y_C=1*(E*I)**-1*(-20*x**3+20*(x-3)**3+40*3**-1*(x -9.5)**3+C_1*x)*10**3

//Result
printf("Deflection under points of two Loads are i.e : at pt D = %.4f m",y_D)
printf("\n                                                    : at pt C = %.4f m",y_C)
```

Scilab code Exa 6.10 Deflection at points

```
// Problem no 6.10,Page No.161

clc;clear;
close;

```

```
E=200*10**9 //Pa
I=20000*10**-8 //m**4

//Calculations

//Now Taking moment at B
R_a=(1000*3*4.5+1000*2)*6**-1 //Reaction Force at pt A

//On part BC u.d.l of 1KN/m is introduced both above and below
//consider section at distance x i.e X-X and considering moment at section X-X

//M=15500*x*6**-1-1000*x**2*2**-1-1000(x-4)+1000*2**-1*(x-3)**2
//EI*d**2y*d**x=-M=15500*x*6**-1-1000*x**2*2**-1-1000(x-4)+1000*2**-1*(x-3)**2

//Now Integrating above Equation we get Equation of slope
//EI*dy*dx**-1=-15500*x**2*12**-1+1000*x**3*6**-1+1000*(x-4)**2*2**-1+1000*6**-1*(x-3)**3+C_1

//Now Integrating above Equation we get Equation of Deflection
//EI*y=-15500*x**3*36**-1+1000*x**4*24**-1+1000*(x-4)**3*6**-1+1000*24**-1*(x-3)**3+C_1*x+C_2

//At x=0,deflection is zero,i.e y=0  C_2=0
//At x=6,deflection is zero,i.e y=0
x=6
C_1=-(-15500*x**3*36**-1+1000*x**4*24**-1+1000*(x-4)**3*6**-1+1000*(x-3)**4*24**-1)*x**-1 //Constant

//Answer for constant C_1 is incorrect in Book

```

```
//Now Deflection at C,put x=3 m
x=3
y_C=1*(E*I)**-1*(-15500*x**3*36**-1+1000*x
    **4*24**-1+1000*(x-4)**3*6**-1+1000*24**-1*(x-3)
    **3+C_1*x)*10**3

//Now Deflection at D,put x=4 m
x=4
y_D=1*(E*I)**-1*(-15500*x**3*36**-1+1000*x
    **4*24**-1+1000*(x-4)**3*6**-1+1000*24**-1*(x-3)
    **3+C_1*x)*10**3

//Answers for y_C & y_D are incorrect in book

//Result
printf("Deflection at pt C is %.2f mm",y_C)
printf("\n Deflection at pt D is %.2f mm",y_D)
```

Scilab code Exa 6.11 Magnitude of equal Loads

```
// Problem no 6.11,Page No.162

clc;clear;
close;

L=2.5 //m //Length of beam
L_1=1.5 //m //Length from Fixed end
W=50*10**3 //N //Load

//Calculations

//Case-1
y=W*L**3*3**-1 //Deflection of the cantilever at
    free end

```

```
//Case-2
//Deflection of cantilever at free end is
//y_1=W_1*L**3*3**-1+W_1*L_1**3*3**-1+W_1*L_1**3*3**-1*(L-L_1)
//After substituting values in above equation and simplifying further we get

//y_1=22.375*W_1*3**-1

W_1=y*3*22.375**-1*10**-3 //Magnitude of equal Loads
M_1=W*L*10**-3
M_2=W_1*L+W_1*L_1

//Let M_1=sigma_1*z  and M_2=sigma_2*z
//Dividing above two equations we get

//Let X=sigma_1*sigma_2**-1
X=M_2*M_1**-1*100

//Result
printf("Magnitude of equal Loads is  %.2f kN",W_1)
printf("\n Max Bending stress is  %.2f %%",X)
```

Scilab code Exa 6.12 Load taken by prop

```
// Problem no 6.12,Page No.163

clc;clear;
close;

L=4 //m //Length of Beam

//calculations

//Consider a section at distance x from A and B.M at
```

```
    this section is
//M=P*(3-x)-10*x**2+90*x-195

//Now //EI*d**2*y*d**2*x=-P*(3-x)+10*x**2-90*x+195

//On Integrating above equation we get
//E*I*dy*dx**-1=-P*(3*x-x**2*2**-1)+10*x
    **3*2**-1-45*x**2+195*x+C_1

//Again On Integrating above equation we get
//E*I*y=-P*(3*x**2*2**-1-x**3*6**-1)+10*x
    **4*12**-1-15*x**3+195*x**2*2**-1+C_1*x+C_2

//But at x=0,dy*dx**-1=0 we get ,C_1=0
//          x=0,y=0       we get     ,C_2=0
//At x=3 m,y=0
x=3
C_1=0
C_2=0
P=(10*x**4*12**-1-15*x**3+195*x**2*2**-1+C_1*x+C_2)
    *(3*x**2*2**-1-x**3*6**-1)**-1

//Result
printf("Load taken by prop is %.2f",P);printf(" KN")
```

Scilab code Exa 6.13 The central Deflection

```
// Problem no 6.13,Page No.163

clc;clear;
close;

L=6 //m //Span of Beam
sigma=100*10**6 //Pa //Bending stress
E=210*10**9
```

```
y=0.45 //m //Depth

//Calculations

//Taking moment at B
R_a=20*6*3+6*40*2*2**-1

//At a section x from A the rate of Loading =20+2*3**-1*x //KN/m
//S.F=100-20*x-x**2*3**-1
//M=100*x-10*x**2-x**3*9**-1

//Thus B.M will be max where S.F is zero,we get equation as
//x**2+60*x-300=0
a=1
b=60
c=-300

X=b**2-4*a*c
x_1=(-b+X**0.5)*(2*a)**-1
x_2=(-b-X**0.5)*(2*a)**-1

x=4.641
M=100*x-10*x**2-x**3*9**-1 //KN*m //Max bending moment
I=M*sigma**-1*y*1000*2**-1 //m**4 //M.I

//E*I*d**2*y*(d*x**2)**-1=-100*x+10*x**2+x**3*9**-1

//AFter Integrating above EquATION WE get
//E*I*dy*(dx)**-1=-50*x**2+10*3**-1*x**3+x**4*36**-1+C_1
//Again Integrating above EquATION WE get
//E*I*y=-50*x**3*3**-1+10*12**-1*x**4+x**5*180**-1+C_1*x+C_2

//At x=0,y=0   ,C_2=0
```

```
//At x=6,y=0
x=6
C_2=0
C_1=-(-50*x**3*3**-1+10*12**-1*x**4+x**5*180**-1)*x
    **-1

x=3 //m
y=1*(E*I)**-1*(-50*x**3*3**-1+10*12**-1*x**4+x
    **5*180**-1+C_1*x+C_2)*1000*100

//Result
printf("The central Deflection is %.2f",y);printf("
    cm")
```

Scilab code Exa 6.14 Deflection of cantilever

```
// Problem no 6.14,Page No.168

clc;clear;
close;

L=10 //m //Lenght of cantilever beam
P_1=20*10**3 //N //Load at free end
P_2=20*10**3 //N //Load at middle of beam
E=200*10**9 //Pa
I=20000*10**-8 //m**4

//Calculations

//Taking moment at pt B we get
R_a=20*5*10**-1 //Force at pt A

//Now B.M at b=0,at C=-100,at A=-300 KN*m

//Now Area of B.M
```

```
A_1=2**-1*5*100 //KN*m**2
A_2=5*100       //KN*m**2
A_3=2**-1*5*200 //KN*m**2

//Total Area of B.M diagram is given by A
A=A_1+A_2+A_3

theta=A*10**3*(E*I)**-1 //radian

x_1=2*3**-1*5
x_2=3*2**-1*5
x_3=5*3**-1*5
M_1=A_1*x_1
M_2=A_2*x_2
M_3=A_3*x_3

M=M_1+M_2+M_3 //Total moments of B.M about B

y_B=M*10**3*(E*I)**-1 //Deflection a tfree end

//REsult
printf("Slope of cantilever at free end is %.2f",
   theta);printf(" radian")
printf("\n Deflection of cantilever at free end is %
   .2f",y_B);printf(" m")
```

Scilab code Exa 6.15 The reaction at end C

```
// Problem no.6.15,Page no.169

clc;clear;
close;

//Calculations

```

```
//Slope at A is Zero and deflection at C is zero According to Mohr's second theorem
//Let A_1*x_1=Y
Y=1*30**-1*80*4*(3*4**-1*4+2)
P=200*27**-1 //Reaction at ens D

//Result
printf("The reaction at end C is %.2f",P);printf(" KN")
```

Scilab code Exa 6.16 `Deflection at the centre`

```
// Problem no 6.16,Page No.171

clc;clear;
close;

E=200*10**9 //Pa
I=2500*10**-8 //m**4

//Calculations

//Taking moment about A we get
R_a=(30*5+30*1)*6**-1 //Reaction at pt A
R_b=60-R_a //Reaction at pt B

M_c=30*1 //B.M at C
M_d=30*1 //B.M at D
M_a=0 //B.M at a
M_b=0 //B.M at b

//For conjugate beam taking moment about B_dash
R_a_dash=(30*2**-1*(5+1*3**-1)+30*4*3+30*2*3**-1*2**-1)*6**-1
R_b_dash=150-R_a_dash
```

```
y_e=1*(E*I)**-1*(R_a_dash
    *3-30*2*1-2**-1*1*30*(2+1*3**-1))*1000

//Result
printf("Deflection at the centre is %.2f",y_e);
    printf(" m")
```

Chapter 7

Torsion

Scilab code Exa 7.1 Minimum external diameter

```
// Problem no 7.1,Page no.183

clc;clear;
close;

G=84 //Gpa //Modulus of Rigidity
N=110 //no. of revolution
//d*D**-1=0.6 //Ratio of inner diameter to outer
    diameter
sigma_s=63 //MPa //shear stress
L=3 //m //Length of shaft
P=590 //KW //Power

//Calculation

//P=2*%pi*N*T_mean*60000**-1 //KW //Power
T_mean=P*60000*(2*%pi*N)**-1 //N*m //Mean Torque

//I_p=p*32**-1*(D**4-d**4)

//After substituting value of d in above equation we
```

```
get
//I_p=0.0272*%pi*D**4 //m**4 //Polar moment of
    Inertia

T_max=1.2*T_mean //N*m //Max torque

//Using Relation
//T_max*T_p**-1=sigma_s*R**-1=G*theta*L**-1

//After substituting values and simplifying we get

D=(5.7085*10**-3)**0.3333 //m //Diameter of shaft

theta=1.4*%pi*180**-1 //radians

//theta=((T_max*L)*(G*10**9*I_p)) //radians

//After substituting values and simplifying we get
D_1=(1.0513*10**-3)**0.25

//Result
printf("The Minimum external diameter is %.2f",D_1);
    printf(" m")
```

Scilab code Exa 7.2 Percentage saving in weight

```
// Problem no 7.2,Page no.184

clc;clear;
close;

P=295 //KW //Power
N=100 //R.p.m
sigma_s=80 //MPa //shear stress

```

```

//Calculations

T_mean=((P*60000)*(2*%pi*N)**-1) //N*m

//T_max=T_mean=(%pi*D**3*sigma_s)*16**-1
D=((T_mean*16)*(%pi*sigma_s*10**6)**-1)**0.333 //m //Diameter of solid shaft

//For hollow shaft
//I_p_h=%pi*32**-1*(D_1**4-d_1**4) (equation 1)

//Now d_1=0.6*D_1
//substituting above value in equation 1,we get,

//I_p_h=0.0272*%pi*D_1**4

//For solid shaft
//I_p_s=%pi*32**-1*D**4

//T and sigma_s being the same then I_p*R**-1 will be the same for the two shafts
//Using relation  I_p_h*R_1**-1=I_p_s*R**-1

//Substituting values and simplifying we get

D_1=(D**3*0.8704**-1)**0.3333333 //m //External diameter of hollow shaft
d_1=0.6*D_1 //cm //Internal diameter of hollow shaft

A_s=%pi*4**-1*(D*10**2)**2 //cm**2 //Area of solid shaft
A_h=%pi*4**-1*(((D_1*10**2)**2)-((d_1*10**2)**2))

W=(A_s-A_h)*A_s**-1*100 //Percentage //Percentage saving in weight


```

```
//Result
printf("Diameter of solid shaft is %.5f m",D)
printf("\n Percentage saving in weight is %.2f",W);
   printf(" %%")
```

Scilab code Exa 7.7 The maximum shear stress

```
// Problem no 7.7,Page no.188

clc;clear;
close;

P_C=45 //KW Power aplled at C
P_B=15 //KW Power taken off at B
P_BA=30 //KW //Power transmitted across BA
G=85 //GPa

//Calculations (Part-1)

//For BC
P_1=45 //KW //Power across BC
N_1=200  //r.p.m
d_1=0.075 //m //diameter of shaft BC
L_BC=2 //m //Length of shaft BC


T_BC=60000*P_1*(2*%pi*N_1)**-1 //N*m //Torque
   transmitted across BC
sigma_s_BC=16*T_BC*((%pi*(d_1)**3)**-1)*10**-6 //N/m
   **2 //max shear stress in BC
I_p_BC=%pi*32**-1*d_1**4 //m**4 //Polar M.I of BC
theta_1=T_BC*L_BC*(G*10**9*I_p_BC)**-1 //Radian //
   Max angle of twist theta_1 in BC of B relative to
    C

```

```
//For AB
P_2=30 //KW //Power across AB
N_2=200  //r.p.m
d_2=0.05 //m //diameter of shaft AB
L_BC=4 //m //Length of shaft AB


T_AB=60000*P_2*(2*%pi*N_2)**-1 //N*m //Torque transmitted across AB
sigma_s_AB=16*T_AB*(%pi*(d_2)**3)**-1*10**-6 //MN/m**2 //max shear stress in AB
I_p_AB=%pi*32**-1*d_2**4 //m**4 //Polar M.I of AB
theta_2=T_AB*L_BC*(G*10**9*I_p_AB)**-1 //Radian //Max angle of twist theta_1 in AB of A relative to B
C=(theta_1+theta_2)*180*%pi**-1 //radian //Angle of Twist of gear


//Result
printf("Angle of Twist of gear is %.2f",C);printf(" Degree")
printf("\n The maximum shear stress developed in the shaft AB is %.2f MN/m^2",sigma_s_AB)
```

Scilab code Exa 7.8 Total angle of Twist

```
// Problem no 7.8,Page no.189

clc;clear;
close;

L_BC=1.8 //m //Length of BC
L_AB=1.2 //m //Length of AB
sigma_s=70 //MPa //shear stress
```

```
d_1=0.05 //m //diameter of BC
d_2=0.1 //m //diameter of AB
r_BC=0.025 //cm //Radius of BC

//Calculations

I_p_BC=%pi*32**-1*d_1**4 //m**4 //Polar M.I of BC
I_p_AB=%pi*32**-1*d_2**4 //m**4 //Polar M.I od AB

//For BC
//theta_1=T*L_BC*(G*10**9*I_p_BC)**-1 //Angle of Twist of C relative to B
//After substituting and simplifying value, we get

//theta_1=3.4923*10**-5*T

//For AB
//theta_2=T*L_AB*(G*10**9*I_p_AB)**-1 //Angle of Twist of B relative to A
//After substituting and simplifying value, we get

//theta_2=1.45513*T

//sigma_s=T*R*(I_P)**-1 //The max shear stress in BC

//After substituting and simplifying value in above equation, we get

T=sigma_s*10**6*I_p_BC*r_BC**-1
theta_1=3.4923*10**-5*T
theta_2=1.45513*10**-6*T
theta_c=theta_1-theta_2 //radian //total angle of twist

//Result
printf("Total angle of Twist is %.3f radian",theta_c)
```

Scilab code Exa 7.9 The speed at which the shafts to be driven

```
// Problem no 7.9,Page no.190

clc;clear;
close;

D=0.05 //m //Diameter of shaft
sigma_s_a=55 //MPa //shear stress of alloy
sigma_s_s=80 //MPa //shear stress of steel
P=185 //KW //Power

//Calculations

//For alloy shaft,
//theta*L**-1=T*(G_A*I_p_A)**-1

//For steel shaft,
//theta*L*-1=I*(G_S*I_p_S)**-1

//After substituting and simplifying we get
d=(246.2*10**-8)**0.25 //m //Internal diameter of steel shaft

T_1=%pi*16**-1*D**3*sigma_s_s*10**6 //N*m //For alloy shaft max torque
T_2=%pi*16**-1*((D**4-d**4)*D**-1)*sigma_s_s*10**6 //N*m //For steel shaft max torque

//Permissible torque,T_2

//P=2*%pi*N*T_2*(60000)**-1

//After substituting we get
```

```
N=P*60000*(2*%pi*T_2)**-1 //r.p.m //Speed

//Result
printf("The speed at which the shafts to be driven is %.f rpm",N)
```

Scilab code Exa 7.10 The Angle of Twist

```
// Problem no 7.10,Page no.190

clc;clear;
close;

sigma_s=90 //MPa //shear stress of steel
sigma_d=60 //MPa //shear stress of duralumin
G_d=28 //GPa //modulus of rigidity of duralumin
G_s=84 //GPa //modulus of rigidity of steel
L=1 //m //Length of shaft

//Calculations

//theta*L**-1=sigma_s*(G_s*R_s)**-1=sigma_d*(G_d*R_d)**-1

//After substituting and simplifying,we get,
//D=2*d

//T_s=%pi*16**-1*d**3*sigma_s //N*m //torque of steel
//T_d=%pi*16*(((D**4-d**4)*D**4)**-1)*sigma_d //N*m //torque of duralumin

//After substituting and simplifying above two equations,we get,

```

```
//T_s=17.6714*10**6*d**3 //N*m
//T_d=88.3572*d**3 //N*m

//T=T_s+T_d //Total torque

//T=106.02875*10**6*d**3

d=(700*(106.02875*10**6)**-1)**0.333 //m
D=2*d //m
R_s=d*2**-1 //m

theta=(sigma_s*10**6*L*(G_s*10**9*R_s)**-1)*180*%pi**-1 //degree //Angle of twist

//Result
printf("The Angle of Twist is %.2f",theta);printf(" Degree")
```

Scilab code Exa 7.11 Energy stored per cubic meter

```
// Problem no 7.11,Page no.191

clc;clear;
close;

P=4415 //KW //Power transmitted
N=110 //r.p.m
sigma_s=75 //MPs //shear stress
G=85 //GPa

//Calculations

//D=2*d

T=P*60000*(2*%pi*N)**-1 //N*m //Torque Transmitted
```

```
//T=%pi*16**-1*(D**4-d**4)*D**-1*sigma_s //N*m

//After substituting and simplifying above equations
    ,we get ,

D=(T*16*%pi**-1*(sigma_s*10**6)**-1)**(1*3**-1)
d=D*2**-1
X=5*(sigma_s*10**6)**2*(16*G*10**9)**-1

//U*V**-1 //Energy stored
//X=U*V**-1 //Energy stored //Notations has been
    changed

//Result
printf("Diameter of shaft is:D %.2f",D);printf(" cm"
    )
printf("\n                              :d %.2f",d);printf("
    cm")
printf("\n Energy stored per cubic meter is %.2f",X)
    ;printf(" N/m**2")
```

Scilab code Exa 7.12 Diameter of shaft

```
// Problem no 7.12,Page no.192

clc;clear;
close;

P=3680 //KW //Power transmitted
N=110 //r.p.m
X=20000 //N*m //Energy stored
G=85 //GPa

//Calculations
```

```


//U*V**-1=X //Strain Energy per unit volume //Notification has been changed
//X=sigma_s**2*(4*G)**-1*((D**2+d**2)*(D**2)**-1)

T=P*60000*(2*%pi*N)**-1 //N*m //Torque transmitted by shaft
sigma_s=(20000*3*G*10**9)**(1*2**-1) //MPa //shear stress of shaft

