Scilab Textbook Companion for Machine Design by U. C. Jindal[1]

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May 23, 2016

[1]Funded by a grant from the National Mission on Education through ICT, http://spoken-tutorial.org/NMEICT-Intro. This Textbook Companion and Scilab codes written in it can be downloaded from the "Textbook Companion Project" section at the website http://scilab.in

Book Description

Title: Machine Design

Author: U. C. Jindal

Publisher: Dorling Kindersley (India)

Edition: 1

Year: 2010

ISBN: 978-81-317-1659-5

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 3

MECHANICS OF SOLIDS

Scilab code Exa 3.1 MS1

```
1  // sum 3-1
2  clc;
3  clear;
4  d=10;
5  l=1500;
6  m=12;
7  h=50;
8  E=210*10^3;
9  sigut=450;
10 A=%pi*d^2/4;
11 W=m*9.81;
12 sigi=W/A*(1+sqrt(1+(2*E*A*h)/(W*l)));
13 deli=sigi*l/E;
14 siggradual=W/A;
15 sigsudden=2*siggradual;
16
17   // printing data in scilab o/p window
18   printf("sigi is %f N/mm^2      ",sigi);
19   printf("\n deli is %f mm      ",deli);
20   printf("\n siggradual is %f N/mm^2      ",
       siggradual);
```

```
21
22 // The difference in the answer of sigi and
      siggradual is due to round-off errors.
```

Scilab code Exa 3.2 MS2

```
1  // sum 3-2
2  clc;
3  clear;
4  d=5;
5  A=%pi*d^2/4;
6  l=100*10^3;
7  W=600;
8  E=210*10^3;
9  w=0.0784*10^-3;
10 del1=W*l/(A*E);
11 del2=w*l^2/(2*E);
12 del=del1+del2;
13
14   // printing data in scilab o/p window
15   printf("del is %f mm     ",del);
```

Scilab code Exa 3.3 MS3

```
1  // sum 3-3
2  clc;
3  clear;
4  m=25;
5  v=3;
6  E=210*10^3;
7  KE=0.5*m*v^2;
8  d=30;
9  L=2000;
```

```
A=%pi*d^2/4;
U=A*L/(2*E);
del=4*10^-5*A;
W=A*del;
sigi=sqrt(KE*10^3/(W+U));

  // printing data in scilab o/p window
  printf("del is %f N/mm^2      ",sigi);
```

Scilab code Exa 3.4 MS4

```
// sum 3-4
clc;
clear;
P=40*10^3;
A=60*18;
sig=P/A;
r1=12;
b1=60;
SCF1=1.7;
sigmax1=sig*SCF1;
r2=24;
b2=60;
SCF2=1.5;
sigmax2=sig*SCF2;

  // printing data in scilab o/p window
  printf("sigmax1 is %f N/mm^2      ",sigmax1);
  printf("\n sigmax2 is %f N/mm^2      ",sigmax2);
```

Scilab code Exa 3.5 MS5

```
// sum 3-5
```

```
clc;
clear;
p=2.4;
//Let axial movement of nut be La
La=p*45/360;
d=20;
D=30;
L=500;
d1=18;
As=%pi*d1^2/4;
Ac=%pi*(D^2-d^2)/4;
sigt=120/(3.543);
sigb=1.543*sigt;

  // printing data in scilab o/p window
  printf("sigt is %f N/mm^2      ",sigt);
  printf("\n sigb is %f N/mm^2      ",sigb);
```

Scilab code Exa 3.6 MS6

```
// sum 3-6
clc;
clear;
delT=100;
ab=18*10^-6;
aa=23*10^-6;
delta=(360*ab*delT)+(450*aa*delT);
lc=delta-0.6;
Ea=70*10^3;
Eb=105*10^3;
Aa=1600;
Ab=1300;
P=lc/((360/(Ab*Eb))+(450/(Aa*Ea)));
P=P*10^-3;
//Let the change in length be delL
```

```
16 delL=(aa*450*delT)-(P*10^3*450/(Aa*Ea));
17
18   // printing data in scilab o/p window
19   printf("P is %f kN      ",P);
20   printf("\n delL is %f mm      ",delL);
21
22  // The difference in the answer of delL is due to
      round-off errors.
```

Scilab code Exa 3.7 MS7

```
1 // sum 3-7
2 clc;
3 clear;
4 a=23*10^-6;
5 E=70*10^3;
6 l=750;
7 sig=35;
8 delT=((sig*l/E)+0.8)/(l*a);
9
10   // printing data in scilab o/p window
11   printf("delT is %f degC      ",delT);
```

Scilab code Exa 3.8 MS8

```
1 // sum 3-8
2 clc;
3 clear;
4 OA=60;
5 AB=30;
6 OC=-20;
7 CD=-30;
8 theta=30;
```

```
angBEK=2*theta;
OM=14;
KM=49.5;
p1=70;
p2=-30;
angBEH=-37;
angBEI=143;
theta1=angBEH/2;
theta2=angBEI/2;
Tmax=50;
angBEL=53;
angBEN=233;
theta3=angBEL/2;
theta4=angBEN/2;
// printing data in scilab o/p window
  printf("Stress on plane AB is %f MPa     ",OM);
  printf("\n Stress on plane AB is %f MPa     ",KM);
  printf("\n Principal stress p1 is %f MPa     ",p1)
     ;
  printf("\n Principal stress p2 is %f MPa     ",p2)
     ;
  printf("\n Principal angle theta1 is %f deg     ",
     theta1);
  printf("\n Principal angle theta2 is %f deg     ",
     theta2);
  printf("\n Maximum shear stress is %f MPa     ",
     Tmax);
  printf("\n Direction of plane theta3 is %f deg
        ",theta3);
  printf("\n Direction of plane theta4 is %f deg
        ",theta4);

//The answers in the book are written in form of
   degrees and minutes.
```

Scilab code Exa 3.9 MS9

```
// sum 3-9
clc;
clear;
E=200*10^3;
v=0.29;
E1=720*10^-6;
E2=560*10^-6;
p1=121.76;
p2=-76.69;

  // printing data in scilab o/p window
  printf("p1 is %f MN/mm^2      ",p1);
  printf("\n p2 is %f MN/mm^2      ",p2);
```

Scilab code Exa 3.10 MS10

```
// sum 3-10
clc;
clear;
G=38*10^3;
d=10;
P=5*10^3;
A=%pi*d^2/4;
sig=P/A;
deld=0.0002;
//Let the lateral strain be E1
E1=deld/d;
v=2*deld*G/(sig-(2*deld*G));
E=2*G*(1+v)*10^-3;

  // printing data in scilab o/p window
  printf("v is %0.4f      ",v);
  printf("\n E is %0.3f kN/mm^2      ",E);
```

Scilab code Exa 3.11 MS11

```
1 // sum 3-11
2 clc;
3 clear;
4 D=1500;
5 p=1.2;
6 sigt=100;
7 sigc=p*D/2;
8 siga=p*D/4;
9 P=sigc*2*10^3;
10 n=0.75;
11 t=sigc/(n*sigt);
12
13   // printing data in scilab o/p window
14   printf("t is %0.1f mm    ",t);
```

Scilab code Exa 3.12 MS12

```
1 // sum 3-12
2 clc;
3 clear;
4 D=50;
5 t=1.25;
6 d=0.5;
7 n=1/d;
8 p=1.5;
9 siga=p*D/(4*t);
10 sigc=20.27;
11 sigw=sigc/0.31416;
12
```

```
13   // printing data in scilab o/p window
14   printf("sigw is %0.2f N/mm^2     ",sigw);
```

Scilab code Exa 3.13 MS13

```
1  // sum 3-13
2  clc;
3  clear;
4  R1=50;
5  p=75;
6  pmax=125;
7  R2=sqrt((pmax+p)*R1^2/(pmax-p));
8  t=R2-R1;
9
10   // printing data in scilab o/p window
11   printf("t is %0.1f mm     ",t);
```

Scilab code Exa 3.14 MS14

```
1  // sum 3-14
2  clc;
3  clear;
4  R1=40;
5  R2=60;
6  B=50;
7  E=210*10^3;
8  e=41*10^-6;
9  sig=2*R1^2/(R2^2-R1^2);
10 p=E*e/sig;
11 Fr=p*2*%pi*R1*B;
12 u=0.2;
13 Fa=u*Fr*10^-3;
14
```

```
15   // printing data in scilab o/p window
16   printf("Fa is %0.2f kN     ",Fa);
```

Scilab code Exa 3.15 MS15

```
1  // sum 3-15
2  clc;
3  clear;
4  a1=10*1.5;
5  x1=15-0.75;
6  a2=1.5*(15-1.5);
7  x2=(15-1.5)/2;
8  y1=((a1*x1)+(a2*x2))/(a1+a2);
9  y2=a1-y1;
10 Ixx=(10*1.5^3)/12+(10*1.5*(5.06-1.5/2)^2)
      +(1.5*13.5^3/12)+(1.5*13.5*(9.94-6.75)^2);
11 Z1=Ixx/y1;
12 Z2=Ixx/y2;
13 L=3;
14 sigc=50;
15 W=sigc*Z1/L*10^-3;
16
17   // printing data in scilab o/p window
18   printf("W is %0.3f kN     ",W);
```

Scilab code Exa 3.16 MS16

```
1  // sum 3-16
2  clc;
3  clear;
4  D=22;
5  d=20;
6  r=1;
```

```
K=2.2;
sigmax=130;
sigmax=sigmax/K;
Z=%pi*d^3/32;
M=sigmax*Z*10^-3;

  // printing data in scilab o/p window
  printf("M is %0.3f Nm    ",M);
```

Scilab code Exa 3.17 MS17

```
// sum 3-17
clc;
clear;
A=(12*2)+(12*2)+(30-4);
B=sqrt(A/2);
D=2*B;
B1=12;
D1=30;
d=26;
b=1;
Z1=((B1*D1^3)-((B1-b)*d^3))/(B1*D1/2);
Zr=B*D^2/6;
//Let the ratio of both the sections be x
x=Z1/Zr;
M=30*10^6;
sigmax=M/(Z1*10^3);

  // printing data in scilab o/p window
  printf("Z1/Zr is %0.2f      ",x);
  printf("\n sigmax is %0.2f N/mm^2     ",sigmax);
```

Scilab code Exa 3.18 MS18

```
// sum 3-18
clc;
clear;
//Tmax=F/(I*b)*[B*t(d/2+t/2)+(b*d*d/8)];
//T1=F/(I*b)*[B*t*(d+t)/2];
//Tmean=T1+2/3*(Tmax-T1);
//T=Tmax-Tmean;
//T=F*d^2/(24*I);
disp("Difference between maximum and mean shear
   stresses in the web is ,T=F*d^2/(24*I)");
```

Scilab code Exa 3.19 MS19

```
// sum 3-19
clc;
clear;
x1=((13*3*1.5)+(2*15*8))/(39+30);
x2=13-x1;
A=30+39;
E=2*10^7;
Iyy=995.66;
e=54.32;
x=x2-3;
sigb=e*x/Iyy;
sigd=1/69;
sigr=sigd+sigb;
//Let the strain be E1
E1=800*10^-6;
P=E1*E/sigr;
P=P*10^-3;

  // printing data in scilab o/p window
  printf("P is %0.2f kN    ",P);
```

Scilab code Exa 3.20 MS20

```
1  // sum 3-20
2  clc;
3  clear;
4  H=20;
5  D=5;
6  d=3;
7  rho=21;
8  sigd=rho*H;
9  p=2;
10 A=D*H;
11 P=p*A;
12 M=P*H/2;
13 Z=%pi*(D^4-d^4)/(32*D);
14 sigb=M/Z;
15 sigmax=420+sigb;
16 sigmin=420-sigb;
17
18   // printing data in scilab o/p window
19   printf("sigmax is %0.2f kN/m^2     ",sigmax);
20   printf("\n sigmin is %0.2f kN/m^2     ",sigmin);
```

Scilab code Exa 3.21 MS21

```
1  // sum 3-21
2  clc;
3  clear;
4  D=30;
5  R=15;
6  T=0.56*10^6;
7  G=82*10^3;
```

```
J=%pi*R^4/2;
T1=T*R/J;
l=1000;
theta=T*l/(G*J)*180/%pi;
r=10;
Tr=T1*r/R;

  // printing data in scilab o/p window
  printf("T1 is %0.2f N/mm^2     ",T1);
  printf("\n theta is %0.2f deg     ",theta);
  printf("\n Tr is %0.2f N/mm^2     ",Tr);
```

Scilab code Exa 3.22 MS22

```
// sum 3-22
clc;
clear;
T=8*10^3;
d=80;
D=110;
l=2000;
Gst=80*10^3;
Gcop=Gst/2;
Js=%pi*d^4/32;
Jc=%pi*(D^4-d^4)/32;
//Ts=0.777*Tc
Tc=T/1.777*10^3;
Ts=0.777*Tc;
Ts1=Ts/Js*d/2;
Tc1=Tc/Jc*D/2;
//Let tl be Angular twist per unit length
tl=Ts*10^3/(Js*Gst)*180/%pi;
// Let the maximum stress developed when the Torque
   is acting in the centre of the shaft be Ts2 & Tc2
    resp. for steel and copper
```

```
Ts2=Ts1/2;
Tc2=Tc1/2;

  // printing data in scilab o/p window
  printf("Ts1 is %0.3f N/mm^2    ",Ts1);
  printf("\n Tc1 is %0.1f N/mm^2    ",Tc1);
  printf("\n theta/length is %0.3f deg/m    ",tl);
  printf("\n Ts2 is %0.3f N/mm^2    ",Ts2);
  printf("\n Tc2 is %0.2f N/mm^2    ",Tc2);
```

Scilab code Exa 3.23 MS23

```
// sum 3-23
clc;
clear;
D=100;
d=75;
r=6;
K=1.45;
P=20*746;
N=400;
w=2*%pi*N/60;
T=P/w;
Ts=16*T*10^3/(%pi*d^3);
Tmax=K*Ts;

  // printing data in scilab o/p window
  printf("Tmax is %0.3f MPa    ",Tmax);
```

Scilab code Exa 3.24 MS24

```
// sum 3-24
clc;
```

```
clear;
G=84*10^3;
T=28*10^3;
l=1000;
theta=%pi/180;
J=T*l/(G*theta);
d=(J*32/%pi)^(1/4);

  // printing data in scilab o/p window
  printf("d is %0.1f mm    ",d);
```

Scilab code Exa 3.25 MS25

```
// sum 3-25
clc;
clear;
P=2*10^6;
N=200;
w=2*%pi*N/60;
Tm=P/w;
W=5*10^3*9.81;
l=1800;
Mmax=W*l/4;
Tmax=1.8*Tm*10^3;
Me=(Mmax+sqrt(Mmax^2+Tmax^2))/2;
Te=sqrt(Mmax^2+Tmax^2);
sig=60;
Ts=40;
d1=(32*Me/(%pi*sig))^(1/3);
d2=(16*Te/(%pi*Ts))^(1/3);

  // printing data in scilab o/p window
  printf("d is %0.1f mm    ",d2);
```

Scilab code Exa 3.26 MS26

```
1  // sum 3-26
2  clc;
3  clear;
4  Q=4*10^3;
5  P=8*10^3;
6  sig=P;
7  T=Q;
8  p1=(sig/2+sqrt((sig/2)^2+T^2));
9  p2=(sig/2-sqrt((sig/2)^2+T^2));
10 sigyp=285;
11 FOS=3;
12 siga=sigyp/3;
13 A1=p1/siga;
14 d1=sqrt(4*A1/%pi);
15 A2=(p1-p2)*2/(siga*2);
16 d2=sqrt(4*A2/%pi);
17 v=0.3;
18 A3=sqrt(p1^2+p2^2-(2*v*p1*p2))/siga;
19 d3=sqrt(4*A3/%pi);
20
21   // printing data in scilab o/p window
22   printf("d1 is %0.2f mm    ",d1);
23   printf("\n d2 is %0.1f mm    ",d2);
24   printf("\n d3 is %0.2f mm    ",d3);
```

Scilab code Exa 3.27 MS27

```
1  // sum 3-27
2  clc;
3  clear;
```

```
4  sigx=-105;
5  Txy=105;
6  sigy=270;
7  p1=(sigx/2+sqrt((sigx/2)^2+Txy^2));
8  p2=(sigx/2-sqrt((sigx/2)^2+Txy^2));
9  p3=0;
10 Tmax=(p1-p2)/2;
11 siga=sigy/2;
12 if (Tmax<=siga) then
13     printf("The component is safe")
14 end
15
16   // printing data in scilab o/p window
17   printf("\n Tmax is %0.1f MPa    ",Tmax);
```

Scilab code Exa 3.28 MS28

```
1  // sum 3-28
2  clc;
3  clear;
4  rho=0.0078*9.81*10^-6;
5  sigc=150;
6  g=9.81;
7  V=sqrt(sigc*g/rho)*10^-3;
8  R=1;
9  w=V/R;
10 N=w*60/(2*%pi);
11
12   // printing data in scilab o/p window
13   printf("N is %0.3f rpm    ",N);
```

Scilab code Exa 3.29 MS29

```
// sum 3-29
clc;
clear;
R1=50;
R2=200;
N=6*10^3;
w=2*%pi*N/60;
v=0.28;
rho=7800*10^-9;
g=9810;
k1=(3+v)/8;
k2=(1+(3*v))/8;
W=rho*9.81;
x=k1*w^2*W*(R1^2+R2^2)/g;
y=k1*w^2*W*(R1*R2)^2/g;
y1=k1*w^2*W/g;
z=k2*w^2*W/g;
r=sqrt(R1*R2);
sigrmax=x-(y/r^2)-(r^2*y1);
r=50:200
n=length(r);
for i=1:n
    sigr(i)=x-(y/r(i)^2)-(r(i)^2*y1)
end

for j=1:n
    sigc(j)=x+(y/r(j)^2)-(r(j)^2*z)
end

plot (r,sigr);
plot (r,sigc);
xtitle('','r mm');
ylabel('stress  N/mm^2');
xgrid(2);

  // printing data in scilab o/p window
  printf("sigrmax is %0.1f MPa  ",sigrmax);
```

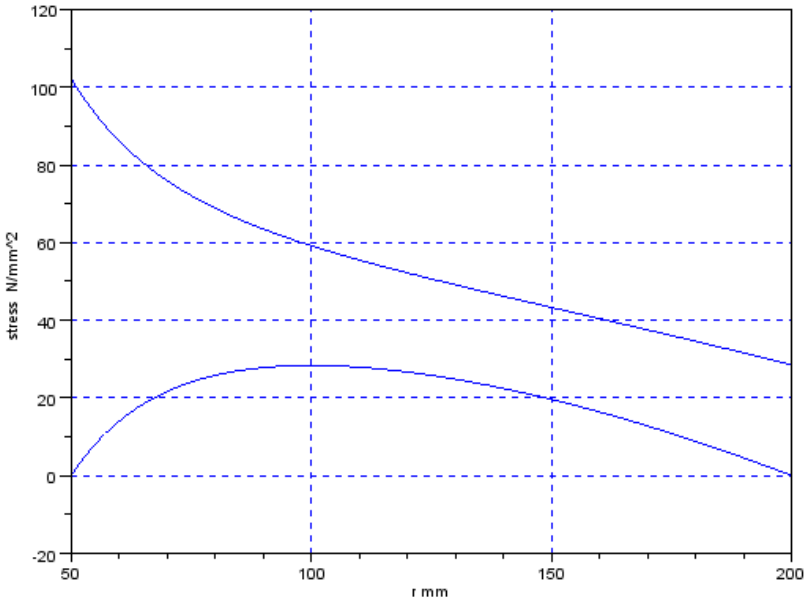

Figure 3.1: MS29

Scilab code Exa 3.30 MS30

```
1 // sum 3-30
2 clc;
3 clear;
4 r=500;
5 to=15;
6 N=3500;
7 w=2*%pi*N/60;
8 sig=80;
```

```
w1=0.07644*10^-3;
g=9810;
a=w1*w^2*r^2/(2*sig*g);
t=to*exp(-a);

  // printing data in scilab o/p window
  printf("t is %0.3f mm  ",t);
```

Scilab code Exa 3.31 MS31

```
// sum 3-31
clc;
clear;
M=60*10^3;
y1=((5*1*2.5)+(6*1*5.5))/(5+6);
y2=6-y1;
R=12;
R1=R-y2;
R1=10.136
R2=11.136;
R3=R1+6;
B=6;
b=1;
A=(B*b)+((B-1)*b);
//Let x= h^2/R^2
x=R/A*((B*log(R2/R1))+(b*log(R3/R2)))-1;
x=1/x;
//Let Maximum compressive stress at B be sigB
sigB=M/(A*R)*(1+(x*y1/(R+y1)))*10^-2;
//Let Maximum tensile stress at A be sigA
sigA=M/(A*R)*((y2*x/(R-y2))-1)*10^-2;
// printing data in scilab o/p window
  printf("sigB is %0.1f MPa     ",sigB);
  printf("\n sigA is %0.0f MPa     ",sigA);

```

```
26    //The answer to R^2/h^2 is calculated incorrectly
        in the book.
```

