Scilab Textbook Companion for Mechanics of Structures by S. B. Junnarkar[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 Chapter 1 example 1

```
clear all;
clc;
P = 5.5 ;//Axial pull in tons
E = 13000 ;//modulus of elasticity tons/in^2
l = 120 ;//length in inches
A = %pi/4 ;//Area of resisting section in^2
p = P/A ;//Intensity of stress in tons/in^2
e = p/E ;//strain
delta_l =  l*e;//elongation of the bar in inches
printf('The elongation of the bar is %.4f inch',
   delta_l);
```

Scilab code Exa 1.2 Chapter 1 example 2

```
clear all;
clc;
s_p = 200;//steam pressure in lb/in^2
l = 4;//length in inches
```

```
b = 4;//breadth in inches
p = 14000;//permissible streaa in lb/in^2
P = s_p*l*b;//Pull on each bolt in lb-wt
A = P/p ;//necessary area of bolt-section
d = sqrt(4*A/%pi) ;//minimum diameter in inches
printf('The minimum diameter d of each stay bolt =
    %0.2f inch',d);
```

Scilab code Exa 1.3 Chapter 1 example 3

```
clear all;
clc;
D = 8;//external diameter in inches
d = 6;//internal diameter in inches
sigma = 36;//ultimate stress in tons/in^2
n = 6;//safety factor
A = 0.25*%pi*(D^2 - d^2);//Area of section in in^2
P =  sigma*A; //crushing load for the column in tons
P_safe = P/n ;//safe load in tons
printf('Safe load = %d tons',P_safe);
//there is an error in the answer given in textbook.
```

Scilab code Exa 1.4 Chapter 1 example 4

```
clear all;
clc;
sigma = 20;//ultimate sheat stress in tons/in^2
d = 1/2;//diameter of the hole in inches
t = 3/8;//thickness of the plate in inches
A = 0.25*%pi*d^2;//area of the cross-section of the
    punch in^2
P = %pi*d*t*sigma;//necessary force in tons
sigma_comp = P/A;//compressive stress on the punch
```

```
printf('The compressive stress of the punch = %d
    tons/in^2',sigma_comp);
//there is an error in the answer given in textbook.
```

Scilab code Exa 1.5 Chapter 1 example 5

```
clear all;
clc;
b = 8;//width in inches
t = 3/8;//thickness in inches
l = 20;//length in feets
P = 22;//pull in tons
E = 13500;//modulus of elasticity in tons/in^2
sigma = 0.3;//poisson/s ratio
A = b*t;//in in^2
V = l*A*12;//in cub.inch
p = P/A;//in tons/in^2
e = p/E;
delta_l = e*l*12;//stretch of the bar in inches
Lateral_strain = e*sigma ;//lateral strain
del_b = b*Lateral_strain;//in inches
del_t = t*Lateral_strain;//in inches
k = e*(1-2*sigma);//(del_V)/(V)
del_V = k*V;//change in volume in cub.inch
printf('The change in volume is %.3f cub.inch',del_V
    );
```

Scilab code Exa 1.6 Chapter 1 example 6

```
clear all;
clc;
d = 7/8;//diameter of the bar in inches
l = 10;//length in feets
```

```
P = 6;;//axial pull in tons
E = 13000;//modulus of elsticity in tons/in^2
m = 4;
A = 0.25*%pi*d^2;//in in^2
V = 0.25*%pi*d^2*l*12;//volume in cub.inches
p = P/A;//in tons/in^2
e = p/E;
del_l = e*l*12;//stretchof the bar in inches
Lateral_strain = e/m ;//lateral strain
del_d = Lateral_strain*d;//Contraction in diameter
    in inches
printf('The Contraction in diameter is %f inches',
    del_d);
k = e*(1-2/m);//(del_V)/(V)
del_V = k*V;//change in volume in cub.inch
printf('\n The change in volume is %.4f cub. inch',
    del_V);
W = 0.5*P*del_l;;//work done in stretching the bar
    in in-ton
printf('\n The work done in stretching the bar is %
    .4f in-ton',W);
//there is an error in the answer given in textbook.
```

Scilab code Exa 1.7 Chapter 1 example 7

```
clear all;
clc;
L = 24;//length of the bar in ft
d1 = 9/8;//diameter of the bar in inches
l1 = 6;//in ft
d2 = 1;//in inches
l2 = 12;//in ft
d3 = 5/4;//in inches
l3 = L-l1-l2;//in ft
P = 10000;//axial compression in lb-wt
```

```
E = 28*10^6;//modulus of elasticity in lb/in^2
A1 = 0.25*%pi*d1^2;//in in^2
A2 = 0.25*%pi*d2^2;//in in^2
A3 = 0.25*%pi*d3^2;//in in^2
p1 = P/A1 ;//in lb/in^2
e1 = p1/E;
p2 = P/A2 ;//in lb/in^2
e2 = p2/E;
p3 = P/A3 ;//in lb/in^2
e3 = p3/E;
del_l1 = e1*l1*12;//in inches
del_l2 = e2*l2*12;//in inches
del_l3 = e3*l3*12;//in inches
del_l = del_l1+del_l2+del_l3;//total change in length in ft
W = 0.5*P*del_l/12;//energy stored in the bar in ft-lbs
printf('Total change in length of the bar is %.3f inches',del_l);
printf('\n The energy stored in the bar is %.1f ft-lbs',W);
//there is an error in the answer given in textbook.
```

Scilab code Exa 1.8 Chapter 1 example 8

```
clear all;
clc;
P = 1200;//axial pull in lb-wt
d1 = 1;//diameter of one end in inches
d2 = 0.5;//diameter of other end in inches
l = 10;//length of the rod in inches
E = 14*10^6;//modulus of elsticity in lb/in^2
del_l = 4*P*l/(%pi*E*d1*d2);//change in length in inches
printf('The change in length of the rod is %.4f
```

```
inches',del_l);
```

Scilab code Exa 1.9 Chapter 1 example 9

```
clear ;
clc ;
d = 1;//diameter of the steel bar in inches
l = 12;//length of the steel bar in inches
d1 = 3/2;//external diameter in inches
d2 = 1;//internal diameter in inches
P = 5;//axial pull in tons
E_s = 30*10^6;//modulus of elasticity of steel in lb/in^2
E_b = 14*10^6;//modulus of elasticity of brass in lb/in^2
A_s = 0.25*%pi*d^2;//area of the steel section in in^2
A_b = 0.25*%pi*(d1^2-d2^2);//area of the brass section in in^2
P_b = (P/((E_s/E_b)*A_s+A_b))*A_b;//load resisted by the brass tube in tons
P_s = P-P_b;//bal;ance load resisted by the steel tube
e = (P_b/A_b)*2240/E_b ;//strain
printf('The strain e = %.4f',e);
del_l = e*l ;//extension of the bar in inches
printf('\n The extension of the bar = %.4f inches',del_l);
W = 0.5*P*del_l;//work done in stretching in inch-ton
printf('\n The work done in stretching is %.3f inch-ton',W);
```

Scilab code Exa 1.10 Chapter 1 example 10

```
clear ;
clc ;
a = 12;//length of each side in inches
d = 9/8;//diameter of each reinforced bar in inches
r = 3;//distance of centre from the edges in inches
p_c = 600;//in lb/in^2
n = 18;//modular ration E_s/E_c
A_s = 4*0.25*%pi*d^2;//in in^2
A_c = a^2 - A_s;//in in^2
p_s = n*p_c;//in lb/in^2
P = p_s*A_s+p_c*A_c;//safe central load in lb-wt
printf('Safe central load = %d lb-wt',P);
printf('\n Of this, the reinforcing bars carry %d lb
    -wt',p_s*A_s);

//there is an error in the answer given in textbook.
```

Scilab code Exa 1.11 Chapter 1 example 11

```
clear ;
clc ;
l = 8;//length in feet
d = 0.5;//diameter in inches
r = 30;//distance between two rods in inches
P = 2000;//load in lb-wt
E_s = 30*10^6;//modulus of elsticity of steel rod
E_b = 16*10^6;//modulus of elsticity of brass rod
A_s = 0.25*%pi*d^2;//section area in in^2
p_b = P/(A_s*(1+(E_s/E_b)));
p_s = (P/A_s) - p_b ;
P_b = A_s*p_b;
P_s = A_s*p_s;
printf('P_s = %.1f lb/in^2\n and P_b = %.1f lb/in^2'
```

```
,P_s,P_b);
x = r*P_b/P ;//
printf('\n  x = %.2f inches',x);
```

Scilab code Exa 1.12 Chapter 1 example 12

```
clear ;
clc ;
alpha = 0.0000062 ;//co-efficient of the expansion in "per F"
t = 100;//in F
d = 3/4;//in inches
del = 0.02;//in inches
l = 15;//in ft
E = 13000;//in tons/in^2
e = alpha*t - (del/(l*12));
p = E*e;//in tons/in^2
A = 0.25*%pi*d^2;//in in^2
P = p*A ;//in tons
printf('Tensile strain imposed by end-grips,e = %.5f',e);
printf('\n p = %.2f tons/in^2\n P = %.2f tons',p,P);
```

Scilab code Exa 1.13 Chapter 1 example 13

```
clear;
clc;
d = 1;//diameter of steel bar in inches
d1 = 3/2;//external diameter of brass tube in inches
d2 = 1;//internal diameter of brass tube in inches
t = 100;//in F
alpha_s = 0.0000062;//alpha of steel in "per F"
alpha_b = 0.000010;//alpha of brass in "per F"
```

```
E_s = 30*10^6;//in lb/in^2
E_b = 14*10^6;//in lb/in^2
A_s = 0.25*%pi*d^2;//section area of steel bar in in
    ^2
A_b = 0.25*%pi*(d1^2-d2^2);//section area of brass
    tube in in^2
p_b = t*(alpha_b-alpha_s)*E_s/((A_b/A_s)+(E_s/E_b));
p_s = (A_b/A_s)*p_b;
printf('The stresses induced in each metal are, p_b
    = %d lb/in^2\n          p_s = %d lb/in^2',p_b,p_s);
```

Scilab code Exa 1.14 Chapter 1 example 14

```
clear;
clc;
D = 4;//diameter of the wheel in ft
p = 6 ;//hoop stress in tons/in^2
alpha = 0.0000062;//in "per F"
E = 13000;//in tons/in^2
d = (1/(1+(p/E)))*D*12;//internal diameter in inches
t = (D*12-d)/(d*alpha);
printf('The least temperature the tube must be
    heated is, t = %.1f F',t);
```

Scilab code Exa 1.15 Chapter 1 example 15

```
clear;
clc;
p = 8;//normal stress intensity in tons/in^2
theta = 35*%pi/180;//inclination of the section in
    degrees
P = p*cos(theta);//resultant stress intensity in
    tons/in^2
```

```
p_n = P*cos(theta);//normal stress intensity in tons/in^2
p_t = P*sin(theta);//tangential stress intensity in tons/in^2
p_max = 0.5*p;//maximum possible shear in tons/in^2
angle = 45;//inclination of these planes in degrees
printf('Resultant stress intensity = %.2f tons/in^2',P);
printf('\n normal stress intensity = %.2f tons/in^2',p_n);
printf('\n tangential stress intensity = %.2f tons/in^2',p_t);
printf('\n The maximum possible shear on any plane is %d tons/in^2',p_max);
printf('\n and these planes are inclined at %d degrees to the normal section.',angle);
```

Scilab code Exa 1.16 Chapter 1 example 16

```
clear;
clc;
d = 9/8;//diameter of the steel bar in inches
P = 6;//tensile load in tons
del_l = 0.0036 ;//extension of length inches
l = 8;//gauge length in inches
del_d = 0.00015;//change in diameter in inches
A = 0.25*%pi*d^2;//section area in in^2
p = P/A;//stress in tons/in^2
e = del_l/l;//strain
E = p/e;//modulus of elasticity in tons/in^2
LS = del_d/d;//lateral strain
PR = LS/e;//poisson's ratio
N = E/(2*(1+PR));//rigidity modulus in tons/in^2
K = E/(3*(1-2*PR));//bulk modulus in tons/in^2
printf('Poisson ratio 1/m = %.4f',PR);
```

```
printf('\n  E = %d tons/in^2',E);
printf('\n  N = %d tons/in^2',N);
printf('\n  K = %d tons/in^2',K);

//there is an error in the answer given in textbook.
```

Scilab code Exa 1.17 Chapter 1 example 17

```
clear;
clc;
N = 2640;//rigidity modulus in tons/in^2
d = 3/8;//diameter of the rod in inches
P = 1/2;//axial pull in tons
del_d = 0.000078;//change in diameter in inches
A = 0.25*%pi*d^2;//section area in in^2
p = P/A ;//stress tons/in^2
LS = del_d/d;//lateral strain
m = p/(LS*2*N) - 1;
E = 2*N*(1 + 1/m);//modulus of elasticity in ton/in
  ^2
PR = 1/m;//poisson's ratio
printf('Poisson ratio 1/m = %.3f',PR);
printf('\n    E = %d ton/in^2',E);

//there is an error in the answer given in textbook.
```

Chapter 2

Principal planes and principal stresses

Scilab code Exa 2.1 Chapter 2 example 1

```
clear;
clc;
p_1 = 5;//principal stress in tons/in^2
p_2 = 5/2;//principal stress in tons/in^2
theta = 50*%pi/180;//angle in degrees
p_n = p_1*cos(theta)^2+p_2*sin(theta)^2;//normal
    stress intensity
p_t = (p_1-p_2)*sin(theta)*cos(theta);//tangential
    stress intensity
p = sqrt((p_1*cos(theta))^2+(p_2*sin(theta))^2);//
    resultant intensity of stress
alpha = atan((p_2*sin(theta))/(p_1*cos(theta)));//in
     radians
alpha = alpha*180/%pi;//in degrees
printf('Normal stress intensity p_n = %.2f tons/in^2
    ',p_n);
printf('\n Tangential stress intensity p_t = %.2f
    tons/in^2',p_t);
printf('\n Resultant stress intensity p = %.2f tons/
```

```
in^2',p);
printf('\n angle alpha p_n = %.2f degrees',alpha);

//there is an error in the answer given in text book
```