//T=%pi*16**-1*((D**4-d**4)*D**-1)*sigma_s

//After substituting and simplifying above equations ,we get ,

d=((T*16*3**0.5)*(%pi*8*sigma_s)**-1)**(1*3**-1)
D=3**0.5*d

//Result
printf("Diameter of shaft is D= %.2f",D);printf(" m")
printf("\n                         d= %.2f",d);printf(" m")
```

Scilab code Exa 7.13 Power transmitted by compound shaft

```
// Problem no 7.13,Page no.193

clc;clear;
close;

D=8 //cm //Diameter of bronze
d=5 //cm //diameter of steel shaft
R_b=4 //cm //Radius of bronze
```

```
R_s=2.5 //cm //Radius of steel shaft
sigma_b=40 //MPa //shear stress of bronze
sigma_s=65 //MPa //shear stress of steel shaft
N=500 //r.p.m
G_s=85 //GPa //Modulus of rigidity of steel
G_b=45 //GPa //Modulus of rigidity of bronze

//Calculations

I_p_s=%pi*32**-1*(5*10**-2)**4 //m**4 //Polar M.I of Steel shaft
I_p_b=%pi*32**-1*((8*10**-2)**4-(5*10**-2)**4) //m**4 //Polar M.I of Bronze shaft

//T*(G_b*I_p_b)**-1=T_s*(G_s*I_s)**-1

//After substituting and simplifying above equations,we get

//T_b=2.94*T_s

T_b=I_p_b*sigma_b*10**6*(R_b*10**-2)**-1 //N*m //Torque carried by bronze
T_s=I_p_s*sigma_s*10**6*(R_s*10**-2)**-1 //N*m //Torque carried by steel shaft
T_s_1=T_b*2.94**-1 //N*m

T=T_b+T_s_1 //N*m //Total Torque
P=(2*%pi*N*T*(60000)**-1) //KW //Power transmitted

//Result
printf("Power transmitted by compound shaft is %.2f",P);printf(" KW")
```

Scilab code Exa 7.14 shear stress in shaft

```
// Problem no 7.14,Page no.194

clc;clear;
close;

d=10 //cm //Diameter of shaft
r=5 //cm //radius of shaft
P=100 //KW //Power
N=120 //r.p.m
n=6
L_k=14 //cm //Length of key
B_k=2.5 //cm //width of key
n=6
d_b=2 //cm //Diameter of bolt
D_b=30 //cm //Diameter of bolt circle
R_b=15 //cm //radius

//Calculations

T=(P*60000*(2*%pi*N)**-1)*10**2 //N*m //Torque
I_p=%pi*32**-1*d**4 //Polar M.I of shaft
sigma_s=T*r*(I_p)**-1 //N/cm**2
sigma_k=T*(L_k*B_k*r)**-1 //N/cm**2
sigma_b=T*4*(n*%pi*d_b**2*R_b)**-1 //N/cm**2

//Result
printf("shear stress in shaft %.2f",sigma_s);printf(" N/cm**2")
printf("\n                   Key %.2f",sigma_k);printf(" N/cm**2")
printf("\n                 bolts %.2f",sigma_b);printf(" N/cm**2")
```

Chapter 8

Springs

Scilab code Exa 8.1 Mean Diameter of coil

```
// Problem 8.1,Page no.206

clc;clear;
close;

k=1 //KN/m //stiffness of spring
P=45 //N //Maximum Load
sigma_s=126 //MPa //Max shear stress
L=4.5 //cm //Lenght of spring
G=42 //GPa //Modulus of rigidity

//Calculations

//sigma_s_max=16*P*R*(%pi*d**3)**-1 //Max shear
    stress

//After substituting values in above equation and
    simolifying we get
//1000=42*10**9*d**4*(64*R**3*n)**-1    (//Equation
    1)

```

```
//R=0.175*10**6*%pi*d**3 //Radius of spring (Equation 2)

//L=n*d //solid length of spring
//Thus simplifying above equation , n=L*d**-1

//substituting value of n and R in (equation 1) we get ,

d=(42*10**9*(1000*64*4.5*10**-2*(0.175*%pi)**3*(10**6)**3)**-1)**0.25*10**2 //cm //diameter of helical spring

//substituting value d in (equation 2) we get ,
R=0.175*10**6*%pi*(d)**3*10**-6*100 //cm //Radius of coil
D=2*R //cm //Mean diameter of coil
n=0.045*0.00306**-1 //Number of turns


//Result
printf("The Diameter of wire is %.3f cm",d)
printf("\n The Mean Diameter of coil is %.2f",D);printf(" cm")
```

Scilab code Exa 8.2 Diameter of steel wire

```
// Problem 8.2,Page no.207


clc;clear;
close;

L=15 //cm //Length of close coiled helical spring
U=50 //N*m //Strain energy
```

```
sigma_s=140 //MPa //Shear stress
D=10 //cm //Mean coil diameter
G=80 //GPa //Modulus of rigidity

R=D*2**-1 //cm //Mean coil Radius

//Calculations

//Let dell be the deflection of the spring when fully compressed
// 0.15-dell=n*d (Equation 1)

//U=(sigma_s)**2*V*(4*G)**-1 //Strain energy

//After substituting values in above equation and simolifying we get
V=50*4*80*10**9*((140*10**6)**2)**-1 //m**3 //Volume of spring

//But V=%pi*4**-1*d**2*2*%pi*R*n
//After substituting values in above equation and simolifying we get
//n=3.308*10**-3*(d**2)**-1 //Number of turns

//We know, T=P*R
//Now substituting values in T and simolifying we get
//P=549.7787*10**6*d**3  //Load

//U=P*dell*2**-1
//After substituting values in above equation and simolifying we get
//dell=0.18189*10**-6*d**3 //Deflection

//After substituting values in above equation and simolifying we get

//d**3-22.0533*10**-3*d**2-1.21261*10**-6=0
```

```
Coeff=[1 -22.0533*10**-3 0 -1.21261*10**-6]
d=roots(Coeff)  //Diameter of steel wire
n=3.308*10**-3*((d(1)**2)**-1) //no.of coils

//Result
printf("Diameter of steel wire is %.5f m",d(1))
printf("\n number of coils  = %d",ceil(n))
```

Scilab code Exa 8.3 Max shear stress

```
// Problem 8.3,Page no.208

clc;clear;
close;

k=10 //KN/m //stiffness
L=40 //cm //Length of coil when adjacent coil touch each other
G=80 //GPa //Modulus of rigidity
//dell=0.002*n //Max compression

//Calculation

//k=G*d**4*(8*D**3*n)**-1 //Stiffness
//After substituting values in above equation and simolifying we get
//d**4=D**3*n*10**-6      (Equation 1)

//L=n*d, //After substituting values we get
//n=0.4*d**-1               (Equation 2)

//Again, d*D**-1=1*10**-1
//After solving above ratios we get,D=10*d

```

```
//After substituting values in Equation 1 And
   Equation 2 we get
d=(10**3*0.4*10**-6)**0.5*100 //cm
D=10*d //cm //Mean Diameter
R=D*2**-1 //cm //Mean Radius
n=0.4*(d*10**-2)**-1 //Number of turns
dell=0.002*n*100 //Deflection

//k=P*dell**-1
//after solving above equation we get
P=k*10**3*dell*10**-2 //N //Load

sigma_s_max=16*P*R*10**-2*(%pi*(d*10**-2)**3)**-1 //
   N/m**2 //Max shear stress

//Result
printf("The wire diameter is %.2f",d);printf(" cm")
printf("\n The Mean diameter is %.2f",D);printf(" cm
   ")
printf("\n Max Load applied is %.2f",P);printf(" N")
printf("\n Max shear stress is %.f N/m^2",
   sigma_s_max)
```

Scilab code Exa 8.4 The number of Turns

```
// Problem 8.4,Page no.209

clc;clear;
close;

G=80 //GPa //Modulus of rigidity
P=1 //KN //Load
dell=10 //cm //Deflection
sigma_s=350 //MPa //Max shear stress
rho=78000 //N/m**3 //Density of materials
```

```

//Calculations

U=P*1000*dell*10**-2*2**-1 //N*m //Energy stored

//Again U=sigma_s**2*V*(4*G)**-1
//After substituting values in above equation and further simplifying we get
V=50*4*80*10**9*((350*10**6)**2)**-1 //m**3 //Volume

W=V*rho //N //Weight

//Now T=P*R=%pi*d**3*sigma_s*16**-1
//After substituting values in above equation and further simplifying
D=(10**6*16*(2*%pi*350*10**6)**-1)**0.5*10**2 //cm //Mean diameter of coil

k=P*10**3*(dell*10**-2)**-1 //stiffness

//Also k=D*n**-1*10**6
//After substituting values in above equation and further simplifying
n=10**6*D*10**-2*k**-1 //number of turns

//Result
printf("The Value of weight is %.3f N",W)
printf("\n Mean coil diameter is %.2f",D);printf(" cm")
printf("\n The number of Turns is %.d",ceil(n))
```

Scilab code Exa 8.5 Max Extension of the Spring

```
// Problem 8.5,Page no.210

```

```
clc;clear;
close;

d=6 //mm //Diameter of steel wire
n=50 //number of turns
D=5 //cm //Mean Diameter
R=D*2**-1 //cm //Radius of coil
G=80 //GPa //Modulus of Rigidity
P=150 //KN //Load

//Calculation

//Dell=64*P*R**3*n*(G*d**4)**-1 //Deflection
//After substituting values in above equation and simplifying we get
//P=2073.6*dell //Gradually applied equivalent Load

//loss of potential Energy of the weight=Gain of strain Energy of the spring
//150*(0.05+dell)=P*dell*2**-1
//After substituting values in above equation we get

//dell**2-0.1446*dell-0.00723=0
//Above Equation is in the form of ax^2+bx+c=0

a=1
b=-0.1446
c=-0.00723

//First computing value of b^2-4ac and store it in a variable say X
X=b**2-(4*a*c)
//now roots are given as x=(-b+X**0.5)/(2*a) and second root is negative sign before X


dell_1=(-b+X**0.5)*(2*a)**-1*10**2
dell_2=(-b-X**0.5)*(2*a)**-1*10**2
```

```

P=2073.6*dell_1*10**-2 //N

sigma=16*P*R*10**-2*(%pi*(d*10**-3)**3)**-1 //N/m**2
    //Max stress

//Result
printf("The Max Extension of the Spring is %.2f",
   dell_1);printf(" cm")
printf("\n The Max stress is %.3e N/m^2",sigma)
```

Scilab code Exa 8.6 Max Deflection Produced

```
// Problem 8.6,Page no.209

clc;clear;
close;

W=200 //N //weight
v=4 //m/s //velocity of spring
sigma=600 //MPa //max allowable stress in spring
G=80 //GPa //Modulus of rigidity
rho=78000 //N/m**3 //density
d=8 //mm //diameter of spring
D=5 //cm //Mean Diameter of coil


//Calculation

E=W*v**2*(2*9.81)**-1 //N*m //Kinetic Energy //
   Notification has been changed

//U=sigma_s**2*V*(4*G)**-1 //Strain Energy stored
   inthe spring

```

```
//After substituting values in above equation and simplifying we get
V=163.1*4*80*10**9*((600*10**6)**2)**-1  //Volume

W=rho*V //N //Weight of spring

//Now V=%pi*4**-1*d**2*%pi*D*n
//After substituting values in above equation and simplifying we get
n=0.000145*4*(%pi**2*0.008**2*0.05)**-1 //number of turns of spring

//T=P*R=%pi*16**-1*d**3*sigma_s //Torsion
//After substituting values in above equation and simplifying we get
P=%pi*0.008**3*600*10**6*(0.025*16)**-1 //N

//Now U=P*dell*2**-1
//Again, After substituting values in above equation and simplifying we get
dell=163.1*2*(2412.743)**-1*10**2 //cm

//Result
printf("The Max Deflection Produced is %.2f",dell);printf(" cm")
printf("\n Number of coil are %d",ceil(n))
```

Scilab code Exa 8.7 Extension in spring

```
// Problem 8.7,Page no.211

clc;clear;
close;

n=12 //number of coils
```

```
d=3 //cm //mean diameter
k=720 //N/m //stiffness of spring
sigma_s=190 //MPa //Max shear stress
G=80 //GPa //Modulus of rigidity
D=3 //mm //Diameter of outer spring

//Calculations
R=D*2**-1 //mm //Radius of outer spring

//Dell_1=64*P*(R*10**-3**3*n*(G*10**9*(d*10**-3)**4)
    **-1 //m //Extension of first spring
//After substituting values and further simplifying
    we get
//Dell_1=0.0004*P //m

//Dell_2=64*P*(R*10**-3**3*n*(G*10**9*(d_1)**4)**-1
    //m //Extension of first spring
//After substituting values and further simplifying
    we get
//Dell_2=3.24*10**-14*P*(d_1**4)**-1 //m //where d_1
     is diameter of inner spring

//Dell=Dell_1+Dell_2
//After substituting values and further simplifying
    we get
//dell=0.0004*P+3.24*10**-14*P*((d)**4)**-1

//But dell=P*k**-1=P*720**-1

//Now substituting value of dell in above equation
    we get
d_1=(3.24*10**-14*(1*720**-1-0.0004)**-1)**0.25 //cm
     //diameter of inner spring

//Now T=P*R=%pi*d_1**3*dell_s*sigma_s*16**-1
//simplifying above equation further
//P=%pi*d**3*sigma_s*(16*R)**-1
//Now substituting values and further simplifying we
```

```
    get
P=%pi*d_1**3*sigma_s*10**6*(16*R*10**-2)**-1 //N //
    Limiting Load

dell=P*k**-1*10**2 //cm //Total Elongation

//Result
printf("Greatest Load that can be carried by
    composite spring is %.f N",P)
printf("\n Extension in spring is %.2f",dell);printf
    (" cm")
```

Scilab code Exa 8.8 Stiffness of inner spring

```
// Problem 8.8,Page no.212

clc;clear;
close;

//Outer spring
n_1=10 //number of coils
D_1=3 //cm //Diameter of coil
d_1=3 //mm //diameter of wire
dell_1=2 //cm //deflection of spring

//Inner spring
n_2=8 //number of coils

G=80 //GPa //Modulus of rigidity

//Calculation

R_1=D_1*2**-1
P_1=G*10**9*dell_1*10**-2*(d_1*10**-3)**4*(64*(R_1
    *10**-2)**3*n_1)**-1 //Load carried outer spring
```

```
for compression of 2 cm

P_2=100-P_1 //N //Load carried by inner spring
k_2=P_2*0.01**-1 //N/m //stiffness of inner spring

//D_2=D_1*10**-2-d_1*10**-3-2*dell_1*10**-2-d_2 //Diameter of inner spring
//Further simplifying above equation we get
//D_2=0.023-d_2

//Now from stiffness equation of inner spring
//k=G*d_2**4*(8*D_2**3*n_2)**-1
//Now substituting values and further simplifying we get
//d**4=(0.023-d)**3*312500**-1

//As d is small compared with 0.023,as a first appromixation
d_2_1=(0.023**3*312500**-1)**0.25 //m

//Second Approximation
d_2_2=((0.023-d_2_1)**3*312500**-1)**0.25 //m

//Final approximation
d_2_3=((0.023-d_2_2)**3*312500**-1)**0.25*100 //cm

//Result
printf("Stiffness of inner spring is %.2f",k_2); printf(" N/m")
printf("\n Wire Diameter of inner spring is %.3f cm",d_2_3)
```

Scilab code Exa 8.9 `Height measured from top of uncompressed spring`

```
// Problem 8.9,Page no.212
```

```
clc;clear;
close;

L= 3 //m //Length of rod
d_1=25*10**-3 //m //Diameter of rod
n= 5 //no. of coils
sigma=70*10**6 //MPa  //instantaneous stress
E=70*10**9 //Pa
G=80*10**9 //Pa
D=24*10**-2 //Spring diameter
R=d_1*2**-1 //spring radius
d=4*10**-2 //diameter of steel

//Calculations

dell_1=sigma*L*(E)**-1

//Let P be the equivalent applied Load which will
    produce same stress of 70 MPa
P=%pi*4**-1*(d_1)**2*E*10**-3 //KN

//deflection of the spring is given by
dell_2=P*64*R**3*n*(G*d**4)**-1

//Now Loss of Potential Energy of the weight=strain
    energy stored in the rod and the spring
//Height measured from top of uncompressed  spring
h=((P*dell_1*2**-1+P*dell_2*2**-1)*(5.5*10**3)**-1-(
    dell_1+dell_2))*10**2

//Shear stress in the spring is given by
sigma_s=16*P*R*(%pi*d**3)**-1*10**-6 //MPa

//Result
printf("Height measured from top of uncompressed
    spring %.2f",h);printf(" cm")
printf("\n max shearing stress is %.2f",sigma_s);
```

```
printf(" MPa")

// Answer is wrong in the textbook.
```

Scilab code Exa 8.10 The Radius of plate

```
// Problem 8.10,Page no.213

clc;clear;
close;

L=75 //cm //Legth of Leaf spring
P=8 //KN //Load
y_c=20 //mm //Deflection
sigma=200 //MPa //Bending stress
E=200 //GPa //modulus of Elasticity
//b=12*t

//Calculation

//y_c=sigma*L**2*(4*E*t)**-1
//After substituting values and further simplifying we get
t=200*10**6*(75*10**-2)**2*(4*200*10**9*0.02)**-1*10**2 //Thickness of plate

b=12*t //width of plate

//Now using relation we get
//sigma=3*P*L*(2*n*b*t**2)**-1
//After substituting values and further simplifying we get
n=3*8*10**3*0.75*(2*200*10**6*0.084*0.007**2)**-1

//Y_c=L**2*(8*R)**-1
```

```
R=(L*10**-2)**2*(8*y_c*10**-3)**-1 //m //Radius of
    spring

//Result
printf("The thickness of plate is %.2f",t);printf("
    cm")
printf("\n The width of plate is %.2f",b);printf("
    cm")
printf("\n The number of plate is %d",ceil(n))
printf("\n The Radius of plate is %.2f m",R)
```

Scilab code Exa 8.11 The Radius of Curvature

```
// Problem 8.11,Page no.214

clc;clear;
close;

L=75 //cm //span of laminated steel spring
P=7.5 //KN //Load
y_c=5 //cm //Central Deflection
sigma=400 //MPa //Bending stress
E=200 //GPa //Modulus of Elasticity
//b=12*t

//Calculations

//y_c=3*P*L**3*(8*E*n*b*t**3)**-1 //Deflection
//After substituting values and further simplifying
    we get
//nt**4=9.887*10**-9    (Equation 1)

//We Know sigma=3*P*L*(2*n*b*t**3)**-1 //bending
    stress
//Again after substituting values and further
```

```
    simplifying we get
//nt**3=1.757*10**-6    (Equation 2)

//After Divviding (Equation 1) by (Equation 2) we
    have
t=9.887*10**-9*(1.757*10**-6)**-1*10**2 //cm

//substituting value of t in Equation 2) we get
n=1.757*10**-6*((t*10**-2)**3)**-1 //Number of
    plates
R=(L*10**-2)**2*(8*y_c*10**-2)**-1 //Radius of
    curvature

//Result
printf("The thickness of Plates is %.2f",t);printf("
    cm")
printf("\n The Number of Plates is %d",ceil(n))
printf("\n The Radius of Curvature of Plates is %.2f
    ",R);printf(" m")
```

Scilab code Exa 8.12 Radius of curvature

```
// Problem 8.12,Page no.214

clc;clear;
close;

L=1.3 //m //Length of carriage spring
b=10 //cm //width of spring
t=12 //mm //thickness of spring
sigma=150 //MPa //Bending stresses
E=200 //GPa //Modulus of Elasticity
U=120 //N*m //Strain Energy

