

Scilab Textbook Companion for  
Mechanics of Structures  
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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.

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# Chapter 1

## Simple stresses and strains

Scilab code Exa 1.1 Chapter 1 example 1

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

---

Scilab code Exa 1.2 Chapter 1 example 2

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

```

5 b = 4; //breadth in inches
6 p = 14000; //permissible stress in lb/in^2
7 P = s_p*1*b; //Pull on each bolt in lb-wt
8 A = P/p ; //necessary area of bolt-section
9 d = sqrt(4*A/%pi) ; //minimum diameter in inches
10 printf('The minimum diameter d of each stay bolt =
    %0.2f inch ',d);

```

---

### Scilab code Exa 1.3 Chapter 1 example 3

```

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

```

---

### Scilab code Exa 1.4 Chapter 1 example 4

```

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

```

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

---

#### Scilab code Exa 1.5 Chapter 1 example 5

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

---

#### Scilab code Exa 1.6 Chapter 1 example 6

```
1 clear all;
2 clc;
3 d = 7/8;//diameter of the bar in inches
4 l = 10;//length in feet
```

```

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

```

---

### Scilab code Exa 1.7 Chapter 1 example 7

```

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

```

```

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

```

---

### Scilab code Exa 1.8 Chapter 1 example 8

```

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

```

```
inches',del_1);
```

---

### Scilab code Exa 1.9 Chapter 1 example 9

```
1 clear ;
2 clc ;
3 d = 1; //diameter of the steel bar in inches
4 l = 12; //length of the steel bar in inches
5 d1 = 3/2; //external diameter in inches
6 d2 = 1; //internal diameter in inches
7 P = 5; //axial pull in tons
8 E_s = 30*10^6; //modulus of elasticity of steel in lb
   /in^2
9 E_b = 14*10^6; //modulus of elasticity of brass in lb
   /in^2
10 A_s = 0.25*%pi*d^2; //area of the steel section in in
   ^2
11 A_b = 0.25*%pi*(d1^2-d2^2); //area of the brass
   section in in^2
12 P_b = (P/((E_s/E_b)*A_s+A_b))*A_b; //load resisted by
   the brass tube in tons
13 P_s = P-P_b; //balance load resisted by the steel
   tube
14 e = (P_b/A_b)*2240/E_b ; //strain
15 printf('The strain e = %.4f',e);
16 del_1 = e*l ; //extension of the bar in inches
17 printf('\n The extension of the bar = %.4f inches',
   del_1);
18 W = 0.5*P*del_1; //work done in stretching in inch-
   ton
19 printf('\n The work done in stretching is %.3f inch-
   ton',W);
```

---

Scilab code Exa 1.10 Chapter 1 example 10

```
1 clear ;
2 clc ;
3 a = 12; //length of each side in inches
4 d = 9/8; //diameter of each reinforced bar in inches
5 r = 3; //distance of centre from the edges in inches
6 p_c = 600; //in lb/in^2
7 n = 18; //modular ration E_s/E_c
8 A_s = 4*0.25*%pi*d^2; //in in^2
9 A_c = a^2 - A_s; //in in^2
10 p_s = n*p_c; //in lb/in^2
11 P = p_s*A_s+p_c*A_c; //safe central load in lb-wt
12 printf('Safe central load = %d lb-wt',P);
13 printf('\n Of this , the reinforcing bars carry %d lb
    -wt',p_s*A_s);
14
15 //there is an error in the answer given in textbook.
```

---

Scilab code Exa 1.11 Chapter 1 example 11

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

```

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

```

---

### Scilab code Exa 1.12 Chapter 1 example 12

```

1 clear ;
2 clc ;
3 alpha = 0.0000062 ;//co-efficient of the expansion
   in "per F"
4 t = 100; //in F
5 d = 3/4; //in inches
6 del = 0.02; //in inches
7 l = 15; //in ft
8 E = 13000; //in tons/in^2
9 e = alpha*t - (del/(1*12));
10 p = E*e; //in tons/in^2
11 A = 0.25*pi*d^2; //in in^2
12 P = p*A ; //in tons
13 printf('Tensile strain imposed by end-grips ,e = %.5f
   ',e);
14 printf('\n p = %.2f tons/in^2\n P = %.2f tons ',p,P);

```

---

### Scilab code Exa 1.13 Chapter 1 example 13

```

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

```



```

9 E_s = 30*10^6; //in lb/in^2
10 E_b = 14*10^6; //in lb/in^2
11 A_s = 0.25*%pi*d^2; //section area of steel bar in in
    ^2
12 A_b = 0.25*%pi*(d1^2-d2^2); //section area of brass
    tube in in^2
13 p_b = t*(alpha_b-alpha_s)*E_s/((A_b/A_s)+(E_s/E_b));
14 p_s = (A_b/A_s)*p_b;
15 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

```

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

```

---

**Scilab code Exa 1.15** Chapter 1 example 15

```

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

```

```

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

```

---

#### Scilab code Exa 1.16 Chapter 1 example 16

```

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

```

```

17 printf('\n E = %d tons/in^2',E);
18 printf('\n N = %d tons/in^2',N);
19 printf('\n K = %d tons/in^2',K);
20
21 //there is an error in the answer given in textbook.

```

---

**Scilab code Exa 1.17** Chapter 1 example 17

```

1 clear;
2 clc;
3 N = 2640; //rigidity modulus in tons/in^2
4 d = 3/8; //diameter of the rod in inches
5 P = 1/2; //axial pull in tons
6 del_d = 0.000078; //change in diameter in inches
7 A = 0.25*pi*d^2; //section area in in^2
8 p = P/A ; //stress tons/in^2
9 LS = del_d/d; //lateral strain
10 m = p/(LS*2*N) - 1;
11 E = 2*N*(1 + 1/m); //modulus of elasticity in ton/in
    ^2
12 PR = 1/m; //poisson's ratio
13 printf('Poisson ratio 1/m = %.3f',PR);
14 printf('\n E = %d ton/in^2',E);
15
16 //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

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

```

    in^2',p);
14 printf('\n angle alpha p_n = %.2f degrees ',alpha);
15
16 //there is an error in the answer given in text book

```

---

### Scilab code Exa 2.3 Chapter 2 example 3

```

1 clear;
2 clc;
3 d = 3/4 ;//inches
4 P = 2;//tons
5 Q = 0.5;//tons
6 m = 4;
7 A = 0.25*pi*d^2;//in^2
8 p = P/A ;//tons/in^2
9 q = Q/A;//tons/in^2
10 theta = 0.5*atan(2*q/p);//radians
11 theta1 = theta*180/pi;//degrees
12 theta2 = theta1+90;//degrees
13 printf('The inclination of principal planes to the
    axis of the bolt will be %.2f degress and %.2f
    degrees respectively ',theta1,180-theta2);
14 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);
15 p_1 = 0.5*p+sqrt(0.25*p^2+q^2);//tons/in^2
16 p_2 = 0.5*p-sqrt(0.25*p^2+q^2);//tons/in^2
17 p_max = 0.5*(p_1-p_2);//tons/in^2
18 p_s = p_1-(p_2/m);//tons/in^2
19 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);
20 printf('\n Maximum shear stress is p_max = %.2f tons

```

```

    /in^2',p_max);
21 printf('\n The stress which acting alone will
    produce the same maximum strain is given by, %.2f
    tons/in^2',p_s);
22
23 //there is an error in the answer given in text book

```

---

#### Scilab code Exa 2.4 Chapter 2 example 4

```

1 clear;
2 clc;
3 q = 2; //tons/in^2
4 p = 5; //tons/in^2
5 p_dash = 2; //tons/in^2
6 theta = 0.5*atan(2*q/(p-p_dash)); //radians
7 theta1 = theta*180/%pi; //degrees
8 theta2 = theta1+90; //degrees
9 p_1 = 0.5*(p+p_dash)+sqrt(q^2 + 0.25*(p-p_dash)^2);
    //tons/in^2
10 p_2 = 0.5*(p+p_dash)-sqrt(q^2 + 0.25*(p-p_dash)^2);
    //tons/in^2
11 q_max = 0.5*(p_1-p_2); //tons/in^2
12 printf('The principal stresses are p_1 = %d tons/in
    ^2 ., tensile\n p_2 = %d tons/in^2., tensile',p_1
    ,p_2);
13 printf('\n The maximum shear stress is %.1f tons/in
    ^2., the planes offering it being inclined at %.2
    f 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);
14 //there is an error in the answer given in text book

```

---

#### Scilab code Exa 2.5 Chapter 2 example 5

```

1 clear;
2 clc;
3 p_res = 6; //tons/in^2
4 p_dash = 4; //tons/in^2
5 theta = 30*%pi/180; //degrees
6 p_n = 4; //tons/in^2
7 p = p_res*cos(theta); //tons/in^2
8 q = p_res*sin(theta); //tons/in^2
9 L = 2*q/(p-p_dash);
10 theta = 0.5*atan(2*q/(p-p_dash));
11 theta1 = theta*180/%pi; //degrees
12 theta2 = theta1+90; //degrees
13 p_1 = 0.5*(p+p_dash)+sqrt(q^2 + 0.25*(p-p_dash)^2);
    //tons/in^2
14 p_2 = 0.5*(p+p_dash)-sqrt(q^2 + 0.25*(p-p_dash)^2);
    //tons/in^2
15 p_max = 0.5*(p_1-p_2); //tons/in^2
16 printf('Theta1 = %.2f degrees and Theta2 = %.2f
    degrees ',theta1,theta2);
17 printf('\n p_1 = %.2f tons/in^2., tensile\n p_2 = %.2
    f tons/in^2., tensile ',p_1,p_2);
18 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