Scilab code Exa 2.3 Chapter 2 example 3

```
clear;
clc;
d = 3/4 ;//inches
P = 2;//tons
Q = 0.5;//tons
m = 4;
A = 0.25*%pi*d^2;//in^2
p = P/A ;//tons/in^2
q = Q/A;//tons/in^2
theta = 0.5*atan(2*q/p);//radians
theta1 = theta*180/%pi;//degrees
theta2 = theta1+90;//degrees
printf('The inclination of principal planes to the
    axis of the bolt will be %.2f degress and %.2f
    degrees respectively',theta1,180-theta2);
printf('\n The inclination of maximum shear planes
    to the axis of the bolt will be %.2f degress and
    %.2f degrees respectively',theta1+45,180-theta2
    -45);
p_1 = 0.5*p+sqrt(0.25*p^2+q^2);//tons/in^2
p_2 = 0.5*p-sqrt(0.25*p^2+q^2);//tons/in^2
p_max = 0.5*(p_1-p_2);//tons/in^2
p_s = p_1-(p_2/m);//tons/in^2
printf('\n The principal stresse are given by p_1 =
    %.2f tons/in^2., tensile\n  p_2 = %.2f tons/in^2\n
      p_2 = %.2f tons/in^2 ., compressive',p_1,p_2,-
    p_2);
printf('\n Maximum shear stress is p_max = %.2f tons
```

```
/in^2',p_max);
printf('\n The stress which acting alone will produce the same maximum strain is given by, %.2f tons/in^2',p_s);

//there is an error in the answer given in text book
```

Scilab code Exa 2.4 Chapter 2 example 4

```
clear;
clc;
q = 2;//tons/in^2
p = 5;//tons/in^2
p_dash = 2;//tons/in^2
theta = 0.5*atan(2*q/(p-p_dash));//radians
theta1 = theta*180/%pi;//degrees
theta2 = theta1+90;//degrees
p_1 = 0.5*(p+p_dash)+sqrt(q^2 + 0.25*(p-p_dash)^2);//tons/in^2
p_2 = 0.5*(p+p_dash)-sqrt(q^2 + 0.25*(p-p_dash)^2);//tons/in^2
q_max = 0.5*(p_1-p_2);//tons/in^2
printf('The principal stresses are p_1 = %d tons/in^2 .,tensile\n  p_2 = %d tons/in^2., tensile',p_1,p_2);
printf('\n The maximum shear stress is %.1f tons/in^2., the planes offering it being inclined at %.2f degrees and %.2f degrees \n to the plane having the normal stress intensity of %d tons/in^2.',q_max,theta1+45,theta2+45,p);
//there is an error in the answer given in text book
```

Scilab code Exa 2.5 Chapter 2 example 5

```
clear;
clc;
p_res = 6;//tons/in^2
p_dash = 4;//tons/in^2
theta = 30*%pi/180;//degrees
p_n = 4;//tons/in^2
p = p_res*cos(theta);//tons/in^2
q = p_res*sin(theta);//tons/in^2
L = 2*q/(p-p_dash);
theta = 0.5*atan(2*q/(p-p_dash));
theta1 = theta*180/%pi;//degrees
theta2 = theta1+90;//degrees
p_1 = 0.5*(p+p_dash)+sqrt(q^2 + 0.25*(p-p_dash)^2);
    //tons/in^2
p_2 = 0.5*(p+p_dash)-sqrt(q^2 + 0.25*(p-p_dash)^2);
    //tons/in^2
p_max = 0.5*(p_1-p_2);//tons/in^2
printf('Theta1 = %.2f degrees and Theta2 = %.2f
    degrees',theta1,theta2);
printf('\n p_1 = %.2f tons/in^2.,tensile\n p_2 = %.2
    f tons/in^2.,tensile',p_1,p_2);
printf('\n The maximum shear intensity will be %.2f
    tons/in^2 across the planes of maximum shear.',
    p_max);
```

Scilab code Exa 2.6 Chapter 2 example 6

```
clear;
clc;
p_1 = 7;//tons/in^2
p_2 = 4;//tons/in^2
p_3 = 3;//tons/in^2
m = 4;
E = 13000;//tons/in^2
e_1 = (p_1/E)+(p_2/(m*E))-(p_3/(m*E));
```

```
e_2 = (p_2/E)+(p_1/(m*E))+(p_3/(m*E));
e_3 = (p_3/E)-(p_1/(m*E))+(p_2/(m*E));
printf('e_1 = %.6f,  tensile\n e_2 = %.4f,
    compressive\n e_3 = %.6f, tensile',e_1,e_2,e_3);
```

Scilab code Exa 2.7 Chapter 2 example 7

```
clear;
clc;
a = 2;//inches
l = 6;//inches
E = 13000;//tons/In^2
m = 1/0.3;
P = 20;//tons
p_1 = P/a^2;//tons/in^2
p_2 = p_1/(2*(m-1));//tons/in^2
e_1 = (5-0.6*p_2)/E;//tons/in^2
del_l = e_1*l;//inches
printf('The contraction in the length del_l = %.5f
    inches',del_l);
```

Chapter 3

Impact or shock loading

Scilab code Exa 3.1 Chapter 3 example 1

```
clear;
clc;
d = 3/2;//inches
l = 10;;//feet
P = 8;//tons
E = 13500;//tons/in^2
A = 0.25*%pi*d^2;//in^2
p = 2*P/A;// tons/in^2
e = p/E;
del_l = e*l*12;//inches
W = P*del_l;//inch-ton
printf('The maximum instantaneous stress produced is
    , p = %.2f tons/in^2',p);
printf('\n The corresponding strain is e = %.6f \n
    del_l = %.2f inches',e,del_l);
printf('\n The work done on the rod and stored by it
     is %.2f inch-ton.',W);

//there is an error in the answer given in text book
```

Scilab code Exa 3.2 Chapter 3 example 2

```
clear;
clc;
l = 6;//feet
d = 1;//inches
h = 4;//inches
E = 30*10^6;//lb/in^2
A = 0.25*%pi*d^2;//in^2
P = 50;//lb
p = (P/A)+sqrt((P^2/A^2)+(2*E*P*h)/(A*l*12));
e = p/E;
del_l = e*l*12//inches
printf('Maximum instantaneous stress produced is p =
    %d lb/in^2',p);
printf('\n Maximum instantaneous extension produced
    is del_l = %.3f lb/in^2',del_l);

//there is an error in the answer given in text book
```

Scilab code Exa 3.3 Chapter 3 example 3

```
clear;
clc;
l = 10;//feet
d = 5/4;//inches
p = 8;//tons/in^2
E = 13000;//tons/in^2
A = 0.25*%pi*d^2;//in^2
e = p/E;
del_l = e*l*12;//inches
W = 0.5*p^2*A*l*12/E;// inch-ton
```

```
h = W*10-del_l;//inches
printf('Instantaneous elongation is del_l = %.3f
   inches',del_l);
printf('\n Height of the drop is h = %.2f inches',h)
   ;
```

Scilab code Exa 3.4 Chapter 3 example 4

```
clear;
clc;
w = 4;//tons
v = 2;//miles per hour
l = 150;//feet
d = 3/2;//inches
E = 13000;// tons/in^2
g = 32;// ft/sec^2
A = 0.25*%pi*d^2;// in^2
KE = w*(v*17.6)^2/(2*g*12);// inch-tons
p = sqrt(KE*(2*E)/(A*l*12));// tons/in^2
del_l = p*l*12/E;// inches
printf('Maximum instantaneous stress produced is p =
    %.2f tons/in^2',p);
printf('\n Maximum instantaneous extension produced
   is del_l = %d inch',del_l);
```

Scilab code Exa 3.5 Chapter 3 example 5

```
clear;
clc;
d = 2;//inches
l = 8;//feet
U = 50;// ft-lbs
E = 28*10^6;// lb/in^2
```

```
V = 0.25*%pi*d^2*l*12;// in^3
p = sqrt(2*U*12*E/V);// lb/in^2
e = p/E;
del_l = e*l*12;// inches
printf('Maximum instantaneous stress produced is p = %d lb/in^2',p);
printf('\n Maximum instantaneous extension produced is del_l = %.4f inches',del_l);
//there is an error in the answer given in text book
```

Scilab code Exa 3.6 Chapter 3 example 6

```
clear;
clc;
l = 12;//feet
d1_A = 1;//inch
d2_A = 2;//inches
l1_A = 4;//inches
l2_A = 8;//inches
d1_B = 1;//inch
d2_B = 2;//inches
l1_B = 8;//inches
l2_B = 4;//inches
p_A = 15/2;// tons/in^2
p_B = sqrt((2/3)*p_A^2);// tons/in^2
r1 = (9*%pi/8)/(3*%pi/4);//ratio of energies if both bars are allowed to reach the proof stress
V_A  = 0.25*%pi*d1_A^2*l1_A+ 0.25*%pi*d2_A^2*l2_A;// in^3
V_B  = 0.25*%pi*d1_B^2*l1_B+ 0.25*%pi*d2_B^2*l2_B;// in^3
r2 = ((3/16)*p_B^2)/((1/12)*p_B^2);//ratio of enrgies
printf('Maximum instantaneous stress produced is p_B = %.2f tons/in^2',p_B);
```

```
printf('\n Ratio of energies stored if both bars are
    allowed to reach the proof stress is r1 = %.2f '
   ,r1);
printf('\n Ratio of energies stored at the same
   stress per unit volume, is r2 = %.2f ',r2);
```

Chapter 5

Beams and Bending 2

Scilab code Exa 5.1 Chapter 5 example 1

```
clear;
clc;
b = 6;// inches
t = 1/2;// inch
R = 40;// feet
E = 13000;// tons/in^2
y = t/2;// inch
f = (E/(R*12))*(y);// tons/in^2
printf('The maximum intensity of stress induced is f
    = %.2f tons/in^2',f);
```

Scilab code Exa 5.2 Chapter 5 example 2

```
clear;
clc;
d = 14;// inches
I = 442.57;//inch units
f = 8;// tons/in^2
```

```
E = 13000;// tons/in^2
R = E*d/(2*f);// inches
M_r = f*(I/(d/2));// ton-inches
printf('The radius to which it should be bent is R = %d inches or %.1f feet',R,R/12);
printf('\n The moment of resistance is M_r = %.1f ton-inches',M_r);
```

Scilab code Exa 5.3 Chapter 5 example 3

```
clear;
clc;
d = 16;// inches
I = 618;// inch units
l = 24;// feet
f = 15/2;// tons/in^2
Z = I/(d/2);// inch-units
M_r = f*Z;// ton-inches
//If the load is uniformly spread over its span,BM = W*l/8
W1 = 8*M_r/(12*l);//tons
//If the load is concentrated at the centre,BM = W*l/4
W2 = 4*M_r/(12*l);//tons
printf('If the load is uniformly spread over its span, then W is given by \n W = %.1f tons\n = %.3f ton per foot run',W1,W1/l);
printf('\n If the load is concentrated at the centre, then W is given by\n W = %.2f tons',W2);
```

Scilab code Exa 5.4 Chapter 5 example 4

```
clear;
```

```
clc;
d = 20;// inches
I = 1673;// inch units
W = 3/4;// ton per foot run
f = 8;// tons/in^2
Z = I/(d/2);// inch-units
M_r = f*Z;// ton-inches
l = sqrt(M_r*32/(3*12));//feet
printf('The maximum permissible span for this beam
    is l = %.2f feet',l);
```

Scilab code Exa 5.5 Chapter 5 example 5

```
clear;
clc;
function [M,f]=func(W,l,d,b,Z)
    M = 0.5*W*d - (W/l)*d*b;
    f = M*12/Z;
endfunction
b = 6;// inches
d = 12;// inches
l = 16;// feet
W = 6000;// lb-wt
Z = (1/6)*b*d^2;
d1 = 2;// feet
d2 = 4;// feet
d3 = 6;// feet
d4 = 8;// feet
b1 = 1// feet
b2 = 2;// feet
b3 = 3;// feet
b4 = 4;// feet
[M2,f2] = func(W,l,d1,b1,Z);
[M4,f4] = func(W,l,d2,b2,Z);
[M6,f6] = func(W,l,d3,b3,Z);
```

```
[M8,f8] = func(W,l,d4,b4,Z);
printf('At %d feet ,M2 = %d lb-feet and f2 = %.1f lb/
   in^2\n At %d feet ,M4 = %d lb-feet and f4 = %d lb/
   in^2 \n At %d feet ,M4 = %d lb-feet and f6 = %.1f
   lb/in^2\n At %d feet ,M4 = %d lb-feet and f8 = %d
   lb/in^2\n',d1,M2,f2,d2,M4,f4,d3,M6,f6,d4,M8,f8);
```

Scilab code Exa 5.6 Chapter 5 example 6

```
clear;
clc;
w = 160;// lb. per sq. foot
b = 3;// inches
d = 9;// inches
l = 15;// feet
f = 1200;// lb. per sq. inch
Z = (1/6)*b*d^2;// in^3
M_r = f*Z;// lb-inches
x = M_r/(w*l^2*12/8);// feet
printf('x = %.1f feet',x);

//The answer is correct only, but it is approximated
    in the text book
```

Scilab code Exa 5.7 Chapter 5 example 7

```
clear;
clc;
l = 20;// feet
b = 9;// inches
h = 10;// feet
w = 120;// lb. per cub. foot
f = 1100;// lb/in^2
```

```
W = w*(3/4)*l*h;// lb-wt
BM_max = W*l*12/8;// lb-inches
//assumnig d = 2b
b = (6*BM_max/(f*4))^(1/3);// inches
d = 2*b;// inches
printf('b = %.2f inches\n d = %.2f inches',b,d);
printf('\n A section %d X %d will therfore do.',b,d)
    ;
```

Scilab code Exa 5.8 Chapter 5 example 8

```
clear;
clc;
B = 5;// inches
D = 12;// inches
t1 = 0.55;// inches
t2 = 0.35;// inches
f = 15/2;// tons/in^2
l = 16;// feet
b = B-t2;// inches
d = D-2*t1;// inches
I_xx = (B*D^3 - b*d^3)/12;// in^4
Z = I_xx/6;// in^3
M_r = f*Z;// ton-inches
W = M_r/(l*12/8);// tons
w = W/l;// ton per foot run
printf('W = %.2f tons\n w = %.2f ton per foot run',W
    ,w);
```

Scilab code Exa 5.9 Chapter 5 example 9

```
clear;
clc;
```

```
D = 19.5;// inches
d = 18;// inches
l = 30;// feet
t1 = 3/4;// inch
rho1 = 450;// lb. per cub. foot
rho2 = 62.5;// lb. per cub. foot
A = 0.25*%pi*(D^2 - d^2);// sq. in
DW = rho1*l*A/144;// lb-wt
WW = rho2*0.25*%pi*(D-d)^2*l;// lb-wt
W = DW+WW;// lb-wt
BM_max = W*l*0.0004467202*12/8;// ton-inches
I_xx = (%pi/64)*(D^4 - d^4);// in^4
Z_xx = I_xx/(0.5*d+t1);// ton/in^2
f = BM_max/Z_xx;// ton/in^2
printf('The maximum stress f = %.3f ton/in^2',f);

//there is an error in the answer given in text book
```