//Calculation
```

```
//V=n*b*t*L //Volume of carriage spring
//U=sigma**2*(6*E)**-1*V
//After substituting values in above equation and
    further simplifying we get
n=120*6*200*10**9*2*((150*10**6)
    **2*10*10**-2*12*10**-3*1.3)**-1

sigma_1=(120*6*200*10**9*2*(9*0.1*0.012*1.3)**-1)
    **0.5*10**-6 //MPa //Actual Bending stress

R=E*t*(2*sigma_1)**-1 //m

//Result
printf("The number of plates is %d",ceil(n))
printf("\n Radius of curvature is %.3f m",R)
```

Scilab code Exa 8.13 Max instantaneous stress

```
// Problem 8.13,Page no.215

clc;clear;
close;

P=200 //N //Load
h=10 //cm //Height of Load dropped
n=10 //Number of turns
b_1=5 //cm //width of plates
t=6 //mm //thickness of plates
L=75 //cm //Length of plates
E=200 //GPa //Modulus of Elasticity

//Calculaion

//Let P be the equivalent gradually applied load
```

```
which would cause the same stress as is caused by the impact Load
//200(0.1+dell)=P*dell*2**-1 (Equation 1)

//dell=3*P*L**3*(8*E*n*b*t**3)**-1 //Deflection
//After substituting values in above equation and further simplifying we get
//P=136533.33*dell

//After substituting values of P in (equation 1) and further simplifying we get
//200(0.1+dell)=136533.33*dell**2*2**-1

//simplifying above equation we get
//dell**2-2.93*10**-3*dell-2.93*10**-4=0
//The Above Equation is in the form of ax**2+bx+c=0
a=1
b=-2.93*10**-3
c=-2.93*10**-4

//First computing value of b^2-4ac and store it in a variable say X
X=b**2-(4*a*c)
//now roots are given as x=(-b+X**0.5)/(2*a) and second root is negative sign before X

dell_1=(-b+X**0.5)*(2*a)**-1
dell_2=(-b-X**0.5)*(2*a)**-1

//Now deflection cannot be negative so consider value of dell_1

P=136533.33*dell_1
sigma=3*P*L*10**-2*(2*n*b_1*10**-2*(t*10**-3)**2)**-1*10**-6 //MPa //Max instantaneous stress
R=(L*10**-2)**2*(8*dell_1)**-1 //Radius of curvature

//Result
```

```
printf("Max instantaneous stress in plates is %.2f",
    sigma);printf(" MPa")
printf("\n Radius of curvature of spring is %.2f",R)
    ;printf(" m")
```

Scilab code Exa 8.14 The Radius of curvature

```
// Problem 8.14,Page no.215

clc;clear;
close;

L=70 //cm //Length of Longest plate
n=10 //Number of turns
b_1=5 //cm //width of plates
P=3.5 //KN //central Load
t=6 //mm //thickness of plates
L=75 //cm //Length of plates
y_c=1.8 //cm //central deflection
sigma=190 //MPa //allowable bending stress
//b=12*t
E=200 //GPa //Modulus of Elasticity

//Calculation
//The Above Equation is in the form of ax**2+bx+c=0
a=1
b=-2.93*10**-3
c=-2.93*10**-4

y_c=3*P*L**3*(8*n*E*b*t**3)**-1 //Deflection (//
    Equation 1)
sigma=3*P*L*(2*n*b*t**2)**-1 //stress
//Dividing Equation 1 by Equation 2 we get
//y_c*sigma**-1=L**2*(4*E*t)**-1
//After substituting values in above equation and
```

```
    further simplifying we get
t=190*10**6*0.7**2*(1.8*10**-2*4*200*10**9)**-1*10**3 //thickness of plate
b=12*t //Width of plates

//sigma=3*2**-1*P*L*(n*b*t**2)**-1 //stress
//After substituting values in above equation and further simplifying we get
n=3*3.5*10**3*0.7*(2*190*10**6*0.077583*(6.465*10**-3)**2)**-1

//Now sigma*y**-1=E*R**-1
//simplifying above equationwe get
R=200*10**9*6.465*10**-3*(2*190*10**6)**-1 //Radius of Curvature
a=L*10**-2*(2*n)**-1*10**3 //Overlap

//Result
printf("size of the plate is: %.2f",b);printf(" mm")
printf("\n                    : %.2f",t);printf(" mm")
printf("\n Overlap of plates is %.2f",a);printf(" mm")
printf("\n Number of plates is %d",ceil(n))
printf("\n The Radius of curvature is %.3f m",R)
```

Scilab code Exa 8.15 Mean Radius of Open coiled spring

```
// Problem 8.15,Page no.216

clc;clear;
close;

alpha=30 //degree //helix angle
```

```
dell=2.3*10**-2 //m //Vertical displacement
W=40 //N //Axial Load
d=6*10**-3 //steel rod diameter
E=200*10**9 //Pa
G=80*10**9 //Pa

//Calculations

//from equation of deflection of the spring under the Load we get
//R**3*n=8.49*10**-4

//Let R**3*n=X
X=8.49*10**-4  //Equation 1

//from equation of angular rotation
//R**2*n=8.1*10**-3

//Let R**2*n=Y
Y=8.1*10**-3   //Equation 2

//After dividing equation 1 by equation 2 we get R
//Let Z=R

Z=X*Y**-1
R=Z*10**2 //cm //Mean Radius

//Result
printf("Mean Radius of Open coiled spring of helix angle is %.2f",R);printf(" cm")
```

Scilab code Exa 8.16 The Max Permissible Load

```
// Problem 8.16,Page no.217

```

```
clc;clear;
close;

n=10 //Number of coils
sigma=100 //MPa //Bending stress
sigma_s=110 //MPa //Twisting stress
//D=8*d
dell=1.8 //cm //Max extension of of wire
E=200 //GPa //Modulus of Elasticity
G=80 //GPa //Modulus od Rigidity

//Calculation

//M=W*R*sin_alpha=%pi*d**3*sigma_1*32**-1 //(
    Equation 1) //Bending moment
//As D=8*d
//then R=D*2**-1
//Therefore , R=4*d

//Now substituting values in equation 1 we get
//W*sin_alpha=2454369.3*d**2  (Equation 2)

//T=W*R*cos_alpha=%pi*d**3*sigma_s //Torque  (
    Equation 3)
//Now substituting values in equation 3 we get
//W*cos_alpha=5399612.4*d**2    (Equation 4)

//Dividing Equation 2 by Equation 4 we get ,
//tan_alpha=0.4545
alpha=atan(0.4545)*180*%pi**-1

//From Equation 2 we get
//W=2454369.3*d**2*(sin24.443)**-1
//W=5931241.1*d**2   (Equation 5)

//dell=64*W*R**3*n*sec_alpha*(d**4)**-1*((cos_alpha)
    **2*G**-1+2*sin_alpha**2*E**-1)
//Now substituting values in above equation  we get
```

```
//W=33140.016*d  (Equation 6)

//From Equation 5 and Equation 6 we get
//5931241.1*d**2=33140.016*d
//After simplifying above equation we get
d=33140.016*5931241.1**-1 //m //Diameter of wire
W=33140.016*d //N //MAx Permissible Load

//Result
printf("The Max Permissible Load is %.2f",W);printf(
    " N")
printf("\n The Wire Diameter is %.6f m",d)
```

Scilab code Exa 8.18 Necesscary torque

```
// Problem 8.18,Page no.218

clc;clear;
close;

//Calculation

n=10 //number of coils
d=2*10**-2 //m //Diameter of wire
D=12*10**-2 //m //Diameter of coiled spring
R=0.06 //m //Radius of coiled spring
dell=0.5*10**-2 //Deflection
E=200*10**9 //Pa
G=80*10**9 //Pa
alpha=30 //degree

//Calculations

//beta=64*W*R**2*n*sinalpha*(d**4)**-1*(1*G**-1-2*E
    **-1)+64*T*R*n*secalpha*(d**4)**-1*(sin**2alpha*G
```

```
**-1+2*cos**2 alpha*E**-1)=0
//From above equation anf simplifying we get

//T=-6.11*10**-3*W

//dell=64*W*R**3*n*sec(alpha)*(d**4)**-1*[(cos(alpha))**2*G**-1+2*(sin(alpha))**2*E**-1]+64*T*R**2*n*sin(alpha)*(d**4)**-1*[1*G**-1+2*E**-1]

//After substituting Values and further simplifying we get
//1.1847*10**-5*W+1.62*10**-4*T=0.005

//Now substituting value of T in above equation we get
//1.1847*10**-5*W-9.8982*10**-7*W=0.005
W=0.005*(1.1847*10**-5-9.8982*10**-7)**-1 //N
T=-6.11*10**-3*W //N*m

//Result
printf("The axial Load is %.2f",W);printf(" N")
printf("\n Necesscary torque is %.2f",T);printf(" N*m")
```

Scilab code Exa 8.19 Axial Load

```
// Problem 8.19,Page no.219

clc;clear;
close;

d=6 //mm //Diameter of steel wire
n=1 //number of turns
D=6.5 //cm //Mean of diameter
G=80 //GPa //modulus of rigidity
```

```
P_1=150 //Load
p=1.5 //cm //%pitch of coil

//Calculation

R=D*2**-1
//For one turn deflection is
dell=p-d*10**-1 //cm

//dell=64*P*R**3*n*(G*d**4)**-1
//Now, after simplifying further we get,
P=dell*10**-2*G*10**9*(d*10**-3)**4*(64*(R*10**-2)
    **3*n)**-1 //N //Axial Load

dell_2=dell*8 //cm //Total Displacement //
    Notification has been changed
U=P*dell_2*10**-2*2**-1 //N-m //Strain Energy

//Potential Energy given by 150N Load is
//U=150*(h+0.072)

//After simplifying above equation we get
h=(U*P_1**-1-0.072)*10**2 //cm //Height from which
    150 N load falls

//Result
printf("Axial Load is %.2f",P);printf(" N")
printf("\n Height from which 150 N load falls is %.2
    f",h);printf(" cm" )
```

Scilab code Exa 8.20 Estimation of axial extension

```
// Problem 8.20,Page no.219

clc;clear;
```

```
close;

alpha=30 //degree
E=200*10**9 //Pa
G=80*10**9 //pa

//Calculations

//For alpha=30 //Degree
//dell=64*W*R**3*n*sec(alpha)*(d**4)**-1*(cos(alpha)
    **2*G**-1+2*sin(alpha)**2*E**-1)
//Now substituting values in above equation we get

//dell_1=64*W*R**3*n*(d**4)**-1*1330*(10**9)**-1   (
    equation 1)

//For alpha=0 //Degree
//dell=64*W*R**3*n*sec(alpha)*(d**4)**-1*(cos(alpha)
    **2*G**-1+2*sin(alpha)**2*E**-1)
//Now substituting values in above equation we get

//dell_2=64*W*R**3*n*(d**4)**-1*1250*(10**9)**-1   (
    equation 2)

//subtracting equation 1 and equation 2 we get
//Let dell_1-dell_2=X
//X=64*W*R**3*n*(d**4)**-1*80*(10**9)

//Let Y=X*dell_1**-1*100
Y=80*1330**-1*100 //% under estimation of axial
    extension

//Result
printf("%% under estimation of axial extension is %
    .2f",Y)
```

Chapter 9

Columns and Struts

Scilab code Exa 9.1 Length of strut

```
// Problem no 9.1,Page no.232

clc;clear;
close;

D=15 //cm //External Diameter
t=2 //cm //Thickness
L=6 //m //Length of cyclinder
E=80*10**9 //Pa
alpha=1*1600**-1
sigma_c=550*10**6 //Pa //compressive stress

//Calculations

d=D-2*t //m //Internal Diameter
A=%pi*4**-1*(D**2-d**2)*10**-4 //m**2 //Areaof Tube
I=%pi*64**-1*(D**4-d**4)*10**-4 //m**4 //M.I of tube
k=(I*A**-1)**0.5 //m //Radius of Gyration

P_e=%pi**2*E*I*(L**2)**-1 //Euler's Load
P_R=sigma_c*A*(1+alpha*(L*k**-1)**2)**-1 //According
```

```
to Rankine's Formula

//The Answer in Textbook is incorrect for P_R

//Now again from Rankine's Formula
//As K=I*A**-1,so substituting in below equation
//Thus Stress calculated from Euler's Formula cannot exceed the yield stress of 550 MPa
L=(%pi**2*E*k**2*(550*10**6)**-1)**0.5*10**-2 //m //Length of cyclinder

//Result
printf("The Length of strut is %.2f",L);printf(" cm")
```

Scilab code Exa 9.2 Maximum Central Deflection

```
// Problem no 9.2,Page no.233

clc;clear;
close;


L=1.5 //m //Length of steelbar
b=2 //cm //bredth of steelbar
d=0.5 //cm //depth of steelbar
sigma=320 //MPa //Yield point
E=210 //GPa //modulus of Elasticity of steelbar

//Calculations

I_min=b*d**3*12**-1*10**-8 //m**4 //Moment of Inertia
P=%pi**2*E*10**9*I_min*(L**2)**-1 //N //N //Crippling Load
```

```
//Let dell=Central Deflection

//M=P*dell //Max Bending moment
//After substituting value in above equation we get
//M=191.9*dell

A=b*d*10**-4 //m**2 //Area of steel bar
sigma_1=P*A**-1*10**-6 //Mpa //Direct stress

Z=b*d**3*10**-6  //Section modulus
//sigma_2=M*Z**-1 //N/m**2 //Bending stress
//After substituting value in above equation we get
//sigma_2=dell*2302.8*10**6 //N/m**2

//sigma=sigma_1+sigma_2
//Now substituting value of Bending stress and direct stress in above equation we get

//320*10**6=1.919*10**6+2302.8*10**6*dell
dell=((320*10**6-1.919*10**6)*(2302.8*10**6)**-1)*10**2 //cm //Central Deflection

//Result
printf("Maximum Central Deflection is %.2f",dell);printf(" cm")
```

Scilab code Exa 9.3 The Safe Load

```
// Problem no 9.3,Page no.233

clc;clear;
close;

dell=1 //cm //Deflection
```

```
FOS=4 //Factor of safety
E=210 //GPa //Modulus of Elasticity of steel bar
W=40 //KN //Load

//Flange Dimensions
b=30 //cm //width of flange
d=5 //cm //depth of flange

//Web Dimensions
d_1=100 //cm //Depth of web
t_1=2 //cm //Thcikness of web

//Calculations

I_xx=(0.3*1.1**3-0.28*1**3)*12**-1 //m**4 //M.I about x-x axis
I_yy=2*0.05*0.3**3*12**-1+1*0.02**3*12**-1 //m**4 //M.I about y-y axis

//From the equation of deflection we get
L=(dell*10**-2*384*E*10**9*I_xx*(5*40*10**3)**-1)**0.25 //m //Length of beam
P=%pi**2*210*I_yy*10**9*4*(L**2)**-1 //N //crippling Load
S=P*4**-1 //N //Safe Load

//Result
printf("The Safe Load is %.2f",S);printf(" N")
```

Scilab code Exa 9.5 The Minimum Diameter

```
// Problem no 9.5,Page no.235

clc;clear;
close;
```

```

L=4 //m //Length of column
W=250 //KN //Safe Load
FOS=5 //Factor of safety
//d=0.8*D //Internal diameter is 0.8 times Extarnal
    Diameter
sigma_c=550 //MPa //Compressive stress
alpha=1*1600**-1 //constant

//Calculations

P=W*FOS //N //Crippling Load

//A=%pi*4**-1(D**2-d**2) //m**2 //Area of hollow
    cyclinder
//After substituting value of d we get

//A=%pi*0.09*D**2

//I=%pi*64**-1*(D**4-d**4) //m**4 //Mo,ent Of
    Inertia
//After substituting value of d we get d we get

//I=0.009225*%pi*D**4

//K=(I*A**-1)**0.5 //Radius of Gyration
//After substituting value of I and A and further
    simplifying we get
//K=0.32*D

//Now using the Relation we get
//P=sigma_c*A*(1+alpha*(l_e*k)**2)**-1 //Rankines
    Formula
//Now Substituting values in above equation we get
//125*10**4=550*10**6*%pi*0.09*D
    **2*(1+1*1600**-1*((2*0.32)**2)**-1)**-1

//Further simplifying and rearranging we get
```

```
//D**4 -0.008038*D**2 -0.0001962397=0

a=1
b=-0.008038
c=-0.0001962397

X=b**2-4*a*c

D_1=((-b+X**0.5)*(2*a)**-1)**0.5*10**2
D_2=((-b-X**0.5)*(2*a)**-1)**0.5

//Thus Diameter cannot be negative , discard value of
    D_2
d=0.8*D_1

//Result
printf("The Minimum Diameter is %.2f",d);printf(" cm
  ")
```

Scilab code Exa 9.6 The Crippling Load

```
// Problem no 9.6,Page no.236

clc;clear;
close;

d=0.04 //m //Internal Diameter of tube
D=0.05 //m //External Diameter of tube
P_1=240*10**3 //N //Compressive Load
P_2=158*10**3//N //Failure Load
L=2 //m //Length of tube
l=3 //m //Length of strut

//Calculations
A=%pi*4**-1*(D**2-d**2) //m**2 //Areaof Tube
```

```
I=%pi*64**-1*(D**4-d**4) //m**4 //M.I of tube
k=(I*A**-1)**0.5 //m //Radius of Gyration
sigma_c=P_1*A**-1 //Pa //Compressive stress

l_e=L*2**-1 //m //According to given condition i.e
    Both ends fixed

//Now from crippling Load Equation we get
alpha=((sigma_c*A*P_2**-1-1)*((l_e*k**-1)**2)**-1)
    *10**4

//Now Crippling Load when L=3 m Is used as strut
l_e_2=l*(2**0.5)**-1
P_3=sigma_c*A*(1+alpha*10**-4*(l_e_2*k**-1)**2)**-1


printf("The Value of constant value alpha is %.2f",
    alpha)
printf("\n The Crippling Load of Tube is %.2f",P_3);
    printf(" N")
```

Scilab code Exa 9.8 The Max stress developed

```
// Problem no 9.8,Page no.239

clc;clear;
close;

D=0.038 //m //External diameter
d=0.035 //m //Internal diameter
P=20*10**3 //N //Load
E=210*10**9 //Pa
e=0.002 //m //Eccentricity
L=1.5 //m //Lenght of tube

```

```
//Calculations

A=%pi*4**-1*(D**2-d**2) //m**2 column
I=%pi*64**-1*(D**4-d**4) //m**4 //M.I of column
m=(P*(E*I)**-1)**0.5

//Let X=secmL*2**-1
X=(1*(cos(m*L*2**-1))**-1)
M=P*e*X //N-m //MAx Bending Moment
sigma_1=P*A**-1*10**-6 //Pa //Direct stress
sigma_2=M*0.019*I**-1*10**-6 //Pa //Bending stress

sigma_c_max=(sigma_1+sigma_2) //MPa //Max compressive stress

//Result
printf("The Max stress developed is %.2f",sigma_c_max);printf(" MPa")
```

Scilab code Exa 9.9 The Max stress developed

```
// Problem no 9.9,Page no.239

clc;clear;
close;

L=5 //m //Length of column
D=0.2 //m //External Diameter
d=0.14 //m //Internal diameter
P=200*10**3 //N //Load
e=0.015 //m //Eccentricity
E=95 *10**9 //Pa

//Calculations

```

```
L_2=L*2**-1 //m //half length of column
A=%pi*4**-1*(D**2-d**2) //m**2 column
I=%pi*64**-1*(D**4-d**4) //m**4 //M.I of column
m=(P*(E*I)**-1)**0.5

//Let X=secmL*2**-1
X=(1*(cos(m*L_2*2**-1))**-1)
M=P*e*X //N-m //MAx Bending Moment
sigma_1=P*A**-1*10**-6 //Pa //Direct stress
sigma_2=M*0.1*I**-1*10**-6 //Pa //Bending stress

sigma_c_max=(sigma_1+sigma_2) //MPa //Max compressive stress

printf("The Max stress developed is %.2f",sigma_c_max);printf(" MPa")
```

Scilab code Exa 9.10 The Percentage Error