```

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

```

```

9 e_2 = (p_2/E)+(p_1/(m*E))+(p_3/(m*E));
10 e_3 = (p_3/E)-(p_1/(m*E))+(p_2/(m*E));
11 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

```

1 clear;
2 clc;
3 a = 2;//inches
4 l = 6;//inches
5 E = 13000;//tons/In^2
6 m = 1/0.3;
7 P = 20;//tons
8 p_1 = P/a^2;//tons/in^2
9 p_2 = p_1/(2*(m-1));//tons/in^2
10 e_1 = (5-0.6*p_2)/E;//tons/in^2
11 del_l = e_1*l;//inches
12 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

```
1 clear;
2 clc;
3 d = 3/2; //inches
4 l = 10; //feet
5 P = 8; //tons
6 E = 13500; //tons/in^2
7 A = 0.25*pi*d^2; //in^2
8 p = 2*P/A; // tons/in^2
9 e = p/E;
10 del_l = e*l*12; //inches
11 W = P*del_l; //inch-ton
12 printf('The maximum instantaneous stress produced is
    , p = %.2f tons/in^2',p);
13 printf('\n The corresponding strain is e = %.6f \n
    del_l = %.2f inches ',e,del_l);
14 printf('\n The work done on the rod and stored by it
    is %.2f inch-ton. ',W);
15
16 //there is an error in the answer given in text book
```

---

### Scilab code Exa 3.2 Chapter 3 example 2

```
1 clear;
2 clc;
3 l = 6; //feet
4 d = 1; //inches
5 h = 4; //inches
6 E = 30*10^6; //lb/in^2
7 A = 0.25*pi*d^2; //in^2
8 P = 50; //lb
9 p = (P/A)+sqrt((P^2/A^2)+(2*E*P*h)/(A*l*12));
10 e = p/E;
11 del_l = e*l*12 //inches
12 printf('Maximum instantaneous stress produced is p =
        %d lb/in^2 ',p);
13 printf('\n Maximum instantaneous extension produced
        is del_l = %.3f lb/in^2 ',del_l);
14
15 //there is an error in the answer given in text book
```

---

### Scilab code Exa 3.3 Chapter 3 example 3

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

```

11 h = W*10-del_l1;//inches
12 printf('Instantaneous elongation is del_l = %.3f
    inches ',del_l1);
13 printf('\n Height of the drop is h = %.2f inches ',h)
    ;

```

---

#### Scilab code Exa 3.4 Chapter 3 example 4

```

1 clear;
2 clc;
3 w = 4;//tons
4 v = 2;//miles per hour
5 l = 150;//feet
6 d = 3/2;//inches
7 E = 13000;// tons/in^2
8 g = 32;// ft/sec^2
9 A = 0.25*pi*d^2;// in^2
10 KE = w*(v*17.6)^2/(2*g*12);// inch-tons
11 p = sqrt(KE*(2*E)/(A*l*12));// tons/in^2
12 del_l1 = p*l*12/E;// inches
13 printf('Maximum instantaneous stress produced is p =
    %.2f tons/in^2 ',p);
14 printf('\n Maximum instantaneous extension produced
    is del_l = %d inch ',del_l1);

```

---

#### Scilab code Exa 3.5 Chapter 3 example 5

```

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

```

```

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

```

---

### Scilab code Exa 3.6 Chapter 3 example 6

```

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

```

```
19 printf('\n Ratio of energies stored if both bars are
    allowed to reach the proof stress is r1 = %.2f '
    ,r1);
20 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

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

---

Scilab code Exa 5.2 Chapter 5 example 2

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

```

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

```

---

### Scilab code Exa 5.3 Chapter 5 example 3

```

1 clear;
2 clc;
3 d = 16; // inches
4 I = 618; // inch units
5 l = 24; // feet
6 f = 15/2; // tons/in^2
7 Z = I/(d/2); // inch-units
8 M_r = f*Z; // ton-inches
9 //If the load is uniformly spread over its span, BM
    = W*l/8
10 W1 = 8*M_r/(12*l); //tons
11 //If the load is concentrated at the centre ,BM = W*
    l/4
12 W2 = 4*M_r/(12*l); //tons
13 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);
14 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

```

1 clear;

```

```

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

```

---

#### Scilab code Exa 5.5 Chapter 5 example 5

```

1  clear;
2  clc;
3  function [M,f]=func(W,l,d,b,Z)
4      M = 0.5*W*d - (W/l)*d*b;
5      f = M*12/Z;
6  endfunction
7  b = 6; // inches
8  d = 12; // inches
9  l = 16; // feet
10 W = 6000; // lb-wt
11 Z = (1/6)*b*d^2;
12 d1 = 2; // feet
13 d2 = 4; // feet
14 d3 = 6; // feet
15 d4 = 8; // feet
16 b1 = 1 // feet
17 b2 = 2; // feet
18 b3 = 3; // feet
19 b4 = 4; // feet
20 [M2,f2] = func(W,l,d1,b1,Z);
21 [M4,f4] = func(W,l,d2,b2,Z);
22 [M6,f6] = func(W,l,d3,b3,Z);

```



```

23 [M8,f8] = func(W,l,d4,b4,Z);
24 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

```

1 clear;
2 clc;
3 w = 160; // lb. per sq. foot
4 b = 3; // inches
5 d = 9; // inches
6 l = 15; // feet
7 f = 1200; // lb. per sq. inch
8 Z = (1/6)*b*d^2; // in^3
9 M_r = f*Z; // lb-inches
10 x = M_r/(w*l^2*12/8); // feet
11 printf('x = %.1f feet',x);
12
13 //The answer is correct only, but it is approximated
    in the text book

```

---

### Scilab code Exa 5.7 Chapter 5 example 7

```

1 clear;
2 clc;
3 l = 20; // feet
4 b = 9; // inches
5 h = 10; // feet
6 w = 120; // lb. per cub. foot
7 f = 1100; // lb/in^2

```

```

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

```

---

#### Scilab code Exa 5.8 Chapter 5 example 8

```

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

```

---

#### Scilab code Exa 5.9 Chapter 5 example 9

```

1 clear;
2 clc;

```

```

3 D = 19.5; // inches
4 d = 18; // inches
5 l = 30; // feet
6 t1 = 3/4; // inch
7 rho1 = 450; // lb. per cub. foot
8 rho2 = 62.5; // lb. per cub. foot
9 A = 0.25*pi*(D^2 - d^2); // sq. in
10 DW = rho1*l*A/144; // lb-wt
11 WW = rho2*0.25*pi*(D-d)^2*l; // lb-wt
12 W = DW+WW; // lb-wt
13 BM_max = W*l*0.0004467202*12/8; // ton-inches
14 I_xx = (pi/64)*(D^4 - d^4); // in^4
15 Z_xx = I_xx/(0.5*d+t1); // ton/in^2
16 f = BM_max/Z_xx; // ton/in^2
17 printf('The maximum stress f = %.3f ton/in^2',f);
18
19 //there is an error in the answer given in text book

```

---

### Scilab code Exa 5.11 Chapter 5 example 11

```

1 clear;
2 clc;
3 b = 6; // inches
4 d = 12; // inches
5 t1 = 7/8; // inch
6 t2 = 1/2; // inch
7 I_xx = (1/12)*(b*d^3 - (b-t2)*(d-2*t1)^3); // in^4
8 Z1 = I_xx/b; // in^3
9 A = 2*b*t1 + 0.5*(d-2*t1); // in^2
10 b = sqrt(A/2); // inches
11 d = 2*b; // inches
12 Z2 = (1/6)*b*d^2; // in^3
13 k = Z1/Z2 ;
14 printf('The ratio of strengths Z1/Z2 = %.2f ',k);
15

```

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

---

**Scilab code Exa 5.12** Chapter 5 example 12

```
1 clear;
2 clc;
3 A = 15.625; // in^2
4 Z1 = 61.75; // in^3
5 Z2 = 14.63; // in^3
6 d = sqrt(4*A/%pi); // inches
7 Z3 = (%pi/32)*d^3; // in^3
8 R1 = Z1/Z3;
9 R2 = Z2/Z3;
10 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

```
1 clear;
2 clc;
3 D = 8; // inches
4 B = 3; // inches
5 t1 = 1/2; // inch
6 t2 = 3/8; // inch
7 b = B-t2; // inches
8 d = D-2*t1; // inches
9 a1 = t1*B; // in^2
10 x1 = 0.5*B; // inches
11 a2 = t2*(D-2*t1); // in^2
12 x2 = 0.5*t2; // inches
13 a3 = B*t1; // in^2
```

```

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

```

---

#### Scilab code Exa 5.14 Chapter 5 example 14

```

1 clear;
2 clc;
3 b = 6; // inches
4 d = 4; // inches
5 t = 5/8; // inch
6 a1 = d*t; // in^2
7 y1 = d/2; // inches
8 a2 = (b-t)*t; // in^2
9 y2 = t/2; // inch
10 a = a1+a2; // in^2
11 J = (a1*y1+a2*y2)/(a1+a2); // inches
12 I_AB = (1/3)*t*d^3 + (1/3)*(b-t)*t^3; // in^4
13 I_xx = I_AB - a*J^2; // in^4
14 I_yy = (1/12)*t*b^3 + (1/12)*(d-t)*t^3; // in^4
15 printf('The position of the c.g is J = %.2f inches ',
    J);
16 printf('\n I_xx = %.2f in^4\n I_yy = %.2f in^4',I_xx
    ,I_yy);
17
18

```