Scilab code Exa 5.11 Chapter 5 example 11

```
clear;
clc;
b = 6;// inches
d = 12;// inches
t1 = 7/8;// inch
t2 = 1/2;// inch
I_xx = (1/12)*(b*d^3 - (b-t2)*(d-2*t1)^3);// in^4
Z1 = I_xx/b;// in ^3
A = 2*b*t1 + 0.5*(d-2*t1);// in^2
b = sqrt(A/2);// inches
d = 2*b;// inches
Z2 = (1/6)*b*d^2;// in^3
k = Z1/Z2 ;
printf('The ratio of strengths Z1/Z2 = %.2f ',k);

```

```
//there is an error in the answer given in text book
```

Scilab code Exa 5.12 Chapter 5 example 12

```
clear;
clc;
A = 15.625;// in^2
Z1 = 61.75;// in^3
Z2 = 14.63;// in^3
d = sqrt(4*A/%pi);// inches
Z3 = (%pi/32)*d^3;// in^3
R1 = Z1/Z3;
R2 = Z2/Z3;
printf('If the strength of the solid circular
    section is taken as unity,\n that of the
    rectangular section is %.2f and of the I-section
    it is %.2f.',R2,R1);
```

Scilab code Exa 5.13 Chapter 5 example 13

```
clear;
clc;
D = 8;// inches
B = 3;// inches
t1 = 1/2;// inch
t2 = 3/8;// inch
b = B-t2;// inches
d = D-2*t1;// inches
a1 = t1*B;// in^2
x1 = 0.5*B;// inches
a2 = t2*(D-2*t1);// in^2
x2 = 0.5*t2;// inches
a3 = B*t1;// in^2
```

```
x3 = 0.5*B;// inches
a = a1+a2+a3;// in^2
P = (a1*x1+a2*x2+a3*x3)/(a1+a2+a3);// inches
I_xx = (1/12)*(B*D^3 - b*d^3);// in^4
I_AB = (1/3)*t1*B^3 + (1/3)*d*t2^3 + (1/3)*t1*B^3;//
    in^4
I_yy = I_AB - a*P^2;// in^4
printf('Position of the c.g of the section P = %.3f
   inches',P);
printf('\n I_xx = %.2f in^4\n I_yy = %.3f in^4',I_xx
   ,I_yy);
//there is an error in the answer given in text book
```

Scilab code Exa 5.14 Chapter 5 example 14

```
clear;
clc;
b = 6;// inches
d = 4;// inches
t = 5/8;// inch
a1 = d*t;// in^2
y1 = d/2;// inches
a2 = (b-t)*t;// in^2
y2 = t/2;// inch
a = a1+a2;// in^2
J = (a1*y1+a2*y2)/(a1+a2);// inches
I_AB = (1/3)*t*d^3 + (1/3)*(b-t)*t^3;// in^4
I_xx = I_AB - a*J^2;// in^4
I_yy = (1/12)*t*b^3 + (1/12)*(d-t)*t^3;// in^4
printf('The position of the c.g is J = %.2f inches',
   J);
printf('\n I_xx = %.2f in^4\n I_yy = %.2f in^4',I_xx
   ,I_yy);
```

```
//14(a)
H = 18;// feet
l = 10;// feet
w = 3/2;// cwt/ per .sq. foot
y_c = 2.97;// inches
y_t = 1.03;// inches
W = (3/40)*(w*l);// tons
BM_max = W*l*12/8;// ton-inches
M_r = BM_max;// ton-inches
f_c = M_r*y_c/I_xx ;// tons/in^2
f_t = M_r*y_t/I_xx ;// tons/in^2
printf('\n\n Maximum stresses induced are f_c = %.2f tons/in^2\n f_t = %.2f tons/in^2',f_c,f_t);
```

Scilab code Exa 5.15 Chapter 5 example 15

```
clear;
clc;
b = 5;// inches
d = 4;// inches
t = 1/2;// inches
a1 = b*t;// in^2
x1 = t/2;// inches
y1 = b/2;// inches
a2 = (d-t)*t;// in^2
y2 = t/2;// inch
x2 = t + 0.5*(d-t);// inches
x_bar = (a1*x1+a2*x2)/(a1+a2);// inches
y_bar = (a1*y1+a2*y2)/(a1+a2);// inches
I_AB = (1/3)*t*b^3 + (1/3)*(d-t)*t^3;// in^4
I_xx = I_AB - (a1+a2)*y_bar^2;// in^4
I_yy = (1/3)*t*d^3 + (1/3)*(b-t)*t^3 - (a1+a2)*x_bar^2;// in^4
printf('The position of c.g is x_bar = %.3f inches, y_bar = %.2f inches',x_bar,y_bar);
```

```
printf('\n I_xx = %.3f in^4\n I_yy = %.2f in^4',I_xx
    ,I_yy);



//Example 15(a)
l = 12;// feet
y_c = y_bar;//inches
y_t = b - y_c;//inches
f_t_max = 7;// tons/in^2
f_c = y_c*f_t_max/y_t;// tons/in^2
M_r = f_t_max*I_xx/y_t;// ton-inches
W = M_r/(l*12/8);// tons
printf('\n \n Total uniformly distribute load over
    the span is W = %.2f tons',W);
```

Scilab code Exa 5.16 Chapter 5 example 16

```
clear;
clc;
b1 = 6;//inches
d1 = 1;//inch
b2 = 9;//inches
d2 = 1;//inch
b3 = 10;//inches
d3 = 2;//inch
a1 = b3*d3;// in^2
y1 = d3/2;// inches
a2 = b2*d2;// in^2
y2 = d3 + b2/2;// inches
a3 = b1*d1;// in^2
y3 = b2+d3+d1/2;// inches
y_bar = (a1*y1+a2*y2+a3*y3)/(a1+a2+a3);//inches
I_AB = (1/3)*b3*d3^3 + (1/12)*d2*b2^3 +b2*(d3+b2/2)
    ^2 + (1/12)*b1*d1^3 + b1*(b2+d3+d1/2)^2;// in^4
```

```
I_xx = I_AB - (a1+a2+a3)*y_bar^2;// in^4
I_yy = (1/12)*(d3*b3^3 + b2*d2^3 +d1*b1^3);// in^4
printf('The c.g of the section is y_bar = %.3f inches',y_bar);
printf('\n I_xx = %.2f in^4\n I_yy = %.2f in^4',I_xx,I_yy);

//Example 16(a)
l = 20;// feet
y_t = y_bar;// inches
y_c = d1+b2+d3-y_t;// inches
f_t = 1.5;// tons/in^2
f_c = y_c*f_t/y_t;// tons/in^2
M_r = f_c*I_xx/y_c;// ton-inches
W = M_r*8/(l*12);// tons
w = W/l;// ton per foot run
printf('\n\n Load required is w = %.2f ton per foot run',w);
```

Scilab code Exa 5.17 Chapter 5 example 17

```
clear;
clc;
b = 12;// inches
d = 6;// inches
h = 14;// inches
t = 1/2;// inch
A = 12.94;// in^2
//section moment of inertia
I_xx_s = 315.3;// in^4
I_yy_s = 22.27;// in^4

I_xx = 2*I_xx_s + 2*((1/12)*h*(2*t)^3 + h*2*t*(d+t)^2);// in^4
I_yy = 2*(I_yy_s + A*(d/2)^2) + 2*((1/12)*2*t*h^3);
```

```
    // in^4
printf('I_xx = %.2f in^4\n I_yy = %.2f in^4',I_xx,
    I_yy);
```

Scilab code Exa 5.18 Chapter 5 example 18

```
clear;
clc;
b = 15;// inches
d = 15/2;// inches
h = 16;// inches
t = 1/2;// inch
P = 0.935;// inches
A = 12.33;// in^2
//section moment of inertia
I_xx_s = 377;// in^4
I_yy_s = 14.55;// in^4

I_xx = 2*I_xx_s + 2*((1/12)*h*(2*t)^3 + h*2*t*(d+t)
    ^2);// in^4
I_yy = 2*(I_yy_s + A*(d/2 + P)^2) + 2*((1/12)*2*t*h
    ^3);// in^4
printf('I_xx = %.2f in^4\n I_yy = %.2f in^4',I_xx,
    I_yy);
```

Scilab code Exa 5.19 Chapter 5 example 19

```
clear;
clc;
b1 = 16;// inches
d1 = 6;// inches
b2 = 9;// inches
d2 = 7;// inches
```

```
A = 14.71;// in^2
I_xx1 = 618.09;// in^4
I_yy1 = 22.47;// in^4
I_xx2 = 208.13;// in^4
I_yy2 = 40.17;// in^4
I_xx = I_xx1 + 2*I_yy2;// in^4
I_yy = I_yy1 + 2*(I_xx2 + A*(b2/2 + 0.5*0.4)^2);// in^4
k_xx = sqrt(I_xx/(3*A));// inches
k_yy = sqrt(I_yy/(3*A));// inches
printf('I_xx = %.2f in^4\n I_yy = %.2f in^4\n k_xx = %.2f inches\n k_yy = %.2f inches',I_xx,I_yy,k_xx,k_yy);
```

Scilab code Exa 5.20 Chapter 5 example 20

```
clear;
clc;
b1 = 7/2;// inches
d1 = 7/2;// inches
t1 = 3/8;// inches
l = 18;// inches
I_xx1 = 2.80;// in^4
I_yy1 = 2.80;// in^4
J = 1;// inch
A = 2.49;// in^2
I_xx = 4*(I_xx1 + A*(l/2 - J)^2);// in^4
k_xx = sqrt(I_xx/(4*A));// inches
printf('I_xx = %.2f in^4\n k_xx = %.1f inches',I_xx,k_xx);
```

Scilab code Exa 5.21 Chapter 5 example 21

```
clear;
clc;
b1 = 12;// inches
d1 = 4;// inches
A = 9.21;// in^2
I_xx1 = 200.1;// in^4
P = 1.055;// inches
I_yy1 = 12.12;// in^4
I_xx = 2*I_xx1;
//for equal strength I_xx = I_yy
x = 2*(sqrt(((I_xx/2)-I_yy1)/A) - P);// in^4
printf('x = %.2f inches',x);

//answer is corrct only, but it is approximated in
    the text book.
```

Scilab code Exa 5.22 Chapter 5 example 22

```
clear;
clc;
d =10;// inches
b = 8;// inches
t1 = 1;// inch
t2 = 0.6;// inch
I = (1/12)*(b*d^3 - (b-t2)*b^3);// in^4
//(i) Resistance to M
R1 = integrate('(t2/I)*y^2','y',-4,4);
//(ii) Resistance to F
R2 = integrate('(4/I)*(25-y^2)','y',4,5);
printf('The moment of resistance offered by the
    flanges is %.3fM. The flanges take up %.1f
    percentage of the B.M.,\n the web resisting only
    %.1f percentage of the B.M',1-R1,(1-R1)*100,R1
    *100);
printf('\n The shear borne by the web is %.4fF. The
```

```
web thus takes up %.2f percentage of the shear
force.,\n the flanges resisting only %.2f
percentage of the shear force',(1-2*R2),(1-2*R2)
*100,2*R2*100);
```

Scilab code Exa 5.23 Chapter 5 example 23

```
clear;
clc;
b = 14;// inches
d = 6;// inches
t1 = 0.7;// inch
t2 = 0.4;// inch
F = 20;// tons
I = (1/12)*(d*b^3 - (d-t2)*(b-2*t1)^3);// in^4
q = F*t1*0.5*(0.5*b + (0.5*b-t1))/I;// ton/in^2
q_max = (F/(I*t2))*(d*t1*0.5*(0.5*b + (0.5*b-t1)) +
    t2*(0.5*b-t1)*(0.5*b-t1)*0.5);// tons/in^2
printf('The maximum intensity of shear stress is
    q_max = %.2f tons/in^2',q_max);
```

Scilab code Exa 5.24 Chapter 5 example 24

```
clear;
clc;
b = 4;// inches
d = 13/2;// inches
t = 1/2;// inch
a = 4;// inches
F = 10;// tons
a1 = b*t;// in^2
y1 = t/2;// inch
a2 = (d-t)*t;// in^2
```

```
y2 = t+0.5*(d-t);// inches
y_bar = (a1*y1+a2*y2)/(a1+a2);// inches
I_AB = (1/3)*b*t^3 + (1/12)*t*(d-t)^3 + (b-2*t)*(b-t
    )^2;// in^4
I_xx = I_AB - (a1+a2)*y_bar^2;// in^4
q = (F/(b*I_xx))*b*t*(y_bar-0.5*t);// ton/in^2
q_max = (F/(t*I_xx))*(b*t*(y_bar-0.5*t) + 0.5*t*(
    y_bar-t)*(y_bar-t));// tons/in^2
printf('The maximum intensity of shear stress at the
     N.A is q_max = %.2f tons/in^2',q_max);
```

Scilab code Exa 5.25 Chapter 5 example 25

```
clear;
clc;
function [p1, p2,theta] = func(p,q)
    p1 = 0.5*p + sqrt(q^2 + 0.25*p^2);
    p2 = 0.5*p - sqrt(q^2 + 0.25*p^2);
    theta = 0.5*atan(2*q/p) * 180/%pi;
endfunction
b = 5;// inches
d = 12;// inches
F = 4800 ;// lb-wt
M = 192000;// lb-inches
I = (1/12)*b*d^3;// in^4

//At 6 inches above the N.A
p6 = M*6/I ; // lb/in^2
q6 = 0;
[p1_6,p2_6,theta6] = func(p6,q6);

//At 4 inches above the N.A
p4 = M*4/I;// lb/in^2
q4 = (F/(I*b))*b*(0.5*d-4)*b;
[p1_4,p2_4,theta4] = func(p4,q4);
```

```
//At 2 inches above the N.A
p2 = M*2/I;// lb/in^2
q2 = (F/(I*b))*b*(0.5*d-2)*4;
[p1_2,p2_2,theta2] = func(p2,q2);

//At the N.A
p = 0;//
q = F*b*0.5^3*d^2/(I*b);// lb/in^2
p1 = q;// lb/in^2
p2 = -q;// lb/in^2

printf('At 6 inches above the N.A, p1 = %d lb/in^2., compressive, and p2 = %d ',p1_6,p2_6);
printf('\n At 4 inches above the N.A, p1 = %.1f lb/in^2., compressive, and p2 = %.2f lb/in^2 ., tensile\n theta1 = %.2f degrees \n theta2 = %.2f degrees',p1_4,-p2_4,theta4,theta4+90);
printf('\n At 2 inches above the N.A, p1 = %.2f lb/in^2., compressive, and p2 = %.2f lb/in^2., tensile\n theta1 = %.2f degrees \n theta2 = %.2f degrees',p1_2,-p2_2,theta2,theta2+90);
printf('\n At the N.A, p1 = %d lb/in^2., compressive, and p2 = %d., tensile ',p1,-p2);

//there is an error in the answer given in text book
```