Scilab code Exa 3.32 MS32

```
1  // sum 3-32
2  clc;
3  clear;
4  R1=24;
5  R2=30;
6  R3=50;
7  R4=54;
8  F=200;
9  y1=((16*4*2)+(2*20*14*4)+(24*6*27))/((16*4)+(2*20*4)
       +(24*6));
10 y2=30-y1;
11 R=24+y2;
12 A=(24*6)+(2*4*20)+(4*16);
13 //Let x= h^2/R^2
14 x=R/A*((24*log(R2/R1))+(2*4*log(R3/R2))+(16*log(R4/
       R3)))-1;
15 x=1/x;
16 M=F*(60+R);
17 sigd=F/A;
18 //Let bending stress at a be sigA
19 sigA=M/(A*R)*((y2*x/(R-y2))-1);
20 //Let bending stress at b be sigB
21 sigB=M/(A*R)*(1+(x*y1/(R+y1)));
22 //Let resultant at a be Ra
23 Ra=(sigA+sigd)*10;
24 //Let resultant at b be Rb
25 Rb=(sigB-sigd)*10;
26 // printing data in scilab o/p window
27   printf("Ra is %0.2f N/mm^2      ",Ra);
28   printf("\n Rb is %0.2f N/mm^2      ",Rb);
```

```
29
30 //The difference in the answers are due to rounding-
      off of values.
```

Scilab code Exa 3.33 MS33

```
1  // sum 3-33
2  clc;
3  clear;
4  F=50;
5  B1=4;
6  B2=8;
7  D=12;
8  y1=D/3*(B1+(2*B2))/(B1+B2);
9  y2=12-y1;
10 R=6+y2;
11 A=(B1+B2)/2*D;
12 //Let x= h^2/R^2
13 a=(B1+((B2-B1)*(y1+R)/D))*log((R+y1)/(R-y2))
14 x=R/(A)*(a -(B2-B1));
15 x=x-1;
16 x=1/x;
17 KG=y2+8;
18 M=F*KG;
19 sigd=F/A;
20 //Let bending stress at a be sigA
21 sigA=M/(A*R)*(1+(x*y1/(R+y1)));
22 //Let bending stress at b be sigB
23 sigB=M/(A*R)*((y2*x/(R-y2))-1);
24 sigA=(sigA-sigd)*10;
25 sigB=(sigB+sigd)*10;
26 // printing data in scilab o/p window
27   printf("sigA is %0.2f MPa      ",sigA);
28   printf("\n sigB is %0.2f MPa      ",sigB);
29
```

```
30    //The difference in the answers are due to
        rounding-off of values.
```

Chapter 4

MANUFACTURING CONSIDERATIONS

Scilab code Exa 4.1 MF1

```
1  // sum 4-1
2  clc;
3  clear;
4  d=70;
5  dmin=50;
6  dmax=80;
7  D=sqrt(dmin*dmax);
8  D=63;
9  i=0.458*(D^(1/3))+(0.001*D);
10
11 //standard tolerance for H8 is ST1
12 ST1=25*i;
13 ST1=ST1*10^-3;
14 //standard tolerance of shaft for grade g7 is ST2
15 ST2=16*i;
16 ST2=ST2*10^-3;
17 es=-(2.5*(D^0.333));
18 es=es*10^-3;
19 ei=es-ST2;
```

```
20 //Lower limit for hole is LLH
21 //Upper limit for hole is ULH
22 //Upper limit for shaft is ULS
23 //Lower limit for shaft is LLS
24 LLH=d;
25 ULH=LLH+ST1;
26 ULS=LLH+es;
27 LLS=ULS-ST2;
28 //Maximum clearance is Cmax
29 //minimum clearance is Cmin
30 Cmax=ULH-LLS;
31 Cmin=LLH-ULS;
32
33   // printing data in scilab o/p window
34   printf("LLH is %0.1f mm ",LLH);
35   printf("\n ULH is %0.3f mm ",ULH);
36   printf("\n ULS is %0.2f mm ",ULS);
37   printf("\n LLS is %0.2f mm ",LLS);
38   printf("\n Cmax is %0.3f mm ",Cmax);
39   printf("\n Cmin is %0.3f mm ",Cmin);
```

Scilab code Exa 4.2 MF2

```
1 // sum 4-2
2 clc;
3 clear;
4 d=25;
5 //Lower limit for hole is LLH
6 //Upper limit for hole is ULH
7 //Upper limit for shaft is ULS
8 //Lower limit for shaft is LLS
9 ULH=d+0.021;
10 LLH=d+0;
11 ULS=d+0.041;
12 LLS=d+0.028;
```

```
13 //Maximum interference is Cmax
14 //minimum interference is Cmin
15 Cmax=ULS-LLH;
16 Cmin=LLS-ULH;
17
18   // printing data in scilab o/p window
19   printf("Cmax is %0.3f mm ",Cmax);
20   printf("\n Cmin is %0.3f mm ",Cmin);
```

Scilab code Exa 4.3 MF3

```
1 // sum 4-3
2 clc;
3 clear;
4 d=50;
5 Es=0.039;
6 Ei=0;
7 es=-9*10^-3;
8 ei=-34*10^-3;
9 //Shaft dia is D
10 D=d+es;
11 //Lower limit for hole is LLH
12 //Upper limit for hole is ULH
13 //Upper limit for shaft is ULS
14 //Lower limit for shaft is LLS
15 ULH=d+Es;
16 LLH=d+Ei;
17 ULS=d+es;
18 LLS=d+ei;
19 //Maximum interference is Cmax
20 //minimum interference is Cmin
21 Cmax=ULH-LLS;
22 Cmin=LLH-ULS;
23
24   // printing data in scilab o/p window
```

```
25    printf("ULH is %0.3f mm ",ULH);
26    printf("\n LLH is %0.3f mm ",LLH);
27    printf("\n ULS is %0.3f mm ",ULS);
28    printf("\n LLS is %0.3f mm ",LLS);
29    printf("\n Cmax is %0.3f mm ",Cmax);
30    printf("\n Cmin is %0.3f mm ",Cmin);
31    disp('Therefore, H8g7 is easy running fit');
```

Scilab code Exa 4.4 MF4

```
1  // sum 4-3
2  clc;
3  clear;
4  d=30;
5  Es=0.025;
6  Ei=0;
7  es=11*10^-3;
8  ei=-5*10^-3;
9  //Shaft dia is D
10 D=d+es;
11 //Lower limit for hole is LLH
12 //Upper limit for hole is ULH
13 //Upper limit for shaft is ULS
14 //Lower limit for shaft is LLS
15 ULH=d+Es;
16 LLH=d+Ei;
17 ULS=d+es;
18 LLS=d+ei;
19 //Maximum interference is Cmax
20 //minimum interference is Cmin
21 Cmax=ULH-LLS;
22 Cmin=ULS-LLH;;
23
24    // printing data in scilab o/p window
25    printf("ULH is %0.3f mm ",ULH);
```

```
26    printf("\n LLH is %0.3f mm ",LLH);
27    printf("\n ULS is %0.3f mm ",ULS);
28    printf("\n LLS is %0.3f mm ",LLS);
29    printf("\n Cmax is %0.3f mm ",Cmax);
30    printf("\n Cmin is %0.3f mm ",Cmin);
```

Chapter 5

INTRODUCTION TO PRESSURE VESSELS

Scilab code Exa 5.1 IPV5 1

```
1 // sum 5-1
2 clc;
3 clear;
4 p=2;
5 Rm=220;
6 //tensile hoop or circumferential stress= sigt
7 sigr=-2;
8 //sigt=(p*Rm)/t;
9 Sa=230/2;
10 //t1=thickness according to maximum principal stress
     theory
11 //t2=thickness according to maximum shear stress
    theory
12 t1=(p*Rm)/Sa;
13 t2=(p*Rm)/(Sa+sigr);
14
15   // printing data in scilab o/p window
16   printf("t1 is %0.2f mm ",t1);
17   printf("\n t2 is %0.3f mm ",t2);
```

Scilab code Exa 5.2 IPV5 2

```
1  // sum 5-2
2  clc;
3  clear;
4  //Elastic limit=sige
5  sige=310;
6  //inside diameter=di
7  di=300;
8  p=1.8;
9  FOS=2;
10 //design stress=sigd;
11 sigd=sige/2;
12 c=0.162;
13 d=380;
14 //cover plate thickness=t;
15 t=d*sqrt(c*p/sigd);
16 t=17;
17 M=di*p*t/4;
18
19 z=(1/6)*1*t^2;
20 //bending stress=sigb;
21 sigb=M/z;
22
23   // printing data in scilab o/p window
24   printf("t is %0.1fmm ",t);
25   printf("\n M is %0.1fmm ",M);
26   printf("\n sigb is %0.1fmm ",sigb);
27   if (sigb<=sigd) then
28     disp ('sigb is below allowable sigd.')
29 end
```

Scilab code Exa 5.3 IPV5 3

```
// sum 5-3
clc;
clear;
sige=220;
v=0.29;
Ri=175;
FOS=3;
Sa=sige/3;
p=10;
//t1=thickness according to maximum principal stress
    theory
//t2=thickness according to maximum shear stress
   theory
x=Sa+(p*(1-(2*v)));
y=Sa-(p*(1+v));
t1=(sqrt(x/y)-1)*Ri;
t1=24;
//t1=((sqrt((Sa+(p*(1-(2*v))))/(Sa-(p*(1+v)))))-1)*
   Ri;
t2=Ri*((sqrt(Sa/(Sa-(2*p))))-1);

  // printing data in scilab o/p window
  printf("t1 is %0.1fmm ",t1);
  printf("\n t2 is %0.3fmm ",t2);

  //The answer to t2 is not calculated in the book.
```

Scilab code Exa 5.4 IPV5 4

```
// sum 5-4
clc;
clear;
p=16;
```

```
5  Ri=250;
6  //Yield strength =sigy;
7  sigy=330;
8  v=0.3;
9  FOS=3;
10 Sa=sigy/3;
11 t=Ri*((sqrt(Sa/(Sa-(2*p))))-1);
12 t=50;
13   // printing data in scilab o/p window
14    printf("t is %0.1fmm ",t);
```

Scilab code Exa 5.5 IPV5 5

```
1  // sum 5-5
2  clc;
3  clear;
4  d=15;
5  Eg=480;
6  t=3;
7  //flange thickness=ft;
8  ft=12;
9  A=%pi*d^2/4;
10 l=d+t+(ft/2);
11 E=210;
12 kb=A*E/l;
13 //effective area of gasket=Ag;
14 Ag=%pi*(((ft+t+d)^2)-(d^2))/4;
15 kg=Ag*Eg/t;
16 // printing data in scilab o/p window
17    printf("kb is %0.3f N/mm ",kb);
18 kb=kb*10^-3;
19 kg=kg*10^-3;
20 if (kb<=kg) then
21     printf("\n The combines stiffness of bolt and
          gasket is %0.3f kN/mm",kg)
```

```
22 end
23
24 //The difference in the value of kb is due to
     rounding-off the value of A
```

Chapter 6

LEVERS

Scilab code Exa 6.1 L1

```
1  // sum 6-1
2  clc;
3  clear;
4  del=10;
5  k=500;
6  W=k*del;
7  //Let load arm be l1
8  l1=200;
9  //Let effort arm be l2
10 l2=500;
11 P=W*l1/l2;
12 Ro=sqrt(W^2+P^2);
13 Ta=40;
14 d=sqrt(Ro*4/(2*%pi*Ta));
15 d=10;
16 pb=10;
17 d1=sqrt(Ro/(pb*1.5));
18 d1=20;
19 l=1.5*d;
20 t=10;
21 T=Ro*4/(2*%pi*d1^2);
```

```
M=(Ro/2*(l/2+t/3))-(Ro/2*l/4);
sigb=32*M/(%pi*d1^3);
sigmax=(sigb/2)+sqrt((sigb/2)^2+T^2);
P=Ro/(l*d1);
D=2*d1;

  // printing data in scilab o/p window
  printf("d1 is %0.1f mm     ",d1);
  printf("\n D is %0.1f mm     ",D);
```

Scilab code Exa 6.2 L2

```
// sum 6-2
clc;
clear;
d1=80;
p=0.981;
Ta=40;
siga=80;
pa=15;
W=%pi*(d1^2)*p/4;
P=W/8;
Ws=W-P;
d=sqrt(W*4/(%pi*2*Ta));
l=1.5*d;
D=2*d;
T=W/(2*%pi*pa^2/4);
M1=P*(700-87.5-(D/2));
h=50;
b=h/4;
Z=b*h^2/6;
sigb=M1/Z;
pmax=80;
T=2465.6/h^2;
pmax=(sigb/2)+sqrt((sigb/2)^2+T^2);
```

```
24
25    // printing data in scilab o/p window
26    printf("h is %0.2f mm      ",h);
27    printf("\n pmax is %0.2f MPa      ",pmax);
28
29    //The difference in the value of pmax is due to
         rounding-off the digits.
```

Scilab code Exa 6.3 L3

```
1  // sum 6-3
2  clc;
3  clear;
4  P=((4*360)+(2*360))/900;
5  Fv=4-2;
6  Fh=P;
7  Fr=sqrt(Fv^2+Fh^2);
8  P1=4*0.36/0.9;
9  Rf=sqrt(4^2+1.6^2);
10 d=sqrt(Rf*10^3/(15*1.25));
11 d=16;
12 l=1.25*d;
13 T=Rf*10^3*4/(2*%pi*d^2);
14 D=2*d;
15 M1=Rf*10^3*(360-(D/2));
16 pa=15;
17 h=80;
18 b=h/4;
19 Z=b*h^2/6;
20 sigb=M1/Z;
21 T=4310/(b*h);
22 pmax=(sigb/2)+sqrt((sigb/2)^2+T^2);
23
24    // printing data in scilab o/p window
25    printf("P is %0.1f KN      ",P);
```

```
26    printf("\n pmax is %0.2f MPa      ",pmax);
```

Scilab code Exa 6.4 L4

```
1  // sum 6-4
2  clc;
3  clear;
4  l=360;
5  P=400;
6  Mh=2*P*l/3;
7  sigb=50;
8  l1=60;
9  d=(Mh*32/(%pi*l1))^(1/3);
10 d=30;
11 L=420;
12 siga=60;
13 H=20;
14 B=H/3;
15 Mx=P*(L-H/2);
16 Tx=2*P*l/3;
17 sigb1=Mx*18/H^3;
18 Td=P/(B*H);
19 Tr=17.17*Tx/H^4;
20 T=Tr+Td;
21 sigmax=(sigb1/2)+sqrt((sigb1/2)^2+T^2);
22 Tmax=sqrt((sigb1/2)^2+T^2);
23 T=P*L;
24 M=P*(l1+(2/3*l));
25 Te=sqrt(T^2+M^2);
26 Ta=40;
27 D=(Te*16/(%pi*Ta))^(1/3);
28 D=30; //Rounding off to nearest whole number
29
30   // printing data in scilab o/p window
31   printf("d is %0.1f mm      ",d);
```

```
32   printf("\n D is %0.1f mm      ",D);
```

Scilab code Exa 6.5 L5

```
1  // sum 6-5
2  clc;
3  clear;
4  l2=300;
5  l=450;
6  P=400;
7  Mx=2*P*l2/3;
8  siga=80;
9  dh=(Mx*32/(%pi*siga))^(1/3);
10 dh=22;
11 L=(2*l2/3)+l;
12 T=P*L;
13 Ta=40;
14 d=(T*16/(%pi*Ta))^(1/3);
15 d=35;
16 d1=1.6*d;
17 Th=T*16*d1/(%pi*(d1^4-d^4));
18 l1=1.5*d;
19 My=P*(L-(d1/2));
20 B=dh;
21 H=sqrt(3.66*75);
22 H=30;
23 Mz=P*l1/2;
24 Te=sqrt(T^2+Mz^2);
25 d2=(Te*16/(%pi*Ta))^(1/3);
26 d2=32;
27 b=d/4;
28 b=9; //Rounding off to nearest whole number
29 t=d/6;
30 t=6; //Rounding off to nearest whole number
31
```

```
32   // printing data in scilab o/p window
33   printf("d is %0.1f  mm     ",d);
34   printf("\n dh is %0.1f mm     ",dh);
35   printf("\n d1 is %0.1f mm     ",d1);
36   printf("\n l1 is %0.1f mm     ",l1);
37   printf("\n d2 is %0.1f mm     ",d2);
38   printf("\n b  is %0.1f  mm     ",b);
39   printf("\n t  is %0.1f  mm     ",t);
```

Scilab code Exa 6.6 L6

```
1  // sum 6-6
2  clc;
3  clear;
4  L=450;
5  P=700;
6  T=P*L;
7  Ta=50;
8  d=(T*16/(%pi*Ta))^(1/3);
9  d=32;
10 d1=1.6*d;
11 d1=52; //Rounding off to nearest whole number
12 l1=1.25*d;
13 My=P*(L-d1/2);
14 sigb=65;
15 H=(My*18/sigb)^(1/3);
16 H=45;
17 B=H/3;
18 T1=P/(B*H);
19 sigmax=(sigb/2)+sqrt((sigb/2)^2+T^2);
20 Mx=P*l1/2;
21 Te=sqrt((T)^2+(Mx^2));
22 d2=(Te*16/(%pi*Ta))^(1/3);
23 d2=d2+6;
24 d2=38; //Rounding off to nearest whole number
```

```
25
26    // printing data in scilab o/p window
27    printf("d is %0.1f  mm     ",d);
28    printf("\n d1 is %0.1f mm     ",d1);
29    printf("\n l1 is %0.1f mm     ",l1);
30    printf("\n B  is %0.1f mm     ",B);
31    printf("\n H  is %0.1f mm     ",H);
32    printf("\n d2 is %0.1f mm     ",d2);
```

Chapter 7

STRUTS AND COLUMNS

Scilab code Exa 7.1 SC1

```
1  // sum 7-1
2  clc;
3  clear;
4  sigc=550;
5  FOS=4;
6  sigw=sigc/FOS;
7  l=4000;
8  le=l/2;
9  A=%pi*(1-0.7^2)/4;
10 K=(1+0.7^2)/16;
11 Pr=800*10^3;
12 a=1/1600;
13 D=130; //Rounding off to nearest whole number
14 d=D*0.7;
15
16   // printing data in scilab o/p window
17   printf("D is %0.1f mm     ",D);
18   printf("\n d is %0.1f mm     ",d);
```

Scilab code Exa 7.2 SC2

```
// sum 7-2
clc;
clear;
l=500;
E=70*10^3;
P=20*10^3;
FOS=2;
d=P*2*12*4*l^2/((%pi)^2*E);
d=(sqrt(8)*d)^0.25;
b=d/sqrt(8);

  // printing data in scilab o/p window
  printf("d is %0.2f mm     ",d);
  printf("\n b is %0.2f mm     ",b);
```

Scilab code Exa 7.3 SC3

```
// sum 7-3
clc;
clear;
Ixx=(2*1696.6)+115.4;
Iyy=1696.6+(2*115.4)+(2*25.27*10.27^2);
A=3*25.27;
Kmin=sqrt(Ixx/75.81);
L=600;
k=L/Kmin;
sigc=110;
c=1/200;
sigw=sigc*(1-(c*k));
Pw=sigw*A;
a=1/7500;
sigc1=320;
Pr=(sigc1*A)/(1+(a*(L/Kmin)^2));
```

```
17 FOS=Pr/Pw;
18
19   // printing data in scilab o/p window
20   printf("FOS is %0.2f      ",FOS);
```

Scilab code Exa 7.4 SC4

```
1  // sum 7-4
2  clc;
3  clear;
4  Iyy=193.4+(2*1.2*1.5^3/12);
5  E=200*10^3;
6  l=500;
7  Pe=(%pi^2)*E*Iyy*10^5/(l^2);
8  A=35.53+(2*1.2*15);
9  sige=Pe/7530;
10 k=sqrt(Iyy/A);
11 xc=75;
12 sig=80;
13 sigo=20.875;
14 A=A*100;
15 P=sigo*A;
16 P=P*10^-3;
17
18   // printing data in scilab o/p window
19   printf("P is %0.1f kN     ",P);
20
21   //The difference in the value of P is due to
       rounding-off the digits.
```

Scilab code Exa 7.5 SC5

```
1  // sum 7-5
```

```
clc;
clear;
sigc=330;
a=1/7500;
t=4;
A=14.5*t^2;
l=300;
Kx=sqrt(1.4626*t^2);
Pr=sigc*A/(1+(a*(l/Kx)^2));
FOS=2;
P=Pr/FOS*10^-3;

  // printing data in scilab o/p window
  printf("P is %0.4f KN     ",P);
```

Scilab code Exa 7.6 SC6

```
// sum 7-6
clc;
clear;
P=1500;
FOS=2;
Pd=FOS*P;
l=280;
E=207*10^3;
I=Pd*l^2/(%pi^2*E);
D=(64*I/(%pi*(1-0.8^4)))^(1/4);
D=8;
d=6.4;

  // printing data in scilab o/p window
  printf("D is %0.1f mm     ",D);
  printf("\n d is %0.1f mm     ",d);
```

Scilab code Exa 7.7 SC7

```
1  // sum 7-7
2  clc;
3  clear;
4  D=500;
5  p=0.3;
6  E=208*10^3;
7  sigc=320;
8  a=1/7500;
9  l=2000;
10 le=l/2;
11 W=%pi*D^2*p/4;
12 FOS=4;
13 Wd=W*FOS;
14 I=Wd*l^2/(%pi^2*E);
15 d=(64*I/%pi)^(1/4);
16 A=%pi*d^2/4;
17 k=d/4;
18 d=45; //Rounding off to nearest whole number
19
20   // printing data in scilab o/p window
21   printf("d is %0.1f mm     ",d);
```

Chapter 8

SPRINGS

Scilab code Exa 8.1 S8 1

```
1 // sum 8-1
2 clc;
3 clear;
4 d=5;
5 D=30;
6 G=84*(10^3);
7 Na=15;
8 //Axial Load W
9 W=300;
10 //Spring index C
11 C=30/5;
12 //Shear stress Augmentation factor Ks
13 Ks=((2*C)+1)/(2*C);
14 //Wahl's factor Kw
15 Kw=(((4*C)-1)/((4*C)-4))+(0.615/C);
16 //Curvature correction factor Kc
17 Kc=Kw/Ks;
18 //Spring stiffness k
19 k=(G*(d^4))/(8*(D^3)*Na);
20 //Axial deflection delta
21 delta=W/k;
```

```
22
23   // printing data in scilab o/p window
24 printf("Ks is %0.4f ",Ks);
25 printf("\n Kw is %0.4f ",Kw);
26 printf("\n Kc is %0.3f ",Kc);
27 printf("\n The Spring Stiffness is %0.1f N/mm",k);
28 printf("\n The Axial deflection is %0.3f mm",delta);
```