```

19 //14(a)
20 H = 18; // feet
21 l = 10; // feet
22 w = 3/2; // cwt/ per .sq. foot
23 y_c = 2.97; // inches
24 y_t = 1.03; // inches
25 W = (3/40)*(w*l); // tons
26 BM_max = W*l*12/8; // ton-inches
27 M_r = BM_max; // ton-inches
28 f_c = M_r*y_c/I_xx ; // tons/in^2
29 f_t = M_r*y_t/I_xx ; // tons/in^2
30 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

```

1 clear;
2 clc;
3 b = 5; // inches
4 d = 4; // inches
5 t = 1/2; // inches
6 a1 = b*t; // in^2
7 x1 = t/2; // inches
8 y1 = b/2; // inches
9 a2 = (d-t)*t; // in^2
10 y2 = t/2; // inch
11 x2 = t + 0.5*(d-t); // inches
12 x_bar = (a1*x1+a2*x2)/(a1+a2); // inches
13 y_bar = (a1*y1+a2*y2)/(a1+a2); // inches
14 I_AB = (1/3)*t*b^3 + (1/3)*(d-t)*t^3; // in^4
15 I_xx = I_AB - (a1+a2)*y_bar^2; // in^4
16 I_yy = (1/3)*t*d^3 + (1/3)*(b-t)*t^3 - (a1+a2)*x_bar
        ^2; // in^4
17 printf('The position of c.g is x_bar = %.3f inches ,
        y_bar = %.2f inches ',x_bar,y_bar);

```

```

18 printf('\n I_xx = %.3f in^4\n I_yy = %.2f in^4',I_xx
    ,I_yy);
19
20
21
22 //Example 15(a)
23 l = 12; // feet
24 y_c = y_bar; //inches
25 y_t = b - y_c; //inches
26 f_t_max = 7; // tons/in^2
27 f_c = y_c*f_t_max/y_t; // tons/in^2
28 M_r = f_t_max*I_xx/y_t; // ton-inches
29 W = M_r/(l*12/8); // tons
30 printf('\n \n Total uniformly distribute load over
    the span is W = %.2f tons',W);

```

---

**Scilab code Exa 5.16** Chapter 5 example 16

```

1 clear;
2 clc;
3 b1 = 6; //inches
4 d1 = 1; //inch
5 b2 = 9; //inches
6 d2 = 1; //inch
7 b3 = 10; //inches
8 d3 = 2; //inch
9 a1 = b3*d3; // in^2
10 y1 = d3/2; // inches
11 a2 = b2*d2; // in^2
12 y2 = d3 + b2/2; // inches
13 a3 = b1*d1; // in^2
14 y3 = b2+d3+d1/2; // inches
15 y_bar = (a1*y1+a2*y2+a3*y3)/(a1+a2+a3); //inches
16 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

```

```

17 I_xx = I_AB - (a1+a2+a3)*y_bar^2; // in^4
18 I_yy = (1/12)*(d3*b3^3 + b2*d2^3 +d1*b1^3); // in^4
19 printf('The c.g of the section is y_bar = %.3f
    inches ',y_bar);
20 printf('\n I_xx = %.2f in^4\n I_yy = %.2f in^4',I_xx
    ,I_yy);
21
22 //Example 16(a)
23 l = 20; // feet
24 y_t = y_bar; // inches
25 y_c = d1+b2+d3-y_t; // inches
26 f_t = 1.5; // tons/in^2
27 f_c = y_c*f_t/y_t; // tons/in^2
28 M_r = f_c*I_xx/y_c; // ton-inches
29 W = M_r*8/(l*12); // tons
30 w = W/l; // ton per foot run
31 printf('\n\n Load required is w = %.2f ton per foot
    run ',w);

```

---

#### Scilab code Exa 5.17 Chapter 5 example 17

```

1 clear;
2 clc;
3 b = 12; // inches
4 d = 6; // inches
5 h = 14; // inches
6 t = 1/2; // inch
7 A = 12.94; // in^2
8 //section moment of inertia
9 I_xx_s = 315.3; // in^4
10 I_yy_s = 22.27; // in^4
11
12 I_xx = 2*I_xx_s + 2*((1/12)*h*(2*t)^3 + h*2*t*(d+t)
    ^2); // in^4
13 I_yy = 2*(I_yy_s + A*(d/2)^2) + 2*((1/12)*2*t*h^3);

```



```

    // in^4
14 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

```

1 clear;
2 clc;
3 b = 15; // inches
4 d = 15/2; // inches
5 h = 16; // inches
6 t = 1/2; // inch
7 P = 0.935; // inches
8 A = 12.33; // in^2
9 //section moment of inertia
10 I_xx_s = 377; // in^4
11 I_yy_s = 14.55; // in^4
12
13 I_xx = 2*I_xx_s + 2*((1/12)*h*(2*t)^3 + h*2*t*(d+t)
    ^2); // in^4
14 I_yy = 2*(I_yy_s + A*(d/2 + P)^2) + 2*((1/12)*2*t*h
    ^3); // in^4
15 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

```

1 clear;
2 clc;
3 b1 = 16; // inches
4 d1 = 6; // inches
5 b2 = 9; // inches
6 d2 = 7; // inches

```

```

7 A = 14.71; // in^2
8 I_xx1 = 618.09; // in^4
9 I_yy1 = 22.47; // in^4
10 I_xx2 = 208.13; // in^4
11 I_yy2 = 40.17; // in^4
12 I_xx = I_xx1 + 2*I_yy2; // in^4
13 I_yy = I_yy1 + 2*(I_xx2 + A*(b2/2 + 0.5*0.4)^2); //
    in^4
14 k_xx = sqrt(I_xx/(3*A)); // inches
15 k_yy = sqrt(I_yy/(3*A)); // inches
16 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

```

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

```

---

Scilab code Exa 5.21 Chapter 5 example 21

```

1 clear;
2 clc;
3 b1 = 12; // inches
4 d1 = 4; // inches
5 A = 9.21; // in^2
6 I_xx1 = 200.1; // in^4
7 P = 1.055; // inches
8 I_yy1 = 12.12; // in^4
9 I_xx = 2*I_xx1;
10 //for equal strength I_xx = I_yy
11 x = 2*(sqrt(((I_xx/2)-I_yy1)/A) - P); // in^4
12 printf('x = %.2f inches',x);
13
14 //answer is corrcet only, but it is approximated in
    the text book.

```

---

**Scilab code Exa 5.22** Chapter 5 example 22

```

1 clear;
2 clc;
3 d =10; // inches
4 b = 8; // inches
5 t1 = 1; // inch
6 t2 = 0.6; // inch
7 I = (1/12)*(b*d^3 - (b-t2)*b^3); // in^4
8 //(i) Resistance to M
9 R1 = integrate('(t2/I)*y^2', 'y', -4,4);
10 //(ii) Resistance to F
11 R2 = integrate('(4/I)*(25-y^2)', 'y', 4,5);
12 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);
13 printf('\n The shear borne by the web is %.4fF. The

```

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

---

### Scilab code Exa 5.23 Chapter 5 example 23

```
1 clear;
2 clc;
3 b = 14; // inches
4 d = 6; // inches
5 t1 = 0.7; // inch
6 t2 = 0.4; // inch
7 F = 20; // tons
8 I = (1/12)*(d*b^3 - (d-t2)*(b-2*t1)^3); // in^4
9 q = F*t1*0.5*(0.5*b + (0.5*b-t1))/I; // ton/in^2
10 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
11 printf('The maximum intensity of shear stress is
    q_max = % .2 f tons/in^2 ',q_max);
```

---

### Scilab code Exa 5.24 Chapter 5 example 24

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

```

11 y2 = t+0.5*(d-t); // inches
12 y_bar = (a1*y1+a2*y2)/(a1+a2); // inches
13 I_AB = (1/3)*b*t^3 + (1/12)*t*(d-t)^3 + (b-2*t)*(b-t
    )^2; // in^4
14 I_xx = I_AB - (a1+a2)*y_bar^2; // in^4
15 q = (F/(b*I_xx))*b*t*(y_bar-0.5*t); // ton/in^2
16 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
17 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

```

1 clear;
2 clc;
3 function [p1, p2,theta] = func(p,q)
4     p1 = 0.5*p + sqrt(q^2 + 0.25*p^2);
5     p2 = 0.5*p - sqrt(q^2 + 0.25*p^2);
6     theta = 0.5*atan(2*q/p) * 180/%pi;
7 endfunction
8 b = 5; // inches
9 d = 12; // inches
10 F = 4800 ; // lb-wt
11 M = 192000; // lb-inches
12 I = (1/12)*b*d^3; // in^4
13
14 //At 6 inches above the N.A
15 p6 = M*6/I ; // lb/in^2
16 q6 = 0;
17 [p1_6,p2_6,theta6] = func(p6,q6);
18
19 //At 4 inches above the N.A
20 p4 = M*4/I; // lb/in^2
21 q4 = (F/(I*b))*b*(0.5*d-4)*b;
22 [p1_4,p2_4,theta4] = func(p4,q4);

```

```

23
24 //At 2 inches above the N.A
25 p2 = M*2/I;// lb/in^2
26 q2 = (F/(I*b))*b*(0.5*d-2)*4;
27 [p1_2,p2_2,theta2] = func(p2,q2);
28
29 //At the N.A
30 p = 0;//
31 q = F*b*0.5^3*d^2/(I*b);// lb/in^2
32 p1 = q;// lb/in^2
33 p2 = -q;// lb/in^2
34
35 printf('At 6 inches above the N.A, p1 = %d lb/in^2.,
        compressive , and p2 = %d ',p1_6,p2_6);
36 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);
37 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);
38 printf('\n At the N.A, p1 = %d lb/in^2., compressive
        , and p2 = %d., tensile ',p1,-p2);
39
40 //there is an error in the answer given in text book

```

---

#### Scilab code Exa 5.26 Chapter 5 example 26

```

1 clear;
2 clc;
3 b = 10;// inches
4 d = 8;// inches
5 t1 = 1;// inch
6 t2 = 0.6;// inch