```
// Problem no 9.10,Page no.240

clc;clear;
close;

L=3 //m //Length of strut
b=0.04 //m //Width of rectangle
d=0.10 //m //Depth if rectangle
P=100*10**3 //N //Axial thrust
w=10*10**3 //N //Uniformly Distributed Load
E=210*10**9 //Pa

//Calculations

A=b*d //m**2 //Area of strut
I=b*d**3*12**-1 //m**4 //M.I
```

```
m=(P*(E*I)**-1)**0.5

//Let X=secmL*2**-1
X=(1*(cos(m*L*2**-1))**-1)

M=w*E*I*P**-1*(X-1)*3**-1 //N*m //Max Bending Moment
sigma_1=P*A**-1 //Pa //Direct stress
sigma_2=M*0.05*I**-1 //Pa //Bending stress

sigma_c_max=sigma_1+sigma_2 //Max compressive stress

//If the Eccentricity of thrust is neglected
M_2=w*L**2*(3*8)**-1 //Max Bending moment
sigma_2_2=M_2*0.05*I**-1 //Pa //Bending stress

sigma_c_max_2=(sigma_1+sigma_2_2)*10**-6 //Pa

//Let Y=Percentage error
Y=((sigma_c_max-sigma_c_max_2*10**6)*sigma_c_max
    **-1)*100

//Result
printf("Max stress induced is %.2f",sigma_c_max_2);
    printf(" MPa")
printf("\n The Percentage Error is %.3f %%",Y)
```

Chapter 10

Analysis of Framed Structures

Scilab code Exa 10.1 Forces in Each members

```
// Problem no 10.1,Page No.249

clc;clear;
close;

//Consider Equilibrium of joint A
//As there are no Load applied at A members AC and
   AB have nothing to Balance
//So they are null members
F_AB=0
F_AC=0

//Consider Equilibrium of joint B

//Applying the summation of horizontal forces  we
   get
F_DB=4*(cos(45*%pi*180**-1))**-1

//Applying the summation of vertical forces  we get
F_BC=F_DB*sin(45*%pi*180**-1)

```

```
//Consider Equilibrium of joint B

//Applying the summation of vertical forces  we get
F_CE=4*(sin(45*%pi*180**-1))**-1

//Applying the summation of horizontal forces  we
    get
F_DC=F_CE*cos(45*%pi*180**-1)

//Result
printf("The Forces in Each members are as follows:
   F_AB = %.f kN",F_AB)
printf("\n
    :F_AC = %.f kN",F_AC)
printf("\n
    :F_DB %.2f",F_DB);printf(" KN(compression)")
printf("\n
    :F_BC %.2f",F_BC);printf(" KN(Tension)")
printf("\n
    :F_CE %.2f",F_CE);printf(" KN(Tension)")
printf("\n
    :F_DC %.2f",F_DC);printf(" KN (compression)" )
```

Scilab code Exa 10.2 Forces in Each members

```
// Problem no 10.2,Page No.250

clc;clear;
close;

//Taking moment at Pt A we get
R_B=100*8*4**-1

//Applying the summation of vertical forces  we get
R_AV=-R_B
```

```

//Applying the summation of horizontal forces  we
    get
R_H=100

//joint B

//Applying the summation of vertical forces  we get
F_CB=R_B

//Applying the summation of horizontal forces  we
    get
F_AB=0 //As there is no force to balance in
    horizontal direction

//joint A

//Applying the summation of horizontal forces  we
    get
F_AC=R_H*(cos(45*%pi*180**-1))**-1

//Applying the summation of vertical forces  we get
F_AD=200-F_AC*sin(45*%pi*180**-1)

//joint C

//Applying the summation of vertical forces  we get
F_EC=200-F_AC*cos(45*%pi*180**-1)

//Applying the summation of horizontal  forces  we
    get
F_DC=F_AC*cos(45*%pi*180**-1)

//joint D

//Applying the summation of horizontal  forces  we
    get
F_DE=F_DC*(cos(45*%pi*180**-1))**-1
```

```

//DF and EF are null members at this joint as each member individually has nothing to balance
F_DF=0
F_EF=0

//Result
printf("The Forces in Each members are as follows: F_AB = %.1f kN",F_AB)
printf("\n:F_CB = %.1f kN (compressive)",F_CB)
printf("\n:F_AC %.2f",F_AC);printf(" KN(Tensile)")
printf("\n:F_AD=%.1f kN (Tensile)",F_AD)
printf("\n:F_EC=%.1f kN N(Compressive)",F_EC)
printf("\n:F_DC=%.1f kN N(Compressive)",F_DC)
printf("\n:F_DE %.2f",F_DE);printf(" KN(Tensile)")
printf("\n:F_DF = %.f kN",F_DF)
printf("\n:F_EF = %.f kN",F_EF)
```

Scilab code Exa 10.3 `Forces in Each members`

```
// Problem no 10.3,Page No.252

clc;clear;
close;

//taking moment at pt A we get
R_D=(90*6+120*3)*9**-1 //Reaction at Pt D
```

```
//Joint D

//Applying the summation of vertical forces we get
F_GD=100*(sin(60*%pi*180**-1))**-1

//Applying the summation of horizontal forces we
    get
F_DC=F_GD*cos(60*%pi*180**-1)

//Joint G

//Applying the summation of vertical forces we get
F_GC=F_GD

//Applying the summation of horizontal forces we
    get
F_FG=F_GD*cos(60*%pi*180**-1)+F_GC*cos(60*%pi
    *180**-1)

//joint C

//Applying the summation of vertical forces we get
F_FC=(115.5*sin(60*%pi*180**-1)-90)*(sin(60*%pi
    *180**-1))**-1

//Applying the summation of horizontal forces we
    get
F_CB=F_DC+F_GC*cos(60*%pi*180**-1)+F_FC*cos(60*%pi
    *180**-1)

//joint F

//Applying the summation of vertical forces we get
F_FB=F_FC

//Applying the summation of horizontal forces we
    get
```

```
F_EF=F_FG+F_FC*cos(60*%pi*180**-1)+F_FB*cos(60*%pi
    *180**-1)

//Joint B

//Applying the summation of vertical forces  we get
F_EB=(120-F_FB*sin(60*%pi*180**-1))*(sin(60*%pi
    *180**-1))**-1

//Applying the summation of horizontal  forces  we
    get
F_BA=F_CB+F_FB*cos(60*%pi*180**-1)-F_EB*cos(60*%pi
    *180**-1)

//Joint E

//Applying the summation of vertical forces  we get
F_AE=F_EB

//Result
printf("Forces in Each members are as follows:F_GD %
    .1f kN (compression)",F_GD)
printf("\n                                        :
    F_DC %.2f",F_DC);printf(" KN(Tension)" )
printf("\n                                        :
    F_GC %.1f kN (Tension)",F_GC)
printf("\n                                        :
    F_FG %.1f kN (Compression)",F_FG)
printf("\n                                        :
    F_FC %.1f kN(compression)",F_FC)
printf("\n                                        :
    F_CB %.2f",F_CB);printf(" KN(Tension)")
printf("\n                                        :
    F_FB %.1f kN(compression)",F_FB)
printf("\n                                        :
    F_EF %.2f",F_EF);printf(" KN(compression)")
printf("\n                                        :
    F_EB %.2f",F_EB);printf(" KN(Tension)")
```

```
printf("\n                                   :    F_BA %.2f",F_BA);printf(" KN(Tension)")
printf("\n                                   :    F_AE %.2f",F_AE);printf(" KN(compression)")
```

Scilab code Exa 10.4 Forces in Each members

```
// Problem no 10.4,Page No.253

clc;clear;
close;

//JOint D

//Applying the summation of vertical forces  we get
F_1=6*sin(30*%pi*180**-1)**-1

//Applying the summation of horizontal  forces  we get
F_5=F_1*cos(30*%pi*180**-1)

//Joint C

//Resolving forces perpendicular to plane
F_6=10*cos(30*%pi*180**-1)

//Resolving forces parallel to plane
F_2=F_1+10*cos(60*%pi*180**-1)

//Joint E

//Applying the summation of vertical forces  we get
F_7=(8+F_6*sin(60*%pi*180**-1))*(sin(60*%pi*180**-1))**-1
F_4=F_5+F_6*cos(60*%pi*180**-1)+F_7*cos(60*180**-1*
```

```
    %pi)

//Resolving forces perpendicular to plane
F_3=F_7*sin(60*%pi*180**-1)

//Resolving forces parallel to plane
F_8=F_2+F_7*cos(30*%pi*180**-1)

//Result
printf("Forces in Each members are as follows:F_1 %
    .2f",F_1);printf(" KN(Tension)")
printf("\n                                            :F_5
     %.2f",F_5);printf(" KN(compression)")
printf("\n                                            :F_6
     %.2f",F_6);printf(" KN(compression)")
printf("\n                                            :F_2
     %.2f",F_2);printf(" KN(Tension)")
printf("\n                                            :F_7
     %.2f",F_7);printf(" KN(Tension)")
printf("\n                                            :F_4
     %.2f",F_4);printf(" KN(compression)")
printf("\n                                            :F_3
     %.2f",F_3);printf(" KN(compression)")
printf("\n                                            :F_8
     %.2f",F_8);printf(" KN(Tension)")
```

Scilab code Exa 10.5 Forces in Each members

```
// Problem no 10.5,Page No.256

clc;clear;
close;

BC=6 //m

```

```
//Calculations

AB=2*BC*(3**0.5)**-1

//Taking moment about B we get
R_A=-(-2000*3-1000*6)*(12*(3**0.5)**-1)**-1 //reaction at the roller support A

//The resultant of all the three Loads is 4000 N acting at right angle to BC at D

//Resolving it vertically we have
V=4000*sin(60*%pi*180**-1)

//Resolving it horizontal we have
H=4000*cos(60*%pi*180**-1)

//Applying the summation of vertical forces  we get
R_B_v=V-R_A

//Applying the summation of horizontal  forces  we get
R_B_h=H
R_B=((R_B_v)**2+(R_B_h)**2)**0.5

tan_theta=R_B_v*R_B_h**-1

//Joint B

//Applying the summation of vertical forces  we get
F_BD=1000*(3**0.5)*2

//Applying the summation of horizontal  forces  we get
F_BE=R_B_h+F_BD*cos(30*%pi*180**-1)

//Joint D
F_DE=2000 //N
```

```
F_CD=F_BD

//Consider equilibrium of truss to the Left of section 2-2
F_CE=R_A*AB*(sin(30*%pi*180**-1)*6)**-1

//Joint A

//Applying the summation of vertical forces  we get
F_AC=R_A*(sin(60*%pi*180**-1))**-1

//Applying the summation of horizontal  forces  we get
F_AE=F_AC*cos(60*%pi*180**-1)

//Result
printf("Forces in Each members are as follows:F_BD %.2f",F_BD);printf(" KN(compression)")
printf("\n                                        :F_BE %.2f",F_BE);printf(" KN(Tension)")
printf("\n                                        :F_DE %.2f",F_DE);printf(" KN(compression)")
printf("\n                                        :F_CD %.2f",F_CD);printf(" KN(compression)")
printf("\n                                        :F_CE %.2f",F_CE);printf(" KN(Tension)")
printf("\n                                        :F_AC %.2f",F_AC);printf(" KN(compression)")
printf("\n                                        :F_AE %.2f",F_AE);printf(" KN(Tension)")
```

Scilab code Exa 10.6 Forces in Each members

```
// Problem no 10.6,Page No.258

```

```
clc;clear;
close;

//Calculations

//Taking moment of the Forces about the hinge A
P=1000*2**0.5*1.2*(0.9)**-1

//Let R_AH be the Horizontal component of the
   reaction at A
R_AH=P-1000*2**0.5
R_A=((R_AH)**2+(1000*2**0.5)**2)**0.5

//Resolving the forces vertically we get
R_AV=1000*2**0.5 //vertical component of the
   reaction at A

//joint A

//Resolving vertically we get
F_BA=1000*2**0.5*(sin(30*%pi*180**-1))**-1

//Resolving horizontally we get
F_AD=2000*2**0.5*3**0.5*2**-1-1000*2**0.5*3**-1 //N

//Joint C

BD=1.2*sin(30*%pi*180**-1)
BE=0.6*sin(30*%pi*180**-1)
ED=0.6*cos(30*%pi*180**-1)
CE=0.9-0.52

theta=atan(BE*CE**-1)*(180*%pi**-1)

F_CB=P*(sin(38.29*%pi*180**-1))**-1

//Resolving vertically
F_CD=F_CB*cos(theta*%pi*180**-1)
```

```

//Joint D

//Resolving horizontally
F_DB=(F_AD-1000*2**0.5)*(cos(60*%pi*180**-1))**-1

//Result
printf("The Pull in chain is %.2f",P);printf(" N")
printf("\n Force in the each members are as follows:
   F_BA %.2f",F_BA);printf(" KN(compressive)")
printf("\n                                          :
   F_AD %.2f",F_AD);printf(" KN(Tensile)")
printf("\n                                          :
   F_CB %.2f",F_CB);printf(" KN(compression)")
printf("\n                                          :
   F_CD %.2f",F_CD);printf(" KN(Tensile)")
printf("\n                                          :
   F_DB %.2f",F_DB);printf(" KN(compressive)")
```

Scilab code Exa 10.7 Forces in Each members

```
// Problem no 10.7,Page No.261
clc;
clear;
close;


//Calculations

theta=atan(1*2**-1)*(180*%pi**-1) //Radian

//Taking moment about A
R_EH=10*8*4**-1

//Horizontal component of reaction at A
```

```
R_AH=20 //KN

//Applying the summation of horizontal  forces  we
    get
F_AB=20*cos(theta*%pi*180**-1)**-1

//Applying the summation of vertical forces  we get
R_AV=10*5**0.5*sin(theta*%pi*180**-1)

//Vertical Reaction at E
R_EV=0

//Joint C

//Applying the summation of vertical forces  we get
F_DC=10*sin(theta*%pi*180**-1)**-1

//Applying the summation of horizontal  forces  we
    get
F_CB=F_DC*cos(theta*%pi*180**-1)

//Joint D

//Applying the summation of vertical forces  we get
F_DB=F_DC*sin(theta*%pi*180**-1)

//Applying the summation of horizontal  forces  we
    get
F_DE=F_DC*cos(theta*%pi*180**-1)

//Joint E

//Applying the summation of vertical forces  we get
F_EB=R_EV*sin(theta*%pi*180**-1)

//Result
printf("Forces in Each members are as follows:F_AB %
    .2f",F_AB);printf(" KN(Tensile)")
```

```
printf("\n                                                    :
   F_DC %.2f",F_DC);printf(" KN(compression)")
printf("\n                                                    :
   F_CB %.2f",F_CB);printf(" KN(Tensile)")
printf("\n                                                    :
   F_DB %.2f",F_DB);printf(" KN(Tensile)")
printf("\n                                                    :
   F_DE %.2f",F_DE);printf(" KN(compression)")
printf("\n                                                    :
   F_EB %.2f",F_EB);printf(" KN")
```

Scilab code Exa 10.8 Forces in Each members

```
// Problem no 10.8,Page No.262

clc;clear;
close;

F_c=20 //KN //Force at C
F_d=5  //KN //Force at D
F_e=15 //KN //Force at E
F_f=10 //KN //Force at F
L_CD=3.6 //m //Length of CD
L_DE=3.6 //m //Length of DE
L_EF=4.8 //m //Length of EF
L_AD=3.6;L_BE=3.6 //m //Length of AD & BE

//Calculations

//Let R_A and R_B be the reactions at pts at A and B

//Taking  moment at A
R_B=-(-F_f*(L_DE+L_EF)+F_c*L_CD-F_e*L_DE)*(L_DE)**-1
R_A=50-R_B

```

```
//Considering section 1-1 through members AB,DB,DE and taking F.B.D of left side of section 1-1

//Taking moment at B
sigma_1=(F_d*L_DE+F_c*(L_CD+L_DE)-R_A*L_DE)*L_AD**-1 //Force i member DE

//Taking moment @ D
sigma_3=(F_c*L_CD)*L_AD**-1 //KN //force in member AB


//Consider triangle DBE
theta=atan(L_BE*L_DE**-1)*(180*%pi**-1)

//Taking moment @ A
sigma_2=(-sigma_1*L_AD+F_c*L_CD)*(L_AD*cos(theta*%pi*180**-1))**-1 //Force in member F_DE

//Now considering section 2-2 passing through members AB,AD,CD and taking left hand F.B.D

//Taking moment @C
sigma_5=(R_A*L_CD-sigma_3*L_AD)*L_CD**-1     //Force in member AD

//Taking moment @A=0
sigma_4=F_c*L_CD*L_AD**-1 //Force in member CD


//Result
printf("Force in member CD is %.2f",sigma_4);printf(" KN(Compressive)")
printf("\n Force in member AD is %.2f",sigma_5);printf(" KN(Tensile)")
printf("\n Force in member BD is %.2f",sigma_2);printf(" KN(Compression)")
printf("\n Force in member AB is %.2f",sigma_1);
```

```
printf(" KN(Tension)")

// Answer is wrong in the textbook.
```

Chapter 11

Combined Direct and Bending Stresses

Scilab code Exa 11.1 Stress at face AB

```
// Problem 11.1,Page no.273

clc;clear;
close;

P=10 //KN //Load
e=0.06 //m //eccentricity
b=0.240 //m //width of column
d=0.150 //m //depth of column

//Calculations

sigma_d=P*(b*d)**-1 //KN/m**2
M=P*e //KN*m //Moment due to eccentricity
Z=(d*(b)**2)*6**-1 //mm**3

sigma_b=M*Z**-1 //KN/m**2

sigma_CD=sigma_d+sigma_b
```

```
sigma_AB=sigma_d-sigma_b

//Result
printf("Stress at face CD is %.2f",sigma_CD);printf(
    " KN/m**2")
printf("\n Stress at face AB is %.2f",sigma_AB);
    printf(" KN/m**2")
```

Scilab code Exa 11.2 The distance of line of thrust

```
// Problem 11.2,Page no.274

clc;clear;
close;

d=2 //cm //Diameter of specimen

//Calculations

//Let P be the Load on the section

A=%pi*4**-1*d**2 //cm**2 //Area of section
I=%pi*64**-1*d**4 //cm**4 //M.I of the section
y=d*2**-1 //cm
Z=I*y**-1 //cm**3 //Section modulus
//M=P.e //Moment

//Stress due to direct load
//sigma_d=(4*P)*(%pi*d**2)**-1 //N/cm**2

//stress due to moment
//sigma_b=(32*P*e)*(%pi*d**3)**-1 N/cm**2

//Maximum stress
//sigma_r_max=(((4*P)*(%pi*d**2)**-1)+((32*P*e)*(%pi
```

```
*d**3)**-1))

//Mean stress
//sigma_r_mean=((4*P)*(%pi*d**2)**-1)

//Since the maximum stress is 20% greater than the mean stress
//(((4*P)*(%pi*d**2))+((32*P*e)*(%pi*d**3)))=1.2*4*P*(%pi*d**2)**-1

//After substituting values and simplifyinf we get

e=0.2*d*8**-1 //cm //distance of line of thrust from the axis

//Result
printf("The distance of line of thrust from the axis is %.2f",e);printf(" cm")
```

Scilab code Exa 11.3 The maximum load column can carry

```
// Problem 11.3,Page no.274

clc;clear;
close;

A=300 //cm**2 //Area of column
e=5 //cm //eccentricity

//Calculations

//sigma_d=P*A**-1 //Direct compressive stress
//M=P*e //Bending Moment
Z=((20**4-10**4)*(6*20)**-1) //cm**3 //Section modulus
```

