Scilab Textbook Companion for Strength Of Materials by R. K. Bansal[1]

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Book Description

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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

simple stresses and strains

Scilab code Exa 1.1 Elongation

```
clear
//
//Given
//Variable declaration
L=150              //Length of the rod in cm
D=20               //Diameter of the rod in mm
P=20*10**3         //Axial pull in N
E=2.0e5            //Modulus of elasticity in N/sq.mm

//Calculation
A=(%pi/4)*(D**2)     //Area in sq.mm
 //case (i):stress
sigma=P/A                   //Stress in N/sq.mm
 //case (ii):strain
e=sigma/E                   //Strain
 //case (iii):elongation of the rod
dL=e*L                      //Elongation of the rod in
   cm

//Result
printf("\n Stress = %0.3f  N/mm^2",sigma)
```

```
printf("\n Strain = %0.6f ",e)
printf("\n Elongation = %0.4f cm",dL)
```

Scilab code Exa 1.2 Diameter of a steel wire

```
clear
//

//Given
//variable declaration
P=4000          //Load in N
sigma=95        //Stress in N/sq.mm

//Calculation
D=(sqrt(P/((%pi/4)*(sigma))))  //Diameter of steel
   wire in mm


//Result
printf("\n Diameter of a steel wire = %0.3f mm",D)
```

Scilab code Exa 1.3 Youngs Modulus of brass rod

```

clear
//

//Given
//Variable declaration
D=25          //Diameter of brass rod in mm
P=50*10**3    //Tensile load in N
L=250         //Length of rod in mm
dL=0.3        //Extension of rod in mm
```

```
//Calculation
A=(%pi/4)*(D**2)     //Area of rod in sq.mm
sigma=(P/A)       //Stress in N/sq.mm

e=dL/L                    //Strain
E=(sigma/e)               //Youngs Modulus in N/sq.m

//Result
printf("\n Youngs Modulus of a rod,E = %0.3f  GN/m^2
   ",E*(10**-3))
```

Scilab code Exa 1.4 Percentage decrease in

```
clear
//

//Given
//Variable Declaration
D=3           //Diameter of the steel bar in cm
L=20          //Gauge length of the bar in cm
P=250         //Load at elastic limit in kN
dL=0.21       //Extension at a load of 150kN in mm
Tot_ext=60    //Total extension in mm
Df=2.25       //Diameter of the rod at the failure in
    cm

//Calculation
A=((%pi/4)*(D**2))     //Area of the rod in sq.m


//case (i):Youngs modulus
e=((150*1000)/(7.0685))    //stress in N/sq.m

sigma=dL/(L*10)                  //strain
```

```
E=((e/sigma)*(10**-5))      //Youngs modulus in GN/sq.m


//case (ii):stress at elastic limit
stress=int(((P*1000)/A))*1e-2    //stress at elastic limit in MN/sq.m


//case (iii):percentage elongation
Pe=(Tot_ext*1e2)/(L*10)

//case (iv):percentage decrease in area
Pd=(D**2-Df**2)/D**2*1e2


//Result
printf("\n NOTE:The Youngs Modulus found in the book is incorrect.The correct answer is,")
printf("\n Youngs modulus,E = %0.3f  GN/m^2",E)
printf("\n Stress at the elastic limit,Stress = %0.3f  MN/m^2",stress)
printf("\n Percentage elongation = %d%%",Pe)

printf("\n Percentage decrease in area = %.2f%%",Pd)
```

Scilab code Exa 1.5 internal diameter

```
clear
//

//Given
//Variable declaration
sigma=125*10**6      //Safe stress in N/sq.m
P=2.1*10**6          //Axial load in N
```

```
D=0.30                 //External diameter in m

//Calculation

d=(sqrt((D**2)-P*4/(%pi*sigma)))*1e2  //internal
   diameter in cm


//Result
printf("\n internal diameter = %0.3f  cm",d)
```

Scilab code Exa 1.6 internal diameter

```
clear
//

//Given
//Variable declaration
stress=480        //ultimate stress in N/sq.mm
P=1.9*10**6       //Axial load in N
D=200             //External diameter in mm
f=4               //Factor of safety

//Calculation
sigma=stress/f
                                           //Working
   stress or Permissable stress in N/sq.mm
d=sqrt((D**2)-((P*4)/(%pi*sigma)))  //internal
   diameter in mm

//Result
printf("\n internal diameter = %0.3f  mm",d)
```

Scilab code Exa 1.15 Extension of the rod

```
clear
//

//Given
//Variable declaration
D1=40       //Larger diameter in mm
D2=20       //Smaller diameter in mm
L=400       //Length of rod in mm
P=5000      //Axial load in N
E=2.1e5     //Youngs modulus in N/sq.mm

//Calculation
dL=((4*P*L)/(%pi*E*D1*D2))   //extension of rod in
    mm

//Result
printf("\n Extension of the rod = %0.3f  mm",dL)
```

Scilab code Exa 1.16 Modulus of elasticityE

```
clear
//

//Given
//Variable declaration
D1=30           //Larger diameter in mm
D2=15           //Smaller diameter in mm
L=350           //Length of rod in mm
P=5.5*10**3     //Axial load in N
dL=0.025        //Extension in mm

//Calculation
E=int((4*P*L)/(%pi*D1*D2*dL))   //Modulus of
```

```
elasticity in N/sq.mm

//Result
printf("\n Modulus of elasticity,E = %.5eN/mm^2",E)
```

Scilab code Exa 1.17 Extension of the roddL

```
clear
//

//Given
//Variable declaration
L=2.8*10**3           //Length in mm
t=15                  //Thickness in mm
P=40*10**3            //Axial load in N
a=75                  //Width at bigger end in mm
b=30                  //Width at smaller end in mm
E=2e5                 //Youngs Modulus in N/sq.mm

//Calculation
dL=(((((P*L)/(E*t*(a-b)))*((log(a)-log(b)))))     //extension of rod in mm


//Result
printf("\n Extension of the rod,dL = %0.3f  mm",dL)
```

Scilab code Exa 1.18 Axial load

```
clear
//

//Given
```

```
//Variable declaration
dL=0.21             //Extension in mm
L=400               //Length in mm
t=10                //Thickness in mm
a=100               //Width at bigger end in mm
b=50                //Width at smaller end in mm
E=2e5               //Youngs Modulus in N/sq.mm

//Calculation
P=int(dL/(((L)/(E*t*(a-b)))*((log(a)-log(b)))))*1e-3       //Axial load in kN


//Result
printf("\n Axial load = %0.3f  kN",P)
```