```

```

7 M = 500; // ton-inches
8 F = 25; // tons
9 I = (1/12)*(d*b^3 - (d-t2)*d^3); // in^4
10
11 //At the top
12 p = M*b/(2*I); // tons/in^2
13 q = 0;
14 p1 = p; // tons/in^2
15 p2 = 0;
16 printf('At the top, principal stresses are \n p1 = %
    .2f tons/in^2\n p2 = %d tons/in^2',p1,p2);
17
18 //In the web, 4 inches from the N.A
19 p = M*d/(2*I); // tons/in^2
20 q = F*d*t1*0.5*(d+t1)/(I*t2); // tons/in^2
21 theta = 0.5*atan(2*q/p);
22 theta1 = theta*180/%pi;
23 theta2 = theta1+90;
24 p1 = 0.5*p + sqrt(q^2 + 0.25*p^2); // tons/in^2
25 p2 = 0.5*p - sqrt(q^2 + 0.25*p^2); // tons/in^2
26 printf('\n In the web, 4 inches from the N.A.: \n The
    principal stress 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);
27
28 //At the N.A
29 p = 0;
30 q = (F/(I*t2))*(d*t1*0.5*(d+t1) + t2*0.5*d^2*t1);
31 p1 = q; // tons/in^2
32 p2 = -q; //tons/in^2
33 printf('\n The principal stress across the diagonal
    are %.2f tons/in^2., compressive on one plane
    and %.2f tons/in^2., tensile on the other.',q,q);
34
35 //there is an error in the answer given in text book

```

---

Scilab code Exa 5.27 Chapter 5 example 27

```
1 clear;
2 clc;
3 W = 10; // tons
4 l = 16; // feet
5 f = 15/2; // tons/in^2
6 //section modulus required
7 SM = W*l*12/(8*f); // in^3
8 //for this section modulus
9 l1 = 12; // inches
10 b1 = 5; // inches
11 t1 = 0.55; // inches
12 t2 = 0.35; // inches
13 I_xx = 220; // in^4
14 F_max = 5; // tons
15 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
16 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

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



```
10 M_w = f_w*(1/6)*2*b*D^2; // lb-inches
11 M_s = f_t*(1/6)*t*d^2; // lb-inches
12 M = M_w + M_s; // lb-inches
13 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

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

---

Scilab code Exa 6.3 Chapter 6 example 3

```

1 clear;
2 clc;
3 b = 4; // inches
4 d = 9; // inches
5 l = 12; // feet
6 y_c = 1/4; // inches
7 E = 1.5*10^6; // lb/in^2
8 I = (1/12)*b*d^3; // in^4
9 W = y_c*384*E*I/(5*12^3*1^3); // inches
10 printf('Uniform distributed load, the beam should
        carry is , W = %d lb-wt',W);
11
12 //there is an error in the answer given in text book

```

---

#### Scilab code Exa 6.4 Chapter 6 example 4

```

1 clear;
2 clc;
3 d = 6; // feet
4 l = 60; // feet
5 f = 15/2; // tons/in^2
6 E = 13000; // tons/in^2
7 k1 = 2*f/(12*d); // k1 = M_r/I
8 k2 = k1/(1*12/8); //k2 = W/I
9 y_c = (5/384)*k2*1^3 *12^3 /E; // inches
10 //If the giredr is of constant deapth and uniform
    strength , it bends to an arc of a circle of
    radius R
11 R = E*d*12/(2*f); // inches
12 delta = (1*12)^2 /(8*R); // inches
13 printf('The deflection for a uniformly distributed
        load on it is ,delta = %.2f inches',delta);

```

---

Scilab code Exa 6.5 Chapter 6 example 5

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

---

Scilab code Exa 6.6 Chapter 6 example 6

```
1 clear;
2 clc;
3 w = 550; // lb. per foot run
4 f = 1000; // lb/in^2
5 l = 20; // feet
6 d_limit = 15; // inches
7 E = 1.5*10^6; // lb/in^2
8 //central ddeflection
9 delta = (1/2); // inches
10 d = (5/24)*(f/E)*20*12/(1/(2*20*12)); // inches
11 M = w*l*1*12/8; // lb-inches
12 b = M/(f*(1/6)*d^2); // inches
13 printf('A section with d = %d inches , b = %d inches
    will do. ',round(d),round(b));
14 f1 = (1/(2*20*12))*(d_limit/(1*12))*E/(5/24); // lb/
    in^2
15 b = M/(f1*(1/6)*d_limit^2); // inches
16 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);
17
18 //tha answer is correct only , but it is approximated
```

in the text book.

---

**Scilab code Exa 6.7** Chapter 6 example 7

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

---

**Scilab code Exa 6.8** Chapter 6 example 8

```
1 clear;
2 clc;
3 d = 12; // inches
```

```

4 h = 5; // inches
5 l = 20; // feet
6 E = 13000; //tons/in^2
7 I_xx = 220; // in^4
8 W = 4; // tons
9 W1 = 3; // tons
10 a = 15; // feet
11 b = l-a; // feet
12 a1 = 16; // feet
13 b1 = l-a1; // feet
14 K1 = (-2*W1*b1*l)/(W1*b1-W*b);
15 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));
16 x = -0.5*K1 + sqrt(-K2 + 0.25*K1^2); // feet
17 x1 = l-x; // feet
18 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
19 printf('The position of the maximum deflection is , x
        = %.2f feet.',x);
20 printf('\n And the maximum deflection is , y_max = %
        .4f inches.',y_max);

```

---

### Scilab code Exa 6.9 Chapter 6 example 9

```

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

```

```

11 //integrating  $M = E*I*y''$ , to get  $E*I*y'$  and making
     $y' = 0$ ;, we get maximum deflection
12  $x = 9.18$ ; // by trial and error method
13  $y\_derivative = -R\_A*0.5*x^3 + x^4 /6 + 0.5*(2/3)*(1/b$ 
     $)*(1/4)*x^5 + 469.8$ ;
14  $y = -R\_A*0.5*x^3 /3 + x^4 /24 + 0.5*(2/3)*(1/b$ 
     $*(1/(4*5))*x^5 + 469.8*x$ ;
15  $y\_max = y$ ; // inches
16 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

```

1 clear;
2 clc;
3  $b = 18$ ; // inches
4  $d = 6$ ; // inches
5  $l = 16$ ; // feet
6  $W = 2$ ; // tons
7  $h = 1/2$ ; // inches
8  $I\_xx = 841.76$ ; //  $in^4$ 
9  $E = 13000$ ; //  $tons/in^2$ 
10  $P = W + \text{sqrt}(2*W*h*48*E*I\_xx/(1*12)^3 + 2*W)$ ; // tons
11  $M\_max = P*1*12/4$ ; // ton-inches
12  $Z = 2*I\_xx/b$  ; //  $in^3$ 
13  $f = M\_max/Z$  ; //  $tons/in^2$ 
14  $delta = P*(1*12)^3 / (48*E*I\_xx)$ ; // inches
15 printf('The maximum instantaneous deflection  $delta =$ 
     $%.4f$  inches\n and stress induced ,  $f = %.3f$  tons
    / $in^2$  ', $delta,f$ );
16 //there is an error in the answer given in text book

```

---

Scilab code Exa 6.11 Chapter 6 example 11

```
1 clear;
2 clc;
3 l = 3; // feet
4 b = 3; // inches
5 t = 3/8; // inches
6 W = 1500; // lb.
7 f = 12; // tons/in^2
8 E = 30*10^6; // tons/in^2
9 M_max = W*l*12/4 ; // lb-inches
10 M_r = f*(1/6)*b*t^2 *2240; // lb-inches
11 n = M_max/M_r ; // no. of plates
12 n = round(n+1);
13 f = M_max/(n*(1/6)*b*t^2); // lb/in^2
14 R = E/(2*f/t) ; // inches
15 delta = (l*12)^2 /(8*R); // inches
16 printf('Number of plates required, n = %d',n);
17 printf('\n The central deflection, delta = %.4f inch
. ',delta);
18 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

```
1 clear;
2 clc;
3 d = 6; //inches
4 b = 3/4; //inch
5 P = 18; //tons
6 e = 1/8; //inch
7 A = b*d; //sq.in
8 M = P*e; //ton-in
9 Z = (1/6)*b*d^2; //in^3
10 p_0 = P/A; // tons/in^2
11 p_b = M/Z; // ton/in^2
12 p_max = p_0+p_b; // tons/in^2
13 p_min = p_0-p_b; // tons/in^2
14 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

```

1 clear;
2 clc;
3 d1 = 12; //inches
4 t = 1; //inch
5 d2 = d1-2*t; //inches
6 P = 5; //tons
7 e = 12; //inch
8 A = 0.25*pi*(d1^2-d2^2); //sq.in
9 M = P*e; //ton-in
10 Z = %pi*(d1^4-d2^4)/(32*d1); //in^3
11 p_0 = P/A; // tons/in^2
12 p_b = M/Z; // ton/in^2
13 p_max = p_0+p_b; // tons/in^2
14 p_min = p_0-p_b; // tons/in^2
15 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

```

1 clear;
2 clc;
3 l = 6; //inches
4 b = 4; //inches
5 d = 1/2; //inch
6 P = 10; //tons
7 r = 1.5; //inches
8 A = 4.771; // in^2
9 J = 0.968; // inches
10 I_xx = 6.07; // in^4
11 I_yy = 8.64; // in^4
12 e = r-J; // inches
13 M = P*e; // ton-inches
14 y_t = J; //inches
15 y_c = b-y_t; //inches