Scilab code Exa 5.26 Chapter 5 example 26

```
clear;
clc;
b = 10;// inches
d = 8;// inches
t1 = 1;// inch
t2 = 0.6;// inch
```

```
M = 500;// ton-inches
F = 25;// tons
I = (1/12)*(d*b^3 - (d-t2)*d^3);// in^4

//At the top
p = M*b/(2*I);// tons/in^2
q = 0;
p1 = p;// tons/in^2
p2 = 0;
printf('At the top, principal stresses are \n p1 = %.2f tons/in^2\n p2 = %d tons/in^2',p1,p2);

//In the web, 4 inches from the N.A
p = M*d/(2*I);// tons/in^2
q = F*d*t1*0.5*(d+t1)/(I*t2);// tons/in^2
theta = 0.5*atan(2*q/p);
theta1 = theta*180/%pi;
theta2 = theta1+90;
p1 = 0.5*p + sqrt(q^2 + 0.25*p^2);// tons/in^2
p2 = 0.5*p - sqrt(q^2 + 0.25*p^2);// tons/in^2
printf('\n In the web, 4 inches from the N.A.:\n The principal stresse are p1 = %.2f tons/in^2., compressive\n p2 = %.2f tons/in^2., tensile\n theta1 = %.1f degrees\n theta2 = %.1f degrees',p1,-p2,theta1,theta2);

//At the N.A
p = 0;
q = (F/(I*t2))*(d*t1*0.5*(d+t1) + t2*0.5*d*2*t1);
p1 = q;// tons/in^2
p2 = -q;//tons/in^2
printf('\n The principal stresse across the diagonal are %.2f tons/in^2., compressive on one plane and %.2f tons/in^2., tensile on the other.',q,q);

//there is an error in the answer given in text book
```

Scilab code Exa 5.27 Chapter 5 example 27

```
clear;
clc;
W = 10;// tons
l = 16;// feet
f = 15/2;// tons/in^2
//section modulus required
SM = W*l*12/(8*f);// in^3
//for this section modulus
l1 = 12;// inches
b1 = 5;// inches
t1 = 0.55;// inches
t2 = 0.35;// inches
I_xx = 220;// in^4
F_max = 5;// tons
q_max = (F_max/(I_xx*t2))*(F_max*t1*(0.5*l1-0.5*t1)
    + t2*0.5*(0.5*l1-t1)^2);// tons/in^2
printf('The maximum intensity of shear stress is
    q_max = %.2f tons/in^2',q_max);
```

Scilab code Exa 5.28 Chapter 5 example 28

```
clear;
clc;
b = 9/2;// inches
D = 12;// inches
d = 10;// inches
t = 1/2;// inches
f_w = 1000;// lb/in^2
m = 18;//m = E_s/E_w
f_t = m*d*f_w/D ;// lb/in^2
```

```
M_w = f_w*(1/6)*2*b*D^2;// lb-inches
M_s = f_t*(1/6)*t*d^2;// lb-inches
M = M_w + M_s;// lb-inches
printf('Skin stresse in steel plate is, M_s = %d lb-
    inches\n The total moment of resistance is M = %d
     lb-inches',M_s,M);
```

Chapter 6

Beams and bending 3

Scilab code Exa 6.1 Chapter 6 example 1

```
clear;
clc;
l = 5;// feet
W = 150;// lb
w = 120;// lb. per foot run
l1 = 3;// feet
b = 3;// inches
d = 6;// inches
E = 1.5*10^6;// lb/in^2
I = (1/12)*b*d^3;// in^4
y_B1 = (W*l^3)/(3*E*I);// feet
y_B2 = (w*l1*l1^3)/(8*E*I) + (l-l1)*(w*l1*l1^2)/(6*E
    *I);// feet
y_B = (12^3)*(y_B1+y_B2);// inches
printf('The deflection at the free end = %.4f inches
    ',y_B);
```

Scilab code Exa 6.3 Chapter 6 example 3

```
clear;
clc;
b = 4;// inches
d = 9;// inches
l = 12;// feet
y_c = 1/4;// inches
E = 1.5*10^6;// lb/in^2
I = (1/12)*b*d^3;// in^4
W = y_c*384*E*I/(5*12^3*l^3);// inches
printf('Uniform distributed load, the beam should
   carry is, W = %d lb-wt',W);

//there is an error in the answer given in text book
```

Scilab code Exa 6.4 Chapter 6 example 4

```
clear;
clc;
d = 6;// feet
l = 60;// feet
f = 15/2;// tons/in^2
E = 13000;// tons/in^2
k1 = 2*f/(12*d);// k1 = M_r/I
k2 = k1/(l*12/8);//k2 = W/I
y_c = (5/384)*k2*l^3 *12^3 /E;// inches
//If the giredr is of constant deapth and uniform
   strength, it bends to an arc of a circle of
   radius R
R = E*d*12/(2*f);// inches
delta = (l*12)^2 /(8*R);// inches
printf('The deflection for a uniformly distributed
   load on it is,delta = %.2f inches',delta);
```

Scilab code Exa 6.5 Chapter 6 example 5

```
clear;
clc;
f = 8;//tons/in^2
E = 12800;// tons/in^2
k1 = 1/480;//central deflection = k = delta/l
k2 = (5/24)*(f/E)/k1 ;//k2 = d/l =  deapth to span
   ratio
printf('The ratio of deapth to span, d/l = %f ',k2);
```

Scilab code Exa 6.6 Chapter 6 example 6

```
clear;
clc;
w = 550;// lb. per foot run
f = 1000;// lb/in^2
l = 20;// feet
d_limit = 15;// inches
E = 1.5*10^6;// lb/in^2
//central ddeflection
delta = (1/2);// inches
d = (5/24)*(f/E)*20*12/(1/(2*20*12));// inches
M = w*l*l*12/8;// lb-inches
b = M/(f*(1/6)*d^2);// inches
printf('A section with d = %d inches, b = %d inches
   will do.',round(d),round(b));
f1 = (1/(2*20*12))*(d_limit/(l*12))*E/(5/24);// lb/
   in^2
b = M/(f1*(1/6)*d_limit^2);// inches
printf('\n If the deapth of section is limited to %d
    inches, then \n f = %.1f lb/in^2\n b = %.1f
   inches',d_limit,f1,b);

//tha answer is correct only, but it is approximated
```

```
in the text book.
```

Scilab code Exa 6.7 Chapter 6 example 7

```
clear;
clc;
l = 20;// feet
b = 4;// feet
W = 5;// tons
d = 12;// inches
h = 5;// inches
I_xx = 220;// in^4
E = 13000;// tons/in^2
a = l-b;// feet
//for maximum deflection
x = sqrt((a^2 + 2*a*b)/3);// feet
y_max = x*12^3 *((a^2 + 2*a*b) - x^2)/(6*E*I_xx);//
    inches
//for deflection at the centre
x1 = 0.5*l;// inches
y_x1 = x1*12^3 *((a^2 + 2*a*b) - x1^2)/(6*E*I_xx);//
    inches
printf('The position of maximum deflection occurs at
    x = %.2f feet\n The maximum deflection is, y_max
    = %.4f inches',x,y_max);
printf('\n The deflection at the centre, y_%d = %.4f
    inches',x1,y_x1);
```

Scilab code Exa 6.8 Chapter 6 example 8

```
clear;
clc;
d = 12;// inches
```

```
h = 5;// inches
l = 20;// feet
E = 13000; //tons/in^2
I_xx = 220;// in^4
W = 4;// tons
W1 = 3;// tons
a = 15;// feet
b = l-a;// feet
a1 = 16;// feet
b1 = l-a1;// feet
K1 = (-2*W1*b1*l)/(W1*b1-W*b);
K2 = (W*b*a^2 + 2*a*W*b^2 + 2*W1*b1*l^2 - W1*b1*a1^2
    -2*W1*a1*b1^2 +W1*b1*l^2)/(3*(W1*b1 - W*b));
x = -0.5*K1 + sqrt(-K2 + 0.25*K1^2);// feet
x1 = l-x;// feet
y_max = W*b*x*1728*(a^2 +2*a*b -x^2)/(6*E*I_xx*l) +
   W1*b1*x1*1728*(a1^2 +2*a1*b1 -x1^2)/(6*E*I_xx*l);
   // inches
printf('The position of the maximum deflection is, x
    = %.2f feet.',x);
printf('\n And the maximum deflection is, y_max = %
   .4f inches.',y_max);
```

Scilab code Exa 6.9 Chapter 6 example 9

```
clear;
clc;
b = 18;// inches
d = 7;// inches
w1 = 1;// ton per foot run
w2 = 3;// ton per foot run
I_xx = 1149;// in^4
E = 13000;// tons/in^2
R_A = 0.5*b + (b/3);// tons
R_B = 0.5*b + (2*b/3);// tons
```

```
//integrating M = E*I*y'', to get E*I*y' and making y' = 0;, we get maximu deflection
x = 9.18;// by trial and error method
y_derivative = -R_A*0.5*x^3 + x^4 /6 +0.5*(2/3)*(1/b)*(1/4)*x^5 + 469.8;
y = -R_A*0.5*x^3 /3 + x^4 /24 +0.5*(2/3)*(1/b)*(1/(4*5))*x^5 + 469.8*x;
y_max = y;// inches
printf('The position of maximum deflection from the end A, x = %.2f inches and \n Maximum deflection, y_max = %.4f inches',x,y_max*12^3 /(E*I_xx));
```

Scilab code Exa 6.10 Chapter 6 example 10

```
clear;
clc;
b = 18;// inches
d = 6;// inches
l = 16;// feet
W = 2;// tons
h = 1/2;// inches
I_xx = 841.76;// in^4
E = 13000;// tons/in^2
P = W + sqrt(2*W*h*48*E*I_xx/(l*12)^3 + 2*W);// tons
M_max = P*l*12/4;// ton-inches
Z = 2*I_xx/b ;// in^3
f = M_max/Z ;// tons/in^2
delta = P*(l*12)^3 /(48*E*I_xx);// inches
printf('The maximum instantaneous deflection delta = %.4f inches\n and stress induced, f = %.3f tons/in^2',delta,f);
//there is an error in the answer given in text book
```

Scilab code Exa 6.11 Chapter 6 example 11

```
clear;
clc;
l = 3;// feet
b = 3;// inches
t = 3/8;// inches
W = 1500;// lb.
f = 12;// tons/in^2
E = 30*10^6;// tons/in^2
M_max = W*l*12/4 ;// lb-inches
M_r = f*(1/6)*b*t^2 *2240;// lb-inches
n = M_max/M_r ;// no. of plates
n = round(n+1);
f = M_max/(n*(1/6)*b*t^2);// lb/in^2
R = E/(2*f/t) ;// inches
delta = (l*12)^2 /(8*R);// inches
printf('Number of plates required, n = %d',n);
printf('\n The central deflection, delta = %.4f inch.',delta);
printf('\n The initial radius to which the plates must be bent, R = %.3f inches',R);
```

Chapter 8

Direct and bending stresses

Scilab code Exa 8.1 Chapter 8 example 1

```
clear;
clc;
d = 6;//inches
b = 3/4;//inch
P = 18;//tons
e = 1/8;//inch
A = b*d;//sq.in
M = P*e;//ton-in
Z = (1/6)*b*d^2;//in^3
p_0 = P/A;// tons/in^2
p_b = M/Z;// ton/in^2
p_max = p_0+p_b;// tons/in^2
p_min = p_0-p_b;// tons/in^2
printf('p_max = %.1f tons/in^2., tensile\n p_min = %
    .1f tons/in^2., tensile',p_max,p_min);
```

Scilab code Exa 8.2 Chapter 8 example 2

```
clear;
clc;
d1 = 12;//inches
t = 1;//inch
d2 = d1-2*t;//inches
P = 5;//tons
e = 12;//inch
A = 0.25*%pi*(d1^2-d2^2);//sq.in
M = P*e;//ton-in
Z = %pi*(d1^4-d2^4)/(32*d1);//in^3
p_0 = P/A;// tons/in^2
p_b = M/Z;// ton/in^2
p_max = p_0+p_b;// tons/in^2
p_min = p_0-p_b;// tons/in^2
printf('p_max = %.4f ton/in^2.,cmopressive\n p_min =
    %.4f ton/in^2.,\n i.e., %.4f ton/in^2., tensile'
   ,p_max,p_min,-p_min);
```

Scilab code Exa 8.3 Chapter 8 example 3

```
clear;
clc;
l = 6;//inches
b = 4;//inches
d = 1/2;//inch
P = 10;//tons
r = 1.5;//inches
A = 4.771;// in^2
J = 0.968;// inches
I_xx = 6.07;// in^4
I_yy = 8.64;// in^4
e = r-J;// inches
M = P*e;// ton-inches
y_t = J;//inches
y_c = b-y_t;//inches
```

```
//compressive
p_c = M*y_c/I_xx;// tons/in^2
//tensile
p_t = M*y_t/I_xx;// tons/in^2
//compressive
p_0 = P/A ;// tons/in^2
p_max = p_0+p_c;// tons/in^2
p_min = p_0-p_t;// tons/in^2
printf('p_max = %.3f tons/in^2.,compressive\n p_min
   = %.3f tons/in^2.,compressive',p_max,p_min);
```