Scilab code Exa 8.2 S8 2

```
1 // sum 8-2
2 clc;
3 clear;
4 W=196.2;
5 lenthofscale=50;
6 k=196.2/50;
7 C=8;
8 Ks=(1+(0.5/C));
9
10 // Let us choose oil tempered wire 0.6-0.7 %C. Refer
       to Table 8-4 for constants A and m, relating
     strength wire
11 //diameter.
12 G=77.2*(10^3);
13 A=1855;
14 m=0.187;
15 // equating Tmax=0.5*sig(ut).
16 // Ks*(8*W*D/(pi*(d^3)))=0.5*A/(d^2)
17 d1=(Ks*(8*W*C/(%pi*A*0.5)));
18 d=d1^(1/1.813);
19 D=C*d;
20 Na=G*(d^4)/(8*(D^3)*k);
21 //Solid length = SL
22 SL=(Na-1)*d
23
```

```
24
25   // printing data in scilab o/p window
26 printf(" wire diameter is %0.3f mm ",d);
27 printf("\n mean diameter is %0.3f mm ",D);
28 printf("\n Number of acting coils are %0.3f ",Na);
29
30 //The difference in the values of d,D and Na is due
     to rounding-off the digits.
```

Scilab code Exa 8.3 S8 3

```
1 // sum 8-3
2 clc;
3 clear;
4 d=1.626;
5 A=2211;
6 m=0.145;
7 rm=3;
8 ri=(rm-(d/2));
9 sigma=A/(d^m);
10 W=(sigma*%pi*(d^3)*ri)/(32*(rm^2));
11
12   // printing data in scilab o/p window
13 printf("Ultimate tensile Strength is %0.1f MPa ",
     sigma);
14 printf("\n Force at which the spring hook fails is
     %0.1f N ",W);
15
16 //The difference in the values of sigma and W is due
     to rounding-off the digits.
```

Scilab code Exa 8.4 S8 4

```
// sum 8-4
clc;
clear;
Do=25;
// mean coil diameter D=25-d
W=150;
T=800;
G=81000;
// Substituting values in equation T=8*W*D/(%pi*(d^3))
// therefore, the equation becomes d^3 + 0.477*d = 11.936
//consider d=2.2mm, (d can be taken between 2.2-2.3 mm)
d=2.337; //(nearest available wire gauge)
C=9.5;
D=22.2;
Do=D+d;
Ks=1+(0.5/C);
Tmax=Ks*8*W*D/(%pi*(d^3));
// check for safety- Tmax<T;
Lo=100;
Ls=40;
//Lo=Ls+delta+0.15*delta
delta=(Lo-Ls)/1.15;
delta=50;
k=150/50;
Na=(G*d^4)/(8*(D^3)*k);

N=Na+2;
Ls=N*d;
Lo=Ls+(1.15*delta);

  // printing data in scilab o/p window
  printf("d is %0.3fmm ",d);
  printf("\n D is %0.2f mm",D);
  printf("\n Ls is %0.2f mm",Ls);
  printf("\n Lo is %0.2f mm",Lo);
```

```
36   if (Do<=25)
37     disp ('The diameter is within space constraints'
         );
38 end
```

Scilab code Exa 8.5 S8 5

```
1  // sum 8-5A
2  clc;
3  clear;
4  Di=15;
5  Do=20;
6  d=2.3;
7  D=17.5;
8  C=D/d;
9  Ks=1+(0.5/C);
10 Wmax=100;
11 Tmax=Ks*8*Wmax*D/(%pi*(d^3));
12 G=81000;
13 delmax=67.7/2.366;
14 k=100/28;
15 Na=G*(d^4)/(8*k*(D^3));
16 Ls=Na+1; //(for plain ends)
17 delmax=28;
18 //TL= total working length
19 TL=Ls+delmax+(0.15*delmax);
20
21   // printing data in scilab o/p window
22   printf("d is %0.1fmm ",d);
23   printf("\n C is %0.1f ",C);
24    printf("\n Na is %0.1f ",Na);
```

Scilab code Exa 8.6 S8 6

```
// sum 8-6
clc;
clear;
// 18 SWG=1.219MM in dia
d=1.219;
E=198.6*10^3;
G=80.7*10^3;
m=0.19;
A=1783;
sig=A/(d^m);
Tys=(0.4*sig);
Do=12.5;
D=Do-d;
C=D/d;
Ks=((2*C)+1)/(2*C);
W=(Tys*%pi*(d^3))/(8*D*Ks);
Nt=13.5;
Na=Nt-2;
del=(8*W*(D^3)*Na)/(G*(d^4));
Ls=(Nt-1)*d;
Lo=Ls+del+(0.15*del);

  // printing data in scilab o/p window
  printf("Tys is %0.1f MPa ",Tys);
  printf("\n W is %0.1f N ",W);
  printf("\n del is %0.3f mm ",del);
  printf("\n Ls is %0.4f mm ",Ls);
  printf("\n Lo is %0.2f mm ",Lo);

  //Answers in the book for Torsional yeild strength
      have been rounded-off to the nearest whole
     number.
```

Scilab code Exa 8.7 S8 7

```
// sum 8-7
clc;
clear;
d=1.016;
A=2211;
m=0.145;
G=81000;
Nt=16;
Na=16-2;
sig=A/(d^m);
Tys=0.45*sig;
Do=12.6;
D=Do-d;
C=D/d;
Ks=1+(0.5/C);
W=(Tys*%pi*(d^3))/(8*D*Ks);
k=(G*(d^4))/(8*(D^3)*Na);
del=W/k;
Ls=(Nt-1)*d;
Lo=Ls+(1.15*del);


  // printing data in scilab o/p window
  printf("Tys is %0.1f MPa ",Tys);
  printf("\n Do is %0.1f N ",Do);
  printf("\n W is %0.1f N ",W);
  printf("\n k is %0.3f N ",k);
  printf("\n del is %0.2f mm ",del);
  printf("\n Ls is %0.2f mm ",Ls);
  printf("\n Lo is %0.3f mm ",Lo);

  if ((Lo/D)>=5.26)
    disp ('The spring will fail under buckling');
end

//Values after the decimal point has not been
   considered for answer of Torsional yeild strength
    in the book, whereas answers for deflection and
```

free-length is different as entire value of variables is taken for calculation in the code.

Scilab code Exa 8.8 S8 8

```
1  // sum 8-8
2  clc;
3  clear;
4  d=2;
5  Do=20;
6  D=Do-d;
7  C=D/d;
8  Na=9;
9  //Material hard drawn spring steel
10 A=1783;
11 m=0.19;
12 G=81000;
13 sig=A/(d^m);
14 Tys=0.45*sig
15 Kf=1.5;
16 Ta=Tys/Kf;
17 Ks=1+(0.5/C);
18 W=(Ta*%pi*(d^3))/(8*D*Ks);
19 k=(G*(d^4))/(8*(D^3)*Na);
20 del=W/k;
21 Lo=((Na+1)*d)+(1.15*del);
22 p=(Lo-d)/Na;
23
24   // printing data in scilab o/p window
25   printf("k is %0.3f N/mm ",k);
26   printf("\n W is %0.1f N ",W);
27   printf("\n Lo is %0.3f mm ",Lo);
28   printf("\n p is %0.3f mm ",p);
29
30
```

```
31   if ((Lo)>=47.34)
32     disp ('The spring will fail under buckling');
33 end
34
35 //The answer for value of spring rate 'k' is
     misprinted in the book. Due to this all
     subsequent values of del,Lo,p is calucated
     incorrectly in the book.
```

Scilab code Exa 8.9 S8 9

```
1  // sum 8-9
2  clc;
3  clear;
4  // for music wire
5  d1=11.5;
6  A=2211;
7  d=1.5;
8  m=0.145;
9  sigut=A/(d^m);
10 sigy=0.78*sigut;
11 Do=16;
12 E=2*(10^5);
13 Nb=4.25;
14 D=Do-d;
15 C=D/d;
16 Ki=((4*(C^2))-C-1)/(4*C*(C-1));
17 Mmax=(sigy*%pi*(d^3))/(32*Ki);
18 kc=((d^4)*E)/(10.8*D*Nb);
19 theta3=Mmax/kc';
20 l1=20;
21 l2=20;
22 Ne=(l1+l2)/(3*%pi*D);
23 Na=Nb+Ne;
24 k=((d^4)*E)/(10.8*Na*D);
```

```
thetat=Mmax/k';
ke=(3*%pi*(d^4)*E)/(10.8*(l1+l2));
// angdisp=theta1+theta2=Mmax/ke;
angdisp=Mmax/ke;
//D1 is final coil diameter
D1=(Nb*D)/(Nb+theta3);
//IRC=Initial radial clearance
IRC=((D-d)-d1)/2;
//FRC=Final radial clearance
FRC=((D1-d)-d1)/2;


 // printing data in scilab o/p window
 printf("Maximum Torque is %0.2f Nmm ",Mmax);
 printf("\n theta3 is %0.3f turns ",theta3);
 printf("\n Ne is %0.3f turns ",Ne);
 printf("\n ke is %0.1f N/mm ",ke);
 printf("\n theta1+theta2 is %0.4f turns ",angdisp);
 printf("\n D1 is %0.2f mm ",D1);
 printf("\n IRC is %0.2f mm ",IRC);
 printf("\n FRC is %0.2f mm ",FRC);
```

Scilab code Exa 8.10 S8 10

```
// sum 8-10
clc;
clear;
A=1783;
m=0.190;
d=1.5;
D=15;
M=300;
E=20800;
k=30;
//sigult= ultimate strength of the material
```

```
12 // sigy= yield strength of the material
13 sigult=A/(d^m);
14 sigy=0.7*sigult;
15 //siga= allowable yield strength of the material
16 siga=sigy/2;
17 C=D/d;
18 Ki=(4*(C^2)-C-1)/(4*C*(C-1));
19 Z=%pi*(d^3)/32;
20 //sigb=bending strength of the material;
21 sigb=Ki*M/Z;
22 while (sigb>=siga)
23     d=d+0.15;
24     D=15;
25     C=D/d;
26     sigult=A/(d^m);
27 sigy=0.7*sigult;
28 siga=sigy/2;
29 Ki=(4*(C^2)-C-1)/(4*C*(C-1));
30 Z=%pi*(d^3)/32;
31 sigb=Ki*M/Z;
32 end
33 d=2;// rounding off the value of the diameter.
34 D;
35 Na=(d^4)*E/(64*D*k);
36
37   // printing data in scilab o/p window
38   printf("d is %0.1f mm ",d);
39   printf("\n D is %0.1f mm ",D);
40   printf("\n Na is %0.2f mm ",Na);
```

Scilab code Exa 8.11 S8 11

```
1 // sum 8-11
2 clc;
3 clear;
```

```
4  L=1180;
5  W=40*(10^3);
6  Nf=2;
7  Ng=8;
8  E=207*(10^3);
9  //sigut is ultimate strength
10 sigut=1400;
11 FOS=2;
12 //siga= allowable yield strength of the material
13 siga=1400/2;
14 //sigbf=bending strength in full length
15 sigbf=700;
16 b=75;
17 t=((4.5*W*L)/(((3*Nf)+(2*Ng))*sigbf))^(0.5);
18 t=14;
19 I=(Nf*b*(t^3))/12;
20 Wf=(3*Nf*W)/((3*Nf)+(2*Ng));
21 del=(Wf*(L^3))/(48*E*I);
22
23
24  // printing data in scilab o/p window
25  printf("t is %0.0f mm ",t);
26  printf("\n Wf is %0.0f N ",Wf);
27  printf("\n I is %0.0f mm^4 ",I);
28  printf("\n del is %0.1f mm ",del);
```

Scilab code Exa 8.12 S8 12A

```
1  // sum 8-12A
2  clc;
3  clear;
4  W=80000;
5  sigbfr=500;
6  L=1100;
7  Nf=3;
```

```
Ng=10;
N=Nf+Ng;
t=((1.5*W*L)/(N*6*sigbfr))^(1/3);
t=15;
b=6*t;
E=207*10^3;
deli=(W*(L^3))/(8*E*N*b*(t^3));
Wi=(W*Nf*Ng)/(N*((3*Nf)+(2*Ng)));


 // printing data in scilab o/p window
 printf("t is %0.1f mm ",t);
 printf("\n deli is %0.1f mm ",deli);
 printf("\n Wi is %0.0f N ",Wi);
```

Scilab code Exa 8.13 S8 13

```
// sum 8-13
clc;
clear;
//ultimate strength=sigut
sigut=1500;
C=7;
d=3;
D=C*d;
Ks=1+(0.5/C);
Kw=(((4*C)-1)/((4*C)-4))+(0.615/C);
Pmax=120;
Pmin=40;
Pm=80;
Tm=(Ks*8*Pm*D)/(%pi*(d^3));
Ta=(Kw*8*Pmin*D)/(%pi*(d^3));
Tse=0.22*sigut;
Tys=0.45*sigut;
x=(Tys-(0.5*Tse))/(0.5*Tse);
```

```
y=((x)*Ta)+Tm;
FOS=(Tys/y);

  // printing data in scilab o/p window
  printf("Tm is %0.2f MPa ",Tm);
  printf("\n Ta is %0.1f MPa ",Ta);
  printf("\n FOS is %0.3f ",FOS);
```

Scilab code Exa 8.14 S8 14

```
// sum 8-14
clc;
clear;
Tse=360;
Tys=660;
d=25;
P=0.03;
m=40;
Pmin=((%pi*(d^2)*P)/4)+(m*9.81/1000);
k=6;
//Additional load= Padd=k*further compression in
   spring
Padd=k*10;
Pmax=Padd+Pmin;
Pm=(Pmax+Pmin)/2;
Pa=(Pmax-Pmin)/2;
d=2;
D=12;
C=6;
Ks=1+(0.5/C);
Ks=1.083;
Kw=(((4*C)-1)/((4*C)-4))+(0.615/C);
Ta=(Kw*8*Pa*D)/(%pi*(d^3));
Tm=(Ks*8*Pm*D)/(%pi*(d^3));
x=(Tys-(0.5*Tse))/(0.5*Tse);
```

```
25 y=((x)*Ta)+Tm;
26 FOS=(Tys/y);
27
28   // printing data in scilab o/p window
29   printf("Tm is %0.2f MPa ",Tm);
30   printf("\n Ta is %0.3f MPa ",Ta);
31   printf("\n FOS is %0.2f ",FOS);
```

Chapter 9

THREADED FASTENERS

Scilab code Exa 9.1 TF1

```
1  // sum 9-1
2  clc;
3  clear;
4  p1=2;
5  d=16;
6  dt1=d-(0.93825*p1);
7  At1=%pi*dt1^2/4;
8  p2=1.5;
9  d=16;
10 dt2=d-(0.93825*p2);
11 At2=%pi*dt2^2/4;
12
13   // printing data in scilab o/p window
14   printf("At1 is %0.1f mm^2      ",At1);
15   printf("\n At2 is %0.1f mm^2      ",At2);
```

Scilab code Exa 9.2 TF2

```
// sum 9-2
clc;
clear;
W=20*10^3;
n=4;
//Let the load on each bolt be W1
W1=W/n;
At=W1/80;

  // printing data in scilab o/p window
  printf("At is %0.1f mm^2      ",At);
```

Scilab code Exa 9.3 TF3

```
// sum 9-3
clc;
clear;
d=18;
p=2.5;
dr=d-(1.2268*p);
dm=(d+dr)/2;
alpha=atan(p/(%pi*dm));
theta=%pi*30/180;
u1=0.15;
u2=0.13;
x=(tan(alpha)+(u1/cos(theta)))/(1-(tan(alpha)*u1/cos
   (theta)));
K=dm*x/(2*d)+(0.625*u2);

  // printing data in scilab o/p window
  printf("K is %0.5f       ",K);
```

Scilab code Exa 9.4 TF4

```
// sum 9-4
clc;
clear;
d=20;
t=4;
Lg=84;
Ad=%pi*d^2/4;
Eb=205*10^3;
Ed=105*10^3;
kb=Ad*Eb/Lg;
lg=80;
x=5*(lg+(0.5*d))/(lg+(2.5*d));
kp=%pi*Ed*d/(2*log(x));
At=245;
sigb=105;
Pe=20*10^3;
Pb=Pe*kb/(kb+kp);
sigad=Pb/At;
finalst=sigb+sigad;

  // printing data in scilab o/p window
  printf("final stress is %0.2f N/mm^2      ",
     finalst);
```

Scilab code Exa 9.5 TF5

```
// sum 9-5
clc;
clear;
Eb=207*10^3;
Ec=105*10^3;
sigp=650;
At=115;
Pi=0.75*sigp*At;
F=sigp*At;
```

```
10 //Let the additional load Fadd
11 Padd=F-Pi;
12 d=14;
13 Ad=%pi*d^2/4;
14 Lg=63;
15 kb=Ad*Eb/Lg;
16 lg=60;
17 x=5*(lg+(0.5*d))/(lg+(2.5*d));
18 km=%pi*Ec*d/(2*log(x));
19 C=kb/(kb+km);
20 Pe=Padd/C;
21 K=0.2;
22 Ti=Pi*K*d*10^-3;
23
24   // printing data in scilab o/p window
25   printf("Ti is %0.2f Nm      ",Ti);
```

Scilab code Exa 9.6 TF6

```
1 // sum 9-6
2 clc;
3 clear;
4 d=20;
5 sigp=600;
6 At=245;
7 Pi=120*10^3;
8 Pe=30*10^3;
9 C=0.35;
10 Pb=C*Pe;
11 P=Pi+Pb;
12 sigi=Pi/At;
13 sigf=P/At;
14 K=0.18;
15 T=K*d*Pi*10^-3;
16 E1=sigi/sigp;
```

```
17 E2=sigf/sigp;
18
19   // printing data in scilab o/p window
20   printf("sigi is %0.1f MPa      ",sigi);
21   printf("\n sigi is %0.2f MPa      ",sigf);
22   printf("\n T is %0.0f Nm      ",T);
23   printf("\n E1 is %0.3f       ",E1);
24   printf("\n E2 is %0.3f       ",E2);
25
26   //Value upto tenthth place is considered in the
       book for value of final stress in bolt, 'sigf'
```

Scilab code Exa 9.7 TF7

```
1  // sum 9-7
2  // The sum sequence is numbered incorrectly in the
     book, from this sum ownwards.
3  clc;
4  clear;
5  p=2;
6  d=16;
7  dt=d-(0.938*p);
8  At=%pi*dt^2/4;
9  r=60*sqrt(2);
10 Td=1/(4*At);
11 Ta=120;
12 T=8.722*10^-3;
13 P=Ta/T*10^-3;
14
15   // printing data in scilab o/p window
16   printf("P is %0.3f kN       ",P);
17
18   //Value upto hundredth place is considered in the
       book for value of permissible load, 'P'
```

Scilab code Exa 9.8 TF8

```
1  // sum 9-8
2  clc;
3  clear;
4  sigyp=460;
5  FOS=2;
6  Ts=0.577*sigyp/FOS;
7  At=245;
8  r=100;
9  P=Ts*At/1.453*10^-3;
10 // Open prob9p8.txt file
11 fid = mopen('prob9p8.txt', "w");
12 // error message
13   if (fid == -1)
14     error('cannot open file for writing');
15   end
16
17  mfprintf(fid, "Problem 9.8 Solution: \nThe
       eccentric load is %f N       ",P);
18
19   mclose(fid);
20   // printing data in scilab o/p window
21   printf("P is %0.3f kN      ",P);
22
23   //Value of thousandth place of eccentric load, 'P'
       is misprinted in the book.
```

Scilab code Exa 9.9 TF9

```
1  // sum 9-9
2  clc;
```

```
clear;
P=4*10^3;
e=200;
l1=150;
l2=550;
sigyp=420;
FOS=3;
siga=sigyp/3;
M=P*e;
At=12.5;
At=14.2;

  // printing data in scilab o/p window
  printf("At is %0.1f mm^2       ",At);
```

Scilab code Exa 9.10 TF10

```
// sum 9-10
clc;
clear;
Pi=10*10^3;
sigyp=420;
FOS=2;
sige=sigyp/FOS;
K1=0.85;
K2=0.74;
K4=0.868;
SCF=2.4;
K3=1/SCF;
sige=sige*K1*K2*K3*K4;
Pe=10*10^3/3;
Pmax=Pi+Pe;
Pmin=Pi;
Pa=(Pmax-Pmin)/2;
Pm=(Pmax+Pmin)/2;
```

```
19 theta=atan(Pa/Pm);
20 siga=21.132;
21 At=Pa/siga;
22 At=84.2;
23
24   // printing data in scilab o/p window
25   printf("At is %0.1f mm^2      ",At);
26   disp('M12 coarse-pitch bolt with 1.75 mm pitch is
       used');
```

Scilab code Exa 9.11 TF11

```
1  // sum 9-11
2  clc;
3  clear;
4  Pi=15;
5  Pmax=15+3.75;
6  Pmin=15+1.25;
7  Pa=(Pmax-Pmin)/2;
8  Pm=(Pmax+Pmin)/2;
9  K1=0.85;
10 K2=0.7;
11 K4=0.897;
12 SCF=2.4;
13 K3=1/SCF;
14 sige=900/4*K1*K2*K3*K4;
15 siga=28.115;
16 At=Pa*10^3/siga;
17 At=58;
18
19   // printing data in scilab o/p window
20   printf("At is %0.0f mm^2      ",At);
```