```

```

16 //compressive
17 p_c = M*y_c/I_xx; // tons/in^2
18 //tensile
19 p_t = M*y_t/I_xx; // tons/in^2
20 //compressive
21 p_0 = P/A ; // tons/in^2
22 p_max = p_0+p_c; // tons/in^2
23 p_min = p_0-p_t; // tons/in^2
24 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

```

1 clear;
2 clc;
3 b = 5; //inches
4 t = 1/2; //inch
5 P = 12; //tons
6 d = 1/2; //inch
7 r = 3/2; //inch
8 A = (b-d)*t; // in^2
9 p_0 = P/A; // tons/in^2
10 a1 = b*d; // in^2
11 x1 = 0;
12 a2 = d*t; // in^2
13 x2 = -3/2;
14 e = (a1*x1-a2*x2)/(a1-a2); //inches
15 M = P*e; // ton-inches
16 y_c = a1-e; // inches
17 y_t = a1+e; // inches
18 I_yy = (t*b^3)/12 - ((t*d^3)/12 + 0.5*d*r^2); // in^4
19 I_GG = I_yy - (a1-a2)*(e^2); // in^4
20 p_c = M*y_c/I_GG; // tons/in^2
21 p_t = M*y_t/I_GG; // tons/in^2
22 p_max = p_0 + p_t; // tons/in^2

```

```

23 p_min = p_0 - p_c; // tons/in^2
24 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

```

1 clear;
2 clc;
3 h = 20; // feet
4 b = 12; // feet
5 d = 4; // feet
6 p = 30; // lb. per sq.foot
7 rho = 140; // lb. per cubic foot
8 p_0 = rho*h; // lb-ft^2
9 P = p*b*h; // lb-wt
10 M = P*h/2; //lb-ft
11 Z = b*d^2/6; // ft^3
12 p_b = M/Z; // lb/ft^2
13 p_max = p_0 + p_b; // lb/ft^2
14 p_min = p_0 - p_b; // lb/ft^2
15 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

```

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

```

```

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

```

---

#### Scilab code Exa 8.7 Chapter 8 example 7

```

1 clear;
2 clc;
3 h = 60; //feet
4 rho = 130; // lb. per cubic foot
5 D = 12; //feet
6 d = 5; //feet
7 P_h = 24; // lb. per sq. foot
8 p_0 = rho*h; // lb-ft^2
9 P = P_h*D*h; // lb-wt
10 M = P*h/2; // lb-feet
11 Z = %pi*(D^4 - d^4)/(32*D); //lb-ft^3
12 p_b = M/Z; // lb/ft^2
13 p_max = p_0 + p_b; // lb/ft^2
14 p_min = p_0 - p_b; // lb/ft^2
15 printf('p_max = %d lb/ft^2., compressive\n p_min =
    %d lb/ft^2., compressive', p_max, p_min);
16
17 //there is an error in the answer given in text book

```

---

#### Scilab code Exa 8.8 Chapter 8 example 8

```

1 clear;
2 clc;
3 h = 120; // feet

```

```

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

```

---

**Scilab code Exa 8.9** Chapter 8 example 9

```

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

```

---

**Scilab code Exa 8.10** Chapter 8 example 10

```

1 clear;
2 clc;
3 h = 20; // feet
4 b = 4; // feet
5 d = 12; // feet
6 h1 = 18; // feet
7 //density of masonry
8 rho_m = 140; // lb-ft^3

```

```

9 //density of water
10 rho_w = 62.5; // lb-ft^3
11 W = rho_m*0.5*(b+d)*h; // lb-wt
12 //to locate its line of action divide the dam
    section into a rectangle and a triangle
13 x1 = b/2; //feet
14 a1 = b*h; // sq. feet
15 a2 = 0.5*(d-b)*h; // sq. feet
16 x2 = b+((d-b)/3); // feet
17 x_bar = (a1*x1+a2*x2)/(a1+a2); // feet
18 P = rho_w*h1^2/2; // lb-wt
19 z = x_bar + (h1/3)*(P/W); // feet
20 e = z - d/2; // feet
21 p_0 = W/d; // lb/ft^2
22 M = W*e; // lb-feet
23 Z = 1*d^2*1/6; // ft^3
24 p_b = M/Z; // lb-ft^2
25 p_max = p_0 + p_b; // lb-ft^2
26 p_min = p_0 - p_b; // lb-ft^2
27 printf('p_max = %.1f lb/ft^2., compressive at B.\n
    p_min = %.1f lb/ft^2., compressive at A.',p_max,
    p_min);
28
29 //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

```
1 clear;
2 clc;
3 // n = l/k
4 n1 = 40;
5 n2 = 60;
6 n3 = 80;
7 n4 = 100;
8 n5 = 120;
9 n6 = 140;
10 n7 = 160;
11 n8 = 180;
12 n9 = 200;
13 E = 13000; // tons/in^2
14 //m = P/A
15 m1 = 4*pi^2 *E/n1^2; // tons per sq. inch
16 m2 = 4*pi^2 *E/n2^2; // tons per sq. inch
17 m3 = 4*pi^2 *E/n3^2; // tons per sq. inch
18 m4 = 4*pi^2 *E/n4^2; // tons per sq. inch
19 m5 = 4*pi^2 *E/n5^2; // tons per sq. inch
```



```

20 m6 = 4*pi^2 *E/n6^2; // tons per sq. inch
21 m7 = 4*pi^2 *E/n7^2; // tons per sq. inch
22 m8 = 4*pi^2 *E/n8^2; // tons per sq. inch
23 m9 = 4*pi^2 *E/n9^2; // tons per sq. inch
24 printf('l/k : %d      %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);
25
26 //there is a minute error in the answer given in
    text book

```

---

#### Scilab code Exa 9.2 Chapter 9 example 2

```

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

```

---

#### Scilab code Exa 9.3 Chapter 9 example 3

```

1 clear;
2 clc;
3 b = 10; // inches
4 d = 6; // inches
5 l = 15; // feet
6 A = 11.77; // in^2

```

```

7 I_xx = 204.80; // in^4
8 I_yy = 21.76; // in^4
9 f_c = 21; // tons/in^2
10 a = 1/7500;
11 n = 3; //factor of safety
12 k = sqrt(I_yy/A); // radius of gyration
13 P = f_c*A/(1+(a/2)*(1*12/k)^2); // tons
14 P_s = P/n; // safe load
15 printf('The safe axial load = %.3f tons',P_s);
16
17 //there is a minute calculation error in the answer
    given in text book

```

---

#### Scilab code Exa 9.4 Chapter 9 example 4

```

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

```

approximated in the text book

---

**Scilab code Exa 9.5** Chapter 9 example 5

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

---

**Scilab code Exa 9.6** Chapter 9 example 6

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

```

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

```

---

#### Scilab code Exa 9.7 Chapter 9 example 7

```

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

```

```

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

```

---

### Scilab code Exa 9.8 Chapter 9 example 8

```

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

```

---

### Scilab code Exa 9.9 Chapter 9 example 9

```

1 clear;
2 clc;
3 P = 80; // tons
4 p_max = 5; // tons/in^2
5 E = 13000; // tons/in^2
6 A = 38.38; // in^2
7 I_yy = 451.94; // in^4
8 y_c = 6; // inches
9 l = 20; // inches
10 k = sqrt(I_yy/A); // inches
11 Z_yy = I_yy/y_c; // in^3
12 p_0 = P/A; // tons/in^2
13 p_b = p_max-p_0; // tons/in^2
14 M_max = p_b*Z_yy; // ton-inches
15 e = M_max/(P*sec(0.5*1*12*sqrt(P/(E*I_yy)))); //
    inches
16 printf('The maximum possible eccentricity , e = %.2f
    inches ',e);

```

---

#### Scilab code Exa 9.10 Chapter 9 example 10

```

1 clear;
2 clc;
3 e = 7/4; // inches
4 E = 13000; // tons/in^2
5 p = 5; // tons/in^2
6 y_c = 6; // inches
7 l = 20; // feet
8 A = 38.38; // in^2
9 k = sqrt(11.78); // inches
10 I = 11.78; // in^4
11 p_e = (%pi)^2 *E*k^2 /(1*12)^2; // tons/in^2
12 //from Perry 's formula
13 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
14 P = p_0*A; // tons
15 printf('The safe load , P = %.2f tons ',P);
16
17 //there is a minute calculation error in the answer
    given in text book

```

---

### Scilab code Exa 9.11 Chapter 9 example 11

```

1 clear;
2 clc;
3 b1 = 10; // inches
4 d1 = 6; // inches
5 b2 = 12; // inches
6 d2 = 1/2; // inches
7 l = 16; // feet
8 A_s = 11.77; // in^2
9 I_xxs = 204.80; // in^4
10 I_yys = 21.76; // in^4
11 A = A_s + 2*b2*d2; // in^2
12 I_yy = I_yys + 2*(1/12)*d2*b2^3; // in^4
13 k = sqrt(I_yy/A); // inches
14 //from the Perry–Robertson formula
15 n = 0.003*l*12/k;
16 p_e = 13000*%pi^2/((1*12)/k)^2 ; // tons/in^2
17 f = 18; // tons/in^2
18 x = 0.5*(f+p_e*(1+n));
19 p_0 = x - sqrt(x^2 - f*p_e); // tons/in^2
20 P = p_0*A; // tons
21 P_safe = P/2.36; // tons
22 printf('The safe load , P = %.1f tons ',P_safe);
23
24 //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

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

---

Scilab code Exa 10.2 Chapter 10 example 2

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



```

6 p = 200; // lb/in^2
7 E = 30*10^6; // lb/in^2
8 PR = 0.3; // poisson's ratio
9 f1 = p*d*12/(2*t); // lb/in^2
10 f2 = p*d*12/(4*t); // lb/in^2
11 f_s = 0.5*(f1-f2); // lb/in^2
12 e1 = (f1/E)-(PR*f2/E); // lb/in^2
13 e2 = (f2/E)-(PR*f1/E); // lb/in^2
14 del_d = e1*d*12; // inches
15 del_l = e2*1*12; // inches
16 del_V = (e2+2*e1)*0.25*pi*(12*d)^2 * 1*12; // cub.
    inches
17 printf('Maximum intensity of shear stress induced =
    %d lb/in^2',f_s);
18 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

```

1 clear;
2 clc;
3 d = 30; // inches
4 H = 300; // feet
5 w = 62.5;
6 f = 2800;
7 //intensity of water pressur
8 p = w*H/144; // lb/in^2
9 t_limit = p*d/(2*f); // inches
10 printf('Thickness of metal required is %.4f inches',
    t_limit);
11
12 //the answer is correct only, but it is approximated
    in the text book.