Scilab code Exa 8.4 Chapter 8 example 4

```
clear;
clc;
b = 5;//inches
t = 1/2;//inch
P = 12;//tons
d = 1/2;//inch
r = 3/2;//inch
A = (b-d)*t;// in^2
p_0 = P/A;// tons/in^2
a1 = b*d;// in^2
x1 = 0;
a2 = d*t;// in^2
x2 = -3/2;
e = (a1*x1-a2*x2)/(a1-a2);//inches
M = P*e;// ton-inches
y_c = a1-e;// inches
y_t = a1+e;// inches
I_yy = (t*b^3)/12 - ((t*d^3)/12 + 0.5*d*r^2);// in^4
I_GG = I_yy - (a1-a2)*(e^2);// in^4
p_c = M*y_c/I_GG;// tons/in^2
p_t = M*y_t/I_GG;// tons/in^2
p_max = p_0 + p_t;// tons/in^2
```

```
p_min = p_0 - p_c;// tons/in^2
printf('p_max = %.1f tons/in^2., tensile\n p_min = %
    .2f tons/in^2., tensile',p_max,p_min);
```

Scilab code Exa 8.5 Chapter 8 example 5

```
clear;
clc;
h = 20;// feet
b = 12;// feet
d = 4;// feet
p = 30;// lb. per sq.foot
rho = 140;// lb. per cubic foot
p_0 = rho*h;// lb-ft^2
P = p*b*h;// lb-wt
M = P*h/2;//lb-ft
Z = b*d^2/6;// ft^3
p_b = M/Z;// lb/ft^2
p_max = p_0 + p_b;// lb/ft^2
p_min = p_0 - p_b;// lb/ft^2
printf('p_max = %d lb/ft^2., compressive\n p_min =
    %d lb/ft^2., compressive',p_max,p_min);
```

Scilab code Exa 8.6 Chapter 8 example 6

```
clear;
clc;
h = 80;// feet
p = 28;// lb. per sq.foot
rho = 126;// lb. per cubic foot
p_0 = rho*h/2240;// tons-ft^2
p_max = 7;// tons/ft^2
d = 4;// feet
```

```
p_b = p_max - p_0;// tons/ft^2
D = sqrt(3*p*h^2 /(2*p_b*2240) +sqrt(d^4 + (3*p*h^2
    /(2*p_b*2240))^2));// feet
t = 0.5*(D-d);// feet
printf('The necessary thickness is, t = %d feet',
    round(t));
```

Scilab code Exa 8.7 Chapter 8 example 7

```
clear;
clc;
h = 60;//feet
rho = 130;// lb. per cubic foot
D = 12;//feet
d = 5;//feet
P_h = 24;// lb. per sq. foot
p_0 = rho*h;// lb-ft^2
P = P_h*D*h;// lb-wt
M = P*h/2;// lb-feet
Z = %pi*(D^4 - d^4)/(32*D);//lb-ft^3
p_b = M/Z;// lb/ft^2
p_max = p_0 + p_b;// lb/ft^2
p_min = p_0 - p_b;// lb/ft^2
printf('p_max = %d lb/ft^2., compressive\n p_min =
    %d lb/ft^2., compressive',p_max,p_min);

//there is an error in the answer given in text book
```

Scilab code Exa 8.8 Chapter 8 example 8

```
clear;
clc;
h = 120;// feet
```

```
d = 5;// feet
h1 = 49;// feet
p = 42;// lb. per square foot
c = 0.6;
//p = k*sqrt(x)
k = p/sqrt(h1);
M = integrate('18*x^(3/2)','x',0,120);
printf('Bending moment at the foot of the chimney is
    , M = %d lb-ft',M);
//there is an error in the answer given in text book
```

Scilab code Exa 8.9 Chapter 8 example 9

```
clear;
clc;
h = 100;// feet
d = 4;// feet
p = 50;// lb. per square foot
c = 2/3;
M = integrate('(100*x/3)*(10-(6*x/100))','x',0,100);
printf('Bending moment at the foot of the chimney is
    , M = %d lb-feet',M);
```

Scilab code Exa 8.10 Chapter 8 example 10

```
clear;
clc;
h = 20;// feet
b = 4;// feet
d = 12;// feet
h1 = 18;// feet
//density of masonary
rho_m = 140;// lb-ft^3
```

```
//density of water
rho_w = 62.5;// lb-ft^3
W = rho_m*0.5*(b+d)*h;// lb-wt
//to locate its line of action divide the dam
    section into a rectangle and a triangle
x1 = b/2;//feet
a1 = b*h;// sq. feet
a2 = 0.5*(d-b)*h;// sq. feet
x2 = b+((d-b)/3);// feet
x_bar = (a1*x1+a2*x2)/(a1+a2);// feet
P = rho_w*h1^2/2;// lb-wt
z = x_bar + (h1/3)*(P/W);// feet
e = z - d/2;// feet
p_0 = W/d;// lb/ft^2
M = W*e;// lb-feet
Z = 1*d^2*1/6;// ft^3
p_b = M/Z;// lb-ft^2
p_max = p_0 + p_b;// lb-ft^2
p_min = p_0 - p_b;// lb-ft^2
printf('p_max = %.1f lb/ft^2., compressive at B.\n
   p_min = %.1f lb/ft^2., compressive at A.',p_max,
   p_min);

//there is an error in the answer given in text book
```

Chapter 9

Columns and struts of uniform section

Scilab code Exa 9.1 Chapter 9 example 1

```
clear;
clc;
// n =l/k
n1 = 40;
n2 = 60;
n3 = 80;
n4 = 100;
n5 = 120;
n6 = 140;
n7 = 160;
n8 = 180;
n9 = 200;
E = 13000;// tons/in^2
//m = P/A
m1 = 4*%pi^2 *E/n1^2;// tons per sq. inch
m2 = 4*%pi^2 *E/n2^2;// tons per sq. inch
m3 = 4*%pi^2 *E/n3^2;// tons per sq. inch
m4 = 4*%pi^2 *E/n4^2;// tons per sq. inch
m5 = 4*%pi^2 *E/n5^2;// tons per sq. inch
```

```
m6 = 4*%pi^2 *E/n6^2;// tons per sq. inch
m7 = 4*%pi^2 *E/n7^2;// tons per sq. inch
m8 = 4*%pi^2 *E/n8^2;// tons per sq. inch
m9 = 4*%pi^2 *E/n9^2;// tons per sq. inch
printf('l/k : %d     %d     %d     %d     %d     %d     %d
      %d     %d\n P/A: %d    %.1f   %.1f   %.2f   %.2f
   %.1f   %.2f   %.2f   %.2f',n1,n2,n3,n4,n5,n6,n7,n8,
   n9,m1,m2,m3,m4,m5,m6,m7,m8,m9);

//there is a minute error in the answer given in
   text book
```

Scilab code Exa 9.2 Chapter 9 example 2

```
clear;
clc;
d = 1;// inches
t = 1/8;// inches
l = 10;// feet
E = 13500;// tons/in^2
D = d+2*t;// inches
I = (%pi/64)*(D^4 - d^4);// in^4
P = 20.25*E*I/(12*l)^2 ;// tons
printf('The collapsing load, P = %.2f tons',P);
```

Scilab code Exa 9.3 Chapter 9 example 3

```
clear;
clc;
b = 10;// inches
d = 6;//inches
l = 15;// feet
A = 11.77;// in^2
```

```
I_xx = 204.80;// in^4
I_yy = 21.76;// in^4
f_c = 21;// tons/in^2
a = 1/7500;
n = 3;//factor of safety
k = sqrt(I_yy/A);// radius of gyration
P = f_c*A/(1+(a/2)*(l*12/k)^2);// tons
P_s = P/n;// safe load
printf('The safe axial load = %.3f tons',P_s);

//there is a minute calculation error in the answer
    given in text book
```

Scilab code Exa 9.4 Chapter 9 example 4

```
clear;
clc;
l = 16;// feet
F = 30;// tons
n = 8;// factor of safety
k = 0.8;//k = d/D
f_c = 36;// tons/in^2
a = 1/1600;
r = 0.25*%pi*(1-k^2);//r = A/D^2
P = n*F;// tons
D1 = sqrt(P/(f_c*r*2) +sqrt((P/(f_c*r))*((a/4)*(l
    *12)^2)/((1+k^2)/16) + (P/(f_c*r*2))^2));//
    inches
D = round(D1);// inches
d = k*D;// inches
t = (D-d)/2;// inches
printf('The internal diameter d = %.1f inches',d);
printf('\n The thickness of the metal will be %.2f
    inches',t);
// the answer is correct only, but it is
```

```
approximated in the text book
```

Scilab code Exa 9.5 Chapter 9 example 5

```
clear;
clc;
l = 5;// feet
b = 5/2;// inches
d = 5/2;// inches
h = 1/4;// inches
n = 3;// factor of safety
A = 1.19;// in^2
k = 0.49;// minimum radius of gyration
f_c = 21;// lb/in^2
a = 1/7500;
P = f_c*A/(1+(a/2)*((l*12)^2)/k^2);// tons
P_safe = P/n;// tons
printf('The safe axial load = %.2f tons',P_safe);
```

Scilab code Exa 9.6 Chapter 9 example 6

```
clear;
clc;
b1 = 10;// inches
d1 = 7/2;// inches
r = 9/2;// inches
b2 = 12;// inches
d2 = 1/2;// inches
l = 20;// feet
n = 4;// factor of safety
A_s = 7.19;// in^2
I_xx1 = 109.42;// in^4
I_yy1 = 7.42;// in^4
```

```
d = 0.97;// inches
f_c = 21;// lb/in^2
a = 1/7500;
A = 2*A_s + 4*b2*d2;// in^2
I_xx = 2*I_xx1 + 2*((1/12)*b2*(2*d2)^3 + b2*(r+2*d2)
    ^2);// in^4
I_yy = 2*(1/12)*(2*d2)*b2^3 + 2*(I_yy1 + A_s*(0.5*r+
    d)^2);// in^4
k = sqrt(min(I_xx,I_yy)/A);// minimum radius of
    gyration
P = f_c*A/(1+ a*((l*12)^2/k^2));// tons
P_safe = P/n;// tons
printf('The safe axial load = %d tons',round(P_safe)
    );
```

Scilab code Exa 9.7 Chapter 9 example 7

```
clear;
clc;
m = 4;// no. of angles
b = 7/2;// inches
d = 7/2;// inches
h = 3/8;// inches
s = 18;// inches
l = 30;// feet
n = 3;// factor of safety
A = 2.49;// in^2
J = 1;// inches
I_xxs = 2.80;// in^4
I_yys = I_xxs;// in^4
//from the chapter V.
I = 648.64;// in^4
k = sqrt(65.2);// in^2
f_c = 21;// lb/in^2
a = 1/7500;
```

```
P = m*f_c*A/(1+a*((l*12)^2)/k^2);// tons
P_safe = P/n;// tons
printf('The safe axial load = %.1f tons',P_safe);
```

Scilab code Exa 9.8 Chapter 9 example 8

```
clear;
clc;
D = 7;// inches
t = 3/4;// inches
l = 16;// feet
P = 12;// tons
e = 3/4;// inches
E = 6000;// tons/in^2
d = D-2*t;// inches
A = 0.25*%pi*(D^2 - d^2);// in^2
I = (%pi/64)*(D^4 - d^4);// in^4
p_0 = P/A;// tons/in^2
Z = 2*I/D;// in^3
M = P*e*sec(0.25*l*12*sqrt(P/(E*I)));// ton-inches
p_b = M/Z;// tons/in^2
p_max = p_0+p_b;// tons/in^2
p_min = p_0-p_b;// tons/in^2
//if tension is just on the point being induced in the section, p_b = p_0
e = p_0*t*Z/M;// inches
printf('Stress intensities, p_max = %.3f tons/in^2., compressive\n     p_min = %.3f tons/in^2., compressive',p_max,p_min);
printf('\n Maximum possible eccentricity, e = %.2f inches',e);
```

Scilab code Exa 9.9 Chapter 9 example 9

```
clear;
clc;
P = 80;// tons
p_max = 5;// tons/in^2
E = 13000;// tons/in^2
A = 38.38;// in^2
I_yy = 451.94;// in^4
y_c = 6;// inches
l = 20;// inches
k = sqrt(I_yy/A);// inches
Z_yy = I_yy/y_c;// in^3
p_0 = P/A;// tons/in^2
p_b = p_max-p_0;// tons/in^2
M_max = p_b*Z_yy;// ton-inches
e = M_max/(P*sec(0.5*l*12*sqrt(P/(E*I_yy))));// inches
printf('The maximum possible eccentricity , e = %.2f inches',e);
```

Scilab code Exa 9.10 Chapter 9 example 10

```
clear;
clc;
e = 7/4;// inches
E = 13000;// tons/in^2
p = 5;// tons/in^2
y_c = 6;// inches
l = 20;// feet
A = 38.38;// in^2
k = sqrt(11.78);// inches
I = 11.78;// in^4
p_e = (%pi)^2 *E*k^2 /(l*12)^2;// tons/in^2
//from Perry's formula
p_0 = 0.5*((p_e*1.2*e*y_c/k^2)+p_e+p)-sqrt((0.5*((p_e*1.2*e*y_c/k^2)+p_e+p))^2 - p_e*p);// tons/in
```

```
^2
P = p_0*A;// tons
printf('The safe load, P = %.2f tons',P);

//there is a minute calculation error in the answer given in text book
```

Scilab code Exa 9.11 Chapter 9 example 11

```
clear;
clc;
b1 = 10;// inches
d1 = 6;// inches
b2 = 12;// inches
d2 = 1/2;// inches
l = 16;// feet
A_s = 11.77;// in^2
I_xxs = 204.80;// in^4
I_yys = 21.76;// in^4
A = A_s + 2*b2*d2;// in^2
I_yy = I_yys + 2*(1/12)*d2*b2^3;// in^4
k = sqrt(I_yy/A);// inches
//from the Perry-Robertson formula
n = 0.003*l*12/k;
p_e = 13000*%pi^2/((l*12)/k)^2 ;// tons/in^2
f = 18;// tons/in^2
x = 0.5*(f+p_e*(1+n));
p_0 = x - sqrt(x^2 - f*p_e);// tons/in^2
P = p_0*A;// tons
P_safe = P/2.36;// tons
printf('The safe load, P = %.1f tons',P_safe);

//there is a minute calculation error in the answer given in text book
```

Chapter 10

Radial pressure cylindrical and spherical shells

Scilab code Exa 10.1 Chapter 10 example 1

```
clear;
clc;
d = 2;// feet
p = 250;// lb/in^2
f = 12000;// lb/in^2
t_limit = p*d*12/(2*f) ;// inches
printf('The necessary thickness of metal for
   seamless pipe is %.2f inches',t_limit);
```