Scilab code Exa 1.20 Decrease in the length of the compound tube

```
clear
//

//Given
//Variable declaration
Di_s=140        //Internal diameter of steel tube in mm
De_s=160        //External diameter of steel tube in mm
Di_b=160        //Internal diameter of brass tube in mm
De_b=180        //External diameter of brass tube in mm
P=900e3         //Axial load in N
L=140           //Length of each tube in mm
Es=2e5          //Youngs modulus for steel in N/sq.mm
Eb=1e5          //Youngs modulus for brass in N/sq.mm

//Calculation
As=(%pi/4*(De_s**2-Di_s**2))      //Area of steel tube in sq.mm
```

```
Ab=(%pi/4*(De_b**2-Di_b**2))       //Area of brass
    tube in sq.mm

sigmab=(P/(2*As+Ab))                    //Stress in
    steel in N/sq.mm

sigmas=2*sigmab                               //Stress
     in brass in N/sq.mm
Pb=int(sigmab*Ab)*1e-3                        //Load
    carried by brass tube in kN
Ps=(P*1e-3)-(Pb)                              //Load
    carried by steel tube in kN
dL=(sigmab/Eb*(L))                      //Decrease in
    length in mm


//Result
printf("\n Stress in brass = %0.3f  N/mm^2",sigmab)
printf("\n Stress in steel = %0.3f  N/mm^2",sigmas)
printf("\n Load carried by brass tube = %0.3f  kN",
    Pb)
printf("\n Load carried by stress tube = %0.3f  kN",
    Ps)
printf("\n Decrease in the length of the compound
    tube= %0.3f  mm",dL)
```

Scilab code Exa 1.28 Thermal stress

```
clear
//Given
//Variable declaration
L=2*10**2          //Length of rod in cm
T1=10              //Initial temperature in degree
    celsius
```

```
T2=80              //Final temperature in degree celsius
E=1e5*10**6        //Youngs Modulus in N/sq.m
alpha=0.000012     //Co-efficient of linear expansion

//Calculation
T=T2-T1                               //Rise in temperature in degree celsius
dL=alpha*T*L                          //Expansion of the rod in cm
sigma=int((alpha*T*E)*1e-6)           //Thermal stress in N/sq.mm

//Result
printf("\n Expansion of the rod = %0.3f  cm",dL)
printf("\n Thermal stress = %0.3f  N/mm^2",sigma)
```

Scilab code Exa 1.29 Pull in the rod when the ends yield

```
clear
//

//Given
//Variable declaration
d=3*10             //Diameter of the rod in mm
L=5*10**3          //Area of the rod in sq.mm
T1=95              //Initial temperature in degree celsius
T2=30              //Final temperature in degree celsius
E=2e5*10**6        //Youngs Modulus in N/sq.m
alpha=12e-6        //Co-efficient of linear expansion in per degree celsius

//Calculation
```

```
A=%pi/4*(d**2)          //Area of the rod
T=T1-T2                    //Fall in temperature in
    degree celsius

//case(i) When the ends do not yield
stress1=int(alpha*T*E*1e-6)     //Stress in N/sq.mm
Pull1=(stress1*A)         //Pull in the rod in N


//case(ii) When the ends yield by 0.12cm
delL=0.12*10
stress2=int((alpha*T*L-delL)*E/L*1e-6)      //Stress
     in N/sq.mm
Pull2=(stress2*A)                        //Pull in the
    rod in N


//Result
printf("\n Stress when the ends do not yield = %0.3f
     N/mm^2",stress1)
printf("\n Pull in the rod when the ends do not
    yield = %0.3f  N",Pull1)
printf("\n Stress when the ends yield = %0.3f  N/mm
    ^2",stress2)
printf("\n Pull in the rod when the ends yield = %0
    .3f  N",Pull2)
```

Scilab code Exa 1.30 `Stress in steel`

```
clear
//
//
//Given
//Variable declaration
Ds=20                  //Diameter of steel rod in mm
```

```
Di_c=40                //Internal diameter of copper
    tube in mm
De_c=50                //External diameter of copper
    tube in mm
Es=200*10**3           //Youngs modulus of steel in N/
    sq.mm
Ec=100*10**3           //Youngs modulus of copper in N/
    sq.mm
alpha_s=12e-6          //Co-efficient of linear
    expansion of steel in per degree celsius
alpha_c=18e-6          //Co-efficient of linear
    expansion of copper in per degree celsius
T=50                   //Rise of temperature in degree
    celsius

//Calculation
As=(%pi/4)*(Ds**2)
                                                     //
    Area of steel rod in sq.mm
Ac=(%pi/4)*(De_c**2-Di_c**2)
                                           //Area of
    copper tube in sq.mm
sigmac=(((alpha_c-alpha_s)*T)/(((Ac/As)/Es)+(1/Ec)))
     //Compressive stress in copper
sigmas=(sigmac*(Ac/As))
                                             //Tensile
    stress in steel


//Result
printf("\n Stress in copper = %0.3f  N/mm^2",sigmac)
printf("\n Stress in steel = %0.3f  N/mm^2",sigmas)
```

Scilab code Exa 1.31 Stress in copper

```
clear
//

//Given
//Variable declaration
Dc=15              //Diameter of copper rod in mm
Di_s=20            //Internal diameter of steel in mm
De_s=30            //External diameter of steel in mm
T1=10              //Initial temperature in degree celsius
T2=200             //Raised temperature in degree celsius
Es=2.1e5           //Youngs modulus of steel in N/sq.mm
Ec=1e5             //Youngs modulus of copper in N/sq.mm
alpha_s=11e-6      //Co-efficient of linear expansion of steel in per degree celsius
alpha_c=18e-6      //Co-efficient of linear expansion of copper in per degree celsius

//Calculation
Ac=(%pi/4)*Dc**2                    //Area of copper tube in sq.mm
As=(%pi/4)*(De_s**2-Di_s**2)        //Area of steel rod in sq.mm
T=T2-T1                                     //Rise of temperature in degree celsius
sigmas=(((alpha_c-alpha_s)*T)/(((As/Ac)/Ec)+(1/Es)))

sigmac=(sigmas*(As/Ac))


//Result
printf("\n NOTE: The answers in the book for stresses are wrong.The correct answers are,")
printf("\n Stress in steel = %0.3f  N/mm^2",sigmas)
printf("\n Stress in copper = %0.3f  N/mm^2",sigmac)
```

Scilab code Exa 1.32 Stress in steel

```
clear
//
//Given
//Variable declaration
Dg=20              //Diameter of gun metal rod in mm
Di_s=25            //Internal diameter of steel in mm
De_s=30            //External diameter of steel in mm
T1=30              //Temperature in degree celsius
T2=140             //Temperature in degree celsius
Es=2.1e5           //Youngs modulus of steel in N/sq.mm
Eg=1e5             //Youngs modulus of gun metal in N/
   sq.mm
alpha_s=12e-6      //Co-efficient of linear expansion
   of steel in per degree celsius
alpha_g=20e-6      //Co-efficient of linear expansion
   of gun metal in per degree celsius

//Calculation
Ag=(%pi/4)*Dg**2                //Area of gun metal in
    sq.mm
As=(%pi/4)*(De_s**2-Di_s**2)    //Area of steel in sq.
   mm
T=T2-T1                                 //Fall in
   temperature in degree celsius
sigmag=(((alpha_g-alpha_s)*T)/(((Ag/As)/Es)+(1/Eg)))

sigmas=(sigmag*(Ag/As))


//Result
printf("\n Stress in gun metal rod = %0.3f  N/mm^2",
   sigmag)
```

```
printf("\n Stress in steel = %0.3f  N/mm^2",sigmas)
```

Scilab code Exa 1.33 Area of the bar at the upper end

```
clear
//

//Given
//Variable declaration
P=600e3          //Axial load in N
L=20e3           //Length in mm
w=0.00008        //Weight per unit volume in N/sq.mm
A2=400           //Area of bar at lower end in sq.mm

//Calculation
sigma=int(P/A2)              //Uniform stress on the
    bar in N/sq.mm
A1=(A2*(%e^((w*L/sigma))))

//Result
printf("\n Area of the bar at the upper end = %0.3f
    mm^2",A1)
```