```
//sigma_b=M*Z**-1=P*250**-1

//Now sigma_d+sigma_b=60*10**2

//P*300**-1+P*250**-1=6000

//After simplifying we get
P_1=6000*300*250*550**-1 //N //Load

//sigma_b-sigma_d=300

P_2=300*300*250*50**-1 //N //Load

//Result
printf("The maximum load column can carry %.2f",P_2)
    ;printf(" N")
```

Scilab code Exa 11.4 `Min intensities of stress`

```
// Problem 11.4,Page no.275

clc;clear;
close;

D=40 //cm //External diameter of column
d=30 //cm //Internal diameter of column
e=20 //cm //Eccentricity
P=150 //KN //Load

//calculations

A=%pi*4**-1*(D**2-d**2) //cm**2 //Area of the column
Z=%pi*32**-1*((D**4-d**4)*D**-1) //cm**3 //Section
    modulus
```

```
M=P*10**3*e //N*cm //Moment

sigma_r_max=((P*10**3*A**-1)+(M*Z**-1)) //N/cm**2 //Max stress
sigma_r_min=((P*10**3*A**-1)-(M*Z**-1)) //N/cm**2 //Min stress

//Result
printf("Max intensities of stress in the section is %.2f",sigma_r_max);printf(" N/cm**2")
printf("\n Min intensities of stress in the section is %.2f",sigma_r_min);printf(" N/cm**2(tension)")
```

Scilab code Exa 11.5 Stresses at the corners

```
// Problem 11.5,Page no.277

clc;clear;
close;

b=4 //m //width of %pier
d=3 //m //depth of %pier
e_x=1 //m //distance from y axis
e_y=0.5 //m //distance from x axis
P=80 //KN //Load

//Calculations

A=b*d //m**2 //Area of %pier
I_x_x=b*d**3*12**-1 //m**4 //M.I about x-x axis
I_y_y=d*b**3*12**-1 //m**4 //M.I about y-y axis
M_x=P*e_y //KN*m //Moment about x-x axis
M_y=P*e_x //KN*m //Moment about y-y axis

x=2 //m //Distance between y-y axis and corners A
```

```
 and B
y=1.5 //m ////Distance between x−x axis and corners
 A and D

//Part−1
//Stress developed at each corner


sigma_A=P*A**-1+M_x*y*I_x_x**-1-M_y*x*I_y_y**-1 //KN
 /m**2 //stress at A
sigma_B=P*A**-1+M_x*y*I_x_x**-1+M_y*x*I_y_y**-1 //KN
 /m**2 //stress at B
sigma_C=P*A**-1-M_x*y*I_x_x**-1+M_y*x*I_y_y**-1 //KN
 /m**2 //stress at C
sigma_D=P*A**-1-M_x*y*I_x_x**-1-M_y*x*I_y_y**-1 //KN
 /m**2 //stress at D

//Part−2
//Let f be the additional load that should be placed
  at centre

//sigma_c=F*A**−1 //KN/m**2 //compressive stress

//For no tension in %pier section, compressive
 stress is equal to tensile stress
sigma_c=10 //KN/m**2
F=sigma_c*A //KN

//Part−3

sigma=F*A**-1 //KN/m**2 //stress due to additional
 load of 120 KN

sigma_A_1=sigma_A+10 //stress at A
sigma_B_1=sigma_B+10 //stress at B
sigma_C_1=sigma_C+10 //stress at C
sigma_D_1=sigma_D+10 //stress at D

```

```
//Result
printf("Stress at each corner are as follows:
   stress_A %.2f",sigma_A);printf(" KN/m**2")
printf("\n                                       :
   stress_B %.2f",sigma_B);printf(" KN/m**2")
printf("\n                                       :
   stress_C %.2f",sigma_C);printf(" KN/m**2")
printf("\n                                       :
   stress_D %.2f",sigma_D);printf(" KN/m**2(tensile)
   ")

printf("\n\n Additional load that should be placed
   at centre is %.2f",F);printf(" KN")

printf("\n\n Stresses at the corners with the
   additional load in centre are as follows:
   Stress_A_1 %.2f",sigma_A_1);printf(" KN/m**2")
printf("\n

   :Stress_B_1 %.2f",sigma_B_1);printf(" KN/m**2")
printf("\n

   :Stress_C_1 %.2f",sigma_C_1);printf(" KN/m**2")
printf("\n

   :Stress_D_1 %.2f",sigma_D_1);printf(" KN/m**2")
```

Scilab code Exa 11.6 `The minimum diameter of the rod`

```
// Problem 11.11.6,Page no.278

clc;clear;
close;

//d=Diameter of rod
```

```
P=500 //KN
e=0.75 //cm //eccentricity

//calculation

//A=%pi*d**2*4**-1 //cm**2 //Area of rod
//sigma_d=P*A**-1 //KN/cm**2 //stress due to direct load

//After substituting value and simplifying we get,
//sigma_d=2000*(%pi*d**2)**-1 //KN/cm**2

M=P*e //Kn*cm //Moment

//Z=%pi*d**3*32**-1 //cm**3 //section modulus
//sigma_b=M*Z**-1 //KN/cm**2 //Stress due to moment

//After substituting value and simplifying we get,
//sigma_b=12000*(%pi*d**3)**-1 //KN/cm**2

//Max stress
//sigma=sigma_d+sigma_b

//After substituting value and simplifying we get,
//2000*(%pi*d**2)**-1+12000*(%pi*d**3)**-1=12.5

//After simplifying we get,
//d**3-53.05*d-318.3=0

//From Synthetic Division we get d**2+4.73*d-42.918
a=1
b=-4.73
c=-42.918

X=b**2-(4*a*c)

d_1=(-b+X**0.5)*(2*a)**-1
d_2=(-b-X**0.5)*(2*a)**-1
```

```

//Result
printf("The minimum diameter of the rod is %.2f",d_1
   );printf(" cm")
```

Chapter 12

Propped Cantilever

Scilab code Exa 12.1 The Reaction at End C

```
// Problem no 12.1,Page No.286

clc;clear;
close;

L=6 //m //Length of Beam
L_1=4 //m //Length of Beam with udl Load
w=10 //KN/m //u.d.l

//Calculation

//Deflection of cantileverat C due to udl on AB
y_c=w*L_1**4*8**-1+w*L_1**3*6**-1*(L-L_1)

//Deflection of cantileverat C due to prop reaction
   alone
//y_c_2=R_c*L**3*3**-1

//Since both Deflection are Equal
//y_c=y_c_2

```

```
R_c=y_c*(6**3)**-1*3 //Reaction at C

//Result
printf("The Reaction at End C is %.3f kN",R_c)
```

Scilab code Exa 12.2 The safe uniformly Distributed Load

```
// Problem no 12.2,Page No.286

clc;clear;
close;

L=10 //m //Length
b=15 //cm //Width
d=40 //cm //Depth
y_c=1.5*10**-2 //m //Deflection
E=120*10**9
y=0.2
sigma=10*10**6 //Bending stress

//Calculations

I=b*d**3*12**-1*10**-8 //cm  //M.I

//From Deflection at the centre of cantilever we get
w=y_c*192*E*I*(L**4)**-1*10**-3 //udl distributed
   over the cantilever

//From Bending Moment Equation we get
w_2=sigma*I*y**-1*16*(L**2)**-1*10**-3    //udl
   distributed over the cantilever

//Result
printf("The safe uniformly Distributed Load is %.2f"
   ,w_2);printf(" KN/m")
```

Scilab code Exa 12.3 Bending Moment at A

```
// Problem no 12.3,Page No.287

clc;clear;
close;

L=6 //m //span of beam
w=30*10**3 //KN/m //u.d.l
P=160*10**3 //N //concentrated Load

//Calculations

//Consider a section at a distance x from the fixed
    end A and B.M at x
//M_x=R_b*(6-x)-30*2**-1*(6-x)**2-160*(3-x)

//E*I*d**2y*(dx**2)**-1=-M_x=-R_b*(6-x)+15*(6-x)
    +160*(3-x)

//Now Integrating above term we get
//E*I*dy*(dx)**-1=R_b*2**-1*(6-x)**2-5*(6-x)
    **3-80*(3-x)**2+C_1  (Equation 1)

//Now on Integrating we get
//E*I*y=-R_b*6**-1*(6-x)**3+5*4**-1*(6-x)
    **2+80*3**-1*(3-x)**3+C_1*x+C_2  (Equation 2)

//At x=0,dy*dx**-1=0
//substituting in equation 1 we get
//C_1=1800-R_b

//At x=0,y=0
//substituting in equation 2 we get
```

```
//C_2=36*R_b-2340

//At x=6,y=0
R_b=72**-1*(10800-2340)

//At x=0
x=0
M_x=R_b*(6-x)-30*2**-1*(6-x)**2-160*(3-x)

//Result
printf("Bending Moment at A is %.2f",M_x);printf(" KNm")
printf("\n The Reaction at B %.2f",R_b);printf(" KN")
```

Scilab code Exa 12.4 Load taken by prop

```
// Problem no 12.4,Page No.288

clc;clear;
close;

L=4 //span of beam
w_1=20*10**3 //Nm //u.d.l
w_2=30*10**3 //Nm //u.d.l

//Calculations

//consider a section at a distance x from A and B.M at this section is
//M_x=R_b*(3-x)-10*x**2+90*x-195

//Now integrating above equation we get
//E*I*dy*(dx)**-1=-R_b(3*x-x**2*2**-1)+10*x**3*3**-1-45*x**2+195*x+C_1
```

```
//again on Integrating we get
//E*I*y=-R_b*(3*x**2*2**-1-x**3*6**-1)+10*x**4*12**-1-15*x**3+195*x**2*2**-1+C_1*x+C_2

//At x=0,dy*(dx)**-1=0  Therefore C_1=0

//At x=0,y=0  Therefore C_2=0

//At x=3m, y=0
x=3
C_1=0
C_2=0
R_b=-(-10*x**4*12**-1+15*x**3-195*x**2*2**-1-C_1*x-C_2)*(3*x**2*2**-1-x**3*6**-1)**-1

//result
printf("Load taken by prop is %.2f",R_b);printf(" KN")
```

Scilab code Exa 12.5 Reaction at C

```
// Problem no 12.5,Page No.289

clc;clear;
close;

L=2 //m //Span of beam
w=10 //KN/m //u.d.l

//Calculations

//Downward deflection at B(of Beam AB) due to u.d.l of 10 KN/m is
Y_B_1=w*L**4*8**-1
```

```
//Upward deflection at B due to reaction at C alone is
//Y_B_2=R_c*8*3**-1

//Net downward deflection of cantilever at AB at B
//Y_B=Y_B_1-Y_B_2

//Downward Deflection of Beam CD at C due to the reaction
//R_c=R_c*(3*E*I)**-1

//since both deflection at C and B are equal
R_c=20*(1*3**-1+8*3**-1)**-1

//Result
printf("Reaction at C is %.2f",R_c);printf(" KN")
```

Scilab code Exa 12.8 The Bending Moment Diagram

```
// Problem no 12.8,Page No.292

clc;clear;
close;

L=8 //m //span
W=24*10**3 //N/m //U.D.L
y=2*10**-2 //m //deflection
E=20*10**9
I=10**-5 //m**4

//Calculations

//The Downward deflection at C Due to u.d.l
//Y_c=5*W*L**3*(384*E*I)**-1
```

```

//The Upward Deflection at C due to prop Reaction P
//Y_c_1=P*L**3*(48*E*I)**-1

//Since the prop is at the same level as end
    supports
//Y_c_1=Y_c
P_1=5*W*8**-1*10**-3 //KN

//The reaction at A and B is equal
R_a=(24-15)*2**-1
R_b=R_a;
//Shear Force at B
V_B=4.5 //KN

//Shear Force at C
V_C1=4.5-24*2**-1
V_C2=4.5-24*2**-1+15

//Shea rForce at A
V_A=-4.5 //KN

//B.M at C due to u.d.l
M_C1=W*L*8**-1*10**-3 //KN*m

//B.M due to only prop reaction P=15 KN
P=15
M_C2=-P*L*4**-1 //KN*m

//B.M at D
M_D=4.5*1.5-24*8**-1*1.5**2*2**-1

//In second case prop sinks by 2 cm
//Y_c-Y_c_1=2

//So Further simplifying and sunstituting values in
    above equation we get
P=-(2*100**-1-(5*W*L**3*(384*E*I)**-1))*(L**3*(48*E*
```

```
    I)**-1)**-1

//Let Each end reaction be X
X=(24-14.625)*2**-1

//Result
printf("prop reaction is %.2f",P_1);printf(" KN")
printf("\n The End Reaction is %.2f",X);printf(" KN"
    )

//Plotting the Shear Force Diagram
subplot(2,1,1)
X1=[0,4,4,8,8]
Y1=[V_B,V_C1,V_C2,V_A,0]
Z1=[0,0,0,0,0]
plot(X1,Y1,X1,Z1)
xlabel("Length x in m")
ylabel("Shear Force in kN")
title("the Shear Force Diagram")

//Plotting the Bendimg Moment Diagram
subplot(2,1,2)
X2=[0,4,4]
Y2=[0,M_C1,0]
Z2=[0,0,0]
plot(X2,Y2)
xlabel("Lenght in m")
ylabel("Bending Moment in kN.m")
title("the Bending Moment Diagram")
```

Chapter 13

Shear Stresses in Beams

Scilab code Exa 13.2 The Ratio of span to depth

```
// Problem no 13.2,Page No.301

clc;clear;
close;
//W=10*w //KN/m //u.d.l
sigma=805*10**6 //Pa  //Bending stress
Tou=0.85*10**6 //Pa //Shear stress

//Calculations

//M=W*L**2*10**-4*8**-1 //Max B.M
//F=W*L*10**-2*2**-1 //Max S.F
//y=h*2**-1 //depth
//A-b*h //Area of c/s

//Now using relation we get
//sigma=M*h*(2*I)**-1   //Bending stress

//AFter substituitng values we get
//805*10**6=w*l**2*h*(16*10**5*I)**-1   //Equation 1

```

```
//Again using the relation we get
//tou=F*A*y_bar*(I*b)**-1  //shear atress

//AFter substituitng values we get
//0.85*10**6=w*L*h**2*(16*10**5*I)**-1  //Equation 2

//Dividing equation 1 & 2 we get
//L*h**-1=10
//Let L*h**-1=Z
z=10

//Result
printf("The Ratio of span to depth ratio is %.2f",z)
```

Scilab code Exa 13.3 Shear Stress

```
// Problem no 13.3,Page No.302

clc;clear;
close;

L=2 //m //span
w=20*10**3 //N/m //u.d.L
b=12.5 //cm //width of Flange
t=2.5 //cm //flange thickness
w_t=2.5 //cm //web thickness
D=20  //cm //Overall depth
w_d=17.5 //m //Depth of web

//Calculations

F=w*L*2**-1 //N //Max S.F
a_1=b*t //Area of flange
a_2=w_d*w_t //Area of web
y_1=t*2**-1 //C.G of flange
```

```
y_2=w_d*2**-1+t //C.G of web

//C.G of c/s
Y=(a_1*y_1+a_2*y_2)*(a_1+a_2)**-1

//M.I about N.A
I=b*t**3*12**-1+b*t*(Y-y_1)**2+w_t*w_d**3*12**-1+w_t
    *w_d*(y_2-Y)**2

//Shear Stress in flange at the junction with web
//Let tou(Shear stress)=S
//Change in the notifications of Shear Stress For
    convenience
S_1=(F*a_1*(Y-y_1)*10**-6)*(I*10**-8*b*10**-2)
    **-1*10**-3

//Shear Stress in web at the junction with flange
S_2=(F*a_1*(Y-y_1)*10**-6)*(I*10**-8*w_t*10**-2)
    **-1*10**-3

//Max Shear Stres at N.A
S_max=(F*(a_1*(Y-y_1)+(w_t*(Y-t))*((Y-t)*2**-1))
    *10**-6)*(I*10**-8*w_t*10**-2)**-1*10**-3

//Result
printf("The Max shear stress in the beam is %.2f",
    S_max);printf(" KN/m**2")

printf("\n\n Shear stress distribution Diagram")

//Plotting the Shear stress distribution Diagram

X_1=[0,2.5,2.5,4.58,15.42]
Y_1=[0,S_1,S_2,S_max,0]
Z_1=[0,0,0,0,0]
plot(X_1,Y_1,X_1,Z_1)
xlabel("Length x in m")
ylabel("Shear Stress in kN/m**2")
```

Scilab code Exa 13.4 Max Shear Stress

```
// Problem no 13.4,Page No.303

clc;clear;
close;

F=100*10**3 //N //Shear Force
I=11340*10**-8 //m**4 //M.I
b=20 //cm //width of Flange
t=5 //cm //thickness of flange
w_d=20 //cm //Depth of web
w_t=5 //cm //thickness of web

//Calculations

a_1=b*t //cm**2 //Area of flange
a_2=w_d*w_t //cm**2 //Area of web
y_1=t*2**-1 //cm //C.G of flange
y_2=t+w_d*2**-1

//C.G of C/s
Y=(a_1*y_1+a_2*y_2)*(a_1+a_2)**-1

//Shear Stress in flange at the junction with web
//Let tou(Shear stress)=S
//Change in the notifications of Shear Stress For
    convenience
S_1=(F*a_1*(Y-y_1)*10**-6)*(I*b*10**-2)**-1*10**-3

//Shear Stress in web at the junction with flange
S_2=(F*a_1*(Y-y_1)*10**-6)*(I*w_t*10**-2)**-1*10**-3

//Max Shear Stres at N.A
```

```
S_max=(F*(a_1*(Y-y_1)+(w_t*(Y-t))*((Y-t)*2**-1))
   *10**-6)*(I*w_t*10**-2)**-1*10**-3

//Result
printf("Shear Stress in flange at the junction with
   web %.2f",S_1);printf(" KN/m**2")
printf("\n Shear Stress in web at the junction with
   flange %.2f",S_2);printf(" KN/m**2")
printf("\n Max Shear Stress at N.A %.2f",S_max);
   printf(" KN/m**2")
```

Scilab code Exa 13.5 Shear Stress

```
// Problem no 13.5,Page No.304

clc;clear;
close;

D=50 //cm //Overall depth
b=19 //cm //width of flange
t=2.5 //cm //Thickness of Flange
w_t=1.5 //cm //Web thickness
w_d=45 //cm //web thickness
F=400*10**3 //N //Shear Force
I=64500*10**-8 //m**4 //M.I

//Calculations (Part-1)

a_1=b*t //cm**2 //Area of flange
a_2=w_d*w_t //cm**2 //Area of web
y_1=t*2**-1 //cm //C.G of flange
y_2=t+w_d*2**-1

//As section is symmetrical
Y=D*2**-1 //cm
```

```

//Shear Stress in flange at the junction with web
//Let tou(Shear stress)=S
//Change in the notifications of Shear Stress For
    convenience
S_1=(F*a_1*(Y-y_1)*10**-6)*(I*b*10**-2)**-1*10**-3

//Shear Stress in web at the junction with flange
S_2=(F*a_1*(Y-y_1)*10**-6)*(I*w_t*10**-2)**-1*10**-3

//Max Shear Stres at N.A
S_max=(F*(a_1*(Y-y_1)+(w_t*(Y-t))*((Y-t)*2**-1))
    *10**-6)*(I*w_t*10**-2)**-1*10**-3 //kPa

//Calculations (Part-2)

//consider a strip in the flange of thickness dy at
    a distance y from N.A

//S=F*(b*(Y-y)*(Y+y)*2**-1*10**-6)*(I*b*10**-2)**-1
//after substituting values we get
//S=625-y**2*(3225*10**-8)**-1

//shear force carried by small strip
//F_1=625-y**2*(3225*10**-8)**-1*b*dy*10**-4

//Now Integrating above Equation we get
a =625
b =-1
I = integrate('625-y**2','y', 22.5, 25)//, args=(a,b
    ))
//Shear force carried by one flange
F_1=19*3225**-1*10**4*I