Chapter 10

PIPES AND PIPE JOINTS

Scilab code Exa 10.1 PPJ1

```
1  // sum 10-1
2  clc;
3  clear;
4  sigta=140/2;
5  nt=0.75;
6  //Let the flow rate be Q
7  Q=0.25;
8  v=1.2;
9  D=1.13*sqrt(Q/v);
10 D=520;
11 p=0.7;
12 C=9;
13 t=(p*D)/(2*sigta*nt)+C;
14
15   // printing data in scilab o/p window
16   printf(" t is %0.1f mm     ",t);
```

Scilab code Exa 10.2 PPJ2

```
// sum 10-2
clc;
clear;
p=3*8;
sigta=60;
d=150;
t=d/2*sqrt(((sigta+p)/(sigta-p))-1);
t=75*sqrt((84/36)-1);
t=40;
do=d+(2*t);
D=d+(2*t)+20;
w=10;
Ds=d+(2*w);
P=%pi*(Ds^2)*8/4;
sigp=310;
FOS=4;
sigb=77.5;
At=P/(sigb*2);
At=1300;
D=250;
db=45;
b=D;
a=1.8*b;
CD=D+(2*db*1.2);
sigp=310;
Pr=0.75*sigp*At;
Pr=Pr*10^-3;
t=40;
D1=d+(2*t)+20;
D2=D1+(4.6*31);
CD=D2-((3*t)+20);

  // printing data in scilab o/p window
  printf("Pr is %0.2f kN      ",Pr);
  printf("\n D1 is %0.0f mm      ",D1);
  printf("\n D2 is %0.1f mm      ",D2);
  printf("\n CD is %0.1f mm      ",CD);
```

Scilab code Exa 10.3 PPJ3

```
1  // sum 10-3
2  clc;
3  clear;
4  p=14;
5  d=50;
6  sigyp=270;
7  FOS=3;
8  sigta=sigyp/FOS;
9  pt=2*p;
10 t=d/2*sqrt(((sigta+pt)/(sigta-pt))-1);
11 t=10;
12 D1=d+(2*t);
13 Ds=D1+20;
14 P=%pi*(Ds^2)*p/4;
15 sigba=380/4;
16 At=P/(4*sigba);
17 At=245;
18 db=20;
19 Dd=70+(2*20)+5;
20 R=db+2.5;
21 B=(Dd/sqrt(2))+(2*(db+2.5));
22 B=127;
23 Y=Dd/(2*sqrt(2));
24 Rm=34.12;
25 M=(P*Y/2)+(P*Rm/%pi);
26 sigfa=250/5;
27 b=127/70;
28 Z=b/6;
29 tf=sqrt(M/(sigfa*Z));
30 tf=44;
31
32   // printing data in scilab o/p window
```

```
33   printf("d is %0.0f mm      ",d);
34   printf("\n t is %0.0f mm      ",t);
35   printf("\n B is %0.0f mm      ",B);
36   printf("\n R is %0.1f mm      ",R);
37   printf("\n Y is %0.2f mm      ",Y);
38   printf("\n tf is %0.0f mm      ",tf);
```

Scilab code Exa 10.4 PPJ4

```
1  // sum 10-4
2  clc;
3  clear;
4  p=1.25;
5  D=200;
6  nt=0.75;
7  C=9;
8  sigta=20;
9  t=(p*D)/(2*sigta*nt)+C;
10 t=18;
11 D1=D+(2*t);
12 dr=D1+10;
13 sigp=310;
14 sigba=sigp/4;
15 db=16;
16 Db=dr+32+5;
17 Do=Db+(2*db);
18 P=%pi*(251+db)^2*1.25/4;
19 n=6;
20 Y=(Db-dr)/2;
21 M=P/n*Y;
22 Z=dr*tand(30)/6;
23 tf=sqrt(M/(sigta*Z));
24 tf=22;
25 Deff=dr+db+5;
26
```

```
27    // printing data in scilab o/p window
28    printf("D is %0.0f mm     ",D);
29    printf("\n t is %0.0f mm     ",t);
30    printf("\n Y is %0.1f mm     ",Y);
31    printf("\n tf is %0.0f mm     ",tf);
32    printf("\n Deff is %0.0f mm     ",Deff);
```

Chapter 11

RIVETED JOINTS

Scilab code Exa 11.1 RJ1

```
1  // sum 11-1
2  clc;
3  clear;
4  t=20;
5  p=100;
6  d=25;
7  sigt=40;
8  P=(p-d)*t*sigt;
9  Ts=(4*P)/(%pi*d^2);
10 sigb=P/(d*t);
11
12   // printing data in scilab o/p window
13   printf("P is %0.0f N      ",P);
14   printf("\n Ts is %0.2f MPa      ",Ts);
15   printf("\n sigb is %0.0f MPa      ",sigb);
```

Scilab code Exa 11.2 RJ2

```
// sum 11-2
clc;
clear;
t=22;
t1=5*t/8;
d=30;
p=100;
sigt=75;
P=(p-d)*t*sigt;
Ts=(2*P)/(%pi*d^2);
sigb=P/(d*t);
P=P*10^-3
  // printing data in scilab o/p window
  printf("P is %0.1f kN      ",P);
  printf("\n Ts is %0.1f MPa      ",Ts);
  printf("\n sigb is %0.0f N/mm^2      ",sigb);
```

Scilab code Exa 11.3 RJ3

```
//sum 11-3
clc;
clear;
t=15;
t1=5*t/8;
d=25;
n=2;
Ta=80;
sigta=100;
sigba=120;
Ps=n*1.875*%pi*d^2*Ta/4;
Pb=n*d*t*sigba;
p=Pb/(t*Ta)+d;
Pp=p*t*Ta;
n=Pb/Pp;

```

```
17
18    // printing data in scilab o/p window
19    printf("p is %0.0f mm      ",p);
20    printf("\n n is %0.2f       ",n);
```

Scilab code Exa 11.4 RJ4

```
1  // sum 11-4
2  clc;
3  clear;
4  b=200;
5  t=16;
6  d=6*sqrt(t);
7  sigta=80;
8  Ta=60;
9  sigba=100;
10 Pt=(b-d)*t*sigta;
11 Ps=1.875*%pi*d^2*Ta/4;
12 Pb=d*t*sigba;
13 n1=Pt/Pb;
14 n1=6;
15 Pt2=((b-(2*d))*t*sigta)+Pb;
16 Pt3=((b-(3*d))*t*sigta)+(3*Pb);
17 Pp=b*t*sigta;
18 n2=Pt/Pp;
19 n2=n2*100;
20
21   // printing data in scilab o/p window
22   printf("d is %0.0f mm      ",d);
23   printf("\n n1 is %0.0f       ",n1);
24   printf("\n Pt is %0.0f N       ",Pt);
25   printf("\n Pt2 is %0.0f N      ",Pt2);
26   printf("\n Pt3 is %0.0f N      ",Pt3);
27   printf("\n n2 is %0.0f       ",n2);
28
```

```
29   //Answer to strength of rivet in bearing 'Pb' is
       calculated incorrectly in the book, hence Pt2,
       Pt3 is calculated subsequently incorrect.
```

Scilab code Exa 11.5 RJ5

```
1  // sum 11-5
2  clc;
3  clear;
4  a=50;
5  b=75;
6  P=36*10^3;
7  d=24;
8  Ta=60;
9  n=9;
10 A=%pi*d^2/4;
11 Td=P/(n*A);
12 theta=atan(b/a);
13 Ts=54.64;
14 r2=90.184;
15 e=A*29575.7/P;
16
17   // printing data in scilab o/p window
18   printf(" e is %0.1f mm     ",e);
```

Scilab code Exa 11.6 RJ6

```
1  // sum 11-6
2  clc;
3  clear;
4  P=12*10^3;
5  Tmax=100;
6  n=6;
```

```
e=50+50+(5/2);
T=P*e;
Td=P/n;
ra=125;
k=T/((2*125^2)+(2*75^2)+(2*25^2));
Tr=(k*ra)+Td;
A=Tr/Tmax;
d=sqrt(A*4/%pi);
d=12;

  // printing data in scilab o/p window
  printf(" d is %0.0f mm     ",d);
```

Scilab code Exa 11.7 RJ7

```
// sum 11-7
clc;
clear;
t=15;
d=6*sqrt(t);
d=24;
sigta=75;
sigba=105;
Ta=60;
n=4;
Pt=n*%pi*d^2*Ta/4;
x=d*t*sigta;
y=2*t*sigta;
p=(Pt+x)/y;
p=60;
C=4.17;
pmax=(C*t)+41.28;
Pt1=(y*p)-x;
Ps=n*%pi*d^2*Ta/4;
Pb=n*d*t*sigba;
```

```
21 S=2*p*t*sigta;
22 n=Pt1/S;
23 n=n*100;
24
25   // printing data in scilab o/p window
26   printf(" n is %0.0f      ",n);
```

Scilab code Exa 11.8 RJ8

```
1  // sum 11-8
2  clc;
3  clear;
4  D=1500;
5  p=2;
6  nt=0.75;
7  sigut=420;
8  FOS=5;
9  sigta=sigut/FOS;
10 t=p*D/(2*sigta*nt);
11 t=24;
12 d=6*sqrt(t);
13 d=30;
14 Ta=330/5;
15 sigba=640/5;
16 Ps=2*1.875*%pi*(d^2)*Ta/4;
17 p=(Ps/(t*sigta))+d;
18 p=117;
19 t1=5*t/8;
20 Pt=(p-d)*t*sigta;
21 Pp=p*t*sigta;
22 Pb=2*d*t*sigba;
23 n=Ps/Pb;
24 n=n*100;
25
26   // printing data in scilab o/p window
```

```
27    printf(" n is %0.0f       ",n);
```

Scilab code Exa 11.9 RJ9

```
1  // sum 11-9
2  clc;
3  clear;
4  D=1200;
5  p=2.5;
6  sigba=110;
7  Pa=%pi*D^2*p/4;
8  nt=0.8;
9  sigta=80;
10 t=p*D/(2*sigta*nt);
11 t=24;
12 d=6*sqrt(t);
13 d=30;
14 Ta=55;
15 Ps=%pi*(d^2)*Ta/4;
16 Np=Pa/Ps;
17 Np=74;
18 nr=Np/2;
19 p=%pi*(D+t)/nr;
20 pb=2*d;
21 m=1.5*d;
22 Pt=(p-d)*t*sigta;
23 Ps=2*Ps;
24 Pb=2*d*t*sigba;
25 Pp=p*t*sigta;
26 n=Ps/Pp;
27 n=n*100;
28
29   // printing data in scilab o/p window
30   printf(" n is %0.0f       ",n);
```

Chapter 12

WELDED JOINTS

Scilab code Exa 12.1 WJ1

```
1  // sum 12-1
2  clc;
3  clear;
4  h=8;
5  F=100*10^3;
6  t=0.707*h;
7  A=4*60*t;
8  T=F/A;
9
10   // printing data in scilab o/p window
11   printf("T is %0.1f MPa      ",T);
```

Scilab code Exa 12.2 WJ2

```
1  // sum 12-2
2  clc;
3  clear;
4  FOS=3;
```

```
Ta=95/FOS;
P=350*10^3;
h=12.5;
t=0.707*h;
l=P/(2*t*Ta);

  // printing data in scilab o/p window
  printf("l is %0.0f mm     ",l);
```

Scilab code Exa 12.3 WJ3

```
// sum 12-3
clc;
clear;
h=12;
t=0.707*h;
l=60;
Ta=80;
P=2*l*t*Ta;
P=P*10^-3;

  // printing data in scilab o/p window
  printf("P is %0.3f kN     ",P);
```

Scilab code Exa 12.4 WJ4

```
// sum 12-4
clc;
clear;
P=6*10^3;
e=150+(100/2);
T=P*e;
A=200;
```

```
Td=P/A;
r=sqrt(2*50^2);
Ixx=2*(100*50^2);
Iyy=2*100^3/12;
IG=Ixx+Iyy;
Ts=r*T/IG;
Tmax=sqrt((Ts*sind(45))^2+(Td+(Ts*cosd(45)))^2);
Ta=80;
t=Tmax/Ta;
h=sqrt(2)*t;
h=3;
  // printing data in scilab o/p window
  printf("h is %0.0f mm     ",h);
```

Scilab code Exa 12.5 WJ5

```
// sum 12-5
clc;
clear;
h=10;
t=10/sqrt(2);
Ta=80;
x=((50*25)+(50*0))/(50+50);
y=x;
ra=sqrt(x^2+37.5^2);
Ixx=(7.07*50^3/12)+(50*7.07*(12.5^2))
   +(50*7.07*12.5^2);
IG=2*Ixx;
e=100+(50-12.5);
Tr=16.09*10^-3;
P=Ta/Tr;
P=P*10^-3;

  // printing data in scilab o/p window
  printf("P is %0.3f KN     ",P);
```

Scilab code Exa 12.6 WJ6

```
1  // sum 12-6
2  clc;
3  clear;
4  P=16*10^3;
5  l=300;
6  r=50;
7  M=P*l;
8  A=2*%pi*r;
9  Ixx=%pi*r^3;
10 sigb=M*r/Ixx;
11 Td=P/A;
12 Tmax=sqrt((sigb/2)^2+(Td^2));
13 Ta=90;
14 t=Tmax/Ta;
15 h=sqrt(2)*t;
16 h=5;
17   // printing data in scilab o/p window
18   printf("h is %0.0f mm      ",h);
```

Scilab code Exa 12.7 WJ7

```
1  // sum 12-7
2  clc;
3  clear;
4  sigut=415;
5  sige=sigut/3;
6  Ka=0.5;
7  Kb=0.85;
8  Kc=0.897;
```

```
SCF=1.5;
Kd=1/SCF;
FOS=2;
sige1=sige*Ka*Kb*Kc*Kd/FOS;
Pa=50*10^3;
h=10;
t=0.707*h;
l=Pa/(2*sige1*t);

  // printing data in scilab o/p window
  printf("l is %0.0f mm     ",l);
```

Scilab code Exa 12.8 WJ8

```
// sum 12-8
clc;
clear;
l=300;
P=30*10^3;
T=P/(2*l);
Ta=124;
t1=T/Ta;
h1=sqrt(2)*t1;
M=P*l;
Ixx=2*100*110^2;
sigb=M/Ixx*110;
//Let the allowable bending stress is Tab
Tab=200;
t2=sigb/Tab;
h2=t2/0.707;
h2=3;

  // printing data in scilab o/p window
  printf("h is %0.0f mm     ",h2);
```

Scilab code Exa 12.9 WJ9

```
// sum 12-9
clc;
clear;
Ta=60;
l1=60;
l2=40;
P1=Ta*0.707*l1;
P2=Ta*0.707*l2;
P=80*10^3;
h=P/(P1+P2);
h=20;
a=(P2*100)/(P1+P2);

  // printing data in scilab o/p window
  printf("h is %0.0f mm      ",h);
  printf("\n a is %0.0f mm      ",a);
```

Scilab code Exa 12.10 WJ10

```
// sum 12-10
clc;
clear;
P=300*10^3;
l=500;
A=2*l;
Td=P/A;
T=(350-250)*P;
IG=(l^3*2/12)+(l*2*5^2);
r=sqrt(250^2+5^2);
Ts=T*r/IG;
```

```
Ts=Ts+Td;
Ta=110;
t=Ts/Ta;
h=t/0.707;
h=9;

  // printing data in scilab o/p window
  printf("h is %0.0f mm     ",h);
```

Scilab code Exa 12.11 WJ11

```
// sum 12-11
clc;
clear;
t=30;
sigut=417;
sige=sigut/2;
Ka=0.5;
Kb=0.85;
Kc=0.897;
SCF=1.2;
Kd=1/SCF;
FOS=1.5;
sige1=sige*Ka*Kb*Kc*Kd/FOS;
Pa=60*10^3;
l=Pa/(sige1*t);

  // printing data in scilab o/p window
  printf("l is %0.1f mm     ",l);
```

Chapter 13

COTTER AND KNUCKLE JOINTS

Scilab code Exa 13.1 CKJ1

```
1  //sum 13-1
2  clc;
3  clear;
4  F=25*10^3;
5  sigat=50;
6  Ta=40;
7  pa=80;
8  d=sqrt((4*F)/(%pi*sigat));
9  d=26;
10 t=d/4;
11 t=7;
12 d1=1.2*d;
13 d1=32;
14 pc=F/(d1*t);
15 t=10;
16 c=0.75*d;
17 c=20;
18 d2=44;
19 tw=(d2-d1)/2;
```

```
20 b=F/(2*t*Ta);
21 b=34;
22 a=0.5*d;
23 d3=(F/(pa*t))+d1;
24 d3=64;
25 e=F/(Ta*(d3-d1));
26 d4=sqrt((F*4/(%pi*pa))+d1^2);
27 d4=40;
28 f=0.5*d;
29 sigbc=3*F*d3/(t*b^2*4);
30
31   // printing data in scilab o/p window
32   printf(" d is %0.0f mm     ",d);
33   printf("\n d1 is %0.0f mm     ",d1);
34   printf("\n d2 is %0.0f mm     ",d2);
35   printf("\n d3 is %0.0f mm     ",d3);
36   printf("\n d4 is %0.0f mm     ",d4);
37   printf("\n sigbc is %0.1f MPa     ",sigbc);
```

Scilab code Exa 13.2 CKJ2

```
1 // sum 13-2
2 clc;
3 clear;
4 P=40*10^3;
5 sigut=490;
6 FOS=4;
7 sigts=sigut/FOS;
8 sigcs=1.4*sigts;
9 sigs=0.8*sigts;
10 d=sqrt((4*P)/(%pi*sigts));
11 d=21;
12 sigcc=1.4*330/4;
13 Tc=0.8*330/4;
14 t=d/3;
```

```
15 b=P/(2*t*Tc);
16 b=31;
17 t=10;
18 d1=28;
19 d2=40;
20 c=d/2;
21 c=15;
22 a=P/(2*(d2-d1)*98);
23 a=20;
24 L=(2*a)+(2*b)+(2*c)+(2*3);
25
26   // printing data in scilab o/p window
27   printf("d is %0.0f mm     ",d);
28   printf("\n d1 is %0.0f mm     ",d1);
29   printf("\n t is %0.0f mm     ",t);
30   printf("\n b is %0.0f mm     ",b);
31   printf("\n d2 is %0.0f mm     ",d2);
32   printf("\n L is %0.0f mm     ",L);
```

Scilab code Exa 13.3 CKJ3

```
1 // sum 13-3
2 clc;
3 clear;
4 P=40*10^3;
5 sigt=60;
6 sigc=125;
7 T=45;
8 a=sqrt(P*3/(2*sigt));
9 a=33;
10 t=a/3;
11 b=P/(4.5*t*T);
12 b=20;
13 b1=1.25*b;
14 t1=P*3/(4*a*sigt);
```

```
15 t1=16;
16 l2=P/(2*2*T*t1);
17 l2=14;
18 l1=P/(2*a*T);
19 l1=14;
20 l3=(0.6*a);
21 l3=20;
22 l4=11;
23 sigcr=P/(t*a);
24 sigcr1=P/(2*t1*t);
25
26   // printing data in scilab o/p window
27   printf("a is %0.0f mm     ",a);
28   printf("\n t is %0.0f mm     ",t);
29   printf("\n t1 is %0.0f mm     ",t1);
30   printf("\n b is %0.0f mm     ",b);
31   printf("\n b1 is %0.0f mm     ",b1);
32   printf("\n l1 is %0.0f mm     ",l1);
33   printf("\n l2 is %0.0f mm     ",l2);
34   printf("\n l3 is %0.0f mm     ",l3);
35   printf("\n l4 is %0.0f mm     ",l4);
36   printf("\n sigcr is %0.1f MPa     ",sigcr);
37   printf("\n sigcr1 is %0.1f MPa     ",sigcr1);
```

Scilab code Exa 13.4 CKJ4

```
1 // sum 13-4
2 clc;
3 clear;
4 P=50*10^3;
5 sigp=380;
6 FOS=4;
7 sigca=80;
8 Ta=50;
9 sigta=sigp/FOS;
```

```
10 At=P/sigta;
11 d=30;
12 d1=1.5*d;
13 t=P/(sigca*d1);
14 t=14;
15 A=(%pi*(d1^2)/4)-(d1*t);
16 //let tearing stress be sigt
17 sigt=P/A;
18 b=P/(2*t*Ta);
19 b=36;
20
21   // printing data in scilab o/p window
22   printf("d is %0.0f mm      ",d);
23   printf("\n sigt is %0.1f MPa      ",sigt);
24   printf("\n b is %0.0f mm      ",b);
25
26   //The answer to tearing stress in bolt 'sigt' is
       calculated incorrectly in the book.
```

Chapter 14

KEYS AND COUPLINGS

Scilab code Exa 14.1 KC1

```
1  // sum 14-1
2  clc;
3  clear;
4  d=40;
5  r=d/2;
6  P=6*10^3;
7  N=350;
8  sigyt=380;
9  A=%pi*12^2/2;
10 theta=%pi-(2*atan(4/12));
11 alpha=180-(theta*%pi/180);
12 l=2*12*cosd(19.5);
13 A1=l*4/2;
14 Abcd=(A*141/180)-A1;
15 A2=A-Abcd;
16 A3=8*l;
17 w=2*%pi*N/60;
18 T=P/w;
19 Pt=T*10^3/r;
20 sigb=Pt/A2;
21 //Let shear stress developed in key Tk
```

```
22 Tk=Pt/A3;
23 FOS1=sigyt/sigb;
24 FOS2=0.577*sigyt/Tk;
25
26   // printing data in scilab o/p window
27   printf("FOS1 is %0.3f      ",FOS1);
28   printf("\n FOS2 is %0.2f      ",FOS2);
```