Chapter 2

elastic constants

Scilab code Exa 2.1 `change in thickness`

```
clear
//
//

//Given
//Variable declaration
L=4*(10**3)          //Length of the bar in mm
b=30                 //Breadth of the bar in mm
t=20                 //Thickness of the bar in mm
P=30*(10**3)         //Axial pull in N
E=2e5                //Youngs modulus in N/sq.mm
mu=0.3               //Poisson's ratio

//Calculation
A=b*t                           //Area of cross-section in sq.mm
long_strain=P/(A*E)             //Longitudinal strain
delL=long_strain*L              //Change in length in mm
lat_strain=mu*long_strain       //Lateral strain
delb=b*lat_strain               //Change in breadth in
```

```
   mm
delt=t*lat_strain                //Change in thickness in mm

//Result
printf("\n change in length = %0.3f  mm",delL)
printf("\n change in breadth = %0.3f  mm",delb)
printf("\n change in thickness = %0.3f  mm",delt)
```

Scilab code Exa 2.2 Youngs modulus

```
clear
//Given
//Variable declaration
L=30                    //Length in cm
b=4                     //Breadth in cm
d=4                     //Depth in cm
P=400*(10**3)           //Axial compressive load in N
delL=0.075              //Decrease in length in cm
delb=0.003              //Increase in breadth in cm

//Calculation
A=(b*d)*1e2                         //Area of cross-section in sq.mm
long_strain=delL/L                  //Longitudinal strain
lat_strain=delb/b                   //Lateral strain
mu=lat_strain/long_strain           //Poisson's ratio
E=int((P)/(A*long_strain))          //Youngs modulus

//Result
printf("\n Youngs modulus = %.e N/mm^2",E)
```

Scilab code Exa 2.3 Final volume

```
clear
//Given
//Variable declaration
L=4000          //Length of the bar in mm
b=30            //Breadth of the bar in mm
t=20            //Thickness of the bar in mm
mu=0.3          //Poisson's ratio
delL=1.0        //delL from problem 2.1

//Calculation
ev=(delL/L)*(1-2*mu)          //Volumetric strain
V=L*b*t                       //Original volume in mm^3
delV=ev*V                     //Change in volume in mm^3
F=int(V+delV)                 //Final volume in mm^3

//Result
printf("\n Final volume = %0.3f  mm^3",F)
```

Scilab code Exa 2.4 Change in volume

```
clear
//
//Given
//Variable declaration
L=300                //Length in mm
b=50                 //Width in mm
t=40                 //Thickness in mm
P=300*10**3          //Pull in N
E=2*10**5            //Youngs modulus in N/sq.mm
mu=0.25              //Poisson's ratio

```

```
//Calculation
V=L*b*t                                    //Original volume in mm^3
Area=b*t                                   //Area in sq.mm
stress=P/Area                              //Stress in N/sq.mm
ev=(stress/E)*(1-2*mu)                     //Volumetric strain
delV=int(ev*V)                             //Change in volume in mm^3

//Result
printf("\n Change in volume = %0.3f  mm^3",delV)
```

Scilab code Exa 2.7 Change in length breadth height

```

clear
//

//Given
//Variable declaration
L=5*10**3                     //Length in mm
d=30                          //Diameter in mm
P=50*10**3                    //Tensile load in N
E=2e5                         //Youngs modulus in N/sq.mm
mu=0.25                       //Poisson's ratio

//Calculation
V=int(((%pi*d**2*L)/4))               //Volume in mm^3

e=P*4/(%pi*(d**2)*E)                          //Strain of length
delL=(e*L)                                 //Change in length in mm
```

```
lat_strain=(mu*(e))            //Lateral strain

deld=lat_strain*d                              //Change
    in diameter in mm
delV=(V*(0.0003536-(2*lat_strain))) //Change in
    volume in mm^3


//Result
printf("\n Change in length = %0.3f  mm",delL)
printf("\n Change in diameter = %0.3f  mm",deld)
printf("\n Change in volume = %0.3f  mm^3",delV)
```

Scilab code Exa 2.10 Bulk modulus

```
clear
//Given
//Variable declaration
E=1.2e5                     //Youngs modulus in N/sq.mm
C=4.8e4                     //Modulus of rigidity in N/
    sq.mm

//Calculation
mu=(E/(2*C))-1              //Poisson's ratio
K=int(E/(3*(1-2*mu)))       //Bulk modulus in N/sq.mm

//Result
printf("\n Bulk modulus = %.0e N/mm^2",K)
```

Scilab code Exa 2.11 Modulus of elasticity

```
clear
```

```
//Given
//Variable declaration
A=8*8          //Area of section in sq.mm
P=7000         //Axial pull in N
Ldo=8          //Original Lateral dimension in mm
Ldc=7.9985     //Changed Lateral dimension in mm
C=0.8e5        //modulus of rigidity in N/sq.mm

//Calculation
lat_strain=(Ldo-Ldc)/Ldo                                    //Lateral strain
sigma=P/A                                                   //Axial stress in N/sq.mm
mu=(1/((sigma/lat_strain)/(2*C)-1))                         //Poisson's ratio

E=((sigma/lat_strain)/((sigma/lat_strain)/(2*C)-1))         //Modulus of elasticity in N/sq.mm


//Result
printf("\n Modulus of elasticity = %.4e N/mm^2",E)
```

Chapter 3

principal stresses and strains

Scilab code Exa 3.8 Maximum shear stress

```
clear
//

//Given
//Variable declaration
sigma1=100           //Major principal stress in N/
    sq.mm
sigma2=-60           //Minor principal stress in N/
    sq.mm
theta=90-50          //Angle of inclination in
    degrees

//Calculation
sigman=(((sigma1+sigma2)/2)+(((sigma1-sigma2)/2)*cos
    ((%pi/180)*(2*theta))))

sigmat=((sigma1-sigma2)/2*(sin((%pi/180)*(2*theta)))
    )

sigmaR=(sqrt(sigman**2+sigmat**2))

```

```
sigmat_max=int((sigma1-sigma2)/2)

//Result
printf("\n Normal stress = %0.3f  N/mm^2",sigman)
printf("\n Shear stress = %0.3f  N/mm^2",sigmat)
printf("\n Resultant stress = %0.3f  N/mm^2",sigmaR)
printf("\n Maximum shear stress = %0.3f  N/mm^2",sigmat_max)
```

Scilab code Exa 3.9 `Maximum shear stress`

```
clear
//

//Given
//Variable declaration
sigma1=100          //Major principal stress in N/sq.mm
sigma2=-40          //Minor principal stress in N/sq.mm
theta=90-60         //Angle of inclination in degrees

//Calculation
sigman=((sigma1+sigma2)/2)+(((sigma1-sigma2)/2)*cos((%pi/180)*(2*theta)))
sigmat=((sigma1-sigma2)/2*(sin((%pi/180)*(2*theta))))

sigmaR=(sqrt(sigman**2+sigmat**2))

sigmat_max=int((sigma1-sigma2)/2)
phi=int((180/%pi)*(atan(sigmat/sigman)))

//Result
printf("\n Resultant stress in magnitude = %0.3f  N/
```

```
mm^2",sigmaR)
printf("\n Direction of resultant stress = %0.3f degrees",phi)
printf("\n Maximum shear stress = %0.3f  N/mm^2",sigmat_max)
```