//Shear force carried by two flange
F_2=2*F_1

//Shear force carried by web
```

```
F_3=F-F_2

//Result
printf("The shear Force int the section is %.2f",
   S_max);printf(" kPa")
printf("\n Total Shear Force in the web is %.2f",F_3
   );printf(" N")


printf("\n Shear stress distribution Diagram")

//Plotting the Shear stress distribution Diagram

X_1=[0,2.5,2.5,25,47.5,47.5,50]
Y_1=[0,S_1,S_2,S_max,S_2,S_1,0]
Z_1=[0,0,0,0,0,0,0]
plot(X_1,Y_1,X_1,Z_1)
xlabel("Length x in m")
ylabel("Shear Stress in kN/m**2")
```

Scilab code Exa 13.6 The spacing of nails

```
// Problem no 13.6,Page No.305

clc;clear;
close;

F=5*10**3 //N //shea Force
b=20 //cm //width of Flange
t=6 //cm //Thickness of flange
w_d=20 //cm //depth of web
w_t=6 //cm //thickness of web
X=700 //N //Shear Loood

//Calculations
```

```
a_1=b*t //cm**2 //Area ofFlange
a_2=w_d*w_t //cm**2 //Area of web
y_1=t*2**-1 //cm //C.G of Flange
y_2=t+w_d*2**-1 //cm //C.G of Web

Y=(a_1*y_1+a_2*y_2)*(a_1+a_2)**-1

//M.I about N.A
I=b*t**3*12**-1+b*t*(Y-y_1)**2+w_t*w_d**3*12**-1+w_t
   *w_d*(y_2-Y)**2

//Shear Force per metre Length in Plane of contact
   of two Planks
//Let Shear Force per metre Length=F_1
F_1=(F*a_1*(Y-y_1)*10**-6)*(I*10**-8)**-1

//Spacing of nails
s=X*F_1**-1*100

//Result
printf("The spacing of nails along the Length of
   beam is %.2f",s);printf(" cm")
```

Scilab code Exa 13.7 Shear stress in a bolt

```
// Problem no 13.7,Page No.306

clc;clear;
close;

L=3 //m //span
d=5 //cm //depth of each plank
b=15 //cm //width of plank
d_1=1.9 //cm //Diameter of bolt
```

```
s=12.5 //cm //spacing of bolt
w=3.3*10**3 //N.m //u.d.l

//Calculations

//Shear Force at 1.5m from support
F=w*1.5

I=b*(5*d)**3*12**-1 //M.I
A=%pi*4**-1*d_1**2 //area of Bolt
Y=5*d*2**-1 //C.G of beam
y_1=d*2**-1 //c.G of top plank

//Shear Force per metre Length
F_1=F*b*d*(Y-y_1)*10**-6*(I*10**-8)**-1

//Load carried by bolt
W_1=F_1*s*10**-2

//shear stress
X_1=W_1*A**-1*10***+4

//Shear Force per metre Length
F_2=F*b*2*d*((d+y_1)-Y*10**-6)*(I*10**-8)**-1*10**-6

//Load carried by bolt
W_2=F_2*s*10**-2

//shear stress
X_2=W_2*(A*10**-4)**-1*10**-3

//Reult
printf("Shear stress in a bolt Located at 1.5 m from
    support is %.2f",X_2);printf(" KN/m**2")
```

Scilab code Exa 13.8 The Min spacing of screw

```
// Problem no 13.8,Page No.307

clc;clear;
close;

b=15 //cm //width of plank
t=2.5 //cm //thickness of planf
F_1=1250 //N //Shear Force
F_2=5*10**3 //shaear force transmitted by screw
d=15 //cm //Depth of plank
D=20 //cm  //Overall depth

//Calculations

Y=D*2**-1  //C.G of beam
y_1=t*2**-1 //C.G of flange

I=((b*D**3)-(D*2**-1*b**3))*12**-1 //cm**4 //M.I

//Shear Stress in the Flange at 7.5 cm from N.A
X_1=F_2*b*t*(Y-y_1)*10**-6*(I*10**-8*d*10**-2)
    **-1*10**-3

//Shear Stress in the web at 7.5 cm from N.A
X_2=X_1*d*(2*t)**-1

//shear stress at N.A
X_max=F_2*(b*t*(Y-y_1)+2*t*d*2**-1*d*4**-1)*10**-6*(
    I*10**-8*2*t*10**-2)**-1*10**-3

//horizontal shear force per %pitch length to the
    shearing strength of two bolts we have
//X_h=X_2*10**3*2*t*10**-2*p

//Equating horizontal shear force per %pitch length
    to the shearing strength of two bolts we have
```

```
p=F_1*2*(X_2*10**3*2*t*10**-2)**-1*10**2

//Result
printf("The Min spacing of screw along the beam is %.2f",p);printf(" cm")
```

Scilab code Exa 13.9 The Magnitude of Bending

```
// Problem no 13.9,Page No.308

clc;clear;
close;

L=4 //m //span
w=80*10**3 //N/m //u.d.l
D=35 //cm //Overall depth
b=15 //cm //width of Flange
t=2.5 //cm //Thickness of flange
w_d=30 //cm //Depth of web
w_t=1.2 //cm //thickness of web

//Calculations

R_a=160;R_b=160 //KN //Reactions at supports

//Shear FOrce at 1m from left support
F=R_a*10**3-w

M=R_a*10**3-w*2**-1 //B.M at 1m From support

I=(b*D**3-((b-w_t)*w_d**3))*12**-1 //cm**4

y=w_d*2**-1
sigma=M*I**-1*y //N/m**2

```

```
//Shear stress in Flange at the junction with web
X_1=w*b*t*(w_d*2**-1+t*2**-1)*10**-6*(I*10**-8*b
    *10**-2)**-1*10**-3

//Shear stress in web at the junction with Flange
X_2=X_1*15*1.2**-1

//Result
printf("The Magnitude of Bending is %.2f",sigma);
    printf(" N/m**2")
printf("\n Shear stress in web at the junction with
    Flange %.2f",X_1);printf(" KN/m**2")
```

Scilab code Exa 13.10 Shear Stress

```
// Problem no 13.10,Page No.309

clc;clear;
close;

b=25 //cm //width of top FLange
t=5 //cm //thickness of top Flange
D=35 //cm //Depth of overall section
w_d=25 //cm //depth of web
w_t=5 //cm //thickness of web
t_1=5 //cm //thickness of bottom Flange
b_1=15 //cm //width of bottom Flange
sigma=17.5*10**6
F=100*10**3 //N //S.F

//Calculations

a_1=b*t //area of top flange
a_2=w_d*w_t //area of web
a_3=b_1*t_1 //area of bottom Flange
```

```
y_1=t*2**-1 //C.G of top flange
y_3=D-(t_1*2**-1) //C.G of bottom Flange
y_2=D*2**-1 //c.G of Web

Y=(a_1*y_1+a_2*y_2+a_3*y_3)*(a_1+a_2+a_3)**-1

I=b*t**3*12**-1+b*t*(Y-y_1)**2+w_t*w_d**3*12**-1+w_t*w_d*(D*2**-1-Y)**2+b_1*t_1**3*12**-1+b_1*t_1*(y_3-Y)**2

M=sigma*I*10**-8*(Y*10**-2)**-1 //B.M

//Shear Stress in upper Flange at the junction with web
S_1=F*b*t*(Y-y_1)*10**-6*(I*10**-8*b*10**-2)**-1*10**-3

//Shear Stress in web at the junction with upper Flange
S_2=S_1*b*t**-1

//Max shear stress at the N.A
S=F*(b*t*(Y-y_1)+w_t*(Y-t)*(Y-t)*2**-1)*10**-6*(I*10**-8*w_t*10**-2)**-1*10**-3

//Shear Stress in Lower Flange at the junction with web
S_3=F*(a_3*(D-Y-t_1*2**-1))*10**-6*(I*10**-8*b_1*10**-2)**-1*10**-3

//Shear Stress in web at the junction with Lower Flange
S_4=S_3*b_1*t_1**-1

//Result
printf("The Bending Moment section can take is %.2f",M);printf(" N-m")
printf("\n The shear stress Distribution Diagram")
```

```
//Plotting the Shear stress distribution Diagram

X_1=[0,5,5,15.19,30,30,35]
Y_1=[0,S_1,S_2,S,S_3,S_4,0]
Z_1=[0,0,0,0,0,0,0]
plot(X_1,Y_1,X_1,Z_1)
xlabel("Length x in m")
ylabel("Shear Stress in kN/m**2")
```

Chapter 14

Dams and Retaining Walls

Scilab code Exa 14.1 Safety against sliding

```
// Problem no 14.1,Page No.325

clc;clear;
close;
b=2 //m //width
FOS=1.5 //Factor of safety
//rho_mason=2.5*rho_w
mu=0.5 //coeffeicient of friction

//Calculations

//Let L=1 m (length of dam)
L=1
//W=b*H*L*rho
//After substituting values and Further simplifying
   we get
//W=2*H*rho

//Total Pressure
//P=W*H**2*2**-1

```

```
x_bar=b*2**-1 //Distance of Line of action of W from
    waterface

//Distance of pt where resultant cuts the base
    measured from Line of action
//x=P*W**-1*H*3**-1
//After substituting values and Further simplifying
    we get
//x=H**2*30**-1

//x_bar+x=2*b*3**-1
//After substituting values and Further simplifying
    we get
//1+H**2*30**-1=2*b*3**-1
H=(30*(2*b*3**-1-1))**0.5 //height of dam

//Frictional Resistance offered at the base
//F=mu*W
//After substituting values and Further simplifying
    we get
//F=3.16*rho

//Total Lateral Pressure
//P=W*H**2*2**-1
//P=4.99*W

//Factor of safety against sliding
//FOS1=F*P**-1=3.16*4.99**-1*rho_mason*rho_w**-1
FOS1=3.16*4.99**-1*2.5

//FOS1>FOS

//Result
printf("Dam is safe against sliding = %.2f m",FOS1)
```

Scilab code Exa 14.2 The Height of Dam

```
// Problem no 14.2,Page No.327

clc;clear;
close;
D=2 //m //External Diameter
d=1.5 //m //Internal Diameter
P=1600 //N/m**2 //N/m**2 //Wind Pressure
W=19200 //N/m**2 //Weight of masonry

//Calculations

//Let H be max height of dam

//W2=%pi*4**-1*(D**2-d**2)*H*W //weight of chimney
//W2=26400*H

//Eccentricrty
x=(D**2+d**2)*(8*D)**-1

//P2=H*D*P //Lateral thrust of wind on chimney
//P2=3200*H

//Now by using the relation we get P*W**-1=x*(H
    *2**-1)**-1
//After substituting values and Further simplifying
    we get
H=0.39*2*26400*3200**-1

//result
printf("The Height of Dam is %.2f",H);printf(" m")
```

Scilab code Exa 14.3 shear force diagram

```
// Problem no 14.3,Page No.327

clc;clear;
close;
rho_w=10 //KN/m**3 //Density of water
rho_mason=22.4 //KN/m**3 //Density of mason
H=6 //m //height of dam
a=1 //m //width of top
b=4 //m //bottom width
h=5.5 //m //Weight of water depth

//Calculations

//Let L=1 m (length of dam)
L=1

//weight of dam
W=(a+b)*2**-1*H*a*rho_mason

//Lateral thrust
P=rho_w*h**2*a*2**-1

//distance of Line of action of W measured from
    vertical face
x_bar=(b**2+b*a+a**2)*(3*(b+a))**-1

//distance of pt where resultant cuts the base
x=P*W**-1*h*3**-1

//Eccentricity
e=x_bar+x-b*2**-1

//Stress at Pt B
sigma1=W*b**-1*(1-6*e*b**-1)

//stress at Pt C
sigma2=W*b**-1*(1+6*e*b**-1)

```

```
//Result
printf("Max stress intensities at the base is %.2f",
   sigma2);printf(" KN/m**2")
printf("\n Min stress intensities at the base is %.2
   f",sigma1);printf(" KN/m**2")

//Plotting the Shear Force Diagram

X1=[0,L,L]
Y1=[sigma2,sigma1,0]
Z1=[0,0,0]
plot(X1,Y1,X1,Z1)
xlabel("Length x in m")
ylabel("Shear Force in kN")
title("the Shear Force Diagram")
```

Scilab code Exa 14.4 shear force diagram

```
// Problem no 14.4,Page No.329

clc;clear;
close;
H=10 //m //height od dam
a=2 //m //top width
b=5 //m //bottom width
W=25 //KN/m**3 //weight of mason
rho_w=10 //KN/m**3 //density of water

//Calculations

//Let L=1 m (length of dam)
L=1

//weight of dam
W2=(b+a)*H*L*W*2**-1
```

```
////Lateral thrust
P=rho_w*H**2*L*2**-1

//Resultant thrust
R=(P**2+W**2)**0.5

//Distance of Line of action from vertical base
x_bar=(b**2+b*a+a**2)*(3*(b+a))**-1

////distance of pt where resultant cuts the base
x=P*W2**-1*H*3**-1

//Eccentricity
e=x_bar+x-b*2**-1

//Stress at Pt B
sigma1=W2*b**-1*(1-6*e*b**-1)

//stress at Pt C
sigma2=W2*b**-1*(1+6*e*b**-1)

//Result
printf("The Resultant Thrust on the base is %.2f",R)
    ;printf(" KN")

//Plotting the Shear Force Diagram
X1=[0,L,L]
Y1=[-sigma2,-sigma1,0]
Z1=[0,0,0]
plot(X1,Y1,X1,Z1)
xlabel("Length x in m")
ylabel("Shear Force in kN")
title("the Shear Force Diagram")
```

Scilab code Exa 14.5 shear force diagram

```
// Problem no 14.5,Page No.330

clc;clear;
close;
H=30 //m //height of Dam
a=2 //m //top width
b=5 //m //bottom width

h=29 //m //height of water
rho_w=9810 //N/m**3
rho_mason=22560 //N/m**3
sigma1=0 //KN/m**3
sigma2=880 //KN/m**3

//Calculations

//Let L=1 m (length of dam)
L=1

//weight of dam
//W=(a+b)*2**-1*L*H*rho_mason*10**-3
//After substituting values and Further simplifying we get
//W=338.4*(a+b) //equation1

//Pressure at B=0, Sinc etension at base has just been avoided

//Eccentricity
e=b*6**-1  //as sigma1=0

//Pressure at C
//sigma2=W2*b**-1*(1+6*e*b**-1)
//After substituting values and Further simplifying we get
//W=440*b
```

```
//From equation1 ,440*b=338*(a+b)
//b=3.33*a

//the distance of C.Gof dam
//x_bar=(b**2+b*a+a**2)*(3*(b+a))**-1
//After substituting values and Further simplifying
    we get
//x_bar=1.187*a

//distance of pt where resultant cuts the base
//x=P*W2**-1*H*3**-1
//After substituting values and Further simplifying
    we get
//x=27.214*a**-1

//Now x_bar+x=2*3**-1*b
//After substituting values and Further simplifying
    we get
a=(27.17*(2.22-1.187)**-1)**0.5
b=3.33*a

//Result
printf("The top width dam is %.2f",a);printf(" m")
printf("\n The bottom width dam is %.2f",b);printf("
    m")


//Plotting the Shear Force Diagram
X1=[0,L,L]
Y1=[sigma2,sigma1,0]
Z1=[0,0,0]
plot(X1,Y1,X1,Z1)
xlabel("Length x in m")
ylabel("Shear Force in kN")
title("the Shear Force Diagram")
```

Scilab code Exa 14.6 Stresses at the base

```
// Problem no 14.6,Page No.332

clc;clear;
close;
H= 4 //m //height of dam
a=1 //m //Top width
b=3 //m //bottom width
rho1=9810 //N/m**3 //weight of water
rho2=19620 //n/m**3 //Weight of mason

//Calculations

//Let L=1 m (length of dam)
L=1

//weight of dam
W=(a+b)*2**-1*L*H*rho2*10**-3

////Lateral thrust
P=rho1*H**2*L*2**-1*10**-3

//Distance of Line of action from vertical base
x_bar=(b**2+b*a+a**2)*(3*(b+a))**-1

//distance of pt where resultant cuts the base
x=P*W**-1*H*3**-1

//Eccentricity
e=x_bar+x-b*2**-1

//Stress at Pt B
sigma1=W*10**3*b**-1*(1-6*e*b**-1)
```

```
//stress at Pt C
sigma2=W*10**3*b**-1*(1+6*e*b**-1)

//Stresses at the base when resorvoir is empty

e2=x_bar-b*2**-1

//Minus sign indicates sigma_b>sigma_c

//Stress at C
sigma2_2=W*10**3*b**-1*(1+6*e2*b**-1)

//Stress at Pt B
sigma1_2=W*10**3*b**-1*(1-6*e2*b**-1)

//result
printf("When the Reservoir is full :sigma1 %.2f",
   sigma1);printf(" N/m**2")
printf("\n                              :sigma2 %.2f",
   sigma2);printf(" N/m**2")
printf("\n When the Reservoir is empty:sigma1_2 %.2f
   ",sigma1_2);printf(" N/m**2")
printf("\n                              :sigma2_2 %.2f
   ",sigma2_2);printf(" N/m**2")

//Answer is wrong in the textbook.//////
```

Scilab code Exa 14.7 The Min bottom width

```
// Problem no 14.7,Page No.333

clc;clear;
close;
H=8 //m //height of dam
```

```
h=7.5 //m //Height of water
a=1 //m //top width
mu=0.6 //Coeffeicient of friction
rho_mason=22.4 //KN/m**3 //weight of mason
rho_w=9.81 //KN/m**3 //density of water

//Calculations

//weight of dam
//W=(a+b)*2**-1*L*H*rho2*10**-3
//After substituting values and further simplifying we get
//W=89600*(b+1)

//Distance of Line of action from vertical base
//x_bar=(b**2+b*a+a**2)*(3*(b+a))**-1
//After substituting values and further simplifying we get
//x_bar=(1+b+b**2)*(3*(1+b))**-1

//Lateral thrust
P=rho_w*h**2*2**-1

//Min width to avoid tension at base
//Z=x_bar+P*W**-1*h*3**-1
//Z=2*3**-1*b
//After substituting values and further simplifying we get
//b**2+b-24.09=0
a=1
b=1
c=-24.09

X=b**2-4*a*c

b1=(-b+X**0.5)*(2*a)**-1
b2=(-b-X**0.5)*(2*a)**-1

```

```
//Thus width cannot be negative,b1 is considered

//Min width to avoid sliding
//mu*W>P
//After substituting values and further simplifying we get
b=P*10**3*(mu*89600)**-1-1

//Result
printf("The Min bottom width is %.2f",b);printf(" m")
```

Scilab code Exa 14.8 `The Max stresses on the base`

```
// Problem no 14.8,Page No.334

clc;clear;
close;
H=10 //m //height of dam
a=1 //m //top width
b=7 //m //Bottom width
rho_mason=19620 //N/m**3 //weight of mason
rho_w=9810 //N/m**3 //density of water

//Calculations

//Lateral thrust
P=rho_w*H**2*2**-1

//weight of dam
W=(rho_w*H*2**-1*a)+(rho_mason*(a+b)*2**-1*H)

//Taking Moment at B,M_B=0
x_bar=((rho_w*H*2**-1*1*3**-1)+(rho_mason*H*2**-1*2*3**-1)+(rho_mason*H*1.5)+(rho_mason*H
```

```
    *5*11*2**-1*3**-1))*W**-1

//Now using relation we get
x=P*W**-1*H*3**-1

//Eccentricity
e=x_bar+x-b*2**-1

//Max stress
sigma_max=W*b**-1*(1+6*e*b**-1)

//Min stress
sigma_min=W*b**-1*(1-6*e*b**-1)