Scilab code Exa 14.2 KC2

```
1  // sum 14-2
2  clc;
3  clear;
4  n=12;
5  phi=360*%pi/(180*12*2);
6  R1=45/2;
7  R2=50/2;
8  l=60;
9  Rm=(R1+R2)/2;
10 p=6.5;
11 Pn=(R2-R1)*l*p;
12 T=Pn*Rm;
13 T=T*n;
14 N=400;
15 w=2*%pi*N/60;
16 P=T*w;
17 A=(%pi*R1*l)/n;
18 Ts=Pn/A;
19 Ah=(%pi*R2*l)/n;
20 Th=Pn/Ah;
21
22   // printing data in scilab o/p window
23   printf("Ts is %0.2f N/mm^2      ",Ts);
24   printf("\n Th is %0.2f N/mm^2      ",Th);
```

Scilab code Exa 14.3 KC3

```
1  // sum 14-3
2  clc;
3  clear;
4  N=360;
5  w=2*%pi*N/60;
6  sigyt=380;
7  r=25;
8  P=40*10^3;
9  FOS=3;
10 T=P/w;
11 Pt=T*10^3/(2*r);
12 siga=380/3;
13 Ta=0.577*380/3;
14 l1=Pt/(sqrt(2)*12*Ta);
15 l2=Pt*sqrt(2)/(siga*12);
16
17   // printing data in scilab o/p window
18   printf("l1 is %0.0f mm     ",l1);
19   printf("\n l2 is %0.2f mm     ",l2);
```

Scilab code Exa 14.4 KC4

```
1  // sum 14-4
2  clc;
3  clear;
4  N=300;
5  w=2*%pi*N/60;
6  P=12*10^3;
7  Ks=1.25;
8  Pd=P*Ks;
```

```
T=Pd/w;
Tas=50;
d=16*T*10^3/(%pi*Tas);
d=d^(1/3);
d=40;
Ts=10;
d1=(2*d)+13;
x=(d1^4-d^4)/d1;
//Let the shear stress in the key be Tsh
Tsh=T*10^3*16/(%pi*x);
l=3.5*d;
Ft=T*2*10^3/d;
l1=70;
sigak=50;
b=Ft/(l1*sigak);
t=2*Ft/(100*l1);

  // printing data in scilab o/p window
  printf("d is %0.0f mm     ",d);
  printf("\n Tsh is %0.2f MPa     ",Tsh);
  printf("\n b is %0.0f mm     ",b);
  printf("\n t is %0.0f mm     ",t);
```

Scilab code Exa 14.5 KC5

```
// sum 14-5
clc;
clear;
P=36*10^3;
N=200;
w=2*%pi*N/60;
T=P/w;
Tas=45;
d=16*T*10^3/(%pi*Tas);
d=d^(1/3);
```

```
d=60;
d1=(2*d)+13;
l=3.5*d;
Ftk=T*2/d;
lk=l/2;
Tak=40;
sigack=90;
b=Ftk*10^3/(lk*Tak);
t=2*Ftk*10^3/(sigack*lk);
n=4;
sigatb=60;
u=0.25;
dr=16*T*10^3/(u*%pi^2*sigatb*n*d);
dr=sqrt(dr);

  // printing data in scilab o/p window
  printf("d is %0.0f mm     ",d);
  printf("\n b is %0.1f mm     ",b);
  printf("\n t is %0.0f mm     ",t);
  printf("\n dr is %0.3f mm     ",dr);
```

Scilab code Exa 14.6 KC6

```
// sum 14-5
clc;
clear;
P=16*10^3;
N=1000;
w=2*%pi*N/60;
T=P/w;
Ks=1.4;
Td=T*Ks;
Tas=40;
d=16*T*10^3/(%pi*Tas);
d=d^(1/3);
```

```
13 d=32;
14 d1=2*d;
15 l=1.5*d;
16 ds=1.5*d;
17 Tak=40;
18 sigack=70;
19 Ftk=Td*2/d;
20 b=Ftk*10^3/(l*Tak);
21 t=2*Ftk*10^3/(sigack*l);
22 Taf=10;
23 tf=Td*10^3*2/(%pi*Taf*d1^2);
24 Ftb=Td*10^3/(1.5*d*4);
25 Tab=40;
26 db=sqrt(Ftb*4/(Tab*%pi));
27 D=4*d;
28 trp=d/6;
29 Ftb1=Td*10^3/(45*4);
30 db1=sqrt(Ftb1*4/(Tab*%pi));
31
32   // printing data in scilab o/p window
33   printf("d is %0.0f mm     ",d);
34   printf("\n b is %0.0f mm     ",b);
35   printf("\n t is %0.0f mm     ",t);
36   printf("\n db is %0.2f mm     ",db);
37   printf("\n db1 is %0.2f mm     ",db1);
38
39   //The answer to Key thickness 't' is calculated
       incorrectly in the book.
```

Scilab code Exa 14.7 KC7

```
1 // sum 14-5
2 clc;
3 clear;
4 P=30*10^3;
```

```
N=1440;
w=2*%pi*N/60;
T=P/w;
d=36;
d1=30;
d2=2*d;
d3=d1*2;
l=1.5*d;
Dp=3.5*d;
n=6;
Ft=(2*T)/(Dp*n);
p=0.5;
A=Ft/p;
Lf=d;
dp=A/Lf;
M=Ft*10^3*(5+(Lf/2));
db=(32*M/(%pi*40))^(1/3);
db=15;
T=(4*526)/(%pi*db^2);
sigb=32*M/(%pi*db^3);
sigmax=(sigb/2)+sqrt(((sigb/2)^2)+(T^2));
b=d/4;
t=6;
Lf=36;
La=10;
Do=126+30+(2*(5+1))+(2*6);

  // printing data in scilab o/p window
  printf("sigmax is %0.2f MPa     ",sigmax);
  printf("\n b is %0.0f mm      ",b);
  printf("\n t is %0.0f mm      ",t);
  printf("\n Lf is %0.0f mm      ",Lf);
  printf("\n Do is %0.0f mm      ",Do);
```

Chapter 15

SHAFTS

Scilab code Exa 15.2 S2

```
1  // sum 15-2
2  clc;
3  clear;
4  dA=150;
5  dB=250;
6  alpha=20*%pi/180;
7  W=400;
8  sigyt=400;
9  sigut=500;
10 Kb=1.5;
11 Kt=2;
12 T=W*dA/2;
13 Pt=T/(dB/2);
14 Pr1=W*tan(alpha);
15 Pr2=Pt*tan(alpha);
16 RDH=((W*120)-(Pt*320))/440;
17 RcH=W-RDH-Pt;
18 //RcH=400+65.5-240;
19 McH=0;
20 MAH=RcH*120;
21 MBH=RDH*120;
```

```
22 RDV=((Pr1*120)-(Pr2*320))/440;
23 RcV=Pr1-RDV-Pr2;
24 MAV=RcV*120;
25 MBV=RDV*120;
26 Mmax=sqrt((MAH^2)+(MAV^2));
27 T=30*10^3;
28 Ta=0.135*sigut;
29 d=16*sqrt((Kb*Mmax)^2+(Kt*T)^2)/(%pi*Ta);
30 d=d^(1/3);
31
32   // printing data in scilab o/p window
33   printf("d is %0.2f mm    ",d);
```

Scilab code Exa 15.3 S3

```
1  // sum 15-3
2  clc;
3  clear;
4  P=16*746;
5  N=3000;
6  w=2*%pi*N/60;
7  T=P/w*10^3;
8  sigy=400;
9  Ty=sigy/2;
10 FOS=2;
11 Ta=Ty/FOS;
12 d=T*16/(%pi*Ta);
13 d1=d^(1/3);
14 r=3;
15 D=d1+(2*r);
16 SCF=1.196
17 Tys=Ta/SCF;
18 d=T*16/(%pi*Tys);
19 d2=d^(1/3);
20 d=14;
```

```
21 D=d+(2*r);
22
23   // printing data in scilab o/p window
24   printf("d1 is %0.2f mm    ",d1);
25   printf("\n d2 is %0.2f mm    ",d2);
```

Scilab code Exa 15.4 S4

```
1  // sum 15-4
2  clc;
3  clear;
4  P1=24*10^3;
5  P2=10*10^3;
6  sigyt=460;
7  Tya=sigyt*0.3;
8  SCF=2.84;
9  Ta=Tya/SCF;
10 N=400;
11 w=2*%pi*N/60;
12 T1=P1/w;
13 T2=P2/w;
14 d1=T1*16*10^3/(%pi*Ta);
15 d1=d1^(1/3);
16 d2=T2*16*10^3/(%pi*Ta);
17 d2=d2^(1/3);
18 theta1=%pi/3600;
19 l1=120;
20 G=84*10^3;
21 d3=T1*10^3*l1*32/(%pi*G*theta1);
22 d3=d3^(1/4);
23 d4=T2*l1*10^3*32/(%pi*G*theta1);
24 d4=d4^(1/4);
25
26   // printing data in scilab o/p window
27   printf("d1 is %0.2f mm    ",d1);
```

```
28    printf("\n d2 is %0.2f mm    ",d2);
29    printf("\n d3 is %0.1f mm    ",d3);
30    printf("\n d4 is %0.2f mm    ",d4);
```

Scilab code Exa 15.5 S5

```
1  // sum 15-5
2  clc;
3  clear;
4  d=200;
5  r=d/2;
6  N=300;
7  P=5000;
8  D=500;
9  R=D/2;
10 u=0.3;
11 E=205*10^3;
12 G=84*10^3;
13 Ta=60;
14 Kb=1.5;
15 Kt=2;
16 w=2*%pi*N/60;
17 beta1=20*%pi/180;
18 V=r*w;
19 v=R*w;
20 // Let T1-T2 =T
21 T=P/V;
22 x=u*%pi/sin(beta1);
23 T2=T/((exp(x)-1));
24 T1=T2*exp(x);
25 t=P/v;
26 y=u*%pi;
27 T3=t/((exp(x)-1));
28 T4=T3*exp(x);
29 T=P/w;
```

```
30 Rc=2612;;
31 RA=645.1;
32 MB=96.76;
33 MC=-208.96;
34 d=16*10^3*sqrt((Kb*MC)^2+(Kt*T)^2)/(%pi*Ta);
35 d=d^(1/3);
36 l=380;
37 J=%pi*d^4/32;
38 theta=T*10^3*l/(G*J);
39 theta=theta*180/%pi;
40
41   // printing data in scilab o/p window
42   printf("d is %0.1f mm    ",d);
43   printf("\n theta is %0.2f deg    ",theta);
```

Scilab code Exa 15.6 S6

```
1 // sum 15-6
2 clc;
3 clear;
4 T=400;
5 Pt=4800;
6 Pg=3600;
7 sigyt=360;
8 E=205*10^3;
9 G=80*10^3;
10 Kb=2;
11 Kt=1.5;
12 FOS=3;
13 RC=((Pt*90)+(Pg*200))/140;
14 RA=8400-RC;
15 MB=RA*0.9;
16 MC=Pg*0.045;
17 Te=sqrt((Kb*MC)^2+(Kt*T)^2);
18 Ta=0.577*sigyt/FOS;
```

```
19 d=16*10^3*Te/(%pi*Ta);
20 d=d^(1/3);
21 L=110;
22 J=%pi*d^4/32;
23 T=400;
24 theta=T*10^3*L/(G*J);
25 theta=theta*180/%pi;
26
27   // printing data in scilab o/p window
28   printf("d is %0.0f mm    ",d);
29   printf("\n theta is %0.4f deg    ",theta);
```

Scilab code Exa 15.7 S7

```
1 // sum 15-7
2 clc;
3 clear;
4 T=47*10^3;
5 M=32*10^3;
6 d=20;
7 siga=32*M/(%pi*d^3);
8 Tm=16*T/(%pi*d^3);
9 sige=75;
10 Tys=165;
11 n=1/sqrt((siga/sige)^2+(Tm/Tys)^2);
12
13   // printing data in scilab o/p window
14   printf("n is %0.2f     ",n);
```

Chapter 16

POWER SCREWS

Scilab code Exa 16.1 PS1

```
1  // sum 16-1
2  clc;
3  clear;
4  d=30;
5  W=20*10^3;
6  r1=8;
7  r2=16;
8  p=6;
9  u1=0.2;
10 u2=0.15;
11 dm=d-(p/2);
12 alpha=atan(p/(%pi*dm));
13 phi=atan(u1);
14 rm=(r1+r2)/2;
15 Ttr=W*((dm*tan(alpha+phi)/2)+(u2*rm));
16 Ttr=Ttr*10^-3;
17
18   // printing data in scilab o/p window
19   printf("Ttr is %0.3f Nm      ",Ttr);
20
21   //The answer to Ttr is slightly different than in
```

```
the book due to rounding-off of values.
```

Scilab code Exa 16.2 PS2

```
// sum 16-2
clc;
clear;
d=50;
W=20*10^3;
r1=10;
r2=30;
p=7;
u1=0.12/cosd(15);
u2=0.15;
dm=d-(p/2);
alpha=atan(3*p/(%pi*dm));
phi=atan(u1);
rm=(r1+r2)/2;
Tr=W*((dm*tan(alpha+phi)/2)+(u2*rm));
Tr=Tr*10^-3;
Te=W*((dm*tan(phi-alpha)/2)+(u2*rm));
Te=Te*10^-3;
n=dm/2*tan(alpha)/(dm*tan(alpha+phi)/2+(u2*rm));
L=0.30;
Ph=Tr/L;

  // printing data in scilab o/p window
  printf("Tr is %0.2f Nm     ",Tr);
  printf("\n Te is %0.3f Nm     ",Te);
  printf("\n n is %0.4f       ",n);
  printf("\n Ph is %0.2f N     ",Ph);

  //The answers to Tr, Te and Ph is slightly
     different than in the book due to rounding-off
     of values.
```

Scilab code Exa 16.3 PS3

```
// sum 16-3
clc;
clear;
d=30;
W=5*10^3;
p=5;
rm=45/2;
u1=0.15/cosd(14.5);
u2=0.15;
dm=d-(p/2);
alpha=atan(p/(%pi*dm));
phi=atan(u1);
Tr1=W*((dm*tan(alpha+phi)/2)+(u2*rm));
Tr1=Tr1*10^-3;
n1=dm/2*tan(alpha)/(dm*tan(alpha+phi)/2+(u2*rm));
T1=W*((dm*tan(phi-alpha)/2)+(u2*rm));
T1=T1*10^-3;
n2=dm/2*tan(alpha)/(dm*tan(phi-alpha)/2+(u2*rm));
u2=0.02;
Tr2=W*((dm*tan(alpha+phi)/2)+(u2*rm));
Tr2=Tr2*10^-3;
n3=dm/2*tan(alpha)/(dm*tan(alpha+phi)/2+(u2*rm));
Te=W*((dm*tan(phi-alpha)/2)+(u2*rm));
Te=Te*10^-3;
n4=dm/2*tan(alpha)/(dm*tan(phi-alpha)/2+(u2*rm));

  // printing data in scilab o/p window
  printf("Tr1 is %0.3f Nm      ",Tr1);
  printf("\n n1 is %0.4f       ",n1);
  printf("\n T1 is %0.3f Nm      ",T1);
  printf("\n n2 is %0.4f       ",n2);
  printf("\n Tr2 is %0.3f Nm      ",Tr2);
```

```
33    printf("\n n3 is %0.4f      ",n3);
34    printf("\n Te is %0.3f Nm     ",Te);
35    printf("\n n4 is %0.4f      ",n4);
36
37    //The answer to T1 is misprinted in the book.
```

Scilab code Exa 16.4 PS4

```
1  // sum 16-4
2  clc;
3  clear;
4  d=28;
5  P=300;
6  L=180;
7  p=8;
8  r1=16;
9  r2=46;
10 rm=(r1+r2)/2;
11 u1=0.12;
12 u2=0.15;
13 dm=d-(p/2);
14 alpha=atan(p/(%pi*dm));
15 phi=atan(u1);
16 T=P*L;
17 F=T/((dm*tan(alpha+phi)/2)+(u2*rm));
18 F=F*10^-3;
19
20   // printing data in scilab o/p window
21   printf("F is %0.3f kN     ",F);
```

Scilab code Exa 16.5 PS5

```
1  // sum 16-5
```

```
clc;
clear;
d=25;
p=8;
F=392.4;
L=250;
l=p*2;
u=0.14;
dm=d-(p/2);
alpha=atan(l/(%pi*dm));
phi=atan(u);
T=dm*tan(alpha+phi)/2;
M=F*L;
P=M/T*10^-3;

  // printing data in scilab o/p window
  printf("P is %0.1f kN      ",P);
```

Scilab code Exa 16.6 PS6

```
// sum 16-6
clc;
clear;
d=52;
W=2.2*10^3;
p=8;
r1=15;
r2=30;
rm=(r1+r2)/2;
u1=0.15/cosd(14.5);
dm=d-(p/2);
alpha=atan(p/(%pi*dm));
phi=atan(u1);
Ts=W*dm*tan(alpha+phi)/2;
u2=0.12;
```

```
16 Tc=u2*W*rm;
17 T=10^-3*(Ts+Tc);
18 N=40;
19 w=2*%pi*N/60;
20 P=T*w*10^-3;
21 To=W*dm/2*tan(alpha);
22 n=To/(T*10^3);
23
24   // printing data in scilab o/p window
25   printf("P is %0.2f KW     ",P);
26   printf("\n n is %0.4f      ",n);
```

Scilab code Exa 16.7 PS7

```
1 // sum 16-7
2 clc;
3 clear;
4 alpha=atan(2*0.2/(%pi*0.9));
5 u1=0.15;
6 phi=atan(u1);
7 P=200;
8 L=250;
9 Tt=P*L;
10 W=10*10^3;
11 u2=0.15;
12 x=Tt/W;
13 d=x/0.1716;
14 d=30;
15 p=6;
16 dr=0.8*d;
17 d=24;
18 p=5;
19 dr=d-p;
20 dm=d-(p/2);
21
```

```
22   // printing data in scilab o/p window
23   printf("d is %0.0f mm     ",d);
24   printf("\n p is %0.0f mm     ",p);
```

Scilab code Exa 16.8 PS8

```
1  // sum 16-8
2  clc;
3  clear;
4  FOS=3;
5  sigut=380;
6  Ta=0.577*sigut/FOS;
7  d=25;
8  Tus=460;
9  Ps=%pi*d*Tus;
10 siga=127;
11 dr=sqrt(Ps*4/(%pi*siga));
12 d=30;
13 p=6;
14 dr=d-p;
15 dm=d-(p/2);
16 u1=0.15;
17 alpha=atan(p*2/(%pi*dm));
18 phi=atan(u1);
19 T=Ps*dm*tan(alpha+phi)/2;
20 T1=16*T/(%pi*dr^3);
21 sigc=4*Ps/(%pi*dr^2);
22 sigmax=sigc/2+sqrt((sigc/2^2)+(T1^2));
23 Tmax=sqrt((sigc/2^2)+(T1^2));
24 n=tan(alpha)/tan(alpha+phi);
25 Uo=Ps/2;
26 Ui=Uo/n;
27 wav=%pi/2;
28 wmax=2*wav;
29 I=Ui*2/wmax^2;
```

```
30 k=0.4;
31 Ir=0.9*I*10^-3;
32 m=Ir/k^2;
33 R=0.4;
34 rho=7200;
35 a=sqrt(m/(2*%pi*R*rho));
36 T=T*10^-3;
37
38   // printing data in scilab o/p window
39   printf("T is %0.3f Nm     ",T);
40   printf("\n n is %0.4f      ",n);
41   printf("\n a is %0.5f mm      ",a);
42
43   //The difference in the answers of T is due to
       rounding-off of values.
```

Chapter 17

SLIDING CONTACT BEARINGS

Scilab code Exa 17.1 SCB1

```
1  // sum 17-1
2  clc;
3  clear;
4  Ta=22;
5  u=7/10^9;
6  nj=20;
7  r=25;
8  l=2*r;
9  Ao=30000;
10 Uo=15.3/10^3;
11 c=0.025;
12 //specific weight of the material is rho
13 rho=8.46*(10^-6);
14 Cp=179.8;
15 Tf=Ta+(16*%pi^3*u*nj^2*l*r^3/(Uo*Ao*c));
16 // avg mean film temperature is Tav
17 Tav=(Tf-Ta)/2;
18 x= l*c*rho*%pi*r*nj*Cp*10^3;
19 y=Ao*Tav*Uo;
```

```
20 delT=y/x;
21
22   // printing data in scilab o/p window
23   printf("Tav is %0.2f degC ",Tav);
24   printf("\n delT is %0.1f degC ",delT);
```

Scilab code Exa 17.2 SCB2

```
1 // sum 17-2
2 clc;
3 clear;
4 l=60;
5 d=60;
6 r=d/2;
7 ho=0.008;
8 c=0.04;
9 S=0.0446;
10 nj=1260/60;
11 W=6000;
12 p=W/(l*d);
13 u=S*(c/r)^2*p/nj;
14 u=u*10^9;
15
16   // printing data in scilab o/p window
17   printf("u is %0.3f cP ",u);
```

Scilab code Exa 17.3 SCB3

```
1 // sum 17-3
2 clc;
3 clear;
4 d=60;
5 r=30;
```

```
6  l=60;
7  c=0.8*10^-3*r;
8  ho=0.2*c;
9  W=21000/2;
10 p=W/(l*d);
11 S=0.0446;
12 nj=1440/60;
13 u=S*(c/r)^2*p/nj;
14 u=u*10^9;
15 // since Q/(r*nj*l)=4.62
16 Q=4.62*r*c*nj*l;
17 Q=Q*60/10^6;
18
19   // printing data in scilab o/p window
20   printf("u is %0.3f cP ",u);
21   printf("\n Q is %0.4f lpm ",Q);
```