Scilab code Exa 3.13 Maximum shear stress at the point

```
clear
//

//Given
//Variable declaration
sigma1=120          //Major tensile stress in N/sq.mm
sigma2=-90          //Minor compressive stress in N/sq.mm
sigma_gp=150        //Greatest principal stress in N/sq.mm

//Calculation
 //case(a):Magnitude of the shearing stresses on the two planes
tau=(sqrt(((sigma_gp-((sigma1+sigma2)/2))**2)-(((sigma1-sigma2)/2)**2)))

 //case(b):Maximum shear stress at the point
sigmat_max=int((sqrt((sigma1-sigma2)**2+(4*tau**2)))/2)

//Result
printf("\n Shear stress on the two planes = %0.3f  N/mm^2",tau)
printf("\n Maximum shear stress at the point = %0.3f  N/mm^2",sigmat_max)
```

Scilab code Exa 3.16 Tangential stresswhen theta

```
clear
//

//Given
//Variable declaration
sigma1=600          //Major tensile stress in N/sq.mm
sigma2=300          //Minor tensile stress in N/sq.mm
tau=450             //Shear stress in N/sq.mm
theta1=45           //Angle of inclination in degrees
theta2=135          //Angle of inclination in degrees

//Calculation
sigman1=int(((sigma1+sigma2)/2)+(((sigma1-sigma2)/2)
   *cos((%pi/180)*(2*theta1)))+(tau*sin((%pi/180)
   *(2*theta1))))
sigman2=int(((sigma1+sigma2)/2)+(((sigma1-sigma2)/2)
   *cos((%pi/180)*(2*theta2)))+(tau*sin((%pi/180)
   *(2*theta2))))
sigmat1=int(((sigma1-sigma2)/2*(sin((%pi/180)*(2*
   theta1)))-(tau*cos((%pi/180)*(2*theta1)))))

sigmat2=int(((sigma1-sigma2)/2*(sin((%pi/180)*(2*
   theta2)))-(tau*cos((%pi/180)*(2*theta2)))))


//Result
printf("\n Normal stress(when theta is 45 degrees)=
   %0.3f  N/mm^2",sigman1)
printf("\n Normal stress(when theta is 135 degrees)=
    %0.3f  N/mm^2",sigman2)
printf("\n Tangential stress(when theta is 45
   degrees)= %0.3f  N/mm^2",sigmat1)
```

```
printf("\n Tangential stress(when theta is 135
    degrees)= %0.3f  N/mm^2",sigmat2)
```

Chapter 4

strain energy and impact loading

Scilab code Exa 4.1 strain energy absorbed by the rod

```
clear
//

//Given
//Variable declaration
P=60*10**3      //Load in N
d=4*10          //diameter in mm
L=5*10**3       //Length of rod in mm
E=2e5           //Youngs Modulus in N/sq.mm


//Calculation
A=(%pi/4)*d**2              //Area in sq.mm
V=int(A*L)                      //Volume of rod in
   cubic.mm
//case (ii):stress in the rod
sigma=(P/A)             //stress in N/sq.mm


```

```
//case (i):stretch in the rod
x=((sigma/E)*L)        //stretch or extension in mm


//case (iii):strain energy absorbed by the rod
U=((sigma**2/(2*E)*V))*1e-3      //strain energy absorbed by the rod in Nm



//Result
printf("\n stress in the rod = %0.3f  N/mm^2",sigma)
printf("\n stretch in the rod = %0.3f  mm",x)
printf("\n strain energy absorbed by the rod = %0.3f N-m",U)
```

Scilab code Exa 4.3 Suddenly applied load

```
clear
//Given
//Variable declaration
A=10*10**2            //Area of bar in sq.mm
L=3*10**3             //Length of bar in mm
x=1.5                 //Extension due to suddenly applied load in mm
E=2e5                 //Youngs Modulus in N/sq.mm

//Calculation
sigma=int(x*E/L)              //Instantaneous stress due to sudden load in N/sq.mm
P=int((sigma*A)/2*1e-3)       //Suddenly applied load in kN

//Result
printf("\n Instantaneous stress produced by a sudden
```

```
    load = %0.3f  N/mm^2",sigma)
printf("\n Suddenly applied load = %0.3f  kN",P)
```

Scilab code Exa 4.4 `Instantaneous elongation`

```
clear
//

//Given
//Variable declaration
L=2*10**3                    //Length in mm
d=50                         //Diameter in mm
P=100*10**3                  //Suddenly applied load in N
E=200e3                      //Youngs Modulus in N/sq.mm

//Calculation
A=(%pi/4)*d**2                //Area in sq.mm
sigma=(2*P/A)           //Instantaneous stress induced in
    N/sq.mm

dL=(sigma*L)/E                    //Elongation in mm

//Result
printf("\n Instantaneous stress induced = %0.3f  N/
   mm^2",sigma)
printf("\n Instantaneous elongation = %0.3f  mm",dL)
```

Scilab code Exa 4.5 `Gradually applied load`

```
clear
//Given
//Variable declaration
A=700                   //Area in sq.mm
```

```
L=1.5*10**3           //Length of a metal bar in mm
sigma=160             //Stress at elastic limit in N/sq.mm
E=2e5                 //Youngs Modulus in N/sq.mm


//Calculation
V=A*L                                  //Volume of bar in sq.mm
Pr=(sigma**2/(2*E)*V)*1e-3             //Proof resilience in N-m
P=int(sigma*A/2*1e-3)                  //Suddenly applied load in kN
P1=int(sigma*A*1e-3)                   //gradually applied load in kN

//Result
printf("\n Proof resilience = %0.3f  N-m",Pr)
printf("\n Suddenly applied load = %0.3f  kN",P)
printf("\n Gradually applied load = %0.3f  kN",P1)
```

Scilab code Exa 4.9 `Instantaneous elongation due to falling weight`

```
clear
//

//Given
//Variable declaration
P=10*10**3              //Falling weight in N
h=30                    //Falling height in mm
L=4*10**3               //Length of bar in mm
A=1000                  //Area of bar in sq.m
E=2.1e5                 //Youngs modulus in N/sq.mm

//Calculation
```

```
sigma=((P/A)*(1+(sqrt(1+((2*E*A*h)/(P*L))))))
delL=(sigma*L/E)


//Result
printf("\n Instantaneous elongation due to falling
    weight = %0.3f  mm",delL)
```

Scilab code Exa 4.10 Strain energy

```
clear
//
//Given
//Variable declaration
P=100              //Impact load in N
h=2*10             //Height in mm
L=1.5*1000         //Length of bar in mm
A=1.5*100          //Area of bar in sq.mm
E=2e5              //Modulus of elasticity in N/sq.mm

//Calculation
V=A*L              //Volume in mm^3
//case(i):Maximum instantaneous stress induced in
    the vertical bar
sigma=((P/A)*(1+(sqrt(1+((2*E*A*h)/(P*L))))))

//case(ii):Maximum instantaneous elongation
delL=(sigma*L/E)

//case(iii):Strain energy stored in the vertical rod
U=(sigma**2/(2*E)*V*1e-3)


//Result
printf("\n NOTE:The answer in the book for
```

```
    instantaneous stress is incorrect.The correct
    answer is,")
printf("\n Maximum instantaneous stress = %0.3f N/
    mm^2",sigma)
printf("\n Maximum instantaneous elongation = %0.3f
    mm",delL)
printf("\n Strain energy = %0.3f N-m",U)
```