//Result
printf("The Max stresses on the base is %.2f",
    sigma_max);printf(" N/m**2")
printf("\n The Min stresses on the base is %.2f",
    sigma_min);printf(" N/m**2")
```

Scilab code Exa 14.10 Safe against bearing

```
// Problem no 14.10,Page No.337

clc;clear;
close;
H=6 //m //height of dam
a=1 //m //top width
b=3 //m //Bottom width
rho_mason=22 //KN/m**3 //weight of mason
rho_earth=16 //KN/m**3 //density of water
phi=30 //Degree //angle of repose
mu=0.5 //Coeffecient of friction

//Calculations
```

```
//Let Length of dam ,L=1 m
L=1 //m

//weight of dam
W=(a+b)*2**-1*L*H*rho_mason

//Lateral thrust
P=rho_earth*H**2*L*2**-1*((1-sin(30*%pi*180**-1))
    *(1+sin(phi*%pi*180**-1))**-1)

//Distance of Line of action from vertical base
x_bar=(b**2+b*a+a**2)*(3*(b+a))**-1

//distance of pt where resultant cuts the base
x=P*W**-1*H*3**-1

//Eccentricity
e=x_bar+x-b*2**-1
e_max=b*6**-1

//stress at toe
sigma2=W*10**3*b**-1*(1+6*e*b**-1)*10**-3

//Safe agaainst bearing

//Frictional Resistance
F=mu*W

if F>P then
    //it is safe against sliding

//Result
printf("Safe against bearing as well as sliding")

end
```

Scilab code Exa 14.11 Shear Force Diagram

```
// Problem no 14.11,Page No.338

clc;clear;
close;
H=8 //m //height of dam
a=1 //m //top width
b=4.5 //m //Bottom width
rho_mason=24 //KN/m**3 //weight of mason
rho_earth=20 //KN/m**3 //density of water
phi=30 //Degree //angle of repose
mu=0.5 //Coeffecient of friction
BC=120 //KN/m**2


//Calculations

//Let Length of dam ,L=1 m
L=1 //m

//weight of dam
W=(a+b)*2**-1*L*H*rho_mason

//Rankine's coeff earth pressure
K=((1-sin(30*%pi*180**-1))*(1+sin(phi*%pi*180**-1))
   **-1)

//Lateral thrust
P=rho_earth*H**2*L*2**-1*K

//Distance of Line of action from vertical base
x_bar=(b**2+b*a+a**2)*(3*(b+a))**-1

```

```
//distance of pt where resultant cuts the base
x=P*W**-1*H*3**-1

//Eccentricity
e=x_bar+x-b*2**-1

//Pressure at heel B
sigma1=W*b**-1*(1-6*e*b**-1)

//Pressure at heel C
sigma2=W*b**-1*(1+6*e*b**-1)

//sigma2 >120 //KN/m**2,so it is unsafe against
    bearing capacity of the soil

//result
printf("Unsafe against the bearing capacity of soil"
    )

//Plotting the Shear Force Diagram

X1=[0,L,L]
Y1=[sigma2,sigma1,0]
Z1=[0,0,0]
plot(X1,Y1,X1,Z1)
xlabel("Length x in m")
ylabel("Shear Force in kN")
title("the Shear Force Diagram")
```

Scilab code Exa 14.12 Shear Force Diagram

```
// Problem no 14.12,Page No.340

clc;clear;
close;
```

```
H=6 //m //height of dam
a=1.5 //m //top width
b=3.5 //m //Bottom width
rho_s=16 //KN/m**3 //density of soil
rho_mason=22.5 //KN/m**3 //density of mason
phi=30 //Degree //angle of repose

//Calculations

//Let Length of dam ,L=1 m
L=1 //m

//weight of dam
W=(a+b)*2**-1*L*H*rho_mason

//Rankine's coeff earth pressure
K=((1-sin(30*%pi*180**-1))*(1+sin(phi*%pi*180**-1))
   **-1)

//Lateral thrust
P=rho_s*H**2*L*2**-1*K

//Distance of Line of action from vertical base
x_bar=(b**2+b*a+a**2)*(3*(b+a))**-1

//distance of pt where resultant cuts the base
x=P*W**-1*H*3**-1

//Eccentricity
e=x_bar+x-b*2**-1

//Pressure at heel B
sigma1=W*b**-1*(1-6*e*b**-1)

//Pressure at heel C
sigma2=W*b**-1*(1+6*e*b**-1)

//Result
```

```
printf("The Max Intensities of soil at the wall is %
   .2f",sigma2);printf(" KN/m**2")
printf("\n The Min Intensities of soil at the wall
   is %.2f",sigma1);printf(" KN/m**2")

//Plotting the Shear Force Diagram
X1=[0,L,L]
Y1=[sigma2,sigma1,0]
Z1=[0,0,0]
plot(X1,Y1,X1,Z1)
xlabel("Length x in m")
ylabel("Shear Force in kN")
title("the Shear Force Diagram")
```

Scilab code Exa 14.13 Pressure at the base of the wall

```
// Problem no 14.13,Page No.341

clc;clear;
close;
H=6 //m //height of dam
a=1 //m //top width
b=3 //m //Bottom width
rho_s=18 //KN/m**3 //density of soil
rho_mason=24 //KN/m**3 //density of mason
alpha=20
phi=30

//Calculations

//Let Length of dam ,L=1 m
L=1 //m

a2=cos(alpha*%pi*180**-1)
b2=(cos(alpha*%pi*180**-1)-((cos(alpha*%pi*180**-1)
```

```
    **2-cos(phi*%pi*180**-1)**2))**0.5)
c2=(cos(alpha*%pi*180**-1)+((cos(alpha*%pi*180**-1)
    **2-cos(phi*%pi*180**-1)**2)**0.5))

X=a2*b2*c2**-1

//Total Pressue on the wall
P=rho_s*H**2*2**-1*X

//The Horizontal component of pressure
P_H=P*cos(20*%pi*180**-1)

//The Vertical component of pressure
P_V=P*sin(20*%pi*180**-1)

//weight of wall
W=(a+b)*H*rho_mason*2**-1

//TotaL Weight
W1=W+P_V

//Taking moment of vertical Loads about B,M_B=0
x_bar=(rho_mason*a*H*0.5+rho_mason*H*2)*W1**-1

x=P_H*W1**-1*H*3**-1

//eccentricity
e=x_bar+x-b*2**-1

//Stress at the toe at C
sigma_max=W1*b**-1*(1+6*e*b**-1)

//Stress at the heel at B
sigma_min=W1*b**-1*(1-6*e*b**-1)

//Result
printf("Pressure at the base of the wall:Pressure at
     the heel %.2f",sigma_min);printf(" KN/m**2")
```

```
printf("\n                                                    :Pressure
    at the toe %.2f",sigma_max);printf(" KN/m**2")
```

Chapter 15

Thin Cylindrical Shells

Scilab code Exa 15.1 Change in Volume

```
// Problem no 15.1,Page no.351

clc;clear;
close;

D=0.8 //m //Diameter of Shell
L=3 //m //Length of shell
t=0.01 //m //thickness of metal
E=200*10**9 //Pa
p=2.5*10**6 //Pa //Internal Pressure
m=4 //Poisson's ratio

//Calculation

sigma_1=p*D*(2*t)**-1 //N/m**2 //Hoop stress
sigma_2=p*D*(4*t)**-1 //N/m**2 //Longitudinal stress

e_1=1*E**-1*(sigma_1-sigma_2*m**-1) //Hoop strain
e_2=1*E**-1*(sigma_2-sigma_1*m**-1) //Hoop strain

d=e_1*D*100 //cm //Increase in Diameter
```

```
l=e_2*L*100 //cm //Increase in Length

dell_v=2*e_1+e_2 //Volumetric strain
V=dell_v*%pi*4**-1*D**2*L*10**6 //cm**3 //Increase
    in Volume

//Result
printf("Change in Diameter is %.3f cm",d)
printf("\n Change in Length is %.3f cm",l)
printf("\n Change in Volume is %.2f",V);printf(" cm
    **3")
```

Scilab code Exa 15.2 Thickness of metal

```
// Problem no 15.2,Page no.352

clc;clear;
close;

D=0.8 //m //iameter of water main
h=100 //m //Pressure head
w=10*10**3 //N/m**3 //Weight of Water
sigma_t=20*10**6 //MPa //Permissible stress

//Calculation

p=w*h //N/m**2 //Pressure of inside the main
t=p*D*(2*sigma_t)**-1*100 //m //Thcikness of metal

//Result
printf("The Thickness of metal is %.2f",t);printf("
    cm")
```

Scilab code Exa 15.3 Maximum diameter of boiler

```
// Problem no 15.3,Page no.352

clc;clear;
close;

p=2*10**6 //MPa //Steam Pressure
t=0.02 //m //thickness of boiler plate
sigma_t=120*10**6 //MPa //Tensile stress
sigma_l=120*10**6 //MPa //Longitudinal stress
rho=0.90 //% //Efficiency of Longitudinal joint
rho_e=0.40 //% //Efficiency of circumferential joint

//Calculations

D_1=sigma_t*2*t*rho*p**-1 //Diameter of boiler
D_2=sigma_l*4*t*rho_e*p**-1 //Diameter of boiler

//Max diameter of boiler is equal to minimum value
    of diameter

//Result
printf("Maximum diameter of boiler is %.2f",D_2);
    printf(" m")
```

Scilab code Exa 15.4 Pressure Exerted by Fluid

```
// Problem no 15.4,Page no.352

clc;clear;
close;

L=0.9 //m //Length of cyclindrical shell
D=0.2 //m //Internal Diameter
```

```
t=0.008 //m //thickness of metal
dV=20*10**-6 //m**3 //Additional volume
E=200*10**9 //Pa
m=1*0.3**-1 //Poissoin's ratio

//Calculations

V=%pi*4**-1*D**2*L //Volume of cyclinder

//Let X=2*e_1+e_2
X=dV*V**-1 //Volumetric strain  (Equation 1)

//e_1=p*D*(2*E*t)**-1*(1-1*(2*m)**-1) //Circumferential strain
//e_2=p*D*(2*E*t)**-1*(1*2**-1-1*(2*m)**-1) //Circumferential strain

//substituting above values in equation 1 we get
p=X*E*t*(D*((1-1*(2*m)**-1)+(1*4**-1-1*(2*m)**-1)))**-1*10**-3 //KN/m**2 //Pressure exerted by fluid
sigma_t=p*D*(2*t)**-1 //KN/m**2 //hoop stress

//Result
printf("Pressure Exerted by Fluid on the cyclinder is %.2f",p);printf(" KN/m**2")
printf("\n Hoop stress is %.2f",sigma_t);printf(" KN/m**2")
```

Scilab code Exa 15.5 Max Permissible Diameter of shell

```
// Problem no 15.5,Page no.353

clc;clear;
close;

```

```
t=0.015 //m //Thickness of plate
sigma_t=120*10**6 //Pa //tensile stress
sigma_l=120*10**6 //Pa //Longitudinal stress
rho=0.7 //% //Efficiency of longitudinal joints
rho_l=0.3 //% //Efficiency of circumferential joints
p=2*10**6 //Pa //Internal pressure
D=1.5 //m //shell diameter

//Calculations (Part-1)

D_1=sigma_t*2*t*rho*p**-1     //m
D_2=sigma_l*4*t*rho_l*p**-1   //m

//Thus max diameter of shell is min of above two
   cases

//Calculations (Part-2)

p_1=sigma_t*2*t*rho*D**-1*10**-6     //MPa
p_2=sigma_l*4*t*rho_l*D**-1*10**-6   //MPa

//Thus Internal pressure is min of above two cases

//Result
printf("Max Permissible Diameter of shell is %.2f",
   D_2);printf(" m")
printf("\n Max Permissible Internal Pressure is %.2f
   ",p_2);printf(" MPa")
```

Scilab code Exa 15.6 The circumferential stresses

```
// Problem no 15.6,Page no.354

clc;clear;
close;
```

```

L=3 //m //Length
D=1 //m //Internal Diameter
t=0.015 //m //thickness
p=1.5*10**6 //Pa //Internal pressure
E=200*10**9 //Pa
m=1*0.3**-1 //Poissoin's ratio

//Calculations

sigma_t=p*D*(2*t)**-1*10**-6 //MPa //Hoop stress
sigma_l=p*D*(4*t)**-1*10**-6 //MPa //Longitudinal stress

dD=(p*D**2*(2*t*E)**-1*(1-1*(2*m)**-1))*10**2 //cm //Change in Diameter
dL=p*D*L*(2*t*E)**-1*(1*2**-1-1*m**-1)*10**2 //cm //Change in Length

V=%pi*4**-1*D**2*L //Volume
dV=p*D*(2*t*E)**-1*(5*2**-1-2*(m)**-1)*V*10**6 //cm //Change in Volume

//Result
printf("The circumferential stresses induced is %.2f",sigma_t);printf(" MPa")
printf("\n The Longitudinal stresses induced is %.2f",sigma_l);printf(" MPa")
printf("\n The change in dimension are:D is %.3f cm",dD)
printf("\n                              :L is %.4f cm",dL)
```

Scilab code Exa 15.7 `Additional quantity of oil`

```
// Problem no 15.7,Page no.355

clc;clear;
close;

L=0.9 //m //Length of cyclinder
D=0.4 //m //Diameter
t=0.006 //m //thickness
p=5*10**6 //Pa //Pressure
E=100*10**9
m=3 //Poissoin's ratio
k=2.6*10**9 //Pa //Bulk modulus

//Calculations

//Let X=dV_1*V_1**-1
X=p*(0.4-2*0.006)*(2*t*E)**-1*(5*2**-1-2*m**-1) //
    Volumetric strain
dV_1=X*%pi*4**-1*0.388**2*L //cm**3 //Increase in
    volume of cyclinder
V_1=%pi*4**-1*0.388**2*L //VOlume
dV_2=p*k**-1*V_1 //DEcrease in volume of oil due to
    increase in pressure

dV=(dV_1+dV_2)*10**6 //Resultant additional space

//Result
printf("Additional quantity of oil to be pumped is %
    .2f",dV);printf(" cm**3")
```

Scilab code Exa 15.8 Thickness of steel plpe

```
// Problem no 15.8,Page no.356

clc;clear;
```

```
close;

A=1600*(3600)**-1 //Kg/sec //Amount of steam
    generated
v=0.24 //m**3/kg //specific volume of steam
sigma_t=4*10**6 //MPa //Tensile stress
V_1=30 //m/s //Velocity of steam
p=1*10**6 //Pa //Steam pressure

//Calculation

V=A*v //m**3/s //volume of steam
D=(V*(%pi*4**-1*V_1)**-1)**0.5*100 //Diameter of
    %pipe
t=p*D*(2*sigma_t)**-1 //Thicknes of %pipe

//Result
printf("Diameter of boiler is %.2f",D);printf(" cm")
printf("\n Thickness of steel plpe is %.2f",t);
    printf(" cm")
```

Scilab code Exa 15.9 `The value of Poissoins ratio`

```
// Problem no 15.9,Page no.359

clc;clear;
close;

P=14*10**3 //N //Axial pull
dL=0.0084 //cm //Elongation
L=0.25 //m //Length
p=7*10**6 //Internal pressure
dL_2=0.0034 //cm //Longation
d=0.0475 //m //Internal diameter
D=0.05 //m //External Diameter
```

```
m=0.25

//Calculation

t=(D-d)*2**-1 //thickness  od tube
A=%pi*4**-1*(D**2-d**2) //Area of tube
sigma=P*A**-1 //stress
e=dL*(L)**-1 //strain
E=sigma*e**-1 //Modulus of Elasticity
sigma_1=p*d*(2*t)**-1 //Hoop stress
sigma_2=p*d*(4*t)**-1 //Longitudinal stress

m=-(sigma_1*(dL_2*L**-1*E-sigma_2)**-1) //POissoin's
    ratio\

//Let X=1*m**-1
X=1*m**-1 //Poissoin's ratio

//Result
printf("The value of Poissoin''s ratio is %.3f",X)
```

Scilab code Exa 15.10 Volume of additional Fluid

```
// Problem no 15.10,Page no.357

clc;clear;
close;

D=0.8 //m //Diameter
t=0.01 //m //Thickness
p=5*10**6 //Pa //Pressure
m=1*0.25**-1
E=200*10**9 //Pa

//Calculations
```

```

sigma_1=5*10**6*0.8*(4*0.01)**-1 //stress
sigma_2=sigma_1
e_1=sigma_1*E**-1-sigma_2*(m*E)**-1 //strain
e_v=3*e_1
V=4*3**-1*%pi*(D*2**-1)**3 //m**3  tress
dell_v=e_v*V*10**6 //cm**3

//Result
printf("Volume of additional Fluid %.3f cm^3",dell_v
  )
```

Scilab code Exa 15.11 Stress in the wire

```
// Problem no 15.11,Page no.358

clc;
clear;
close;


d=0.3 //m //Diameter
D=0.003 //m //Diameter of steel wire
t=0.006 //m //thickness
sigma_w=8*10**6 //Pa //Stress
p=1*10**6 //Pa //Internal pressure
E_s=200*10**9 //Pa //Modulus of Elasticity for steel
E_c=100*10**9 //Pa //Modulus of Elasticity for cast
  iron
m=1*0.3**-1

//Calculations

sigma_p=(sigma_w*%pi*2**-1*d)*(2*t)**-1 //
  compressive hoop stress
```

```
sigma_l=p*d*(4*t)**-1 //Longitudinal stress

//when internal presure is apllied Let sigma_w_1=Tensile in wire and sigma_p_1=tensile hoop in wire
//sigma_p_1*2*t+sigma_w_1*2*d**-1*%pi*4**-1*d**2=p*D

//After substituting values and further simplifying we get
//1.2*sigma_p_1+0.471*sigma_w_1=3000     Equation 1

//1*E_c**-1(sigma_p_1-sigma_1*m**-1+sigma_p)=1*E_s**-1(sigma_w_1-sigma_w)

//After substituting values and further simplifying we get
//sigma_p_1-0.5*sigma_w_1=1.36*10**6
//sigma_p_1=0.5*sigma_w_1-3.39*10**6    Equation 2

//From Equation 2 substituting value of sigma_p_1 in Equation 1


sigma_w_1=(40.68*10**3+0.3*10**6)*(10.71238*10**-3)**-1
sigma_p_1=0.5*sigma_w_1-3.39*10**6

//Let X=sigma_p_1 and Y=sigma_w_1
X=sigma_p_1*10**-6 //MPa //Stresses in %pipe
Y=sigma_w_1*10**-6 //MPa //Stresses in wire

//Result
printf("Stress in the pipe is %.2f",X);printf(" MN/m**2")
printf("\n Stress in the wire is %.2f",Y);printf(" MN/m**2")
```

Scilab code Exa 15.12 The Tension at which wire must have been wound

```
// Problem no 15.12,Page no.359

clc;clear;
close;

D=0.038 //m //External Diameter
d=0.035 //m //Internal Diameter
d_1=0.0008 //m //Steel wire diameter
p=2*10**6 //pa //Pa //Internal Pressure
sigma_t_1=7*10**6 //Pa //Circumferential stress
//E_s=1.6*E_s
m=0.3

//Calculation

t=(D-d)*2**-1 //m Thickness

//sigma_t*2*t=%pi*d*2**-1*sigma_w
//From Above equation we get

//sigma_t=0.419*sigma_w    (Equation 1)

sigma_w_1=(p*d-sigma_t_1*2*t)*(2*d_1**-1*%pi*4**-1*
    d_1**2)**-1 //stress in wire
sigma_l=p*d*(4*t)**-1 //Longitudinal stress in tube

//Now Equating equations of strain in tube and wire
    we get
sigma_w=-(1.6*(sigma_t_1-sigma_l*m)-sigma_w_1)
    *1.67**-1*10**-6

//Result
```

```
printf("The Tension at which wire must have been
    wound is %.2f",sigma_w);printf(" MPa")
```

Chapter 16

Riveted Joints

Scilab code Exa 16.1 Efficiency of joint