```

---

Scilab code Exa 10.4 Chapter 10 example 4

```
1 clear;
2 clc;
3 d = 78; // inches
4 t = 3/4; // inches
5 n1 = 70/100; // efficiency of the longitudinal
   riveted joint
6 f = 6; // tons/in^2
7 n2 = 60/100; // efficiency of the circumferential
   riveted joint
8 p = f*2240/(d/(2*t*n1)); //lb/in^2
9 p = round(p-1);
10 f1 = p*d/(2*t); // lb/in^2
11 f2 = p*d/(4*t*n2); // lb/in^2
12 printf('The permissible steam pressure , p = %d lb/in
   ^2',p);
13 printf('\n The circumferential stress , f1 = %d lb/in
   ^2 = %.2f tons/in^2',f1,f1/2240);
14 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

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

```
8 printf('The thickness of the plate required = %.2f
    inches',t_limit);
9
10 //the answer is correct only, but it is approximated
    in the text book.
```

---

#### Scilab code Exa 10.6 Chapter 10 example 6

```
1 clear;
2 clc;
3 d = 3; // feet
4 t = 1/4; // inches
5 del_V = 9; // cub. inches
6 E = 30*10^6; // lb/in^2
7 PR = 0.3; // poisson's ratio
8 V = (%pi/6)*(12*d)^3; // in^3
9 k = del_V/V;
10 f = k*E/(3*(1-PR)); // lb/in^2
11 p = 4*f*t/(12*d); // lb/in^2
12 printf('The pressure exerted by fluid on the shell,
    p = %d lb/in^2',p);
13
14 //there is a minute calculation error in the answer
    given in text book
```

---

#### Scilab code Exa 10.7 Chapter 10 example 7

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

```

7 E_c = 6000; // tons/in^2
8 PR = 0.3; // Poisson's ratio
9 E_s = 13000; // tons/in^2
10 f_t = 8000; // lb/in^2
11 l = 8;
12 P_c = 1*(%pi/64)*f_t; // lb-wt
13 f_c = P_c/(2*t); // lb/in^2
14 //bursting force per inch unit length
15 f_b = p*d; // lb-wt
16 f_p = (f_b + (1*0.049*PR*p*d/(4*t))*(E_s/E_c))/(1 +
    (1*0.049)*E_s/E_c); // lb/in^2
17 f_w = (f_p - PR*p*d/(4*t))*E_s/E_c; // lb/in^2
18 printf('
    Pipe
    Steel-wire');
19 printf('\n Initially ,    %d lb/in^2., compr.
    %d lb/in^2., tensile ',f_c,f_t);
20 printf('\n Due to p,    %d lb/in^2., tensile .
    %d lb/in^2., tensile ',f_p,f_w);
21 printf('\n Finally ,    %d lb/in^2., tensile .
    %d lb/in^2., tensile ',f_p-f_c,f_w+f_t);
22
23 //there is a calculation error in the answer given
    in text book

```

---

### Scilab code Exa 10.8 Chapter 10 example 8

```

1 clear;
2 clc;
3 d = 12; // inches
4 t = 3; // inches
5 p_x1 = 900; // lb/in^2
6 x1 = 0.5*d; // inches
7 p_x2 = 0;
8 x2 = 0.5*d+t; // inches
9 //from Lamé's formulae

```

```

10 b = (p_x1-p_x2)/((1/x1^2)-(1/x2^2));
11 a = (b/x1^2)- p_x1;
12 f_x1 = (b/x1^2)+a; // lb/in^2
13 f_x2 = (b/x2^2)+a; // lb/in^2
14 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

```

1 clear;
2 clc;
3 d = 5; // inches
4 p = 3; // tons/in^2
5 f = 8; // tons/in^2
6 x = 0.5*d; // inches
7 b = (p+f)/(2/x^2);
8 a = f-(b/x^2);
9 r = sqrt(b/a); //outer radius
10 t = r-0.5*d; //thickness
11 D = 2*t+d; //outer diameter
12 printf('The thickness of metal necessary , t = %.3f
    inches',t);
13 printf('\n the outer diameter will be, D = %.1f
    inches',D);
14
15 //the answer is correct , but it is approximated in
    the text book.

```

---

#### Scilab code Exa 10.10 Chapter 10 example 10

```

1 clear;

```

```

2  clc;
3  d = 9; // inches
4  p = 5000/2240; // lb/in^2
5  f = 8; // tons/in^2
6  PR = 0.3; // Poisson's ratio
7  //(i) Maximum principal stress hypothesis:
8  k_limit1 = sqrt((f + p)/(f - p)); //k_limit = r1/r2
9  r_limit1 = k_limit1*0.5*d; //inches
10 printf('The outer radius in case(i), r2 = %.3f
    inches',r_limit1);
11 //(ii) Maximum principal strain:
12 k_limit2 = sqrt(((f/p - PR)+1)/(f/p - PR -1));
13 r_limit2 = k_limit2*0.5*d; // inches
14 printf('\n The outer radius in case(ii), r2 = %.3f
    inches',r_limit2);
15 //(iii) Maximum shear stress:
16 k_limit3 = sqrt(f/(2*p) /((f/(2*p)) - 1));
17 r_limit3 = k_limit3*0.5*d; // inches
18 printf('\n The outer radius in case(iii), r2 = %.3f
    inches',r_limit3);
19 //(iv) Maximum strain energy
20 K1 = (f^2 /p^2)/(2*((f^2 /(2*p^2)) - (1+PR)));
21 K2 = K1^2;
22 K3 = ((f^2 /(2*p^2)) - (1-PR))/((f^2 /(2*p^2)) - (1+
    PR));
23 k_limit4 = sqrt(K1+sqrt(K2-K3));
24 r_limit4 = k_limit4*0.5*d; // inches
25 printf('\n The outer radius in case(iv), r2 = %.3f
    inches',r_limit4);
26
27 //there are calculation errors in the answer given
    in text book

```

---

Scilab code Exa 10.11 Chapter 10 example 11

```

1 clear;
2 clc;
3 r1 = 0.5*6; // inches
4 r2 = 0.5*12; // inches
5 r3 = 0.5*10; // inches
6 p = 1500; // lb/in^2
7 p_f = 12000; // lb/in^2
8 //Initially , for the inner tube
9 b = -p/((1/r1^2) - (1/r3^2));
10 a = b/r1^2;
11 f_3 = (b/r1^2) +a; // lb/in^2
12 f_5 = (b/r3^2) +a; // lb/in^2
13 //for the outer tube
14 b1 = p/((1/r3^2)-(1/r2^2));
15 a1 = b1/r2^2;
16 f1_5 = (b1/r3^2)+a1; // lb/in^2
17 f1_6 = (b1/r2^2)+a1; // lb/in^2
18 //When the fluid pressure of 12000 lb/in^2, is
    admitted into the compound tube
19 B = p_f/((1/r1^2)-(1/r2^2));
20 A = B/(r2^2);
21 f_3_ = (B/r1^2)+A; // lb/in^2
22 f_5_ = (B/r3^2)+A; // lb/in^2
23 f_6_ = (B/r2^2)+A; // lb/in^2
24 printf('The hoop stresse are');
25 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);
26 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);
27 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_')
28 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);

```

```
29 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

```
1 clear;
2 clc;
3 p = 1500; // lb/in^2
4 E = 30*10^6; // lb/in^2
5 f1_5 = 8318; // lb/in^2
6 f2_5 = 3187.5; // lb/in^2
7 alpha = 0.0000062; // per F
8 r3 = 6; // inches
9 del_r3 = r3*(f1_5+f2_5)/E; // inches
10 t = ((f1_5+f2_5)/E)/(alpha); // inches
11 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

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



```

11 a = a1*(k1^2 -1)/(k2^2 -1);
12 b1 = a1*r1^2;
13 b = a*r2^2;
14 p_ = (b/r3^2) -a;// tons/in^2
15 // for the inner tube
16 f_x1 = (b/r2^2) +a;// tons/in^2
17 f_x2 = (b/r3^2) +a;// tons/in^2
18 // for the outer tube
19 f_x3 = (b1/r3^2) +a1;// tons/in^2
20 f_x4 = (b1/r1^2) +a1;// tons/in^2
21 printf('The hoop stresses are as under:');
22 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);
23 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

```

1 clear;
2 clc;
3 r1 = 0.5*5;// inches
4 p = 5000;// lb/in^2
5 f = 5;// tons/in^2
6 b = (f + p/2240)/((1/r1^3) + (2/r1^3));
7 a = f - (b/r1^3);
8 //external diameter
9 r = (2*b/a)^(1/3);// inches
10 t = r - r1;// inches
11 printf('The thickness of the shell required , t = %.3
    f inches ',t);
12
13 //the answer is approximated in the text book

```



# Chapter 11

## Riveted joints

Scilab code Exa 11.1 Chapter 11 example 1

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

---

Scilab code Exa 11.2 Chapter 11 example 2