Scilab code Exa 4.11 Unknown weight

```
clear
//
//Given
//Variable declaration
delL=2.1            //Instantaneous extension in mm
L=3*10**3           //Length of bar in mm
A=5*100             //Area of bar in mm
h=4*10              //Height in mm
E=2e5               //Modulus of elasticity in N/sq.mm

//Calculation
V=A*L                                   //Volume of bar in
    mm^3

//case(i):Instantaneous stress induced in the
    vertical bar
sigma=int(E*delL/L)

//case(ii):Unknown weight
P=(((sigma**2)/(2*E)*V)/(h+delL))


//Result
printf("\n Instantaneous stress = %0.3f N/mm^2",
    sigma)
```

```
printf("\n Unknown weight = %0.3f  N",P)
```

Scilab code Exa 4.13 Stress produced by the falling weight

```
clear
//
//Given
//Variable declaration
d=12          //Diameter of bar in mm
delL=3        //Increase in length in mm
W=8000        //Steady load in N
P=800         //Falling weight in N
h=8*10        //Vertical distance in mm
E=2e5         //Youngs modulus in N/sq.mm

//Calculation
A=((%pi/4)*d**2)             //Area of bar in sq.mm

L=(E*A*delL/W)                  //Length of the bar in mm

sigma=((P/A)*(1+(sqrt(1+((2*E*A*h)/(P*L))))))

sigma=(sigma)              //Stress produced by the falling weight in N/sq.mm

//Result
printf("\n Stress produced by the falling weight = %0.3f  N/mm^2",sigma)
```

Scilab code Exa 4.14 Stress

```
clear
```

```
//
//Given
//Variable declaration
d=12.5              //Diameter of the rod in mm
delL=3.2            //Increase in length in mm
W=10*1000           //Steady load in N
P=700               //Falling load in N
h=75                //Falling height in mm
E=2.1e5             //Youngs modulus in N/sq.mm

//Calculation
A=((%pi/4)*d**2)                                //
    Area of rod in sq.mm

L=(E*A*delL/W)
                                            //Length of
     the rod in mm

sigma=((P/A)*(1+(sqrt(1+((2*E*A*h)/(P*L)))))) //
    Stress produced by the falling weight in N/mm^2


//Result
printf("\n NOTE:The given answer for stress is wrong
    .The correct answer is,")
printf("\n Stress = %.2f N/mm^2",sigma)
```

Scilab code Exa 4.15 Maximum stress if the load has fallen

```
clear
//

//Given
//Variable declaration
L=1.82*1000         //Length of rod in mm
```

```
h1=30               //Height through which load falls in mm
h2=47.5             //Fallen height in mm
sigma=157           //Maximum stress induced in N/sq.mm
E=2.1e5             //Youngs modulus in N/sq.mm

//Calculation
U=sigma**2/(2*E)        //Strain energy stored in the rod in N-m
delL=sigma*L/E          //Extension of the rod in mm
Tot_dist=h1+delL        //Total distance in mm

//case(i):Stress induced in the rod if the load is applied gradually
sigma1=((U/Tot_dist)*L)


//case(ii):Maximum stress if the load had fallen from a height of 47.5 mm
sigma2=((sigma1)*(1+(sqrt(1+((2*E*h2)/(sigma1*L)))))
)


//Result
printf("\n Stress induced in the rod = %.1f N/mm^2",sigma1)

printf("\n NOTE:The given answer for stress(2nd case) in the book is wrong.The correct answer is,")
printf("\n Maximum stress if the load has fallen = %.2f N/mm^2",sigma2)
```

Scilab code Exa 4.17 Maximum stress inducedwhen a weight of 30kN falls through a h

```
clear
```

```
//

//Given
//Variable declaration
L=4*10**3       //Length of bar in mm
A=2000          //Area of bar in sq.mm
P1=3000         //Falling weight in N(for 1st case)
h1=20*10        //Height in mm(for 1st case)
P2=30*1000      //Falling weight in N(for 2nd case)
h2=2*10         //Height in mm(for 2nd case)
E=2e5           //Youngs modulus in N/sq.mm

//Calculation
V=A*L               //Volume of bar in mm^3

//case(i):Maximum stress when a 3000N weight falls through a height of 20cm
sigma1=(((sqrt((2*E*P1*h1)/(A*L)))))


//case(ii):Maximum stress when a 30kN weight falls through a height of 2cm
sigma2=((P2/A)*(1+(sqrt(1+((2*E*A*h2)/(P2*L))))))


//Result
printf("\n Maximum stress induced(when a weight of 3000N falls through a height of 20cm)= %0.3f  N/mm^2",sigma1)
printf("\n Maximum stress induced(when a weight of 30kN falls through a height of 2cm)= %0.3f  N/mm^2",sigma2)
```

Scilab code Exa 4.18 `Stress induced in the chain due to sudden stoppage`

```
clear
//
//

//Given
//Variable declaration
A=6.25*100      //Area in sq.mm
W=10*10**3      //Load in N
V=(40/60)       //Velocity in m/s
L=10000         //Length of chain unwound in mm
E=2.1e5         //Youngs modulus in N/sq.mm
g=9.81          //acceleration due to gravity

//Calculation
K_E=(((W/g)*(V**2))/2)*1e3          //K.E of the crane in N mm

sigma=(sqrt(K_E*E*2/(A*L)))     //Stress induced in the chain in N/sq.mm


//Result
printf("\n Stress induced in the chain due to sudden stoppage = %0.3f  N/mm^2",sigma)
```

Scilab code Exa 4.19 Maximum stress produced in the rope

```
clear
//

//Given
//Variable declaration
W=60*10**3       //Weight in N
V=1              //Velocity in m/s
L=15*10**3       //Free length in mm
```

```
A=25*100          //Area in sq.mm
E=2e5             //Youngs modulus in N/sq.mm
g=9.81            //acceleration due to gravity

//Calculation
K_E=((W/g)*(V**2))/2*1e3                     //Kinetic
   Energy of the cage in N mm
sigma=(sqrt(K_E*E*2/(A*L)))    //Maximum stress in N/
   sq.mm


//Result
printf("\n Maximum stress produced in the rope = %0
   .3f  N/mm^2",sigma)
```

Scilab code Exa 4.20 `Strain energy per unit volume`

```
clear
//Given
//Variable declaration
tau=50          //Shear stress in N/sq.mm
C=8e4           //Modulus of rigidity in N/sq.mm

//Calculation
ste=(tau**2)/(2*C)     //Strain energy per unit
   volume in N/sq.mm

//Result
printf("\n Strain energy per unit volume = %0.3f  N/
   mm^2",ste)
```