Scilab code Exa 10.2 Chapter 10 example 2

```
clear;
clc;
l = 8;//feet
d = 3;// feet
t = 1/2;// inches
```

```
p = 200;// lb/in^2
E = 30*10^6;// lb/in^2
PR = 0.3;// poisson's ratio
f1 = p*d*12/(2*t);// lb/in^2
f2 = p*d*12/(4*t);// lb/in^2
f_s = 0.5*(f1-f2);// lb/in^2
e1 = (f1/E)-(PR*f2/E);// lb/in^2
e2 = (f2/E)-(PR*f1/E);// lb/in^2
del_d = e1*d*12;// inches
del_l = e2*l*12;// inches
del_V = (e2+2*e1)*0.25*%pi*(12*d)^2 * l*12;// cub.
    inches
printf('Maximum intensity of shear stress induced =
    %d lb/in^2',f_s);
printf('\n del_d = %.6f inches\n del_l = %.6f inches
    \n del_V = %.1f cub. inches',del_d,del_l,del_V);
```

Scilab code Exa 10.3 Chapter 10 example 3

```
clear;
clc;
d = 30;// inches
H = 300;// feet
w = 62.5;
f = 2800;
//intensity of water pressur
p = w*H/144;// lb/in^2
t_limit = p*d/(2*f);// inches
printf('Thickness of metal required is %.4f inches',
    t_limit);

//the answer is correct only, but it is approximated
     in the text book.
```

Scilab code Exa 10.4 Chapter 10 example 4

```
clear;
clc;
d = 78;// inches
t = 3/4;// inches
n1 = 70/100;// efficiency of the longitudinal
    riveted joint
f = 6;// tons/in^2
n2 = 60/100;// efficiency of the circumferential
    riveted joint
p = f*2240/(d/(2*t*n1));//lb/in^2
p = round(p-1);
f1 = p*d/(2*t);// lb/in^2
f2 = p*d/(4*t*n2);// lb/in^2
printf('The permissible steam pressure, p = %d lb/in
    ^2',p);
printf('\n The circumferential stress, f1 = %d lb/in
    ^2 = %.2f tons/in^2',f1,f1/2240);
printf('\n The longitudinal stress, f2 = %d lb/in^2
    = %.2f tons/in^2',f2,f2/2240);
```

Scilab code Exa 10.5 Chapter 10 example 5

```
clear;
clc;
d = 4;// feet
p = 200;// lb/in^2
f = 15000;// lb/in^2
n = 0.7;// efficiency
t_limit = p*d*12/(4*f*n);// inches
```

```
printf('The thickness of the plate required = %.2f
    inches',t_limit);

//the answer is correct only, but it is approximated
    in the text book.
```

Scilab code Exa 10.6 Chapter 10 example 6

```
clear;
clc;
d = 3;// feet
t = 1/4;// inches
del_V = 9;// cub. inches
E = 30*10^6;// lb/in^2
PR = 0.3;// poisson's ratio
V = (%pi/6)*(12*d)^3;// in^3
k = del_V/V;
f = k*E/(3*(1-PR));// lb/in^2
p = 4*f*t/(12*d);// lb/in^2
printf('The pressure exerted by fluid on the shell,
    p = %d lb/in^2',p);

//there is a minute calculation error in the answer
    given in text book
```

Scilab code Exa 10.7 Chapter 10 example 7

```
clear;
clc;
d = 12;// feet
t = 1/2;// inches
d1 = 1/4;// inches
p = 500;// lb/in^2
```

```
E_c = 6000;// tons/in^2
PR = 0.3;// Poisson's ratio
E_s = 13000;// tons/in^2
f_t = 8000;// lb/in^2
l = 8;
P_c = l*(%pi/64)*f_t;// lb-wt
f_c = P_c/(2*t);// lb/in^2
//bursting force per inch unit length
f_b = p*d;// lb-wt
f_p = (f_b + (l*0.049*PR*p*d/(4*t))*(E_s/E_c))/(1 +
   (l*0.049)*E_s/E_c);// lb/in^2
f_w = (f_p - PR*p*d/(4*t))*E_s/E_c;// lb/in^2
printf('                    Pipe
                            Steel-wire');
printf('\n Inititually ,     %d lb/in^2.,compr.
           %d lb/in^2., tensile',f_c,f_t);
printf('\n Due to p,      %d lb/in^2.,tensile.
         %d lb/in^2., tensile',f_p,f_w);
printf('\n Finally ,      %d lb/in^2.,tensile.
         %d lb/in^2., tensile',f_p-f_c,f_w+f_t);

//there is a calculation error in the answer given
   in text book
```

Scilab code Exa 10.8 Chapter 10 example 8

```
clear;
clc;
d = 12;// inches
t = 3;// inches
p_x1 = 900;// lb/in^2
x1 = 0.5*d;// inches
p_x2 = 0;
x2 = 0.5*d+t;// inches
//from Lame's formulae
```

```
b = (p_x1-p_x2)/((1/x1^2)-(1/x2^2));
a = (b/x1^2)- p_x1;
f_x1 = (b/x1^2)+a;// lb/in^2
f_x2 = (b/x2^2)+a;// lb/in^2
printf('The maximum and minimum intensities of
    circumferential stresses are: f_6 = %d lb/in^2.,
    tensile\n    f_9 = %d lb/in^2., tensile',f_x1,f_x2
    );
```

Scilab code Exa 10.9 Chapter 10 example 9

```
clear;
clc;
d = 5;// inches
p = 3;// tons/in^2
f = 8;// tons/in^2
x = 0.5*d;// inches
b = (p+f)/(2/x^2);
a = f-(b/x^2);
r = sqrt(b/a);//outer radius
t = r-0.5*d;//thickness
D = 2*t+d;//outer diameter
printf('The thickness of metal necessary, t = %.3f
    inches',t);
printf('\n the outer diameter will be, D = %.1f
    inches',D);

//the answer is correct, but it is approximated in
    the text book.
```

Scilab code Exa 10.10 Chapter 10 example 10

```
clear;
```

```
clc;
d = 9;// inches
p = 5000/2240;// lb/in^2
f = 8;// tons/in^2
PR = 0.3;// Poisson's ratio
//(i) Maximum principal stress hypothesis:
k_limit1 = sqrt((f + p)/(f - p));//k_limit = r1/r2
r_limit1 = k_limit1*0.5*d;//inches
printf('The outer radius in case(i), r2 = %.3f
    inches',r_limit1);
//(ii) Maximum principal strain:
k_limit2 = sqrt(((f/p - PR)+1)/(f/p - PR -1));
r_limit2 = k_limit2*0.5*d;// inches
printf('\n The outer radius in case(ii), r2 = %.3f
    inches',r_limit2);
//(iii) Maximum shear stress:
k_limit3 = sqrt(f/(2*p) /((f/(2*p)) - 1));
r_limit3 = k_limit3*0.5*d;// inches
printf('\n The outer radius in case(iii), r2 = %.3f
    inches',r_limit3);
//(iv) Maximum strain energy
K1 = (f^2 /p^2)/(2*((f^2 /(2*p^2)) - (1+PR)));
K2 = K1^2;
K3 = ((f^2 /(2*p^2)) - (1-PR))/((f^2 /(2*p^2)) - (1+
    PR));
k_limit4 = sqrt(K1+sqrt(K2-K3));
r_limit4 = k_limit4*0.5*d;// inches
printf('\n The outer radius in case(iv), r2 = %.3f
    inches',r_limit4);

//there are calculation errors in the answer given
    in text book
```

Scilab code Exa 10.11 Chapter 10 example 11

```
clear;
clc;
r1 = 0.5*6;// inches
r2 = 0.5*12;// inches
r3 = 0.5*10;// inches
p = 1500;// lb/in^2
p_f = 12000;// lb/in^2
//Initially , for the inner tube
b = -p/((1/r1^2) - (1/r3^2));
a = b/r1^2;
f_3 = (b/r1^2) +a;// lb/in^2
f_5 = (b/r3^2) +a;// lb/in^2
//for the outer tube
b1 = p/((1/r3^2)-(1/r2^2));
a1 = b1/r2^2;
f1_5 = (b1/r3^2)+a1;// lb/in^2
f1_6 = (b1/r2^2)+a1;// lb/in^2
//When the fluid pressure of 12000 lb/in^2, is
   admitted into the compound tube
B = p_f/((1/r1^2)-(1/r2^2));
A = B/(r2^2);
f_3_ = (B/r1^2)+A;// lb/in^2
f_5_ = (B/r3^2)+A;// lb/in^2
f_6_ = (B/r2^2)+A;// lb/in^2
printf('The hoop stresse are');
printf('\n at x = 3 inches,x = 5 inches initially on
    inner tube are %.1f lb/in^2.., compressive, %.1
   f lb/in^2..,compressive respectively',-f_3,-f_5);
printf('\n at x = 5 inches,x = 6 inches initially on
    outer tube are %.1f lb/in^2.., tensile, %.1f lb
   /in^2..,tensile respectively',f1_5,f1_6);
printf('\n at x = 3 inches,x = 5 inches and x = 6
   inches due to fluid pressure are %d lb/in^2..,
   tensile, %d lb/in^2..,tensile, and %d lb/in^2..,
   tensile respectively',f_3_,f_5_,f_6_')
printf('\n at x = 3 inches,x = 5 inches finally on
   inner tube are %.1f lb/in^2.., tensile, %.1f lb/
   in^2..,tensile respectively',f_3_+f_3,f_5_+f_5);
```

```
printf('\n at x = 5 inches,x = 6 inches finally on outer tube are %d lb/in^2.., tensile, %d lb/in^2.., tensile respectively',f1_5+f_5_,f1_6+f_6_);
```

Scilab code Exa 10.12 Chapter 10 example 12

```
clear;
clc;
p = 1500;// lb/in^2
E = 30*10^6;// lb/in^2
f1_5 = 8318;// lb/in^2
f2_5 = 3187.5;// lb/in^2
alpha = 0.0000062;// per F
r3 = 6;// inches
del_r3 = r3*(f1_5+f2_5)/E;// inches
t = ((f1_5+f2_5)/E)/(alpha);// inches
printf('The minimum temperature to which outer tube should be heated before it can be slipped on, t = %.2f F',t);
```

Scilab code Exa 10.13 Chapter 10 example 13

```
clear;
clc;
r1 = 0.5*9;// inches
r2 = 0.5*3;// inches
r3 = 0.5*6;// inches
del_r3 = 0.5*0.003;// inches
E = 13000;// tons/in^2
k1 = r1/r3;
k2 = r2/r3;
a1 = (del_r3/r3)*E/((k1^2 +1)- (k2^2 +1)*(k1^2 -1)/(k2^2 -1));
```

```
a = a1*(k1^2 -1)/(k2^2 -1);
b1 = a1*r1^2;
b = a*r2^2;
p_ = (b/r3^2) -a;// tons/in^2
// for the inner tube
f_x1 = (b/r2^2) +a;// tons/in^2
f_x2 = (b/r3^2) +a;// tons/in^2
// for the outer tube
f_x3 = (b1/r3^2) +a1;// tons/in^2
f_x4 = (b1/r1^2) +a1;// tons/in^2
printf('The hoop stresses are as under:');
printf('\n For the inner tube, at x = 1/5 inches, f = %.2f tons/in^2., compressive\n   at x = 3 inches, f = %.2f tons/in^2.,compressive',-f_x1,-f_x2);
printf('\n For the outer tube, at x = 3 inches, f = %.2f tons/in^2., tensile\n   at x = 4.5 inches, f = %.2f tons/in^2.,tensile',f_x3,f_x4);
```

Scilab code Exa 10.14 Chapter 10 example 14

```
clear;
clc;
r1 = 0.5*5;// inches
p = 5000;// lb/in^2
f = 5;// tons/in^2
b = (f + p/2240)/((1/r1^3) + (2/r1^3));
a = f - (b/r1^3);
//external diameter
r = (2*b/a)^(1/3);// inches
t = r - r1;// inches
printf('The thickness of the shell required, t = %.3f inches',t);

//the answer is approximated in the text book
```

Chapter 11

Riveted joints

Scilab code Exa 11.1 Chapter 11 example 1

```
clear;
clc;
t = 5/8;// inch
d = 1;// inch
p = 4;// inches
f_t = 28; //tons/in^2
f_s = 20; //tons/in^2
f_b = 40; //tons/in^2
P_t = (p-d)*t*f_t;// tons
P_s = 2*2*0.25*%pi*d^2 *f_s;// tons
P_b = 2*d*t*f_b;//tons
P = p*t*f_t;// tons
n = min(P_t,P_s,P_b)/P ;// efficiency
printf('The efficiency of the joint = %.3f or %.1f
    percentage',n,n*100);
```

Scilab code Exa 11.2 Chapter 11 example 2

```
clear;
clc;
t = 1/2;// inches
d1= 7/8;// inches
p1 = 5/2;// inches
d2= 9/8;// inches
p2 = 7/2;// inches
f_t = 8;// tons/in^2
f_s = 6;// tons/in^2
f_b = 10;// tons/in^2

P_t1 = (p1-d1)*t*f_t;// tons
P_s1 = 0.25*%pi*d1^2 *f_s;// tons
P_b1 = d1*t*f_b;//tons
P1 = p1*t*f_t;// tons
n1 = min(P_t1,P_s1,P_b1)/P1 ;// efficiency
printf('The efficiency of first joint = %.2f = %d
   percentage',n1,n1*100);

P_t2 = (p2-d2)*t*f_t;// tons
P_s2 = 0.25*%pi*d2^2 *f_s;// tons
P_b2 = d2*t*f_b;//tons
P2 = p2*t*f_t;// tons
n2 = min(P_t2,P_s2,P_b2)/P2 ;// efficiency
printf('\n The efficiency of second joint = %.3f = %
   .1f percentage\n',n2,n2*100);

if n2 > n1 then
    printf(' The second joint, with its higher
       efficiency, is stronger');
else
    printf(' The first joint, with its higher
       efficiency, is stronger');
end
```

Scilab code Exa 11.3 Chapter 11 example 3

```
clear;
clc;
t = 3/8;// inches
p2 = 7/2;// inches
f_t = 11/2;// tons/in^2
f_s = 5;// tons/in^2
f_b = 12;// tons/in^2
d = 1.2*sqrt(t);// inches
//d = 0.735, say 0.75 inches
d = 0.75;// inches
P_s = 0.25*%pi*d^2 *f_s;// tons
P_b = d*t*f_b;//tons
P_t_limit = P_s;//tons
p_limit = P_s/(t*f_t) + d;// inches
//p_limit = 1.763, take p = 1.75
p = 1.75;// inches
n = (p-d)/p;// efficiency
printf('The efficiency of the joint = %.1f
   percentage',n*100);
```