```

1  clear;
2  clc;
3  t = 1/2; // inches
4  d1= 7/8; // inches
5  p1 = 5/2; // inches
6  d2= 9/8; // inches
7  p2 = 7/2; // inches
8  f_t = 8; // tons/in^2
9  f_s = 6; // tons/in^2
10 f_b = 10; // tons/in^2
11
12 P_t1 = (p1-d1)*t*f_t; // tons
13 P_s1 = 0.25*pi*d1^2 *f_s; // tons
14 P_b1 = d1*t*f_b; //tons
15 P1 = p1*t*f_t; // tons
16 n1 = min(P_t1,P_s1,P_b1)/P1 ; // efficiency
17 printf('The efficiency of first joint = %.2f = %d
           percentage ',n1,n1*100);
18
19 P_t2 = (p2-d2)*t*f_t; // tons
20 P_s2 = 0.25*pi*d2^2 *f_s; // tons
21 P_b2 = d2*t*f_b; //tons
22 P2 = p2*t*f_t; // tons
23 n2 = min(P_t2,P_s2,P_b2)/P2 ; // efficiency
24 printf('\n The efficiency of second joint = %.3f = %
           .1f percentage\n',n2,n2*100);
25
26 if n2 > n1 then
27     printf(' The second joint , with its higher
           efficiency , is stronger ');
28 else
29     printf(' The first joint , with its higher
           efficiency , is stronger ');
30 end

```

---

### Scilab code Exa 11.3 Chapter 11 example 3

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

---

### Scilab code Exa 11.4 Chapter 11 example 4

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

```

12 printf('Pitch , p = %.3f inches ',p_t_limit);
13 printf('\n Efficiency = %.3f or %d percentage ',n,n
    *100);
14
15 //the answer is approximated in the textbook.

```

---

#### Scilab code Exa 11.5 Chapter 11 example 5

```

1 clear;
2 clc;
3 d = 6; // feet
4 p = 180; // lb/in^2
5 f = 6; // tons
6 n = 70/100; // efficiency
7 d1 = 1; // inches
8 f_s = 5; // tons/in^2
9 f_b = 10; // tons/in^2
10 t = p*d/(2*f*n); // inches
11 // t = 0.6889 inches , say 0.75 inches
12 t = 0.75; //inches
13 P_s = 2*0.25*pi*d1^2*f_s; // tons
14 P_b = d1*t*f_b; // tons
15 p_limit = 2*P_b/(t*f) + d1; // inches
16 //p_limit = 4.33 inches , make it 4 inches
17 p = round(p_limit); // inches
18 n1 = (p-d1)/p; // efficiency
19 printf('Pitch = %.2f inches , make it %d inches.',
    p_limit,p);
20 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

```

1  clear;
2  clc;
3  t = 1/2; // inches
4  a = 1/2; // inches
5  P = 42; // tons
6  d = 3/4; // inches
7  f_t = 7.5; // tons/in^2
8  f_s = 6; // tons/in^2
9  f_b = 12; // tons/in^2
10 P_s = 2*0.25*%pi*d^2 *f_s; // tons
11 P_b = d*t*f_b; // tons
12 n = P/min(P_s,P_b);
13 n = round(n+1);
14 b1 = P/(t*f_t) + d; // inches
15 b = round(b1);
16 e = (b-d)/b; // efficiency
17 f_s = (P/n)/(2*0.25*%pi*d^2) ; // tons/in^2
18 f_b = (P/n)/(d*t); // tons/in^2
19 f1 = P/(a*(b-d)); // tons/in^2
20 f2 = (P-(P/n))/((b-2*d)*t); // tons/in^2
21 f3 = (P-(3*P/n))/((b-3*d)*t); // tons/in^2
22 f4 = (P-(6*P/n))/((b-4*d)*t); // tons/in^2
23 printf('The number of rivets required , n = %d',n);
24 printf('\n The width of the flat required , b = %.2f
    inches , say %d inches ',b1,b);
25 printf('\n The efficiency of the joint = %.2f
    percentage ',e*100);
26 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);
27 printf('\n The tensile stress at section 11, f1 = %
    .3f rons/in^2 ',f1);
28 printf('\n The tensile stress at section 22, f2 = %
    .3f rons/in^2 ',f2);
29 printf('\n The tensile stress at section 33, f3 = %
    .3f rons/in^2 ',f3);
30 printf('\n The tensile stress at section 44, f4 = %
    .3f rons/in^2 ',f4);

```

---

Scilab code Exa 11.7 Chapter 11 example 7

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



```

        in^2 at section 11',P1);
26 elseif P2 == min(P1,P2,P3,P4) then
27     printf('\n The maximum possible pull which the
        flat will safely transmit is P2 = %.1f tons/
        in^2 at section 22',P2);
28 elseif P3 == min(P1,P2,P3,P4) then
29     printf('\n The maximum possible pull which the
        flat will safely transmit is P3 = %.2f tons/
        in^2 at section 33',P3);
30 else
31     printf('\n The maximum possible pull which the
        flat will safely transmit is P4 = %.2f tons/
        in^2 at section 44',P4);
32 end
33
34 //there is a minute error in the answer given
    textbook.

```

---

#### Scilab code Exa 11.8 Chapter 11 example 8

```

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

```

---

Scilab code Exa 11.9 Chapter 11 example 9

```
1 clear;
2 clc;
3 l = 50; // feet
4 b = 4; // feet
5 P = 3; // tons per foot run
6 t = 1/2; // inches
7 b1 = 4; // inches
8 d1 = 4; // inches
9 h1 = 1/2; // inches
10 d = 7/8; // inches
11 f_s = 6; // tons/in^2
12 f_b = 12; // tons/in^2
13 P_s = 2*0.25*pi*d^2 *f_s; // tons
14 P_b = t*d*f_b; // tons
15 R = P_b; // tons
16 F = l*P*2/d1; // tons
17 p_min = R*(1-0.5*b1)/F ; // inches
18 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

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

```
        d1^2);//
12 r = sqrt(40);
13 F = M*r/square_r_sum;// tons
14 theta = atan(d2/d1)//radians
15 theta1 = theta*180/%pi// degrees
16 V = (P/n) + F*cos(theta);// tons
17 H = F*sin(theta);// tons
18 R = sqrt(V^2 + H^2);// tons
19 f_s = R/(0.25*%pi*d^2);// tons/in^2
20 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

```
1 clear;
2 clc;
3 d = 3; //inches
4 HP = 120; //horse power
5 RPM = 180;
6 l = 25; //feet
7 N = 12*10^6; // lb/in^2
8 T = 33000*HP/(2*pi*RPM); // lb-feet
9 f_s = 16*T*12/(pi*d^3); // lb/in^2
10 theta = f_s*l*12/(0.5*d*N); // radian
11 printf('The maximum intensity of shear stress
    induced is f_s = %.d lb/in^2',f_s);
12 printf('\n The angle of twist in degrees is theta =
    %.2f',theta*180/pi);
13
14 //there is a minute error in the answer given in
    textbook.
```

---

Scilab code Exa 12.2 Chapter 12 example 2

```

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

```

---

### Scilab code Exa 12.3 Chapter 12 example 3

```

1 clear;
2 clc;
3 HP = 80;
4 N = 200; // RPM
5 m = 30/100;
6 f = 12000; // lb/in^2
7 T = HP*33000/(2*%pi*N); // lb-feet
8 T_max = (1+m)*T; // lb-feet
9 D = (T_max*12*16/(%pi*f))^(1/3); // inches
10 printf('Suitable diameter is D = %.3f inches',D);
11
12 //the answer is approximated in the textbook.

```

---

### Scilab code Exa 12.4 Chapter 12 example 4

```

1 clear;
2 clc;
3 HP = 750;
4 N = 90; // RPM
5 m = 40/100;
6 f = 12000; // lb/in^2
7 t = 1; // inch

```

```

8 T = HP*33000/(2*%pi*N); // lb-inches
9 T_max = (1+m)*T; // lb-inches
10 //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
11 D = 7.6; //inches
12 d = D - 2; //inches
13 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

```

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

```

---

#### Scilab code Exa 12.6 Chapter 12 example 6

```

1 clear;
2 clc;
3 HP = 3000;
4 RPM = 60;
5 f = 12000; //lb/in^2
6 rho = 480; //lb. per sq. foot
7 k = 3/4; // k = d/D
8 T = HP*33000*12/(2*pi*RPM); // lb-inches
9 D1 = (T*16/(f*pi))^(1/3); // inches
10 D2 = (T/((1+k^2)*(1-k^2)*pi*f/16))^(1/3); // inches
11 d = k*D2; // inches
12 w1 = 0.25*pi*D1^2 *rho/144 ; // lb-wt
13 w2 = 0.25*pi*(D2+d)*(D2-d)*rho/144 ; // lb-wt
14 w = w1-w2; // lb-wt
15 n = (w/w1)*100;
16 printf('The saving in weight per foot run is w = %d
        lb-wt ',w);
17 printf('\n Percentage saving is %.2f ',n);
18
19 //there is a minute error in the answer given in
        textbook.

```

---

### Scilab code Exa 12.7 Chapter 12 example 7

```

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

```

```

12 f_s = T2*12/(%pi/16); // lb/in^2
13 theta = f_s*1/(0.5*d1*N); // radians
14 printf('T1 = %d lb-feet\n T2 = %d lb-feet ',T1,T2);
15 printf('\n f_s = %d lb/in^2',f_s);
16 printf('\n theta = %.5f radian\n          = %.4f
           degrees ',theta,theta*180/%pi);
17 //there is a minute error in the answer given in
    twxtbook

```

---

#### Scilab code Exa 12.8 Chapter 12 example 8