Scilab code Exa 17.4 SCB4

```
1  // sum 17-4
2  clc;
3  clear;
4  l=60;
5  d=60;
6  r=d/2;
7  W=3000;
8  p=W/(l*d);
9  u=30*10^-9;
10 c=0.06;
11 nj=1440/60;
12 S=(r/c)^2*u*nj/p;
13 //For ratio l/d=1, values of different parameters
      are given in matrix A corresponding to S
14 A=[1 0.264 0.6 5.79 3.99
15    1 0.121 0.4 3.22 4.33];
```

```
16 //let ho/c=x
17 x=(A(1,3))-((A(1,3)-(A(2,3)))*((A(1,2))-S)/((A(1,2))
      -(A(2,2))));
18 //let y= (r/c)*f=CFV
19 y=(A(1,4))-((A(1,4)-(A(2,4)))*((A(1,2))-S)/((A(1,2))
      -(A(2,2))));
20 //let z=Q/(r*c*nj*l)=FV
21 z=(A(1,5))-((A(1,5)-(A(2,5)))*((A(1,2))-S)/((A(1,2))
      -(A(2,2))));
22 f=y*c/r;
23 ho=x*c;
24 Q=z*r*c*nj*l;
25 Q=Q*60/10^6;
26 delT=8.3*p*y/z;
27 //let power lost in friction be Pf
28 Pf=2*%pi*nj*f*W*r/10^6;
29
30   // printing data in scilab o/p window
31   printf("f is %0.5f  ",f);
32   printf("\n ho is %0.3f mm ",ho);
33   printf("\n Q is %0.3f lpm ",Q);
34   printf("\n delT is %0.1f degC ",delT);
35   printf("\n Pf is %0.4f KW ",Pf);
```

Scilab code Exa 17.5 SCB5

```
1 // sum 17-5
2 clc;
3 clear;
4 W=22000;
5 nj=960/60;
6 p=2.4;
7 u=20*10^-9;
8 d=sqrt(W/p);
9 d=96;
```

```
r=d/2;
l=d;
S=0.0446;
pact=W/(l*d);
//x=r/c;
x=sqrt(S*pact/(u*nj));
c=r/x;
ho=0.2*c;
Q=r*c*nj*l*4.62;
Q=Q*60/10^6;

  // printing data in scilab o/p window
  printf("d is %0.0f mm ",d);
  printf("\n l is %0.0f mm ",l);
  printf("\n ho is %0.4f mm ",ho);
  printf("\n Q is %0.3f lpm ",Q);

  //The difference in answer to Q is due to rounding
      -off the value of c.
```

Scilab code Exa 17.6 SCB6

```
// sum 17-6
clc;
clear;
W=400*10^3;
Ro=200;
Ri=160;
ho=0.1;
t=150;
// specific gravity is rho
rho=0.86;
pi=2*W*log(Ro/Ri)/(%pi*(Ro^2-Ri^2));
zk=(0.22*t)-(180/t);
z=rho*zk;
```

```
u=z/(10^9);
Q=%pi*pi*ho^3/(6*u*log(Ro/Ri));
Q=Q*60/10^6;

  // printing data in scilab o/p window
  printf("pi is %0.3f MPa ",pi);
  printf("\n Q is %0.2f lpm ",Q);

  //The difference in answer to Q is due to rounding
     -off of values.
```

Scilab code Exa 17.7 SCB7

```
//sum 17-7
clc;
clear;
//let number of pads be n
n=4;
W=100*10^3;
Ro=125;
Ri=50;
t=200;
ho=0.15;
pi=2*W*log(Ro/Ri)/(%pi*(Ro^2-Ri^2));
zk=(0.22*t)-(180/t);
// specific gravity is rho
rho=0.86;
z=rho*zk;
u=z/(10^9);
Q=%pi*pi*ho^3/(6*u*log(Ro/Ri));
Q=Q*60/10^6;

  // printing data in scilab o/p window
  printf("pi is %0.2f MPa ",pi);
  printf("\n Q is %0.3f lpm ",Q);
```

Chapter 18

ROLLING BEARINGS

Scilab code Exa 18.1 RB1

```
1  // sum 18-1
2  clc;
3  clear;
4  Pr=16*10^3;
5  u=0.0011;
6  F=u*Pr;
7  r=20*10^-3;
8  //Let frictional moment be M
9  M=F*r;
10 N=1440;
11 w=2*%pi*N/60;
12 Pf=M*w;
13
14   // printing data in scilab o/p window
15   printf("Pf is %0.2f W    ",Pf);
```

Scilab code Exa 18.2 RB2

```
// sum 18-2
clc;
clear;
C=5590;
Ca=2500;
Pa=625;
Pr=1250;
V=1;
X=0.56;
Y=1.2;
P1=(X*V*Pr)+(Y*Pa);
L1=(C/P1)^3;
V=1.2;
P2=(X*V*Pr)+(Y*Pa);
L2=(C/P2)^3;

  // printing data in scilab o/p window
  printf("L1 is %0.1f million revolutions    ",L1);
  printf("\n L2 is %0.2f million revoltions    ",L2)
     ;
```

Scilab code Exa 18.4 RB4

```
// sum 18-4
clc;
clear;
P=20*10^3;
Co=22400;
C=41000;
Ln=(C/P)^3;
Lh=Ln*10^6/(720*60);

  // printing data in scilab o/p window
  printf("Lh is %0.3f hrs    ",Lh);
```

Scilab code Exa 18.5 RB5

```
// sum 18-5
clc;
clear;
R1x=120;
R1y=250;
R2x=300;
R2y=400;
Lh=8000;
N=720;
Ln=Lh*60*N*10^-6;
R1=sqrt(R1x^2+R1y^2);
R2=sqrt(R2x^2+R2y^2);
//Let load factor be Ks
Ks=1.5;
P1=R1*Ks;
P2=R2*Ks;
C1=P1*(Ln^(1/3));
C2=P2*(Ln^(1/3));
//let designation,d,D,B,C at bearing B1 be De1,d1,D1
   ,B1,C1
d1=25;
D1=37;
B1=7;
C1=3120;
De1=61805;
//let designation,d,D,B,C at bearing B2 be De2,d2,D2
   ,B2,C2
d2=25;
D2=47;
B2=8;
C2=7620;
De2=16005;
```

```
31
32   // printing data in scilab o/p window
33   printf("Designation of Bearing B1 is %0.0f     ",
       De1);
34   printf("\n d1 is %0.0f mm    ",d1);
35   printf("\n D1 is %0.0f mm    ",D1);
36   printf("\n B1 is %0.0f mm    ",B1);
37   printf("\n C1 is %0.0f N    ",C1);
38   printf("\n Designation of Bearing B2 is %0.0f
       ",De2);
39   printf("\n d2 is %0.0f mm    ",d2);
40   printf("\n D2 is %0.0f mm    ",D2);
41   printf("\n B2 is %0.0f mm    ",B2);
42   printf("\n C2 is %0.0f N    ",C2);
43
44   disp('Bearing 61805 at B1 and 16005 at B2 can be
       installed.')
```

Scilab code Exa 18.6 RB6

```
1  // sum 18-6
2  clc;
3  clear;
4  P=7500;
5  N=1440;
6  w=2*%pi*N/60;
7  T=P/w;
8  r=0.2;
9  //Let T1-T2=t
10 t=T/r;
11 T2=t/2.5;
12 T1=3.5*T2;
13 R=0.125;
14 Ft=T/R;
15 Fr=Ft*tan(20*%pi/180);
```

```
16 // RD & RA are reaction forces calculated in
      vertical and horizontal directions from FBD by
      force equilibrium
17 RDv=186.5;
18 RAv=236.2;
19 RDh=36.2;
20 RAh=108.56;
21 RA=sqrt(RAv^2+RAh^2);
22 RD=sqrt(RDv^2+RDh^2);
23 Ks=1.4;
24 P1=RA*Ks;
25 P2=RD*Ks;
26 //let designation,d,D,B,C at bearing B1 be De1,d1,C1
27 d1=25;
28 C1=3120;
29 De1=61805;
30 //let designation,d,D,B,C at bearing B2 be De2,d2,C2
31 d2=25;
32 C2=2700;
33 De2=61804;
34 L1=(C1/P1)^3;
35 Lh1=L1*10^6/(720*60);
36 L2=(C2/P2)^3;
37 Lh2=L2*10^6/(720*60);
38
39   // printing data in scilab o/p window
40   printf("Lh1 is %0.0f hrs    ",Lh1);
41   printf("\n Lh2 is %0.0f hrs    ",Lh2);
42
43   //Incorrect value of P2 is taken in the book while
       calculating L2.
```

Scilab code Exa 18.7 RB7

```
1 // sum 18-7
```

```
clc;
clear;
P=3500;
Lh=6000;
N=1400;
R98=0.98;
R90=0.9;
L98=Lh*60*N/10^6;
x=(log(1/R98)/log(1/R90))^(1/1.17);
L90=L98/x;
C=P*L90^(1/3);

  // printing data in scilab o/p window
  printf("C is %0.0f N    ",C);

  //The difference in the value of C is due to
     rounding-off of value of L.
```

Scilab code Exa 18.8 RB8

```
// sum 18-8
clc;
clear;
n=3;
P=3;
//Let Reliability of system be R
R=0.83;
L94=6;
R94=(R)^(1/n);
x=(log(1/R94)/log(1/0.90))^(1/1.17);
L90=L94/x;
C=P*L90^(1/3);

  // printing data in scilab o/p window
  printf("C is %0.3f kN    ",C);
```

```
16
17   //The difference in the value of C is due to
       rounding-off of value of L.
```

Scilab code Exa 18.9 RB9

```
1  // sum 18-9
2  clc;
3  clear;
4  P1=3000;
5  P2=4000;
6  P3=5000;
7  N1=1440;
8  N2=1080;
9  N3=720;
10 t1=1/4;
11 t2=1/2;
12 t3=1/4;
13 n1=N1*t1;
14 n2=N2*t2;
15 n3=N3*t3;
16 N=(n1+n2+n3);
17 Pe=(((n1*P1^3)+(n2*P2^3)+(n3*P3^3))/N)^(1/3);
18 Lh=10*10^3;
19 L=Lh*60*N/10^6;
20 C=Pe*L^(1/3);
21
22   // printing data in scilab o/p window
23   printf("C is %0.0f N    ",C);
24
25   //The difference in the value of C is due to
       rounding-off of value of Pe
```

Scilab code Exa 18.10 RB10

```
// sum 18-10
clc;
clear;
Co=695;
C=1430;
Pa1=200;
Pr1=600;
x=Pa1/Co;
y=Pa1/Pr1;
e=0.37+((0.44-0.37)*0.038/0.28);
X=1;
Y=0;
P1=600;
Pa2=120;
Pr2=300;
X=0.56;
Y=1.2-(0.2*0.042/0.12);
P2=(X*Pr2)+(Y*Pa2);
N1=1440;
N2=720;
t1=2/3;
t2=1/3;
n1=N1*t1;
n2=N2*t2;
N=(n1+n2);
Pe=(((n1*P1^3)+(n2*P2^3))/N)^(1/3);
L=(C/Pe)^3;
Lh=L*10^6/(N*60);

  // printing data in scilab o/p window
  printf("Lh is %0.2f hrs    ",Lh);

  //The difference in the value of Lh is due to
     rounding-off of value of Pe
```

Chapter 19

FLYWHEEL

Scilab code Exa 19.1 F1

```
1  // sum 19-1
2  clc;
3  clear;
4  R=1200;
5  b=300;
6  t=150;
7  N=500;
8  m=7100*10^-9*b*t;
9  Ar=b*t;
10 Aa=Ar/4;
11 C=(20280/t^2)+0.957+(Ar/Aa);
12 w=2*%pi*N/60;
13 V=w*R*10^-3;
14 siga=2*10^3*m*V^2/(C*Aa*3);
15 theta=30*%pi/180;
16 alpha=30*%pi/180;
17 x1=10^3*m*(V^2)/(b*t);
18 y1=cos(theta)/(3*C*sin(alpha));
19 z1=2000*R*10^-3/(C*t)*((1/alpha)-(cos(theta)/sin(
      alpha)));
20 sigrr1=x1*(1-y1+z1);
```

```
21 theta=0*%pi/180;
22 x2=10^3*m*(V^2)/(b*t);
23 y2=cos(theta)/(3*C*sin(alpha));
24 z2=2000*R*10^-3/(C*t)*((1/alpha)-(cos(theta)/sin(
      alpha)));
25 sigrr2=x2*(1-y2-z2);
26
27   // printing data in scilab o/p window
28   printf("axial stress is %0.2f MPa    ",siga);
29   printf("\n tensile stress for theta=30deg is %0.1f
       MPa    ",sigrr1);
30   printf("\n tensile stress for theta=0deg is %0.2f
      MPa    ",sigrr2);
31
32   //The difference in the value of sigrr1 and sigrr2
       is due to rounding-off of values.
```

Scilab code Exa 19.2 F2

```
1  // sum 19-2
2  clc;
3  clear;
4  N=350;
5  theta1=asin(sqrt((3-0.6)/4));
6  theta1=theta1*180/%pi;
7  theta2=(180)-theta1;
8  //Ti=16000+6000*sind(3*theta);
9  //To=16000+3600*sind(theta);
10 a=-3600*(cosd(theta2)-cosd(theta1));
11 b=2000*(cosd(3*theta2)-cosd(3*theta1));
12 c=a+b;
13 delU=c;
14 Ks=0.05;
15 w=2*%pi*N/60;
16 I=delU/(Ks*w^2);
```

```
17 V=25;
18 Ir=I*0.95;
19 R=V/w;
20 Mr=Ir/R^2;
21 rho=7150;
22 t=sqrt(Mr*(10^6)/(2*%pi*R*2*rho));
23 b=2*t;
24
25   // printing data in scilab o/p window
26   printf("t is %0.2f mm    ",t);
27   printf("\n b is %0.2f mm    ",b);
28   printf("\n R is %0.3f m    ",R);
```

Scilab code Exa 19.3 F3

```
1 // sum 19-3
2 clc;
3 clear;
4 N=300;
5 Ks=0.03;
6 rho=7150;
7 Kr=0.9;
8 w=2*%pi*N/60;
9 WD=(300*2*%pi)+(4*%pi*200/4);
10 Tm=400;
11 delU=%pi*200/16;
12 Ir=Kr*delU/(w^2*Ks);
13 R=Ir/(rho*1.5*0.1*0.1*2*%pi);
14 R=R^(1/5);
15 t=0.1*R*1000;
16 b=1.5*t;
17
18   // printing data in scilab o/p window
19   printf("t is %0.2f mm    ",t);
20   printf("\n b is %0.2f mm    ",b);
```

```
21    printf("\n R is %0.4f m    ",R);
```

Scilab code Exa 19.4 F4

```
1  //sum 19-4
2  clc;
3  clear;
4  d=20;
5  t=12;
6  Tus=450;
7  Pmax=%pi*d*t*Tus;
8  WD=Pmax*t/2*10^-3;
9  n=0.95;
10 Wi=WD/n;
11 delU=5*Wi/6;
12 N=300;
13 w=2*%pi*N/60;
14 Ks=0.2;
15 I=delU/(Ks*w^2);
16 Ir=I*0.9;
17 R=0.5;
18 m=Ir/R^2;
19 rho=7150;
20 t=sqrt(m*10^6/(rho*2*%pi*R*2));
21 b=2*t;
22
23   // printing data in scilab o/p window
24   printf("t is %0.1f mm    ",t);
25   printf("\n b is %0.1f mm    ",b);
26   printf("\n R is %0.1f m    ",R);
```

Scilab code Exa 19.5 F5

```
// sum 19-5
clc;
clear;
U=(500*2*%pi)+(3*%pi*500/2);
Tm=U/(2*%pi);
delU=2.25*%pi*125/2;
Ks=0.1;
N=250;
w=2*%pi*N/60;
I=delU/(Ks*w^2);
t=0.03;
rho=7800;
R=(I*2/(%pi*rho*t))^(1/4);
V=R*w;
v=0.3;
sigmax=rho*V^2*(3+v)/8*10^-6;

  // printing data in scilab o/p window
  printf("R is %0.3f m    ",R);
  printf("\n sigmax is %0.2f MPa    ",sigmax);
```

Scilab code Exa 19.6 F6

```
// sum 19-6
clc;
clear;
N=1.5*8*60;
l=200;
t=1.5/2;
W=350*10^3;
WD=0.15*l*W*10^-6;
n=0.9; //since frictional effect is 10%, effciency
   of system is 90%
Wi=WD/n;
L=400;
```

```
12 delU=(L-(0.15*l))/(L)*10^3*Wi;
13 Ks=0.12;
14 w=2*%pi*N/60;
15 I=delU/(Ks*w^2);
16 Ir=I*0.9;
17 R=0.7;
18 m=Ir/R^2;
19 rho=7150;
20 t=sqrt(m*10^6/(rho*2*%pi*R*1.5));
21 b=1.5*t;
22
23   // printing data in scilab o/p window
24   printf("t is %0.1f mm    ",t);
25   printf("\n b is %0.1f mm    ",b);
```

Scilab code Exa 19.7 F7

```
1 // sum 19-7
2 clc;
3 clear;
4 N=144;
5 //Let n be no. of punches/ min
6 n=8;
7 //Let t be timr for 1 punch
8 t=60/n;
9 theta=N/60*2*%pi*0.6;
10 T=2.1;
11 U=T*theta;
12 //Let U1 be revolution of crankshaft in t sec
13 U1=t*N/60*2*%pi;
14 delU=(U1-theta)/U1*U*10^3;
15 w=2*%pi*1440/60;
16 Ks=0.1;
17 I=delU/(Ks*w^2);
18 Ir=I*0.9;
```

```
rho=7100;

R=Ir/(rho*0.2*0.1*2*%pi);
R=R^(1/5);
t=0.1*R*1000;
b=0.2*R*10^3;
t=40;
b=80;
R=400;
// printing data in scilab o/p window
  printf("t is %0.0f mm    ",t);
  printf("\n b is %0.0f mm    ",b);
  printf("\n R is %0.0f mm    ",R);
```

Chapter 20

FLAT BELT DRIVE

Scilab code Exa 20.1 FBD1

```
1  // sum 20-1
2  clc;
3  clear;
4  b=0.2;
5  P=50*10^3;
6  v=20;
7  m=1.95;
8  d=0.3;
9  D=0.9;
10 C=5.8;
11 u=0.4;
12 //Let density be rho
13 rho=1000;
14 E=40;
15 //Let T1-T2 = T
16 T=P/v;
17 //Let the centrifugal tension be Tc
18 Tc=m*v^2;
19 alpha=asind((D+d)/(2*C));
20 theta=180+(2*alpha);
21 theta=theta*%pi/180;
```

```
22 x = exp(u*theta);
23 T2=(((1-x)*Tc)-T)/(1-x);
24 //T1=T+T2;
25 T1=T+T2;
26 t=m/(b*rho)*10^3;
27 //Let maximum stress be sigmax
28 b=200;
29 d=300;
30 sigmax=(T1/(b*t)+((E*t)/d));
31 sigmin=(T2/(b*t));
32
33   // printing data in scilab o/p window
34   printf("T1 is %0.1f N ",T1);
35   printf("\n T2 is %0.1f N ",T2);
36   printf("\n t is %0.2f mm ",t)
37   printf("\n theta is %0.2f rad ",theta)
38   printf("\n sigmax is %0.2f N/mm^2 ",sigmax);
39   printf("\n sigmin is %0.3f N/mm^2 ",sigmin);
40
41   //The answer for T1 is miscalculated in the book.
```

Scilab code Exa 20.2 FBD2

```
1 // sum 20-2
2 clc;
3 clear;
4 P=12*10^3;
5 d=0.2;
6 D=0.5;
7 C=2;
8 sigmax=2*10^6;
9 t=8*10^-3;
10 //Let density be rho
11 rho=950;
12 u=0.38;
```

```
13 N=1500;
14 //Let angle of contact = thetad
15 thetad=180-(2*asind((D-d)/(2*C)));
16 thetad=thetad*%pi/180;
17 thetaD=(2*%pi)-thetad;
18 v=(2*%pi*N*d)/(60*2);
19 //Let T1-T2=T
20 T=P/v;
21 x=exp(u*thetad);
22 b=(T*x)/((1-x)*t*((rho*v^2)-(sigmax)));
23 b=b*10^3;
24 //Let breadth of the pulley be b1
25 b1=b*10^3+13; //Table 20-3
26 L=sqrt((4*C^2)-(C*(D-d)^2))+((D*thetaD)+(d*thetad))
     /2;
27 // Let pulley crown for d=h1, D=h2
28 h1=0.6;  //Table 20-4
29 h2=1;
30
31   // printing data in scilab o/p window
32   printf("b is %0.2f mm ",b)
33   printf("\n L is %0.2f m ",L)
34   printf("\n b1 is %0.2f mm ",b1);
35   printf("\n h1 is %0.1f mm ",h1);
36   printf("\n h2 is %0.1f mm ",h2);
```