Scilab code Exa 11.4 Chapter 11 example 4

```
clear;
clc;
d = 7/8;// inches
t = 1/2;// inches
f_t = 6;// tons/in^2
f_s = 5;// tons/in^2
f_b = 10;// tons/in^2
p_s = 2*0.25*%pi*d^2*f_s;// tons
P_b = d*t*f_b;// tons
p_t_limit = 2*P_b/3 + d;// inches
n = (p_t_limit-d)/p_t_limit;// efficiency
```

```
printf('Pitch, p = %.3f inches',p_t_limit);
printf('\n Efficiency = %.3f or %d percentage',n,n
    *100);

//the answer is approximated in the textbook.
```

Scilab code Exa 11.5 Chapter 11 example 5

```
clear;
clc;
d = 6;// feet
p = 180;// lb/in^2
f = 6;// tons
n = 70/100;// efficiency
d1 = 1;// inches
f_s = 5;// tons/in^2
f_b = 10;// tons/in^2
t = p*d/(2*f*n);// inches
// t = 0.6889 inches, say 0.75 inches
t = 0.75;//inches
P_s = 2*0.25*%pi*d1^2*f_s;// tons
P_b = d1*t*f_b;// tons
p_limit = 2*P_b/(t*f) + d1;// inches
//p_limit = 4.33 inches, make it 4 inches
p = round(p_limit);// inches
n1 = (p-d1)/p;// efficiency
printf('Pitch = %.2f inches, make it %d inches.',
    p_limit,p);
printf('\n The efficiency of the joint will be %d
    percentage aganist the assumed value of %d
    percentage.',n1*100,n*100);
```

Scilab code Exa 11.6 Chapter 11 example 6

```
clear;
clc;
t = 1/2;// inches
a = 1/2;// inches
P = 42;// tons
d = 3/4;// inches
f_t = 7.5;// tons/in^2
f_s = 6;// tons/in^2
f_b = 12;// tons/in^2
P_s = 2*0.25*%pi*d^2 *f_s;// tons
P_b = d*t*f_b;// tons
n = P/min(P_s,P_b);
n = round(n+1);
b1 = P/(t*f_t) + d;// inches
b = round(b1);
e = (b-d)/b;// efficiency
f_s = (P/n)/(2*0.25*%pi*d^2) ;// tons/in^2
f_b = (P/n)/(d*t);// tons/in^2
f1 = P/(a*(b-d));// tons/in^2
f2 = (P-(P/n))/((b-2*d)*t);// tons/in^2
f3 = (P-(3*P/n))/((b-3*d)*t);// tons/in^2
f4 = (P-(6*P/n))/((b-4*d)*t);// tons/in^2
printf('The number of rivets required, n = %d',n);
printf('\n The width of the flat required, b = %.2f inches, say %d inches',b1,b);
printf('\n The efficiency of the joint = %.2f percentage',e*100);
printf('\n The actual stresses induce in the rivet are, f_s = %.2f tons/in^2\n                f_b = %.2f tons/in^2',f_s,f_b);
printf('\n The tensile stress at section 11, f1 = %.3f rons/in^2',f1);
printf('\n The tensile stress at section 22, f2 = %.3f rons/in^2',f2);
printf('\n The tensile stress at section 33, f3 = %.3f rons/in^2',f3);
printf('\n The tensile stress at section 44, f4 = %.3f rons/in^2',f4);
```

Scilab code Exa 11.7 Chapter 11 example 7

```
clear;
clc;
b = 9;// inches
t = 3/4;// inches
f_t = 8;// tons/in^2
f_s = 5;// tons/in^2
f_b = 10;// tons/in^2
d = 7/8;// inches
P = (b-d)*t*f_t;// tons
P_s = 2*0.25*%pi*d^2 *f_s;// tons
P_b = d*t*f_b;// tons
n = P/min(P_s,P_b);
e = (b-d)/b;// efficiency
P1 = f_t*(b-d)*t;// tons
P2 = f_t*(b-2*d)*t+P_s;// tons
P3 = f_t*(b-3*d)*t+3*P_s;// tons
P4 = f_t*(b-3*d)*t+6*P_s;// tons
printf('The number of rivets required , n = %d',round
   (n+1));
printf('\n The efficiency of the joint = %.1f
   percentage',e*100);
printf('\n The pull at section 11, P1 = %.2f rons/in
   ^2',P1);
printf('\n The pull at section 22, P2 = %.1f rons/in
   ^2',P2);
printf('\n The pull at section 33, P3 = %.2f rons/in
   ^2',P3);
printf('\n The pull at section 44, P4 = %.2f rons/in
   ^2',P4);
if P1 == min(P1,P2,P3,P4) then
    printf('\n The maximum possible pull which the
       flat will safely transmit is P1 = %.2f tons/
```

```
        in^2 at section 11',P1);
elseif P2 == min(P1,P2,P3,P4) then
    printf('\n The maximum possible pull which the
        flat will safely transmit is P2 = %.1f tons/
        in^2 at section 22',P2);
elseif P3 == min(P1,P2,P3,P4) then
    printf('\n The maximum possible pull which the
        flat will safely transmit is P3 = %.2f tons/
        in^2 at section 33',P3);
else
    printf('\n The maximum possible pull which the
        flat will safely transmit is P4 = %.2f tons/
        in^2 at section 44',P4);
end

//there is a minute error in the answer given
   textbook.
```

Scilab code Exa 11.8 Chapter 11 example 8

```
clear;
clc;
P = 150;; //tons
t = 3/4;// inches
d = 1;// inches
f_s = 6;// tons/in^2
f_b = 12;// tons/in^2
P_s = 0.25*%pi*d^2 *f_s;// tons
P_b = t*d*f_b;// tons
n = P/min(P_s,P_b);// no. of rivets required
printf('The number of rivets required , n = %.2f, say
    %d',n,round(n));
```

Scilab code Exa 11.9 Chapter 11 example 9

```
clear;
clc;
l = 50;// feet
b = 4;// feet
P = 3;// tons per foot run
t = 1/2;// inches
b1 = 4;// inches
d1 = 4;// inches
h1 = 1/2;// inches
d = 7/8;// inches
f_s = 6;// tons/in^2
f_b = 12;// tons/in^2
P_s = 2*0.25*%pi*d^2 *f_s;// tons
P_b = t*d*f_b;// tons
R = P_b;// tons
F = l*P*2/d1;// tons
p_min = R*(l-0.5*b1)/F ;// inches
printf('The minimum pitch required is p = %.2f
   inches, say %d inches',p_min,p_min);
```

Scilab code Exa 11.10 Chapter 11 example 10

```
clear;
clc;
P = 2.4;// tons
e = 18;// inches
n = 8;//no. of rivets
d = 7/8;// inches
h = 4;// inches
M = P*e;// ton-inches
d1 = 2;//
d2 = 6;//
square_r_sum = h*((0.5*h)^2 + d2^2) + h*((0.5*h)^2 +
```

```
    d1^2);//
r = sqrt(40);
F = M*r/square_r_sum;// tons
theta = atan(d2/d1)//radians
theta1 = theta*180/%pi// degrees
V = (P/n) + F*cos(theta);// tons
H = F*sin(theta);// tons
R = sqrt(V^2 + H^2);// tons
f_s = R/(0.25*%pi*d^2);// tons/in^2
printf('The maximum shear intensity induced at any
   rivet is \n    f_s = %.2f tons/in^2',f_s);
```

Chapter 12

Shafts and springs in torsion

Scilab code Exa 12.1 Chapter 12 example 1

```
clear;
clc;
d = 3;//inches
HP = 120;//horse power
RPM = 180;
l = 25;//feet
N = 12*10^6;// lb/in^2
T = 33000*HP/(2*%pi*RPM);//  lb-feet
f_s = 16*T*12/(%pi*d^3);// lb/in^2
theta = f_s*l*12/(0.5*d*N);// radian
printf('The maximum intensity of shear stress
   induced is f_s = %.d lb/in^2',f_s);
printf('\n The angle of twist in degrees is theta =
   %.2f',theta*180/%pi);

//there is a minute error in the answer given in
   textbook.
```

Scilab code Exa 12.2 Chapter 12 example 2

```
clear;
clc;
D = 2;// inches
N = 150;// RPM
f_s = 9000;// lb/in^2
M_r = f_s*(%pi/16)*D^3;// lb-inches
HP = M_r*2*%pi*N/(12*33000);//
printf('H.P transmitted is %.2f',HP);
```

Scilab code Exa 12.3 Chapter 12 example 3

```
clear;
clc;
HP = 80;
N = 200;// RPM
m = 30/100;
f = 12000;// lb/in^2
T = HP*33000/(2*%pi*N);// lb-feet
T_max = (1+m)*T;// lb-feet
D = (T_max*12*16/(%pi*f))^(1/3);// inches
printf('Suitable diameter is D = %.3f inches',D);

//the answer is approximated in the textbook.
```

Scilab code Exa 12.4 Chapter 12 example 4

```
clear;
clc;
HP = 750;
N = 90;// RPM
m = 40/100;
f = 12000;// lb/in^2
t = 1;// inch
```

```
T = HP*33000/(2*%pi*N);// lb-inches
T_max = (1+m)*T;// lb-inches
//On solving (4*t)D^3 - (6*t^2)D^2 +(4*t^3 -(16*M/f*
    %pi))D -t^4 = 0, we get D
D = 7.6;//inches
d = D - 2;//inches
printf('A shaft % d inches external diameter and %d
    inches internal diameter will be satisfactory.',
    round(D),round(d));
```

Scilab code Exa 12.5 Chapter 12 example 5

```
clear;
clc;
RPM = 180;// RPM
HP = 130;
f = 9000;// lb/in^2
alpha = 1;//degree
l = 10;// feet
N = 6000;// tons/in^2
T = 33000*HP/(2*%pi*RPM);// lb-feet
D1 = (16*T*12/(f*%pi))^(1/3);// inches
D2 = (T*12*l*12*32*alpha*180/(%pi*N*%pi*2240))^(1/4)
    ;// inches
if D1 > D2 then
    printf('D = %d inches will be suitable for the
        shaft',round(D1));
else
    printf('D = %d inches will be suitable for the
        shaft',round(D2));
end
```

Scilab code Exa 12.6 Chapter 12 example 6

```
clear;
clc;
HP = 3000;
RPM = 60;
f = 12000;//lb/in^2
rho = 480;//lb. per sq. foot
k = 3/4;// k = d/D
T = HP*33000*12/(2*%pi*RPM);// lb-inches
D1 = (T*16/(f*%pi))^(1/3);//inches
D2 = (T/((1+k^2)*(1-k^2)*%pi*f/16))^(1/3);//inches
d = k*D2;// inches
w1 = 0.25*%pi*D1^2 *rho/144 ;// lb-wt
w2 = 0.25*%pi*(D2+d)*(D2-d)*rho/144 ;// lb-wt
w = w1-w2;// lb-wt
n = (w/w1)*100;
printf('The saving in weight per foot run is w = %d
    lb-wt',w);
printf('\n Percentage saving is %.2f',n);

//there is a minute error in the answer given in
    textbook.
```

Scilab code Exa 12.7 Chapter 12 example 7

```
clear;
clc;
l1 = 3;// feet
d1 = 1;// feet
l2 = 9;// feet
M = 200;// lb-wt
l = 9;// inches
N = 12*10^6;// lb/in^2
k = l2/l1;
T1 = M/(1+k);// lb-feet
T2 = k*T1;// lb-feet
```

```
f_s = T2*12/(%pi/16);// lb/in^2
theta = f_s*l/(0.5*d1*N);// radians
printf('T1 = %d lb-feet\n T2 = %d lb-feet',T1,T2);
printf('\n f_s = %d lb/in^2',f_s);
printf('\n theta = %.5f radian\n          = %.4f
    degrees',theta,theta*180/%pi);
//there is a minute error in the answer given in
    twxtbook
```

Scilab code Exa 12.8 Chapter 12 example 8

```
clear;
clc;
D = 5;// inches
HP = 120;
RPM = 150;
b = 5;// inches
h = 1;//inch
n = 6;// no. of bolts
d = 3/4;// inches
T = HP*33000*12/(2*%pi*RPM);// lb-inches
f_s = T*16/(%pi*27);
f_k = T/(b*h*2*d);
f_b = T/(n*0.25*%pi*d^2 * b);// lb-inches
printf('f_s = %d lb/in^2\n f_k = %d lb/in^2\n f_b =
    %d lb/in^2',f_s,f_k,f_b);

//there are errors given in the answers given in the
    textbook
```

Scilab code Exa 12.9 Chapter 12 example 9

```
clear;
```

```
clc;
d = 4;//inches
T = 30;// ton-inches
M = 20;//ton-inches
m = 1/0.3;
f_s = 16*T/(%pi*d^3);// tons/in^2
f_b = 32*M/(%pi*d^3);// tons/in^2
theta = 0.5*atan(T/M);// radians
theta1 = theta*180/%pi;
theta2 = theta1+90;
f1 = 0.5*f_b + sqrt(f_s^2 + 0.25*f_b^2);// tons/in^2
f2 = 0.5*f_b - sqrt(f_s^2 + 0.25*f_b^2);// tons/in^2
Ee = f1 - (f2/m);// tons/in^2
f = sqrt(f1^2 + f2^2 - 2*f1*f2/m);// tons/in^2
printf('Maximum strain is Ee = %.3f tons/in^2',Ee);
printf('\n Maximum strain energy is f = %.3f tons/in
    ^2',f);
```

Scilab code Exa 12.10 Chapter 12 example 10

```
clear;
clc;
HP = 80;
RPM = 120;
b = 10;// feet
h = 3;// feet
F = 8000;// lb-wt
m = 4;
T = HP*33000*12/(2*%pi*RPM*2240);// ton-inches
M = F*h*(b-h)*12/(b*2240);// ton-inches
//(i) The major principal stress f1 is given by
f1 = 6;// tons/in^2
d1 = ((M+sqrt(M^2 + T^2))*16/(%pi*f1))^(1/3);//
    inches

```

```
//(ii) If f_s_dash is the maximum intensity of shear stress
f_s_dash = 3;// tons/in^2
d2 = (sqrt(M^2 + T^2) * 16/(%pi*f_s_dash))^(1/3);// inches

//(iii) If e is the major principal strain
Ee = 6;// tons/in^2
d3 = (((1-(1/m))*M + (1+(1/m))*sqrt(M^2 + T^2))*16/(%pi*Ee))^(1/3);// inches

//(iv) If f is the direct stress which, acting alone will produce the same maximum strain energy
f = 6;// tons/in^2
d4 = ((sqrt(4*M^2 + 2*(m+1)*(T^2)/m))*16/(%pi*f))^(1/3);// inches
printf('The diameter of the shaft in different cases will be, (i) d = %.3f inches\n (ii) d = %.3f inches\n (iii) d = %.3f inches\n (iv) d = %.3f inches',d1,d2,d3,d4);
//there are round-off errors in the answers given in textbook.
```