Chapter 7

bending stresses in beams

Scilab code Exa 7.1 Bending moment

```
clear
//Given
//Variable declaration
b=120              //Width of plate in mm
t=20               //Thickness of plate in mm
R=10*10**3         //Radius of curvature in mm
E=2e5              //Youngs modulus in N/sq.mm

//Calculation
I=b*t**3/12                        //Moment of inertia in mm^4
y_max=t/2                          //Maximum distance in mm
sigma_max=int((E/R)*y_max)         //Maximum stress in N/sq.mm
M=((E/R*I)*(10**-6))       //Bending moment in kNm


//Result
printf("\n Maximum stress = %0.3f  N/mm^2",sigma_max)
```

```
printf("\n Bending moment = %0.3f  kNm",M)
```

Scilab code Exa 7.8 Depth of beam

```
clear
//
//

//Given
//Variable declaration
W=20*1000           //Total load in N
L=3.6               //Span in m
sigma_max=7         //Maximum stress in N/sq.mm

//Calculation
M1=W*L/8*1e3        //Maximum Bending moment in Nmm
b1=((M1*3/(sigma_max*2))**(1/3))        //Breadth of the beam in mm

d1=int((2*b1))      //depth of the beam in mm

M2=W*L/4*1e3        //Maximum Bending moment in Nmm
b2=(((M2*3/(sigma_max*2))**(1/3)))  //Breadth of the beam in mm

d2=2*b2             //depth of the beam in mm

//Result
```

```
printf("\n Dimensions of the cross-section:")
printf("\n Breadth of beam = %0.3f  mm",b1)
printf("\n Depth of beam %0.3f  mm",d1)

printf("\n Dimensions of the cross-section when the
    beam carries a point load at the centre:")
printf("\n Breadth of beam = %0.3f  mm",b2)
printf("\n Depth of beam %0.3f  mm",d2)
```

Chapter 8

shear stresses in beams

Scilab code Exa 8.6 Shear stress at a distance 40mm from N A

```
clear
//
//
//Given
//Variable declaration
D=100              //Diameter in mm
R=D/2              //Radius in mm
F=5*10**3          //Shear force in N
y=40               //given distance from N.A. in mm

//Calculation
//case(i):Average shear stress
A=%pi*R**2
tau_avg=(F/A)

//case(ii):Maximum shear stress for a circular
    section
tau_max=(4/3*tau_avg)

//case(iii):Shear stress at a distance 40mm from N.A
    .
```

```
I=%pi/64*D**4
tau=((F/(3*I)*(R**2-y**2)))

//Result
printf("\n Average shear stress = %0.3f  N/mm^2",
    tau_avg)
printf("\n Maximum shear stress = %0.3f  N/mm^2",
    tau_max)
printf("\n Shear stress at a distance 40mm from N.A.
     = %0.3f  N/mm^2",tau)
```

Scilab code Exa 8.12 Shear stress at N A

```
clear
//
//

//Given
//Variable declaration
F=50*10**3                  //Shear force in N
b=250                       //Base width in mm
h=200                       //height in mm

//Calculation
tau_max=int((3*F)/(b*h))        //Maximum shear stress
    in N/sq.mm
tau=((8*F)/(3*b*h))    //Shear stress at N.A. in N/sq
    .mm


//Result
printf("\n Maximum shear stress = %0.3f  N/mm^2",
    tau_max)
printf("\n Shear stress at N.A. = %0.3f  N/mm^2",tau
    )
```

Chapter 10

dams and retaining walls

Scilab code Exa 10.19 `Minimum stress`

```
clear
//
//
//Given
//Variable declaration
h=20                  //height in m
D=4                   //External diameter in m
d=2                   //Internal diameter in m
p=1                   //Horizontal wind pressure in kN/
   sq.m
w=22                  //specific weight in kN/m^3
K=2/3                 //Co-efficient of wind resistance

//Calculation
A1=(%pi/4)*(D**2-d**2)            //Area of cross-
   section
W=w*A1*h                              //Weigth of the
    chimney in kN
sigma0=W/A1                           //Direct stress
    in kN/sq.mm
A2=D*h                                //Projected
```

```
area of the surface exposed to wind in sq.m
F=K*p*A2                                   //Wind Force in kN
M=F*h/2                                    //Bending moment in kNm
I=(%pi/64)*(D**4-d**4)                 //Moment of inertia
y=D/2                                      //Distance between C.G. of the base section and extreme edge of the base
Z=I/y                                      //Section modulus
sigmab=M/Z                                 //Bending stress
sigma_max=(sigma0+sigmab)      //Maximum stress in kN/sq.m

sigma_min=(sigma0-sigmab)      //Minimum stress in kN/sq.m


//Result
printf("\n Maximum stress = %0.3f  kN/m^2",sigma_max)
printf("\n Minimum stress = %0.3f  kN/m^2",sigma_min)
```

Chapter 12

deflection of beams

Scilab code Exa 12.1 Slope at the support

```
clear
//

//Given
//Variable declaration
L=6*1000          //Length in mm
W=50*1000         //Point load in N
I=78e6            //Moment of Inertia in mm^4
E=2.1e5           //Young's modulus in N/sq.mm

//Calculation
yc=((W*L**3)/(48*E*I))                    //The
   deflection at the centre in mm

thetaB=((180/%pi)*((W*L**2)/(16*E*I)))    //The
   slope at the supports


//Result
printf("\n Deflection at the centre = %0.3f  mm",yc)
printf("\n NOTE:The answer given for slope at the
```

```
    support is wrong.The correct answer is,")
printf("\n Slope at the support = %0.3f  degree",
    thetaB)
```

Scilab code Exa 12.2 Deflection at the centre

```
clear
//

//Given
//Variable declaration
L=4*1000                    //Length in mm

//Calculation
thetaA=((%pi/180)*(1))      //Slope at the ends in
    radians

yc=(thetaA*(L/3))     //Deflection at the centre in
    mm

//Result
printf("\n Deflection at the centre = %0.3f  mm",yc)
```

Scilab code Exa 12.3 Deflection at the centre

```
clear
//

//Given
//Variable declaration
L=3*1000                    //Length in mm

//Calculation
```

```
thetaA=((%pi/180)*(1))     //Slope at the ends in radians

yc=(thetaA*(L/3))     //Deflection at the centre in mm

//Result
printf("\n Deflection at the centre = %0.3f  mm",yc)
```

Scilab code Exa 12.4 `Maximum deflection`

```
clear
//

//Given
//Variable declaration
L=5*1000          //Length in mm
W=5*1000          //Point load in N
a=3*1000          //Distance between point load and left end in mm
E=2e5             //Young's modulus in N/sq.mm
I=1e8             //Moment of Inertia in mm^4

//Calculation
b=L-a             //Width in mm
//case(i):The slope at the left support
thetaA=-(W*a*b)/(6*E*I*L)*(a+2*b)
//case(iii): The deflection under the load
yc=(W*a**2*b**2)/(3*E*I*L)
//case(iii):The maximum deflection
y_max=((W*b)/(9*sqrt(3)*E*I*L)*(((a**2)+(2*a*b))**(3/2)))


//Result
```

```
printf("\n slope at the left support = %0.3f
   radians",thetaA)
printf("\n Deflection under the load = %0.3f  mm",yc
   )
printf("\n Maximum deflection = %0.3f  mm",y_max)
```