Scilab code Exa 20.3 FBD3

```
1 // sum 20-3
2 clc;
3 clear;
4 P=11;
5 N=1440;
6 n=480;
7 C=2.4;
```

```
//Let power transmitte dfrom high speed belt =P1
P1=0.0118;
V=5;
Ks=1.2;
v=15;
d=v*10^3*60/(2*%pi*N);
d=0.2;
D=N/n*d;
//Let angle of contact =thetaA
thetaA=180-(2*asind((D-d)/(2*C)));
thetaA=thetaA*%pi/180;
v=(2*%pi*N*d)/(60*2);
//Let the arc of contact correction factor be Ka
Ka=1.05;
Pd=P*Ka*Ks;
//Let corrected load rating=Pc
Pc=P1*v/V;
b=Pd/(Pc*4);
thetaB=(2*%pi)-thetaA;
L=sqrt((4*C^2)-((D-d)^2))+((d*thetaA/2)+(D*thetaB)
   /2);


  // printing data in scilab o/p window
  printf("v is %0.2f m/s ",v)
  printf("\n b is %0.3f mm ",b)
  printf("\n L is %0.4f m ",L);
```

Scilab code Exa 20.4 FBD4

```
// sum 20-4
clc;
clear;
N=1440;
i=2.5;
```

```
C=3600;
//let load factor be LF
LF=1.3;
P=12*10^3;
n=N/i;
V=16;
d=V*10^3*60/(2*%pi*N);
d=220;
D=d*i;
V=2*%pi*N*d/(2*60*1000);
v=5;
//Let power transmitte dfrom high speed belt =P1
P1=0.0118;
//Let LR be the load rating of belt
LR=P1/v*V;
theta=180+(2*asind((D-d)/(2*C)));
theta=theta*%pi/180;
//Let Arc of contact connection factor be CF
CF=1-(0.03/2);
Pd=P*LF*CF;
b=Pd/(LR*5);
b=80;
L=sqrt((4*C^2)-(D+d)^2)+(theta*(D+d)/2);
L=L*10^-3;

  // printing data in scilab o/p window
  printf("V is %0.1f m/s ",V)
  printf("\n b is %0.0f mm ",b)
  printf("\n L is %0.3f m ",L);
```

Scilab code Exa 20.5 FBD5

```
// sum 20-5
clc;
clear;
```

```
i=3.6;
N=1440;
d=220;
Ks=1.2;
Kf=1.1;
C=5000;
u=0.8;
D=i*d;
//From table 20-7, the following data is available
t=5;
b=120;
Fa=30.64;
//let weight density be w
w=0.106*10^5;
Cp=0.71; //From table 20-6
Cv=1;
T1=Fa*b*t*Cp*Cv;
m=w*b*t/10^6;
V=2*%pi*N*d/(2*60*1000);
Tc=m*V^2/9.81;
theta=180+(2*asind((D-d)/(2*C)));
theta=theta*%pi/180;
x=u*theta;
T2=Tc+((T1-Tc)/exp(x));
Pd=(T1-T2)*V*10^-3;
P=Pd/(Ks*Kf);

  // printing data in scilab o/p window
  printf("V is %0.2f m/s ",V);
  printf("\n Pd is %0.2f KW ",Pd);
  printf("\n P is %0.1f KW ",P);

  //The value of T2 is calculated incorrectly,
     therefore there is a difference in the values
     of Pd and P.
```

Scilab code Exa 20.6 FBD6

```
1  // sum 20-6
2  clc;
3  clear;
4  i=2.5;
5  C=4500;
6  N=960;
7  P=20*10^3;
8  Ks=1.15;
9  Kf=1.10;
10 t=8;
11 //let weight density be w
12 w=0.110*10^5;
13 m=w*t/10^6;
14 Fa=8.75;
15 d=200;
16 D=i*d;
17 u=0.4;
18 V=2*%pi*N*d/(2*60*1000);
19 Pd=P*Ks*Kf;
20 Cp=1;
21 Cv=0.6;
22 //to find b
23 T1=Fa*t*Cp*Cv;
24 Tc=m*V^2/9.81;
25 theta=180-(2*asind((D-d)/(2*C)));
26 theta=theta*%pi/180;
27 x=u*theta;
28 T2=Tc+((T1-Tc)/exp(x));
29 T=Pd/V;
30 b=T/(T1-T2);
31 //b=90;
32 L=sqrt((4*C^2)-(D+d)^2)+(theta*(D+d)/2);
```

```
33 L=L*10^-3;
34
35   // printing data in scilab o/p window
36   printf("V is %0.2f m/s ",V)
37   printf("\n b is %0.3f mm ",b)
38   printf("\n L is %0.3f m ",L);
```

Scilab code Exa 20.7 FBD7

```
1  // sum 20-7
2  clc;
3  clear;
4  b=160;
5  t=7;
6  P=3*10^3;
7  Ks=1.2;
8  d=160;
9  N=1440;
10 D=480;
11 C=2400;
12 w=11200;
13 u=0.4;
14 Fa=7.2;
15 m=w*b*t/10^6;
16 V=2*%pi*N*d/(2*60*1000);
17 Tc=m*V^2/9.81;
18 Cp=0.6; //from table 20-6
19 Cv=0.98; //from table 20-7
20 Ta=Fa*b*Cp*Cv;
21 T=P/V;
22 theta=180-(2*asind((D-d)/(2*C)));
23 theta=theta*%pi/180;
24 x=u*theta;
25 //T2=Tc+((T1-Tc)/exp(x));
26 T2=(T+((exp(x)*Tc)-Tc))/(exp(x)-1);
```

```
27 T1=T+T2;
28 Kf=Ta/T1;
29 Pd=P*Ks*Kf;
30 Pd=Pd*10^-3;
31
32   // printing data in scilab o/p window
33   printf("Tc is %0.0f N ",Tc);
34   printf("\n T1 is %0.2f N ",T1);
35   printf("\n T2 is %0.2f N ",T2);
36   printf("\n Kf is %0.2f  ",Kf);
37   printf("\n Pd is %0.1f KW ",Pd);
38
39   //The difference in values of T1 and T2 is due to
       rounding-off of values.
```

Chapter 21

V BELT DRIVE

Scilab code Exa 21.1 VBELT1

```
1  // sum 21-1
2  clc;
3  clear;
4  P1=12*10^3;
5  d=0.3;
6  D=0.9;
7  C=0.9;
8  A=230*10^-6;
9  //density is rho
10 rho=1100;
11 N=1500;
12 //Maximum stress is sig
13 sig=2.1*10^6;
14 //semi groove angle is b
15 b=20*%pi/180;
16 u=0.22;
17 m=rho*A;
18 v=2*%pi*N*d/(60*2);
19 Tc=m*v^2;
20 T1=A*sig;
21 //wrap angle is thetaA
```

```
22 ang=(D-d)/(2*C);
23 thetaA=%pi/180*(180-(2*asind(ang)));
24 thetaB=((2*%pi)-thetaA);
25 x=u*thetaB;
26 T2=Tc+((T1-Tc)/exp(x));
27 P2=(T1-T2)*v;
28 n=P1/P2;
29 n=3; //(rounding off to nearest whole number)
30
31   // printing data in scilab o/p window
32   printf("Tc is %0.1f N ",Tc);
33   printf("\n T1 is %0.0f N ",T1);
34   printf("\n T2 is %0.1f N ",T2);
35   printf("\n P2 is %0.0f W ",P2);
36   printf("\n n is %0.0f ",n);
```

Scilab code Exa 21.2 VBELT2

```
1  // sum 21-2
2  clc;
3  clear;
4  D=0.6;
5  d=0.3;
6  C=0.9;
7  m=0.193;
8  n=2;
9  N=1500;
10 u=0.3;
11 v=2*%pi*N/60*d/2;
12 P=150*10^3;
13 Tc=m*v^2;
14 //let T1-T2=T
15 T=P/(n*v);
16 thetaA=%pi/180*(180-(2*asind((D-d)/(2*C))));
17 thetaB=((2*%pi)-thetaA);
```

```
18 //Groove angle=b
19 b=17.5*%pi/180;
20 x=u*thetaA/sin(b);
21 y=exp(x);
22 c=(Tc*(1-y));
23 T2=(T+(Tc*(1-y)))/(y-1);
24 //T2=(T-y)/Tc;
25 T1=T+Tc;
26 Lp=2*sqrt((C^2)-((D-d)/2)^2)+(thetaA*d/2)+(thetaB*D
      /2);
27 v=sqrt(T/(3*m));
28
29   // printing data in scilab o/p window
30   printf("Tc is %0.2f N ",Tc);
31   printf("\n T1 is %0.0f N ",T1);
32   printf("\n T2 is %0.2f N ",T2);
33   printf("\n Lp is %0.3f m ",Lp);
34   printf("\n v is %0.2f m/s ",v);
35   printf("\nThe designation of the belt is B-3251-45
       ");
36
37   //The difference in values of T1 and T2 is due to
       rounding-off of values.
```

Scilab code Exa 21.3 VBELT3

```
1 // sum 21-3
2 clc;
3 clear;
4 C=1;
5 m=0.35;
6 d=0.25;
7 P=22*10^3;
8 //Let the smaller pulley dia be n
9 //Let the larger pulley dia be N
```

```
10 n=1000;
11 N=400;
12 D=d*n/N;
13 v=2*%pi*n*d/(60*2);
14 Tc=m*v^2;
15 topwidth=22;
16 h=14;
17 bottomwidth=topwidth-(2*h*tand(20));
18 A=(topwidth+bottomwidth)/2*h;
19 //let allowable tension be Ta
20 Ta=2.2;
21 T1=A*Ta;
22 u=0.28;
23 thetaA=%pi/180*(180-(2*asind((D-d)/(2*C))));
24 thetaB=((2*%pi)-thetaA);
25 //Groove angle=b=19
26 b=19*%pi/180;
27 x=u*thetaA/sin(b);
28 T2=Tc+((T1-Tc)/exp(x));
29 n=P/((T1-T2)*v);
30 Lp=2*sqrt((C^2)-((D-d)/2)^2)+(thetaA*d/2)+(thetaB*D
   /2);
31
32   // printing data in scilab o/p window
33   printf("Tc is %0.2f N ",Tc);
34   printf("\n T1 is %0.1f N ",T1);
35   printf("\n T2 is %0.1f N ",T2);
36   printf("\n n is %0.1f ",n);
37   printf("\n Lp is %0.3f m ",Lp);
38   printf("\nThe designation of the belt is C-3414-47
       ");
39
40  // difference in value of Lp is due to rounding-off
      the values of thetaA and thetaB.
```

Scilab code Exa 21.4 VBELT4

```
// sum 21-4
clc;
clear;
P=12*10^3;
Ks=1.1;
Pd=12*10^3*Ks;
N=1440;
B=17;
t=11;
d=200;
i=3;
D=i*d;
C=1000;
// since angle of contact theta is very small
theta=(D-d)/C;
theta=theta*180/%pi;
Kc=0.8;
Lp=(2*C)+(%pi/2*(D+d))+(((D-d)^2)/(4*C));
Li=Lp-45;
Ki=1.1;
//let number of v-belts required = n
//let the KW rating be KWR
KWR=5.23;
n=(P*Ks)/(KWR*Ks*Ki*10^3);
n=3;

  // printing data in scilab o/p window
  printf("D is %0.1f mm ",D);
  printf("\n C is %0.1f mm ",C);
  printf("\n n is %0.3f ",n);
  printf("\n Li is %0.0f mm ",Li)
```

Scilab code Exa 21.5 VBELT5

```
// sum 21-5
clc;
clear;
N=800;
P=20;
i=2.5;
Ks=1.5; //(from table for 3-5 hrs/day)
Pd=P*Ks;
d=250;
D=i*d;
C=1.6*D;
Lp=(2*C)+(%pi*(D+d)/2)+((D-d)^2)/(4*C);
Li=Lp+74;
Listd=3454;
Lp=Listd+74;
p=[1 -1.0768 0.0175];

function r= myroots (p)

a= coeff (p ,0);
b= coeff (p ,1);
c= coeff (p ,2);
r(1)=( -b+ sqrt (b^2 -4*a*c ))/(2* a);
r(2)=( -b- sqrt (b^2 -4*a*c ))/(2* a);
endfunction
z=roots(p);
KW=9.4;
Kc=0.795;
K1=1;
n=Pd/(KW*Kc*K1);


  // printing data in scilab o/p window
  printf("C is %0.4f m ",z);
  printf("\n Pd is %0.0f KW ",Pd);
  printf("\n n is %0.2f KW ",n);
```

Chapter 22

FRICTION CLUTCHES

Scilab code Exa 22.1 FC221

```
1 // 22-1
2 clc;
3 clear;
4 u=0.28 //(coefficient of friction)
5 N=300 //(Engine rpm)
6 I=7.2
7 Pmax= 0.1;
8 R1=70;
9 R2=110;
10 n=2; //(Both sides of the plate are effective)
11 //Using Uniform Wear Theory
12 //Axial Force W
13 W=n*%pi*Pmax*R1*(R2-R1);
14 //Frictional Torque Tf
15 Tf=u*W*(R1+R2)/2*(10^-3);
16 w=2*%pi*N/60;
17 //Power P
18 P=Tf*w;
19 //Torque = Mass moment of inertia*angular
      acceleration
20 a=Tf/I;
```

```
21 t=w/a;
22 //Angle turned by driving shaft theta1 through which
       slipping takes place
23 theta1=w*t;
24 //angle turned by driven shaft theta2
25 theta2=a*(t^2)/2;
26 E=Tf*(theta1-theta2);
27
28   // printing data in scilab o/p window
29 printf("\nThe force is %0.1f N",W);
30 printf("\nThe Torque is %0.2f Nm",Tf);
31 printf("\nThe Power is %0.0f W",P);
32 printf("\nThe angular acceleration is %0.2f rad/sec
     ^2",a);
33 printf("\nThe time taken is %0.1f sec",t);
34 printf("\nThe energy is %0.2f Nm",E);
35
36 //The difference in the answer of energy 'E' is due
     to rounding-off of values.
```

Scilab code Exa 22.2 FC222

```
1 // 22-2
2 clc;
3 clear;
4 //Power P
5 P=80*10^3; //(Watt)
6 N=3000; //(Engine rpm)
7 w=2*%pi*3*10^3/60
8 Tf=8*10^4/w;
9 Rm=100;//(mm)
10 p=0.2 //N/mm^2
11 u=0.22
12 // let width b= (R1-R2).
13 //Axial force W=2*pi*Rm*b*p
```

```
14 //Torque T=u*W*Rm
15 b=Tf/(u*2*%pi*(Rm^2)*p);
16 b=50;
17 R2=Rm+b;
18 R1=Rm-b;
19 Di=2*R1; //inner diameter
20 W=2*%pi*Rm*b*p;
21 n=8; //n is number of springs
22 //Axial force per spring W1
23 W1=W/n;
24 W1=W1+15;
25 //axial deflection del
26 del=10;
27 //stiffness k
28 k=W1/del;
29 // Spring index C
30 C=6;
31 //number of coils n1
32 n1=6; //Assumption
33 d=k*n*n1*(C^3)/(80*10^3);
34 d=11; // Rounding off to nearest standard value
35 D=C*d;
36 clearance=2;
37 FL=((n1+2)*d)+(2*del)+clearance; // two end coils,
      therefore (2*del)
38
39   // printing data in scilab o/p window
40
41 printf("\nThe Torque is %0.2f Nm",Tf);
42 printf("\nThe width is %0.0f mm",b);
43 printf("\nThe force is %0.0f N",W);
44 printf("\nThe Axial force per spring is %0.0f N",W1)
      ;
45 printf("\nThe Spring stiffness is %0.0f N/mm",k);
46 printf("\nThe Spring wire diameter is %0.0f mm",d);
47 printf("\nThe Mean coil diameter is %0.0f mm",D);
48 printf("\nThe Free length is %0.0f mm",FL);
```

Scilab code Exa 22.3 FC223

```
// 22-3
clc;
clear;
//Power P
P=40*10^3 //Watt
n1=100; //rpm
n2=400; //rpm
//Speed factor Ks
Ks=0.9+0.001*n2;
//Clutch power Pc
Pc=P*n2/(n1*Ks)*10^-3;

  // printing data in scilab o/p window
printf("\nThe Speed factor is %0.1f ",Ks);
printf("\nThe clutch poweris %0.0f KW",Pc);
```

Scilab code Exa 22.4 FC224

```
//22-4
clc;
clear;
// plot Torque vs Ro/Ri
//x=Ro/Ri
//According to Uniform Wear theory
x=[0 0.2 0.4 0.577 0.6 0.8 1.0];
n=length(x);
for i=1:n
    Tf(i)=(x(i)-(x(i)^3));
```

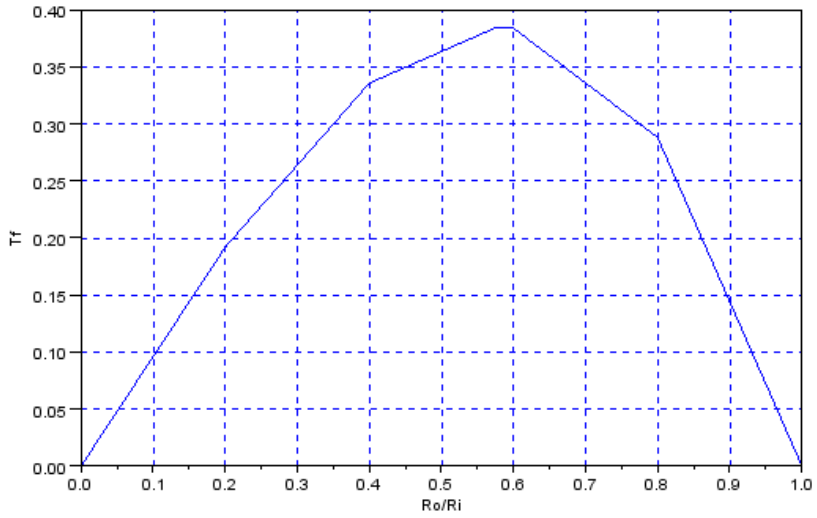

Figure 22.1: FC224

```
11 end
12 plot (x,Tf);
13 xtitle('','Ro/Ri');
14 ylabel('Tf');
15 xgrid(2);
```

Scilab code Exa 22.5 FC225

```
1 // 22-5
2 clc;
3 clear;
4 n1=4;
5 n2=3;
6 n=(n1+n2-1);
7 R2=80;
8 R1=50;
```

```
//According to Uniform Pressure Theory
//W=p*pi*((R2^2)-(R1^2)) T=n*2*u*W*((R2^3)-(R1^3))
   /(((R2^2)-(R1^2))*3)
P=15*10^3;
N=1400;
u=0.25;
w=2*%pi*N/60;
T=P/w;
W=T*3*((R2^2)-(R1^2))/(n*2*u*((R2^3)-(R1^3)))*10^3;
p=W/(%pi*((R2^2)-(R1^2)));

  // printing data in scilab o/p window
printf("\nThe angular speed is %0.2f rad/sec",w);
printf("\nThe Torque is %0.3f Nm",T);
printf("\nThe uniform pressure is %0.3f N/mm^2",p);
printf("\nThe Force is %0.1f N",W);
```

Scilab code Exa 22.6 FC226

```
//FRICTION CLUTCHES
// PAGE 584, 22-6
clc;
P=5*10^3;
N=1000;
w=2*%pi*N/60;
Rm=50;
pm=0.3;
Tf=P/w;
u=0.1;
R2=50*2/(0.6+1);
R1=0.6*R2;
//According to uniform Wear theory
W=pm*Rm*(R2-R1)*2*%pi;
n=Tf*(10^3)/(u*W*Rm);
pmax=pm*Rm/R1;
```

```
17
18   // printing data in scilab o/p window
19 printf("\nThe angular speed is %0.2f rad/sec",w);
20 printf("\nThe Torque is %0.3f Nm",Tf);
21 printf("\nThe Inner radius is %0.1f mm",R1);
22 printf("\nThe Outer radius is %0.1f mm",R2);
23 printf("\nThe number of contacting surfaces is %0.0f
       ",n);
24 printf("\nThe max. pressure is %0.1f N/mm^2",pmax);
```

Scilab code Exa 22.7 FC227

```
1 // 22-7
2 clc;
3 clear;
4 P=12*10^3;
5 N=750 //Speed=N
6 w=2*%pi*N/60;
7 Tf=P/w;
8 p1=0.12;
9 a=12.5;//Semi-cone angle
10 u=0.3;
11 k=u*0.18246*1.121/0.21644;
12 R1=(Tf*(10^3)/k)^(1/3);
13 R2=R1*1.242;
14 Rm=1.121*R1;
15 W=2*%pi*p1*R1*(R2-R1);
16
17   // printing data in scilab o/p window
18 printf("\nThe angular speed is %0.2f rad/sec",w);
19 printf("\nThe Torque is %0.1f Nm",Tf);
20 printf("\nThe Inner radius is %0.1f mm",R1);
21 printf("\nThe Outer radius is %0.1f mm",R2);
22 printf("\nThe mean radius is %0.2f mm",Rm);
23 printf("\nThe axial force is %0.0f N",W);
```

```
24
25 //The difference in the answer is due to rounding-
      off of values.
```

Scilab code Exa 22.8 FC228

```
1  //22-8
2  clc;
3  clear;
4  //semi-cone angle is given as 15 degree
5  k=sin(15*%pi/180);
6  u=0.3;
7  W=300;
8  Rm=90/2;
9  Tf=u*W*Rm/k;
10 Tf=Tf*(10^-3);
11 I=0.4;
12 a=Tf/I;
13 N=1440;
14 w=2*%pi*N/60;
15 t=w/a;
16 //During Slipping
17 theta1=w*t;
18 theta2=theta1/2;
19 U=Tf*(theta1-theta2);
20
21   // printing data in scilab o/p window
22 printf("\nThe Torque is %0.3f Nm",Tf);
23 printf("\nThe angular acceleration is %0.3f rad/sec
      ^2",a);
24 printf("\nThe angular speed is %0.1f rad/sec",w);
25 printf("\nThe time taken is %0.2f sec",t);
26 printf("\nThe Energy lost in friction is %0.0f Nm",U
      );
```