```
// Problem 16.1,Page no.366

clc;clear;
close;

t=1 //cm //thickness of plates
sigma_t=150 //MPa //Working stress
sigma_c=212.5 //MPa //crushing stress
sigma_s=94.5 //MPa //shearing stress

//Calculation (Part-1)

//P_s=%pi*4**-1*d**2*sigma_s //N //Shearing strength
//After substituting values and further simplifying
   we get
//P_s=%pi*4**-1*d**2*94.5*10**6 //N

//P_c=d*t*sigma_c //N //crushing strength
//After substituting values and further simplifying
   we get
//P_c=d*1*10**-2*212.5*10**6 //N
```

```

//P_t=(p-d)*t*sigma_t //N //Strength of plate in tearing
//After substituting values and further simplifying we get
//P_t=(p-d)*1*10**-2*150*10**6

//Now comparing strengths
//P_s=P_c
//%pi*4**-1*d**2*94.5*10**6=d*1*10**-2*212.5*10**6
d=1*10**-2*212.5*10**6*(%pi*4**-1*94.5*10**6)**-1 //m //Diameter of rivet

//Now comparing strengths
//P_t=P_c
//(p-d)*1*10**-2*150*10**6=d*1*10**-2*212.5*10**6
//Afte further simplifying equation we get
//(p-d)=1.4166*d
p=(1.4166*d+d) //m //%pitch length of rivet

P=p*sigma_t*10**6*t*10**-2 //N //Strength of solid plate //Answer for strength of solid plate is incorrect in textbook

rho=(p-d)*p**-1*100 //Efficiency of the joint //Notification has been changed

//Calculation (Part-2)

//P_s=2*%pi*4**-1*d**2*sigma_s //N //Shearing strength
//After substituting values and further simplifying we get
//P_s=2*%pi*4**-1*d**2*94.5*10**6 //N

//P_c=2*d*t*sigma_c //N //crushing strength
//After substituting values and further simplifying we get
```

```
//P_c=2*d*1*10**-2*212.5*10**6 //N

//P_t=(p-d)*t*sigma_t //N //Strength of plate in tearing
//After substituting values and further simplifying we get
//P_t=(p-d)*1*10**-2*150*10**6

//Now comparing strengths
//P_s=P_c
//2*%pi*4**-1*d**2*94.5*10**6=2*d*1*10**-2*212.5*10**6
d=1*10**-2*212.5*10**6*(%pi*4**-1*94.5*10**6)**-1 //m //Diameter of rivet

//Now comparing strengths
//P_t=P_c
//(p-d)*1*10**-2*150*10**6=2*d*1*10**-2*212.5*10**6
//Afte further simplifying equation we get
//(p-d)=2.833*d
p_1=(2.833*d+d) //m //%pitch length of rivets in shearing strength of plate //Notification for %pitch length has been changed

rho_2=(p_1-d)*p_1**-1*100 //Efficiency of the joint //Notification has been changed

//Result
printf("The Efficiency of joint in single rivet is %.2f %%",rho)
printf("\n The Efficiency of joint in double rivet is %.2f %%",rho_2)
```

Scilab code Exa 16.2 Minimum force that will rapture the joint

```
// Problem 16.2,Page no.367

clc;clear;
close;

p=7.5 //cm //%pitch of rivets
t=1.5 //cm //Thickness of plate
d=2.5 //cm //diameter of rivets
sigma_t=400 //MPa //Working stress
sigma_c=640 //MPa //crushing stress
sigma_s=320 //MPa //shearing stress
n=2 //No. of rivets

//Calculation

P_t=(p-d)*t*10**-4*sigma_t*10**6*10**-3 //kN //
    Strength of plate in tearing
P_s=n*%pi*4**-1*d**2*10**-4*sigma_s*10**6*10**-3 //
    kN //Shearing strength
P_c=n*d*t*10**-4*sigma_c*10**6*10**-3 //kN //
    crushing strength

//Thus Minimum force that will rapture the joint is
    least of P_t,P_s,P_c i.e P_t

//Result
printf("Minimum force that will rapture the joint is
    %.2f",P_t);printf(" kN")
```

Scilab code Exa 16.3 Which Joint has higher Efficiency

```
// Problem 16.3,Page no.367

clc;clear;
close;
```

```
d_1=2 //cm //Diameter of rivets
p_1=6 //cm //%pitch of rivet
d_2=3 //cm //Diameter of rivet
p_2=8 //cm //%pitch of rivet
sigma_t=120 //MPa //Working stress
sigma_c=160 //MPa //crushing stress
sigma_s=90 //MPa //shearing stress
t=1.2 //cm //thickness of plate
n=2 //No. of rivets

//Calculation (part-1)

P_t=(p_1-d_1)*t*10**-4*sigma_t*10**6 //N //Strength
    of plate in tearing
P_s=n*%pi*4**-1*d_1**2*10**-4*sigma_s*10**6 //N //
    Shearing strength
P_c=n*d_1*t*10**-4*sigma_c*10**6 //N //crushing
    strength
P=p_1*t*10**-4*sigma_t*10**6 //N //Strength of solid
     per %pitch length

rho_1=P_s*(P)**-1*100 //% //Efficiency of the joint

//Calculation (part-2)

P_t_2=(p_2-d_2)*t*10**-4*sigma_t*10**6 //N //
    Strength of plate in tearing
P_s_2=n*%pi*4**-1*d_2**2*10**-4*sigma_s*10**6 //N //
    Shearing strength
P_c_2=n*d_2*t*10**-4*sigma_c*10**6 //N //crushing
    strength
P_2=p_2*t*10**-4*sigma_t*10**6 //N //Strength of
    solid per %pitch length

rho_2=P_t_2*(P_2)**-1*100 //% //Efficiency of the
    joint

```

```
//Result
printf("First joint has higher Efficiency i.e %.2f",
   rho_1);printf(" %% than second joint")
```

Scilab code Exa 16.4 Diameter of rivets

```
// Problem 16.4,Page no.368

clc;clear;
close;

t=18 //mm //thickness of plates
sigma_t=100 //MPa //Tensile stress //Notification
   has been changed
sigma_s=70 //MPa //Shearing stress //Notification
   has been changed

//Calculations

d=6*t**0.5 //mm //Diameter of rivet //Answer is in
   correct in textbook
s=%pi*4**-1*d**2*10**-6*sigma_s*10**6 //N //Strength
    of one rivet in single shear //Answer is in
   correct in textbook

//Consider strip of joint equal to %pitch p

//S_1=(p-d)*t*10**-3*sigma_t*10**6 //Strength of
   plate against tearing along 1-1
//After substituting values and further simplifying
   we get
//S_1=1800*p-45900          (Equation 1)

//S_2=(p-d)*t*10**-3*sigma_t*10**6+s //Strength of
   plate against tearing along 1-1
```

```
//After substituting values and further simplifying
    we get
//S_1=1800*p-56050.64      (Equation 2)

//But the value of Equation 2 is smaller than
    Equation 1

//Strength of rivets in single shear is
S=4*s

//Equating Equation 2 to shearing value
//1800*p-56050.64=S
p=(S+56050.64)*18000**-1 //cm //%pitch of rivet

//Result
printf("Diameter of rivets is %.2f",d);printf(" mm")
printf("\n pitch of rivet is %.2f",p);printf(" cm")
```

Scilab code Exa 16.5 Efficiency of joint

```
// Problem 16.5,Page no.369

clc;clear;
close;

t=12 //mm //Thickness of plate
d=24 //mm //Diameter of rivets
sigma_t=120 //MPa //stress in tension
sigma_s=200 //MPa //stress in double shear
sigma_b=200 //MPa //stress in Bearing
n=1 //No. of rivet

//Calculation

//P_t=(p-d)*t*10**-4*sigma_t*10**6 //N //Strength of
```

```
    plate in tearing
//After further simplifying we get
//P_t=(p-24)*14400 //N

P_s=n*%pi*4**-1*d**2*10**-6*sigma_s*10**6 //N //
   Shearing strength of rivet in double shear

P_b=n*d*10**-3*t*10**-3*sigma_b*10**6 //N //Bearing
   strength per %pitch length

//Now Equating P_t to P_s or P_b whichever is small
//(p-24)*14400=P_b
p=P_b*14400**-1+24*10**-1 //cm //pitch of rivet
p_min=2.5*d*10**-1 //cm //Minimum pitch

//Now adopting 6.4 cm %pitch

rho=(p-d*10**-1)*p**-1*100

//Result
printf("pitch of rivet is %.2f",p);printf(" cm")
printf("\n Efficiency of joint is %.2f %%",rho)
```

Scilab code Exa 16.6 Pull per pitch length

```
// Problem 16.6,Page no.370

clc;clear;
close;

t=12 //mm //thickness of plate
d=18 //mm //Diameter of rivet
p=8 //cm //%pitch of rivet
sigma_t=460 //MPa //Tensile stress
sigma_s=320 //MPa //shearing stress
```

```
sigma_b=640 //MPa //bearing stress
n=2 //No. of rivet

//Calculation

P_t=(p-d*10**-1)*t*10**-1*10**-4*sigma_t*10**6 //N
   //Strength of plate in tearing
P_s=n*2*%pi*4**-1*d**2*10**-6*sigma_s*10**6 //N //
   Shearing strength of rivet pr %pitch length
P_b=n*d*10**-3*t*10**-3*sigma_b*10**6 //N //Bearing
   strength per %pitch length

//The joint will fail at a pull of P_b

S=p*t*sigma_t*10**6*10**-5 //N //strength of solid
   plate
rho=P_b*S**-1*100 //Efficiency of joint

//Result
printf("Pull per pitch length at which joint will
   fail is %.2f",P_b);printf(" N")
```

Scilab code Exa 16.7 Efficiency of joint

```
// Problem 16.7,Page no.370

clc;clear;
close;

W=270 //KN //Load
t=14 //mm //thickness of plate
b=20 //cm //width of plate
d=20 //mm //diameter of rivet
sigma_s=70  //MPa //shear stress
sigma_b=190 //MPa //stress in bearing
```

```
sigma_t=110 //MPa //stress in tensile

//Calculation

S_1=1.75*%pi*4**-1*b**2*10**-4*sigma_s*10**6 //strength of one rivet in double shear
S_2=20*10**-3*t*10**-3*sigma_b*10**6

n=W*10**3*S_1**-1

//Adopt 7 rivets

//The plates may tear along section 1-1
W_1=(20-4)*10**-2*t*10**-3*sigma_t*10**6 //N //Permissible Load

//The plates may tear along section 2-2,at the same time shearing the 4 rivets along 1-1
W_2=(20-2*2)*10**-2*t*10**-3*sigma_t*10**6+2*S_1 //N //Permissible Load

//The plates may tear along section 3-3,at the same time shearing the rivets along 1-1 and 2-2
W_3=(20-3*2)*10**-2*t*10**-3*sigma_t*10**6+4*S_1 //N //Permissible Load

W_s=7*S_1 //N //Load to shear all the rivets
W_c=7*S_2 //N //Load to crush all the rivets

W_4=b*10**-2*t*10**-3*sigma_t*10**6 //N //Load carried by solid plate

rho=W_1*W_4**-1*100 //% //Efficiency of joint

//Result
printf("Efficiency of joint is %.2f %%",rho)
```

Scilab code Exa 16.8 `Pitch of plate`

```
// Problem 16.8,Page no.371

clc;clear;
close;

D=1.5 //cm //Diameter of boiler
rho=75 //% //Efficiency of joint
sigma_t=85 //MPa //stress in tension
sigma_s=70 //MPa //stress in shear
P=1 //MPa //Steam Pressure //Notification has been
    changed

//Calculation

t=P*10**6*D*(2*sigma_t*10**6*rho*10**-2)**-1*100

//Adopt 12 mm thickness of plate
t_1=12 //mm
d=6*t_1**0.5

//Adopt 21 mm diameter of rivet
d_1=21 //mm

//P_t=(p-d_1*10**-1)*t*10**-1*10**-4*sigma_t*10**6
    //N //Strength of plate in tearing
//After substituting values and further simplifying
    we get
//P_t=(p-2.1)*10200 //N

P_s=1.875*%pi*4**-1*d_1**2*10**-6*2*sigma_s*10**6

//(p-d_1*10**-1)*10200=P_s
```

```
p=P_s*10200**-1+d_1*10**-1

//Result
printf("Pitch of plate is %.2f",p);printf(" cm")
```

Chapter 17

Welded Joints

Scilab code Exa 17.1 Length of weld

```
//Ex no.17.1,Page no.379

clc;
clear;
close;
//Initilization of Variables

b=12 //cm //width of steel plates
t=1 //cm //thickness of steel plates
sigma=75 //MPa //stress

//Calculations

//The maximum Load which the plate can carry
P=b*t*10**-6*sigma*10**6 //N

//Length of weld for static loading

//size of weld is equal to thickness of plate
S=t //cm

```

```
//P=2**0.5*l*S*sigma

//After substituting values and simplifying above
    equation , we get ,
l=((P)*(2**0.5*S*sigma)**-1) //cm

//add 1.25 to allow start and stop of weld run
L=l+1.25 //cm

//Length of weld for Dynamic loading

//The stress concentration factor for transverse
    fillet weld is 1.5

sigma_2=sigma*1.5**-1 //MPa //Permissible tensile
    stress

//P=2**0.5*l_2*S*sigma_2

//After substituting values and simplifying above
    equation , we get ,
l_2=((P)*(2**0.5*S*sigma_2)**-1) //cm

//add 1.25 cm
l_3=l_2+1.25 //cm

//Result
printf("Length of weld for static loading = %.2f cm"
    ,L)
printf("\n Length of weld for Dynamic loading = %.3f
    cm",l_3)
```

Scilab code Exa 17.2 Size of weld

```
//Ex no.17.2,Page no.380
```

```
clc;
clear;
close;

//Initilization of Variables

d=6 //cm //diameter of rod
L=40 //cm //Length of steel plate
P=12 //KN //Load
sigma=180 //MPa //Allowable stress

//Calculations

A=%pi*4**-1*d**2 //cm**2 //Area of rod
M=P*10**3*L //Ncm

F=M*A**-1 //N/cm //Force per unit cm of weld at top
    and bottom

V_s=P*10**3*(%pi*d)**-1 //N/cm //vertical shear

R=(F**2+V_s**2)**0.5 //N/cm //resultant Load

S=R*(sigma)**-1*10**-2 //cm //size of weld

//Result
printf("Size of weld is %.2f cm",S)
```

Scilab code Exa 17.3 Length of weld Under static Loading

```
//Ex no.17.3,Page no.380
clc;clear;close;

//Initilization of Variables

```

```
b=12 //cm //width of plate
S=1;t=1 //cm //thickness of plate
P=50 //KN //load
sigma_s=60 //MPa //shear stress

//Calculations (part-1)

//Under static Loading

//P=2**0.5*l*S*sigma_s

l=((P*10**3)*(2**0.5*S*sigma_s*10**-4*10**6)**-1) //cm

//add 1.25 cm to start and stop weld run

L=l+1.25 //cm //length of weld

//Calculations (part-2)

//Under Fatigue load

//stress concentration factor for parallel fillet weld is 2.7

sigma_s_2=sigma_s*2.7**-1 //MPa //permissible shear stress

//P=2**0.5*l_2*S*sigma_s_2

l_2=((P*10**3)*(2**0.5*S*sigma_s_2*10**-4*10**6)**-1) //cm

//add 1.25 cm

l_3=l_2+1.25 //cm //length of weld

//Result
```

```
printf("Length of weld Under static Loading is %.3f cm",L)
printf("\n Length of weld Under Ftigue Loading is %.3f cm",l_3)
```

Scilab code Exa 17.4 `size of end fillet`

```
//Ex no.17.4,Page no.381
clc;clear;close;

//Initilization of Variables

sigma_t=100 //MPa //tensile stress
P=170 //KN //Load

//Calculations

//For equal stress in the welds A and B, the load shared by the fillet welds will be proportional to size of weld

//t_a=0.7*s //Effective throat thickness of weld A in upper plate
//s=size of weld

//t_b=1.05*s //Effective throat thickness of weld B in lower plate

//For weld A
//P_1=l*t*sigma_t

//After substituting values and simplifying above equation , we get ,
//P_1=84000*s //N      (equation 1)

```

```
//P_2=l*t_2*sigma_t

//After substituting values and simplifying above
   equation , we get ,
//P_2=126000*s //N      (equation 2)

//After adding equation 1 and 2, we get,
//P=210000*s            (equation 3)

//Now equating total forces of the fillets to load
   on the plates
s=P*10**3*210000**-1 //cm

//Result
printf("size of end fillet is %.2f cm",s)
```

Scilab code Exa 17.5 size of weld

```
//Ex no.17.5,Page no.381
clc;clear;close;

//Initilization of Variables

L_1=30 //cm //length of longitudinal weld
L_2=16 //cm //length of transverse weld
//t=0.7*s //Effective thickness of weld
sigma_t_1=100 //MPa //working stress for transverse
   welds
sigma_t_2=85 //MPa //working stress for longitudinal
    welds
P=150 //KN //load

//Calculations

//For transverse weld
```

```
//P_1=L_1*t*10**-4*sigma_t_1*10**6

//After substituting values and simplifying above
   equation , we get ,
//P_1=112000*s //N

//For longitudinal weld
//P_2=L_2*t*10**-4*sigma_t_2*10**6

//Total force of resistance of weld
//P=P_1+P_2 //N

//after adding we get ,
//P=290500*s //N

//Now equating total forces of resistance to pull of
    the joint
s=P*10**3*290500**-1 //cm

//Result
printf("size of weld is %.3f cm",s)
```

Scilab code Exa 17.6 Distance of centre of gravity

```
//Ex no.17.6,Page no.382
clc;clear;close;

//Initilization of Variables

P=200 //KN //Load carried by the angle
S=0.6 //mm //size of weld
b=4.46 //cm //Distance of centre of gravity of the
   angle from the top shorter leg
a=10.54 //cm //Distance of centre of gravity of the
   angle from the top edge of the angle
```

```
sigma_s=102.5 //MPa //shear stress
//l_1=Length of the top weld
//l_2=length of the bottom weld
//L=l_1+l_2 //cm //total length weld

//Using the relation
//P=L*0.7*S*sigma_s

//After substituting values and simplifying we get
L=(P*10**3)*(0.7*S*sigma_s*10**-4*10**6)**-1 //cm (
    equation 1)

//Using the relation
l_1=(L*b)*(a+b)**-1 //cm

//substituting this value in equation 1 we have,
l_2=L-l_1 //cm

//Result
printf("Distance of centre of gravity of the angle
    from the top edge of the angle = %.2f cm",l_2)
```

Scilab code Exa 17.7 size of weld

```
//Ex no.17.7,Page no.383
clc;clear;close;

//Initilization of Variables

P=12 //KN //Load
sigma_s=75 //N/mm**2 //shear stress
e=12 //cm
r_1=2.5 //cm

//Calculations
```

```
//A=(2*S*l)*(2)**0.5
//sigma_s=P*A**-1 //MPa //shear stress

//After substituting values and simplifying we get
//sigma_s=16.97*S**-1 //MPa

//I_g=S*l*(3*b**2+l**2)*(6)**-1 //cm**4 //Polar
    moment of Inertia of weld

//After substituting values and simplifying we get
//I_g=180.833*S //cm**4
r_2=((8*2**-1)**2)+((5*2**-1)**2)**0.5 //cm //max
    radius of weld

//sigma_s_2=P*e*r_2*I_g**-1 //MPa //shear stress due
     to bending moment

cos_theta=r_1*r_2**-1

//Now using the relation
//sigma_s=(sigma_s_1**2+sigma_s_2**2+2sigma_s_1*
    sigma_s_2*cos_theta

S=(2363.8958*5625**-1)**0.5 //cm //size of the weld

//Result
printf("size of the weld = %.3f cm",S)
```