Scilab code Exa 12.5 `Maximum deflection`

```
clear
//
//

//Given
//Variable declaration
b=200                   //Width in mm
d=300                   //Depth in mm
L=5*1000                //Span in mm
L_star=5                //Span in m
w=9*1000                //Uniformly distributed load in
    N/m
E=1e4                   //Youngs modulus in N/sq.mm

//Calculation
W=w*L_star                                  //Total
   load in N
I=b*d**3/12                                 //Moment
   of Inertia in mm^4

//case(i):the slope at the support
thetaA=(-(W*(L**2))/(24*E*I))


//case(ii):maximum deflection
yc=(W*L**3)/(E*I)*(5/384)

```

```
//Result
printf("\n Slope at the support = %0.3f  radians",-thetaA)
printf("\n Maximum deflection = %0.3f  mm",yc)
```

Scilab code Exa 12.6 `Width of beam`

```
clear
//Given
//Variable declaration
L=5*1000        //Length in mm
L_star=5        //Length in m
w=9             //Uniformly distributed load in kN/m
f=7             //Bending stress in N/sq.mm
E=1e4           //Young's modulus in N/sq.mm
yc=10           //Central deflection in mm

//Calculation
W=w*L_star*1e3                          //Total load in N
bd3=((W*(L**3)*12*5)/(E*yc*384))        //width X depth^3 in mm^4
M=(W*L/8)                               //Maximum bending moment in Nmm
bd2=(M*12/(f*2))                  //width X depth^2 in mm^3

d=(bd3/bd2)                       //Depth of beam in mm

b=(M*12/(f*2)/d**2)              //Width of beam in mm

//Result
printf("\n Depth of beam = %0.3f  mm",d)
printf("\n Width of beam = %0.3f  mm",b)
```

Scilab code Exa 12.7 Depth of beam

```
clear
//Given
//Variable declaration
L=5*1000         //Length in mm
f=8              //Bending stress in N/sq.mm
yc=10            //Central deflection in mm
E=1.2e4          //Youngs modulus in N/sq.mm

//Calculation
d=((5*L**2*(f*2*8))/(E*384*yc)*1e-1)   //Depth of
    beam in cm


//Result
printf("\n Depth of beam = %0.3f  cm",d)
```

Scilab code Exa 12.8 Deflection under the load

```
clear
//Given
//Variable declaration
L=6*1000          //Length in mm
W=40*1000         //Point load in N
a=4*1000          //Distance of point load from left
    support in mm
I=7.33e7          //Moment of Inertia in mm^4
E=2e5             //Youngs modulus in sq.mm

//Calculation
```

```
b=L-a                                          //Width of
   beam in mm
yc=(-(W*a**2*b**2)/(3*E*I*L))   //Deflection under
   the load in mm


//Result
printf("\n Deflection under the load = %0.3f  mm",yc
   )
```

Chapter 13

deflection of cantilevers

Scilab code Exa 13.1 Deflection at the free end

```
clear
//

//Given
//Variable declaration
L=3*1000              //Length in mm
W=25*1000             //Point load in N
I=1e8                 //Moment of Inertia in mm^4
E=2.1e5               //Youngs modulus in N/sq.mm

//Calculation
//case(i):Slope of the cantilever at the free end
thetaB=((W*(L**2))/(2*E*I))

//case(ii):Deflection at the free end
yB=((W*L**3)/(E*I*3))


//Result
printf("\n Slope at the free end = %0.3f  rad",
   thetaB)
```

```
printf("\n Deflection at the free end = %0.3f  mm",yB)
```

Scilab code Exa 13.2 Slope at the free end of 3m rod

```

clear
//

//Given
//Variable declaration
L=3*1000              //Length in mm
W=50*1000             //Point load in N
a=2*1000              //Distance between the load and fixed end in mm
I=1e8                 //Moment of Inertia in mm^4
E=2e5                 //Youngs modulus in N/sq.mm

//Calculation
//case(i):Slope at the free end
thetaB=(W*(a**2))/(2*E*I)
//case(ii):Deflection at the free end
yB=(((W*a**3)/(E*I*3))+((W*(a**2))/(2*E*I)*(L-a)))


//Result
printf("\n Slope at the free end = %0.3f  rad",thetaB)
printf("\n Deflection at the free end = %0.3f  mm",yB)
```

Scilab code Exa 13.3 Deflection at the free end of 2 and half m cantilever

```
clear
//

//Given
//Variable declaration
L=2.5*1000              //Length in mm
w=16.4                  //Uniformly distributed load in
    kN/m
I=7.95e7                //Moment of Inertia in mm^4
E=2e5                   //Youngs modulus in N/sq.mm

//Calculation
W=w*L                               //Total load in N
yB=((W*L**3)/(E*I*8))     //Deflection at the free
   end in mm


//Result
printf("\n Deflection at the free end = %0.3f  mm",
   yB)
```

Scilab code Exa 13.4 Uniformly distributed load

```
clear
//Given
//Variable declaration
b=120            //Width in mm
d=200            //Depth in mm
L_star=2.5       //Length in m
L=2.5*1000       //Length in mm
yB=5             //Deflection at free end in mm
E=2e5            //Youngs modulus in N/sq.mm

//Calculation
```

```
I=(b*d**3)/12                        //Moment of
   Inertia in mm^4
w=(yB*8*E*I)/(L**3*L_star)/1e3       //Uniformly
   distributed load in N/m

//Result
printf("\n Uniformly distributed load = %0.3f  kN/m"
   ,w)
```

Scilab code Exa 13.5 Deflection at the free end of 3m rod

```

clear
//

//Given
//Variable declaration
L=3*1000            //Length in mm
w=10                //Uniformly distributed load in N
   /mm
a=2*1000            //Length of Uniformly distributed
    load from fixed end in mm
I=1e8               //Moment of Inertia in mm^4
E=2e5               //Youngs modulus in N/sq.mm

//Calculation
//case(i):Slope at the free end
thetaB=(w*(a**3))/(6*E*I)
//case(ii):Deflection at the free end
yB=(((w*a**4)/(E*I*8))+((w*(a**3))/(6*E*I)*(L-a)))


//Result
printf("\n Slope at the free end = %0.3f  rad",
   thetaB)
```

```
printf("\n Deflection at the free end = %0.3f  mm",yB)
```

Scilab code Exa 13.6 calculate slope and deflection

```

clear
//

//Given
//Variable declaration
L=3*1000             //Length in mm
w=10                 //Uniformly distributed load in N/mm
a=2*1000             //Length of Uniformly distributed load from fixed end in mm
I=1e8                //Moment of Inertia in mm^4
E=2e5                //Youngs modulus in N/sq.mm

//Calculation
//case(i):Slope at the free end
thetaB=(((w*(L**3))/(6*E*I))-((w*((L-a)**3))/(6*E*I)))

//case(ii):Deflection at the free end
yB=(((w*L**4)/(E*I*8))-((((w*(L-a)**4)/(8*E*I))+((w*(L-a)**3)/(6*E*I)*a)))


//Result
printf("\n Slope at the free end = %0.3f  rad",thetaB)
printf("\n Deflection at the free end = %0.3f  mm",yB)
```