Scilab code Exa 12.11 Chapter 12 example 11

```
clear;
clc;
D = 12;// inches
d = 6;// inches
HP = 2400;
RPM = 80;
```

```
M = 40;// ton-feet
P = 25;// tons
PR = 0.3;//poisson's ratio
A = 0.25*%pi*(D^2 - d^2);// in^2
Z = (%pi/32)*(D^4 - d^4)/D;// in^3
J = (%pi/16)*(D^4 - d^4)/D;// in^3
p_0 = P/A ;// ton/in^2
p_b = M*12/Z ;// tons/in^2
f_b = p_0 + p_b;//tons/in^2
f_s = HP*33000*12/(2*%pi*RPM*2240*J);// tons/in^2
theta = 0.5*atan(2*f_s/f_b);// radians
theta1 = theta*180/%pi;// degrees
theta2 = theta1+90;//degrees
f_1 = 0.5*f_b + sqrt(f_s^2 + 0.25*f_b^2);//tons/in^2
f_2 = 0.5*f_b - sqrt(f_s^2 + 0.25*f_b^2);//tons/in^2
f = sqrt(0.25*f_b^2 + f_s^2);// tons/in^2
Ee = f_1 - PR*f_2;// tons/in^2
printf('The maximum principal stresse are f_1 = %.3f
    tons/in^2.,compressive \n        f_2 = %.3f tons/
   in^2., tensile',f_1,-f_2);
printf('\n theta1 = %.1f degrees\n theta2 = %.1f
   degrees',theta1,theta2);
printf('\n The maximum shear intensity = %.3f tons/
   in^2',f);
printf('\n Maximum strain is , Ee = %.3f tons/in^2',
   Ee);

//there are minute errors in the answers given in
   textbook.
```

Scilab code Exa 12.12 Chapter 12 example 12

```
clear;
clc;
RPM = 180;
```

```
P = 10;// tons
v = 25;// feet per minute
n = 64/100;// efficiency of the crane
f = 5500;// lb/in^2
l = 10;// feet
N = 12*10^6;// lb/in^2
W = P*v*2240/n;// ft-lbs
T = W*12/(2*%pi*RPM);// lb-inches
s = (T/(0.208*f))^(1/3);// inches
theta = 7.11*T*l*12*180/(%pi*N*s^4);// degrees
printf('The size of the shaft is s = %.3f inches',s);
printf('\n The angle of the twist in the shaft for a length of %d feet, theta = %.3f degrees',l,theta);
//there is a round-off error in the answer given in textbook.
```

Scilab code Exa 12.13 Chapter 12 example 13

```
clear;
clc;
d = 3/8;// inches
n = 12;//no. of complete turns
D = 4;// inches
W = 50;// lb-wt
N = 12*10^6;// lb/in^2
T = W*0.5*D;// lb-inches
f_s = T*16/(%pi*d^3);//lb/in^2
delta = 64*W*(D^3 /8)*n/(N*d^4);// inches
E = 0.5*W*delta;// inch-lbs
printf('Shear stress induced is f_s = %d lb/in^2',f_s);
printf('\n Deflection under the pull is delta = %.3f inches',delta);
```

```
printf('\n Energy stored = %.3f lb-inches',E);

//there is a minute error in the answer given in
   textbook.
```

Scilab code Exa 12.14 Chapter 12 example 14

```
clear;
clc;
W = 2;// tons
v = 4;// miles per hour
n = 18;// no. of coils
delta = 9;// inches
N = 6000;// tons/in^2
d = 1;// inch
D = 8;// inches
KE = 12*(W*(v*44/30)^2)/(2*32);// inch-tons
P = (delta*N*d^4)/(64*n*(0.5*D)^3);// tons
E = 0.5*P*delta;// inch-tons
m = KE/E ;// no. of springs required
printf('The number of springs required m = %d',round
   (m));
```

Scilab code Exa 12.15 Chapter 12 example 15

```
clear;
clc;
W = 5;// cwt
n = 18;// no. of coils
delta = 9;// inches
d = 1;// inch
D = 8;// inches
N = 6000;// tons/in^2
```

```
P = (delta*N*d^4)/(64*n*(0.5*D)^3);// tons
h = (0.5*P*delta*20/W)-delta;// inches
printf('The height of drop h = %.3f inches',h);
```

Scilab code Exa 12.16 Chapter 12 example 16

```
clear;
clc;
s = 1/4;// inch
n = 12;// no. of coils
D = 3;// inches
f_s = 45000;// lb/in^2
N = 12*10^6;// lb/in^2
T = 0.208*f_s*s^3;// lb-inches
W = T/(0.5*D);// lb-wt
theta = 7.11*T*%pi*D*12/(N*s^4);//rdaians
delta = 0.5*D*theta;// inches
printf('Maximum possible axial load is W = %.1f lb-
    wt',W);
printf('\n Deflection , delta = %.3f inches',delta);

//there is a minute error in the answer given in
    textbook.
```

Scilab code Exa 12.17 Chapter 12 example 17

```
clear;
clc;
d = 3/8;// inches
n = 12;//no. of complete turns
D = 4;// inches
W = 50;// lb-wt
N = 12*10^6;// lb/in^2
```

```
E = 30*10^6;// lb/in^2
M = 75;// lb-inches
I = (%pi/64)*d^4;// in^4
Z = 2*I/d;// in^3
f = M/Z ;// lb/in^2
phi = M*%pi*D*12/(E*I);// radians
n_ = (phi/(2*%pi)) + n;// increase in no. of turns
printf('The bending stress is f = %d lb/in^2',f);
printf('\n n_new = %.5f turns',n_);

//there are minute errors in the answers given in textbook.
```

Scilab code Exa 12.18 Chapter 12 example 18

```
clear;
clc;
d = 3/8;// inches
n = 12;//no. of complete turns
D = 4;// inches
W = 50;// lb-wt
N = 12*10^6;// lb/in^2
alpha = 15*%pi/180;// degrees
E = 30*10^6;// lb/in^2
T = W*0.5*D*cos(alpha);// lb-inches
M = W*0.5*D*sin(alpha);// lb-inches
J = %pi*d^4 /32;// in^4
I = %pi*d^4 /64;// in^4
delta = 64*W*((D/2)^3)*n*sec(alpha)*((cos(alpha)^2)/N + (2*sin(alpha)^2)/E)/d^4 ;// inches
f = 32*W*0.5*D*sin(alpha)/(%pi*d^3) ;// lb/in^2
f_s = T*16/(%pi*d^3);// lb/in^2
f_1 = 0.5*f + sqrt(f_s^2 + 0.25*f^2);// lb/in^2
f_2 = 0.5*f - sqrt(f_s^2 + 0.25*f^2);// lb/in^2
f_s_dash = sqrt(f_s^2 + 0.25*f^2);// lb/in^2
```

```
printf('Deflection , delta = %.3f inches',delta);
printf('\n f = %d lb/in^2\n f_s = %d lb/in^2',f,f_s)
    ;
printf('\n The maximum intensity of shear stress =
    %d lb/in^2',f_s_dash);

//there are calculation errors in the answers given
    in textbook
```

Scilab code Exa 12.19 Chapter 12 example 19

```
clear;
clc;
d = 3/8;// inches
n = 12;//no. of complete turns
D = 4;// inches
M = 75;// lb-inches
N = 12*10^6;// lb/in^2
alpha = 15*%pi/180;// degrees
E = 30*10^6;// lb/in^2
phi_dash = (64/d^4)*M*0.5*D*n*sec(alpha)*((2*(cos(
    alpha))^2)/E + ((sin(alpha))^2)/N);// radians
DELTA = 64*M*((0.5*D)^2)*n*sin(alpha)*((1/N) - (2/E)
    )/d^4;// inches
printf('Angle of rotation phi_dash = %.4f radians or
    %.2f degrees',phi_dash,phi_dash*180/%pi);
printf('\n The axial deflection = %.4f inches',DELTA
    );
```

Chapter 13

Elements of reinforced concrete

Scilab code Exa 13.1 Chapter 13 example 1

```
clear;
clc;
b = 10;//inches
d = 1;//inches
h = 20;//inches
r = 2;//inches
M_r = 500000;//lb-inches
m = 15;
A_r = 4*0.25*%pi*d^2;//in^2
h_eff = h-r;//inches
K = m*A_r/(b*h_eff);//inches
n1 = sqrt((K)^2+(2*K))-K;
n = n1*h_eff;//inches
a = h_eff-(n/3);//inches
c = 2*M_r/(b*n*a);//lb/in^2
t = (h_eff-n)*m*c/n;//lb/in^2
printf('The stress induced in the concrete and steel
    , t = %d lb/in^2',t);

//there is a minute error in the answer given in
    textbook.
```

Scilab code Exa 13.2 Chapter 13 example 2

```
clear;
clc;
b = 8;//inches
d = 7/8;//inches
h = 18;//inches
r = 2;//inches
c = 750;//lb/in^2
t_limit = 18000;//lb/in^2
m = 8;
h_eff = 16;//inches
m = 18;
A_t = 3*0.25*%pi*d^2;//in^2
K = m*A_t/(b*h_eff);//inches
n1 = sqrt((K)^2+(2*K))-K;
n = n1*h_eff;//inches
a = h_eff - (n/3);//inches
t = m*c*(h_eff-n)/n;//lb/in^2

if t<t_limit then
    t = t;
else
    t = t_limit;
end

M_r = t*A_t*a;// lb/inches
W = M_r*8/(12*h_eff);//lb-wt
printf('The distance of the N.A from the top edge, n
    = %.3f inches.',n);
printf('\n The safe moment of inertia is, t = %d lb/
    in^2.',t);
printf('\n Unifromly distributed load over the beam,
    W = %d lb-wt. or %d lb. per foot run',W,W
```

```
/16.011);

//there are calculation errors given in the answer in textbook.
```

Scilab code Exa 13.3 Chapter 13 example 3

```
clear;
clc;
function Z = quadratic(d,M_c,c_limit,b)
    n = poly(0,"n");
    p = n^2-(d*3)*n + M_c*3/(0.5*c_limit*b);
    Z = roots(p);
endfunction
b = 12;//inches
h = 22;//inches
r = 2;//inches
W = 1500;//lb per foot run
d = h-r;//feet
l = 20;//inches
c_limit = 700;// lb/in^2
m = 15;
M_c = W*20*l*b/8;// lb-inches
Z = quadratic(d,M_c,c_limit,b);
n = round(Z(2));
t = m*c_limit*(d-n)/n;// lb/in62
A_t = 0.5*c_limit*b*n/t;// in^2
printf('Area of steel reinforcement required is, A_t = %d in^2',A_t);
printf('\n Corresponding stress in steel is, t = %d lb/in^2',t);
```

Scilab code Exa 13.4 Chapter 13 example 4

```
clear;
clc;
m = 15;
t = 18000;// lb/in^2
c = 700;// lb/in^2
b = 12;;// inches
M = 900000;//bending moment lb/inches
k1 = 1/((t/(m*c))+1);//k = n/d
k2 = 1-k1/3;//k2 = a/d
p = 0.5*c*k1/(t);
d = sqrt(M/(0.5*c*b*k1*k2));//inches
A_t = p*b*d;// sq.inches
A_t_previous = 0.25*%pi*(7/8)^2;//section area with
    diameter 7/8 inches
n = A_t/A_t_previous;
printf('Effective deapth is d = %.2f inches',d);
printf('\n A_t = %.3f sq.inches',A_t);
```

Scilab code Exa 13.5 Chapter 13 example 5

```
clear;
clc;
l = 20;//feet
W = 500;// lb per foot run
c = 750;// lb/in^2
t = 18000;// lb/in^2
m = 15;
BM_max = W*l*l*12/8 ;// lb-inches
//by making the effective deapth d twice the width b
d = (BM_max/(126*0.5))^(1/3);//inches
b = 0.5*d;//inches
//necessary reinforcement is 0.8% of concrete
    section
A_t = 0.008*b*d;// in^2
printf('d = %.2f inches\n b = %.2f inches',d,b);
```

```
printf('\n A_t = %.3f in^2',A_t);
```

Scilab code Exa 13.6 Chapter 13 example 6

```
clear;
clc;
W = 180;// lb per sq.foot
l = 10;// feet
b = 12;//inches
c = 750;// lb/in^2
m = 15;
M = W*l*l*12/8;//lb-inches
d_new = sqrt(M/(126*b));//inches
A_t = 0.8*b*d_new/100;//in^2
//using 3/8 inch rods
d1 = 3/8;//inches
A1 = 0.25*%pi*(d1)^2;//in^2
r1 = A1*b/A_t;//inch
//using 1/2 inch rods
d2 = 1/2;//inches
A2 = 0.25*%pi*(d2)^2;//in^2
r2 = A2*b/A_t;//inches
printf('d = %.3f inches',d_new);
printf('\n A_t = %.3f in^2',A_t);
printf('\n Using %.3f inch rods, spacing centre to
    centre will be %.2f inches',d1,r1);
printf('\n Using %.2f inch rods, spacing centre to
    centre will be %.1f inches',d2,r2);
//there are round-off errors in the answer given in
    textbook
```

Scilab code Exa 13.7 Chapter 13 example 7

```
clear;
clc;
l = 12;//feet
w = 150;// lb per sq.foot
//Live load
LL = w*l;//lb-wt
//Dead Load assuming the slab thickness to be 6 inches
t = 6;//inches
DL = t*l*12;//lb-wt
//total load
W = LL+DL;//lb-wt
M = W*l*12/10;//lb-inches
d = sqrt(M/(12*126));
printf('d = %.3f inches',d);
//With about an inch to cover the slab will be 6 inch thick
A_t = 0.8*l*d/100;// in^2
//using 1/2 inch rods
d1 = 1/2;//inches
A1 = 0.25*%pi*(d1)^2;//in^2
r1 = A1*l/A_t;//inches
printf('\n Per foot width of slab, A_t = %.4f in^2',A_t);
printf('\n Using %.2f inch rods, spacing centre to centre will be %.3f inches',d1,r1);
//there are minute calculation errors in the answer given in textbook.
```