```

1 clear;
2 clc;
3 D = 5; // inches
4 HP = 120;
5 RPM = 150;
6 b = 5; // inches
7 h = 1; //inch
8 n = 6; // no. of bolts
9 d = 3/4; // inches
10 T = HP*33000*12/(2*%pi*RPM); // lb-inches
11 f_s = T*16/(%pi*27);
12 f_k = T/(b*h*2*d);
13 f_b = T/(n*0.25*%pi*d^2 * b); // lb-inches
14 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);
15
16 //there are errors given in the answers given in the
    textbook

```

---

#### Scilab code Exa 12.9 Chapter 12 example 9

```

1 clear;

```



```

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

```

---

#### Scilab code Exa 12.10 Chapter 12 example 10

```

1  clear;
2  clc;
3  HP = 80;
4  RPM = 120;
5  b = 10; // feet
6  h = 3; // feet
7  F = 8000; // lb-wt
8  m = 4;
9  T = HP*33000*12/(2*%pi*RPM*2240); // ton-inches
10 M = F*h*(b-h)*12/(b*2240); // ton-inches
11 // (i) The major principal stress f1 is given by
12 f1 = 6; // tons/in^2
13 d1 = ((M+sqrt(M^2 + T^2))*16/(%pi*f1))^(1/3); //
      inches
14

```

```

15 //(ii) If f_s_dash is the maximum intensity of shear
    stress
16 f_s_dash = 3; // tons/in^2
17 d2 = (sqrt(M^2 + T^2) * 16/(%pi*f_s_dash))^(1/3); //
    inches
18
19 //(iii) If e is the major principal strain
20 Ee = 6; // tons/in^2
21 d3 = (((1-(1/m))*M + (1+(1/m))*sqrt(M^2 + T^2))*16/(
    %pi*Ee))^(1/3); // inches
22
23 //(iv) If f is the direct stress which, acting alone
    will produce the same maximum strain energy
24 f = 6; // tons/in^2
25 d4 = ((sqrt(4*M^2 + 2*(m+1)*(T^2)/m))*16/(%pi*f))
    ^(1/3); // inches
26 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);
27 //there are round-off errors in the answers given in
    textbook.

```

---

#### Scilab code Exa 12.11 Chapter 12 example 11

```

1 clear;
2 clc;
3 D = 12; // inches
4 d = 6; // inches
5 HP = 2400;
6 RPM = 80;

```

```

7 M = 40; // ton-feet
8 P = 25; // tons
9 PR = 0.3; //poisson 's ratio
10 A = 0.25*pi*(D^2 - d^2); // in^2
11 Z = (%pi/32)*(D^4 - d^4)/D; // in^3
12 J = (%pi/16)*(D^4 - d^4)/D; // in^3
13 p_0 = P/A ; // ton/in^2
14 p_b = M*12/Z ; // tons/in^2
15 f_b = p_0 + p_b; //tons/in^2
16 f_s = HP*33000*12/(2*pi*RPM*2240*J); // tons/in^2
17 theta = 0.5*atan(2*f_s/f_b); // radians
18 theta1 = theta*180/%pi; // degrees
19 theta2 = theta1+90; //degrees
20 f_1 = 0.5*f_b + sqrt(f_s^2 + 0.25*f_b^2); //tons/in^2
21 f_2 = 0.5*f_b - sqrt(f_s^2 + 0.25*f_b^2); //tons/in^2
22 f = sqrt(0.25*f_b^2 + f_s^2); // tons/in^2
23 Ee = f_1 - PR*f_2; // tons/in^2
24 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);
25 printf('\n theta1 = %.1f degrees\n theta2 = %.1f
        degrees ',theta1,theta2);
26 printf('\n The maximum shear intensity = %.3f tons/
        in^2',f);
27 printf('\n Maximum strain is , Ee = %.3f tons/in^2',
        Ee);
28
29 //there are minute errors in the answers given in
        textbook.

```

---

### Scilab code Exa 12.12 Chapter 12 example 12

```

1 clear;
2 clc;
3 RPM = 180;

```

```

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

```

---

### Scilab code Exa 12.13 Chapter 12 example 13

```

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

```

```
14 printf('\n Energy stored = %.3f lb-inches ',E);
15
16 //there is a minute error in the answer given in
    textbook.
```

---

**Scilab code Exa 12.14** Chapter 12 example 14

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

---

**Scilab code Exa 12.15** Chapter 12 example 15

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

```

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

```

---

### Scilab code Exa 12.16 Chapter 12 example 16

```

1 clear;
2 clc;
3 s = 1/4; // inch
4 n = 12; // no. of coils
5 D = 3; // inches
6 f_s = 45000; // lb/in^2
7 N = 12*10^6; // lb/in^2
8 T = 0.208*f_s*s^3; // lb-inches
9 W = T/(0.5*D); // lb-wt
10 theta = 7.11*T*%pi*D*12/(N*s^4); // rdaians
11 delta = 0.5*D*theta; // inches
12 printf('Maximum possible axial load is W = %.1f lb-
    wt ',W);
13 printf('\n Deflection , delta = %.3f inches ',delta);
14
15 //there is a minute error in the answer given in
    textbook.

```

---

### Scilab code Exa 12.17 Chapter 12 example 17

```

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

```

```

8 E = 30*10^6; // lb/in^2
9 M = 75; // lb-inches
10 I = (%pi/64)*d^4; // in^4
11 Z = 2*I/d; // in^3
12 f = M/Z ; // lb/in^2
13 phi = M*%pi*D*12/(E*I); // radians
14 n_ = (phi/(2*%pi)) + n; // increase in no. of turns
15 printf('The bending stress is f = %d lb/in^2',f);
16 printf('\n n_new = %.5f turns',n_);
17
18 //there are minute errors in the answers given in
    textbook.

```

---

#### Scilab code Exa 12.18 Chapter 12 example 18

```

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

```

```

20 printf('Deflection , delta = %.3f inches ',delta);
21 printf('\n f = %d lb/in^2\n f_s = %d lb/in^2',f,f_s)
    ;
22 printf('\n The maximum intensity of shear stress =
    %d lb/in^2',f_s_dash);
23
24 //there are calculation errors in the answers given
    in textbook

```

---

**Scilab code Exa 12.19** Chapter 12 example 19

```

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

```

---



# Chapter 13

## Elements of reinforced concrete

Scilab code Exa 13.1 Chapter 13 example 1

```
1 clear;
2 clc;
3 b = 10; //inches
4 d = 1; //inches
5 h = 20; //inches
6 r = 2; //inches
7 M_r = 500000; //lb-inches
8 m = 15;
9 A_r = 4*0.25*%pi*d^2; //in^2
10 h_eff = h-r; //inches
11 K = m*A_r/(b*h_eff); //inches
12 n1 = sqrt((K)^2+(2*K))-K;
13 n = n1*h_eff; //inches
14 a = h_eff-(n/3); //inches
15 c = 2*M_r/(b*n*a); //lb/in^2
16 t = (h_eff-n)*m*c/n; //lb/in^2
17 printf('The stress induced in the concrete and steel
    , t = %d lb/in^2',t);
18
19 //there is a minute error in the answer given in
    textbook.
```

---

Scilab code Exa 13.2 Chapter 13 example 2

```
1 clear;
2 clc;
3 b = 8; //inches
4 d = 7/8; //inches
5 h = 18; //inches
6 r = 2; //inches
7 c = 750; //lb/in^2
8 t_limit = 18000; //lb/in^2
9 m = 8;
10 h_eff = 16; //inches
11 m = 18;
12 A_t = 3*0.25*%pi*d^2; //in^2
13 K = m*A_t/(b*h_eff); //inches
14 n1 = sqrt((K)^2+(2*K))-K;
15 n = n1*h_eff; //inches
16 a = h_eff - (n/3); //inches
17 t = m*c*(h_eff-n)/n; //lb/in^2
18
19 if t<t_limit then
20     t = t;
21 else
22     t = t_limit;
23 end
24
25 M_r = t*A_t*a; // lb/inches
26 W = M_r*8/(12*h_eff); //lb-wt
27 printf('The distance of the N.A from the top edge, n
        = %.3f inches.',n);
28 printf('\n The safe moment of inertia is , t = %d lb/
        in^2.',t);
29 printf('\n Uniformly distributed load over the beam,
        W = %d lb-wt. or %d lb. per foot run',W,W
```

```

        /16.011);
30
31 //there are calculation errors given in the answer
    in textbook.

```

---

### Scilab code Exa 13.3 Chapter 13 example 3

```

1  clear;
2  clc;
3  function Z = quadratic(d,M_c,c_limit,b)
4      n = poly(0,"n");
5      p = n^2-(d*3)*n + M_c*3/(0.5*c_limit*b);
6      Z = roots(p);
7  endfunction
8  b = 12;//inches
9  h = 22;//inches
10 r = 2;//inches
11 W = 1500;//lb per foot run
12 d = h-r;//feet
13 l = 20;//inches
14 c_limit = 700;// lb/in^2
15 m = 15;
16 M_c = W*20*l*b/8;// lb-inches
17 Z = quadratic(d,M_c,c_limit,b);
18 n = round(Z(2));
19 t = m*c_limit*(d-n)/n;// lb/in^2
20 A_t = 0.5*c_limit*b*n/t;// in^2
21 printf('Area of steel reinforcement required is , A_t
    = %d in^2 ',A_t);
22 printf('\n Corresponding stress in steel is , t = %d
    lb/in^2 ',t);

```

---

### Scilab code Exa 13.4 Chapter 13 example 4

```

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

```

---

### Scilab code Exa 13.5 Chapter 13 example 5

```

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

```

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

---

### Scilab code Exa 13.6 Chapter 13 example 6

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

---

### Scilab code Exa 13.7 Chapter 13 example 7

```

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

```

---