Scilab code Exa 13.10 Deflection at the free end of 4m rod

```

clear
//

//Given
//Variable declaration
L=4*1000            //Length in mm
w=50                //load at fixed end in N/mm
I=1e8               //Moment of Inertia in mm^4
E=2e5               //Youngs modulus in N/sq.mm

//Calculation
//case(i):Slope at the free end
thetaB=(-(w*(L**3))/(24*E*I))

//case(ii):Deflection at the free end
yB=((w*L**4)/(E*I*30))


//Result
printf("\n Slope at the free end = %0.3f  rad",-
   thetaB)
printf("\n Deflection at the free end = %0.3f  mm",
   yB)
```

Chapter 16

torsion of shafts and springs

Scilab code Exa 16.1 Maximum torque

```
clear
//
//Given
//Variable declaration
D=150                       //Diameter of the shaft in mm
tau=45                      //Maximum shear stress in N/sq.mm

//Calculation
T=int(%pi/16*tau*D**3)*1e-3   //Maximum torque transmitted by the shaft in N-m

//Result
printf("\n Maximum torque = %0.3f  N-m",T)
```

Scilab code Exa 16.3 Maximum torque transmitted by the shaft

```
clear
```

```
//

//Given
//Variable declaration
Do=200      //Outer diameter in mm
Di=100      //Inner diameter in mm
tau=40      //Maximum shear stress in N/sq.mm

//Calculation
T=int(((%pi)/16*tau*((Do**4-Di**4)/Do)))*1e-3 //Maximum torque transmitted by the shaft in Nm


//Result
printf("\n Maximum torque transmitted by the shaft = %0.3f Nm",T)
```

Scilab code Exa 16.7 Maximum Internal diameter

```
clear
//
//

//Given
//Variable declaration
Do=120          //External diameter in mm
P=300*1000      //Power in W
N=200           //Speed in r.p.m
tau=60          //Maximum shear stress in N/sq.mm

//Calculation
T=((P*60)/(2*%pi*N))*1e3                    //Torque transmitted in Nmm

Di=(((Do**4)-((T*16*Do)/(%pi*tau)))**(1/4))       //
```

```
    Maximum internal diameter in mm


//Result
printf("\n Maximum Internal diameter = %0.3f  mm",Di
    )
```

Scilab code Exa 16.8 `Maximum shear stress`

```
clear
//
//Given
//Variable declaration
D=15*10          //Diameter of shaft in mm
P=150*1e3        //Power transmitted in W
N=180            //Speed of shaft in r.p.m

//Calculation
T=(P*60)/(2*%pi*N)*1e3          //Torque transmitted
    in Nmm
tau=int((16*T)/(%pi*D**3))      //Maximum shear stress
     in N/sq.mm

//Result
printf("\n Maximum shear stress = %0.3f  N/mm^2",tau
    )
```

Scilab code Exa 16.9 `Percentage saving in weight`

```
clear
//
//
//Given
```

```
//Variable declaration
P=300*1000        //Power in W
N=100             //Speed in r.p.m
tau=80            //Maximum shear stress in N/sq.mm

//Calculation
//case(a):
T=(P*60)/(2*%pi*N)*1e3        //Torque transmitted in Nmm
D=(((16*T)/(%pi*tau))**(1/3))                //Diameter of solid shaft in mm

//case(b):
Do=(((T*16)/(%pi*tau*(1-0.6**4)))**(1/3))    //External diameter of hollow shaft in mm

Di=0.6*Do                                          //Internal diameter of hollow shaft in mm
Per=(D**2-(Do**2-Di**2))/(D**2)*100                 //Percentage saving in weight

//Result
printf("\n Diameter of solid shaft = %0.3f  mm",D)
printf("\n Percentage saving in weight = %.2f%%",Per)
```

Scilab code Exa 16.10 Diameter of the shaft

```
clear
//
//Given
//Variable declaration
P=75e3        //Power transmitted in W
N=200         //R.P.M of the shaft
```

```
tau=70        //Shear stress in N/sq.mm

//Calculation
T=P*60/(%pi*2*N)*1e3                          //Mean
    Torque transmitted in Nmm
Tmax=1.3*T                                          //
    Maximum Torque transmitted in Nmm
D=((16*Tmax/(%pi*tau))**(1/3))          //Suitable
    diameter of the shaft in mm


//Result
printf("\n Diameter of the shaft = %d mm",D)
```

Scilab code Exa 16.11 Internal diameter of hollow shaft

```
clear
//
//Given
//Variable declaration
P=300e3       //Power transmitted in W
N=80          //speed of the shaft in r.p.m
tau=60        //Maximum shear stress in N/sq.mm

//Calculation
T=P*60/(%pi*2*N)*1e3
                                            //Mean Torque
    transmitted in Nmm
Tmax=1.4*T
                                                     //
    Maximum Torque transmitted in Nmm
D=((16*Tmax/(%pi*tau))**(1/3))                    //
    Suitable diameter of the shaft in mm

Do=(((Tmax*16)/(%pi*tau*(1-0.6**4)))**(1/3))    //
```

```
External diameter of hollow shaft in mm

Di=0.6*Do                                                    //
   Internal diameter of hollow shaft in mm

//Result
printf("\n External diameter of hollow shaft = %d mm
   ",Do)

printf("\n Internal diameter of hollow shaft = %d mm
   ",Di)
```

Chapter 24

theories of failure

Scilab code Exa 24.10 `Diameter of the bolt`

```
clear
//
//

//Given
//Variable declaration
P=9*1000                        //Axial pull in N
F=4.5*1000                      //Shear force in N
sigmat_star=225                 //Elastic limit in
    tension in N/sq.mm
Sf=3                            //Factor of safety
mu=0.3                          //Poisson's ratio
sigma3=0                        //third principle stress

//Calculation
sigmat=sigmat_star/Sf
sigma=(P/(%pi/4))
tau=(F/(%pi/4))
sigma1=((tau)+int((sqrt((sigma/2)**2+tau**2))))

sigma2=((tau)-int((sqrt((sigma/2)**2+tau**2))))
```

```
d=(((((sigma1-sigma2)**2+(sigma2-sigma3)**2+(sigma3-sigma1)**2)/(2*(sigmat**2)))**(1/4)))


//Result
printf("\n Diameter of the bolt = %0.3f  mm",d)
```

Scilab code Exa 24.12 Thickness of plate on the basis of maximum shear strain ener

```
clear
//
//
//Given
//Variable declaration
d=1.2                  //Diameter in m
p=1.5                  //Internal pressure in MN/sq.m
sigmat_star=200        //Yield stress in MN/sq.m
Sf=3                   //Factor of safety

//Calculation
sigmat=sigmat_star/Sf     //Permissible stress in simple tension in MN/sq.m

//case(i):Thickness on the basis of Maximum principal stress theory
t1=((p*d)/2)/sigmat*1e3

//case(ii):Thickness on the basis of Maximum shear stress theory
t2=((p*d)/2)/sigmat*1e3

//case(iii):Thickness on the basis of Maximum shear strain energy theory
t3=(sqrt((((p*d/2)**2)+((p*d/4)**2)-((p*d/2)*(p*d/4)
```

```
))/(sigmat**2)))


//Result
printf("\n Thickness of plate on the basis of maximum principal stress theory = %0.3f mm  ",t1)
printf("\n Thickness of plate on the basis of maximum shear stress theory = %0.3f mm ",t2)
printf("\n Thickness of plate on the basis of maximum shear strain energy theory = %0.3f mm  ",t3)
```