Scilab code Exa 22.9 FC229

```
1  // 22-9
2  clc;
3  clear;
4  P=15*10^3;
5  Ka=1.25;
6  N=1500;
7  w=2*%pi*N/60;
8  Tf=P/w;
9  d=(Tf*16/(50*%pi))^(1/3);
10 d=25;
11 Rm=5*d;
12 Pav=0.12;
13 u=0.22;
14 b=Tf/(%pi*u*Pav*(Rm^2));
15 b=40;
16 R1=Rm-(b*sin(15*%pi/180)/2);
17 R2=Rm+(b*sin(15*%pi/180)/2);
18
19   // printing data in scilab o/p window
20 printf("\nThe Torque is %0.2f Nm",Tf);
21 printf("\nThe shaft diameter is %0.0f mm",d);
22 printf("\nThe width is %0.0f mm",b);
23 printf("\nThe Inner radius is %0.1f mm",R1);
24 printf("\nThe Outer radius is %0.1f mm",R2);
```

Scilab code Exa 22.10 FC2210

```
1  // 22-10
2  clc;
3  clear;
```

```
4  w2=2*%pi*1400/60;
5  w1=0.8*w2;
6  P=40*10^3;
7  T=P/w2;
8  n=4;
9  T1=T/4;
10 R=0.16;//Inner radius of drum
11 r=0.13;//radial distance of each shoe from axis of
       rotation
12 u=0.22;//coefficient of friction
13 x=u*r*R*((w2^2)-(w1^2))
14 m =T1/x;
15 l=R*%pi/3;
16 N=T1/(R*u);
17 p=1*10^5;
18 b=N/(p*l)*10^3;
19
20   // printing data in scilab o/p window
21 printf("\nThe full speed is %0.1f rad/sec",w2);
22 printf("\nThe engagement speed is %0.2f rad/sec",w1)
       ;
23 printf("\nThe number of shoes is %0.0f ",n);
24 printf("\nThe Torque is %0.1f Nm",T);
25 printf("\nThe Torque per shoe is %0.1f Nm",T1);
26 printf("\nThe mass per shoe is %0.2f kg",m);
27 printf("\nThe length of friction lining is %0.5f m",
       l);
28 printf("\nThe width is %0.1f mm",b);
```

Chapter 23

BRAKES

Scilab code Exa 23.1 B23 1

```
1 // sum 23-1
2 clc;
3 clear;
4 W=20e3;
5 m=W/9.81;
6 //diameter of brake drum
7 Db=0.6;
8 p=1;
9 Vi=1;
10 Vf=0;
11 D=1;
12 R=0.5;
13 wi=Vi/R;
14 wf=0;
15 w=1;
16 Vav=0.5;
17 S=2;
18 t=S/Vav;
19 //angle turned by by hoist drum=theta
20 theta=0.5*wi*t;
21 K.E=0.5*m*Vi^2;
```

```
22 P.E=2*W;
23 T.E=K.E+P.E;
24 T=T.E/theta;
25 P=wi*T*10^-3;
26 Rb=Db/2;
27 Ft=0.5*T*p/Rb;
28 u=0.35;
29 N=Ft/u;
30 //contact area of brake lining=A
31 A=N/p;
32 b=0.3*Db;
33 L=A*10^-6/(b);
34 //angle subtended at brake drum centre=theta2
35 theta2=2*(asin(L/Db));
36 theta2=theta2*180/%pi; // converting radian to
      degree
37
38   // printing data in scilab o/p window
39   printf("T is %0.1f Nm ",T);
40   printf("\n P is %0.4f kW ",P);
41   printf("\n b is %0.2f m ",b);
42   printf("\n L is %0.3f m ",L);
43   printf("\n theta2 is %0.0f deg ",theta2);
```

Scilab code Exa 23.2 B23 2

```
1 // sum 23-2
2 clc;
3 clear;
4 b=80;
5 t=2;
6 theta=225*%pi/180;
7 u=0.22;
8 //F1/F2=e^(u*theta)
9 //let F1/F2=x;
```

```
x=exp(u*theta);
//maximum tensile stress in steel tape is siga
siga=60;
A=b*t;
F1=siga*A;
F2=F1/x;
r=0.2;
T=(F1-F2)*r;
OA=30;
OB=100;
OC=350;
P=((F2*OB)+(F1*OA))/OC;
OA=F2*OB/F1;

  // printing data in scilab o/p window
  printf("F1 is %0.0f N ",F1);
  printf("\n F2 is %0.1f N ",F2);
  printf("\n T is %0.2f Nm ",T);
  printf("\n OA is %0.2f mm ",OA);
```

Scilab code Exa 23.3 B23 3

```
// sum 23-3
clc;
clear;
theta=%pi/3;
r=160;
u=0.3;
pmax=0.9;
b=40;
R=(4*r*sin(theta))/((2*theta)+sin(2*theta));
//frictional torque is T
T=2*u*pmax*b*(r^2)*sin(theta);
T=2*T*10^-3;
Rx=0.5*pmax*b*r*((2*theta)+(sin(2*theta)))*10^-3;
```

```
14 Ry=u*Rx;
15
16   // printing data in scilab o/p window
17   printf("T is %0.2f Nmm ",T);
18   printf("\n R is %0.3f mm ",R);
19   printf("\n Rx is %0.3f kN ",Rx);
20   printf("\n Ry is %0.2f kN ",Ry);
```

Scilab code Exa 23.4 B23 4

```
1  // sum 23-4
2  clc;
3  clear;
4  d=320;
5  r=d/2;
6  b=50;
7  u=0.3;
8  pmax=1;
9  c=115*2;
10 // From to fig. 23-9, distance OA=R is calculated.
11 R=sqrt(115^2+66.4^2);
12 C=115*2;
13 theta1=0;
14 theta2=120*%pi/180;
15 theta0=120*%pi/180;
16 thetamax=%pi/2;
17 Tr=u*pmax*b*r^2*(cos(theta1)-cos(theta2))/sin(
      thetamax)*10^-3;
18 //the notation 'r' is used for moments of right hand
       shoe, similarly 'l' for the left shoe.
19 Mfr=u*pmax*b*r*(4*r*(cos(theta1)-cos(theta2))+(R*(
      cos(2*theta1)-cos(2*theta2))))/(4*sin(thetamax))
      *10^-3;
20 Mpr=pmax*b*r*R*((2*theta0)-(sin(2*theta2)-(sin(
      theta1))))/(4*sin(thetamax))*10^-3;
```

```
21 F=(Mpr-Mfr)/c*10^3;
22 //Mpl+Mfl=F*c;
23 x=F*c*10^-3;
24 y=(Mpr/pmax)+(Mfr/pmax);
25 pmax2=x/y;
26 Tl=pmax2*Tr;
27 Mpl=pmax2*Mpr;
28 Mfl=pmax2*Mfr;
29 T=Tl+Tr;
30
31   // printing data in scilab o/p window
32   printf("Tr is %0.0f Nm ",Tr);
33   printf("\n Mf is %0.2f Nm ",Mfr);
34   printf("\n Mp is %0.2f Nm ",Mpr);
35   printf("\n Tl is %0.1f Nm ",Tl);
36   printf("\n Mfl is %0.2f Nm ",Mfl);
37   printf("\n Mpl is %0.2f Nm ",Mpl);
38   printf("\n F is %0.1f N ",F);
39   printf("\n T is %0.1f Nm ",T);
40
41   //The difference in the answers are due to
       rounding-off of values.
```

Scilab code Exa 23.5 B23 5

```
1 // sum 23-5
2 clc;
3 clear;
4 m=1100;
5 V=65*5/18;
6 t=4;
7 r=0.22;
8 mb=12;
9 C=460;
10 S=0.5*V*t;
```

```
11 //Total kinetic energy TE=K.E(vehicle)+K.E(rotating
     parts).
12 TE=((0.5*m*(V^2))+(0.1*0.5*m*(V^2)));
13 E=TE/4;
14 w=V/r;
15 theta=S/r;
16 T=E/theta;
17 delT=E/(mb*C);
18
19   // printing data in scilab o/p window
20   printf("S is %0.2f m ",S);
21   printf("\n E is %0.2f Nm ",E);
22   printf("\n T is %0.2f Nm ",T);
23   printf("\n delT is %0.2f ",delT);
24
25 //The difference in the answers are due to rounding-
     off of values.
```

Scilab code Exa 23.6 B23 6

```
1 // sum 23-6
2 clc;
3 clear;
4 T=35000;
5 u=0.4;
6 p=0.7;
7 r=200;
8 N=T/(u*r)
9 b=sqrt(N/p);
10 l=b;
11 //2theta = theta2
12 theta2=2*asin(l/(2*r));
13 F=u*N;
14 P=((250*N)-(u*N*80))/550;
15 Ry=N-P;
```

```
16 Rx=u*N;
17 R=sqrt(Rx^2+Ry^2);
18 w=2*%pi*100/60;
19 // Rate of heat generated is Q
20 Q=u*N*w*r/1000;
21
22   // printing data in scilab o/p window
23   printf("N is %0.1f N ",N);
24   printf("\n b is %0.0f mm ",b);
25   printf("\n P is %0.1f N ",P);
26   printf("\n R is %0.2f N ",R);
27   printf("\n Q is %0.2f J/s ",Q);
28
29 //The answer to Rate of heat generated 'Q' is
     calculated incorrectly in the book.
```

Scilab code Exa 23.7 B23 7

```
1  // sum 23-7
2  clc;
3  clear;
4  Vi=20*5/18;
5  Vf=0;
6  m=80;
7  pmax=1;
8  u=0.1;
9  S=50;
10 KE=0.5*m*Vi^2;
11 N=KE/(u*S*2);
12 t=sqrt(N/(pmax*3));
13 b=3*t;
14
15   // printing data in scilab o/p window
16   printf("KE is %0.1f Nm ",KE);
17   printf("\n N is %0.2f N ",N);
```

```
18    printf("\n t is %0.1f mm ",t);
19    printf("\n b is %0.1f mm ",b);
20
21 //The difference in the answers are due to rounding-
      off of values.
```

Chapter 24

ROPE DRIVE

Scilab code Exa 24.1 RD1

```
1  // sum 24-1
2  clc;
3  clear;
4  P=150000;
5  m=0.4;
6  D=1.8;
7  d=0.6;
8  C=4.2;
9  V=15;
10 Fc=m*V^2;
11 BL=44.81*10^3;
12 FOS=35;
13 F1=BL/FOS;
14 theta=%pi-(2*asin((D-d)/(2*C)));
15 beta=22.5*%pi/180;
16 u=0.13;
17 x=u*theta/sin(beta);
18 F2=(F1-Fc)/exp(x);
19 n=P/((F1-F2)*V);
20 n=13;
21
```

```
22   // printing data in scilab o/p window
23   printf("n is %0.0f    ",n);
```

Scilab code Exa 24.2 RD2

```
1  // sum 24-2
2  clc;
3  clear;
4  W=1000;
5  m=0.498;
6  BL=78;
7  d=12;
8  Am=0.39*d^2;
9  dw=sqrt(Am*4/(6*19*%pi));
10 Ew=74.4*10^3;
11 Ds=56*d;
12 sigb=Ew*dw/Ds;
13 Wb=sigb*%pi*(d^2)/4*10^-3;
14 l=20;
15 Ws=m*l;
16 a=1.2;
17 Wa=a*(W/2+Ws)*10^-3;
18 //Let the static load be Ps
19 Ps=(W/2+Ws)*9.81*10^-3;
20 //let the effective load  be Peff
21 Peff=Ps+Wb+Wa;
22 FOS1=BL/Peff;
23 FOS2=BL/(5+0.612);
24
25   // printing data in scilab o/p window
26   printf("annual FOS is %0.2f    ",FOS1);
27   printf("\n FOS neglecting bending load is %0.1f
       ",FOS2);
```

Scilab code Exa 24.3 RD3

```
1 // sum 24-3
2 clc;
3 clear;
4 d=12;
5 sigut=1960;
6 Pb=0.0025*sigut;
7 Ds=480;
8 F=Pb*d*Ds/2;
9 W=F*2*10^-3;
10
11   // printing data in scilab o/p window
12   printf("W is %0.3f kN    ",W);
```

Scilab code Exa 24.4 RD4

```
1 // sum 24-4
2 clc;
3 clear;
4 sigut=1770;
5 Pb=0.0018*sigut;
6 W=4000;
7 a=2.5/2;
8 Ws=90*0.5;
9 Wa=(W+Ws)*a/9.81;
10 Weff=W+Wa;
11 d=sqrt(Weff*2/(23*Pb));
12 d=12;
13
14   // printing data in scilab o/p window
15   printf("d is %0.0f mm    ",d);
```

Chapter 25

GEARS

Scilab code Exa 25.1 G1

```
1  // sum 25-1
2  clc;
3  clear;
4  Zp=25;
5  Zg=60;
6  m=5;
7  dp=m*Zp;
8  dg=m*Zg;
9  CD=(dp+dg)/2;
10 ha=m;
11 hf=1.25*m;
12 c=hf-ha;
13 r=0.4*m;
14
15   // printing data in scilab o/p window
16   printf("dp is %0.0f mm  ",dp);
17   printf("\n dg is %0.0f mm  ",dg);
18   printf("\n CD is %0.1f mm  ",CD);
19   printf("\n ha is %0.0f mm  ",ha);
20   printf("\n hf is %0.2f mm  ",hf);
21   printf("\n c is %0.2f mm  ",c);
```

```
22    printf("\n r is %0.0f mm    ",r);
```

Scilab code Exa 25.2 G2

```
1  // sum 25-2
2  clc;
3  clear;
4  N=800;
5  P=6000;
6  n=200;
7  Cs=1.4;
8  sigb=150;
9  FOS=2;
10 Zp=18;
11 Zg=Zp*N/n;
12 Y=%pi*(0.154-(0.912/Zp));
13 p=[1 0 -9.5846 -38.135];
14
15 function r= myroots (p)
16
17 a= coeff (p ,0);
18 b= coeff (p ,1);
19 c= coeff (p ,2);
20 d= coeff (p, 3);
21 r(1)=( -b+ sqrt (b^2 -4*a*c ))/(2* a);
22 r(2)=( -b- sqrt (b^2 -4*a*c ))/(2* a);
23 endfunction
24 m=roots(p);
25 m=4.5;
26 dp=m*Zp;
27 dg=m*Zg;
28 // printing data in scilab o/p window
29   printf("dp is %0.0f mm  ",dp);
30   printf("\n dg is %0.0f mm  ",dg);
```

Scilab code Exa 25.3 G3

```
1  // sum 25-3
2  clc;
3  clear;
4  Zp=30;
5  N=1000;
6  Zg=75;
7  m=5;
8  b=60;
9  sigut=450;
10 BHN=350;
11 Cs=1.5;
12 FOS=2;
13 dp=m*Zp;
14 dg=m*Zg;
15 v=2*%pi*N*dp/(60*1000*2);
16 Cv=3/(3+v);
17 sigb=450/3;
18 Y=0.358;
19 Sb=m*b*sigb*Y;
20 Q=(2*Zg)/(Zp+Zg);
21 K=0.16*(BHN/100)^2;
22 Sw=b*dp*Q*K;
23 Pt=Sb*Cv/(Cs*FOS);
24 P=Pt*v;
25 P=P*10^-3;
26
27   // printing data in scilab o/p window
28   printf("Sb is %0.0f N   ",Sb);
29   printf("\n Sw is %0.0f N   ",Sw);
30   printf("\n P is %0.3f kW   ",P);
31
32 //The difference in the value of Sw is due to
```

rounding-off of the value of Q.

Scilab code Exa 25.4 G4

```
1  // sum 25-4
2  clc;
3  clear;
4  n=240;
5  P=8000;
6  N=1200;
7  CD=300;
8  Cs=1.5;
9  alpha=20*%pi/180;
10 G=N/n;
11 dp=CD*2/6;
12 dg=5*dp;
13 v=2*%pi*N*dp/(60*1000*2);
14 Cv=3/(3+v);
15 Pt=P/v;
16 Peff=Pt*Cs/Cv;
17 m=4;
18 b=10*m;
19 FOS=2;
20 Sb=Peff*FOS;
21 sigut=600;
22 sigb=sigut/3;
23 Zp=dp/m;
24 Zg=dg/m;
25 Q=(2*Zg)/(Zp+Zg);
26 K=Sb/(b*dp*Q);
27 BHN=sqrt(K/0.16)*100;
28 BHN=333;
29
30   // printing data in scilab o/p window
31   printf("BHN is %0.0f     ",BHN);
```

Scilab code Exa 25.5 G5

```
1  // sum 25-5
2  clc;
3  clear;
4  alpha=20*%pi/180;
5  N=800;
6  P=6000;
7  sigut=450;
8  i=5;
9  Cs=1.3;
10 v=3.6;
11 FOS=2;
12 Pt=P/v;
13 Cv=3/(3+v);
14 sigb=sigut/3;
15 dp=3.6*1000*2*60/(2*%pi*N);
16 dp=86;
17 Sb=Pt*Cs/Cv*FOS;
18 //Let x be m^2*Y
19 x=Sb/(10*sigb);
20 m=5;
21 Zp=18;
22 dp=m*Zp;
23 Zg=i*Zp;
24 dg=m*Zg;
25 b=10*m;
26 phip=m+(0.25*sqrt(dp));
27 ep=32+(2.5*phip);
28 phig=m+(0.25*sqrt(dg));
29 eg=32+(2.5*phig);
30 e=ep+eg;
31 e=e*10^-3;
32 Ps=Cs*Pt;
```

```
33 r1=dp/2;
34 r2=dg/2;
35 Pd=e*N*Zp*b*r1*r2/(2530*sqrt(r1^2+r2^2));
36 Q=(2*Zg)/(Zp+Zg);
37 K=Sb/(b*dp*Q);
38 BHN=sqrt(K/0.16)*100;
39
40   // printing data in scilab o/p window
41   printf("Ps is %0.2f N    ",Ps);
42   printf("\n Pd is %0.1f N    ",Pd);
43   printf("\n BHN is %0.0f    ",BHN);
```

Scilab code Exa 25.6 G6

```
1 // sum 25-4
2 clc;
3 clear;
4 P=9000;
5 N=900;
6 n=150;
7 sigut=750;
8 BHN=300;
9 Cs=1.5;
10 FOS=2;
11 i=N/n;
12 x=sqrt(i);
13 Zp=18;
14 Zg=x*Zp;
15 Zg=44;
16 //Let actual speed reduction be xa
17 xa=Zg/Zp;
18 n1=N/xa^2;
19 T1=P*60/(2*%pi*N);
20 i2=N/xa;
21 T2=N/i2*T1;
```

```
22 m=6;
23 dp=Zp*m;
24 dg=m*Zg;
25 phip=m+(0.25*sqrt(dp));
26 ep=16+(1.25*phip);
27 phig=m+(0.25*sqrt(dg));
28 eg=16+(1.25*phig);
29 e=ep+eg;
30 e=e*10^-3;
31 Pt=26000;
32 Ps=Cs*Pt;
33 r1=dp/2;
34 r2=dg/2;
35 b=10*m;
36 Pd=e*i2*Zp*b*r1*r2/(2530*sqrt(r1^2+r2^2));
37 Q=(2*Zg)/(Zp+Zg);
38 sigb=sigut/3;
39 Y=0.308;
40
41 Sb=b*m*sigb*Y;
42 K=0.16*(BHN/100)^2;
43 Sw=b*dp*K*Q;
44
45   // printing data in scilab o/p window
46   printf("m is %0.0f mm   ",m);
47   printf("\n Pd is %0.3f N   ",Pd);
48   printf("\n Sw is %0.0f N   ",Sw);
49
50   //The difference in the values is due to rounding-
       off of the values.
```

Chapter 26

HELICAL GEARS

Scilab code Exa 26.1 HG1

```
1  // sum 26-1
2  clc;
3  clear;
4  Zp=20;
5  Zg=50;
6  alphan=20*%pi/180;
7  phi=15*%pi/180;
8  mn=4;
9  m=mn/cos(phi);
10 alpha=180/%pi*atan(tan(alphan)/(cos(phi)));
11 dp=Zp*m;
12 dg=Zg*m;
13 ha=4;
14 hd=1.25*mn;
15 //Let addendum circle dia of pinion be Pa
16 Pa=dp+(2*mn);
17 //Let dedendum circle dia of pinion be Pd
18 Pd=dp-(2.5*mn);
19 //Let addendum circle dia of gear be Ga
20 Ga=dg+(2*mn);
21 //Let dedendum circle dia of gear be Gd
```

```
Gd=dg-(2.5*mn);
b=%pi*mn/sin(phi);

  // printing data in scilab o/p window
  printf("m is %0.2f mm  ",m);
  printf("\n alpha is %0.3f deg  ",alpha);
  printf("\n Pa is %0.1f mm  ",Pa);
  printf("\n Pd is %0.1f mm  ",Pd);
  printf("\n Ga is %0.0f mm  ",Ga);
  printf("\n Gd is %0.0f mm  ",Gd);
  printf("\n b is %0.2f mm  ",b);
```

Scilab code Exa 26.2 HG2

```
// sum 26-2
clc;
clear;
P=5000;
Zp=25;
Zg=50;
mn=4;
alphan=20*%pi/180;
phi=20*%pi/180;
N=1200;
m=mn/cos(phi);
dp=Zp*m;
dg=Zg*m;
v=2*%pi*N*dp/(60*2*1000);
Pt=P/v;
Pa=Pt*tan(phi);
Pr=Pt*tan(alphan)/cos(phi);

  // printing data in scilab o/p window
  printf("Pt is %0.2f N  ",Pt);
  printf("\n Pa is %0.1f N  ",Pa);
```

```
22    printf("\n Pr is %0.2f N  ",Pr);
```

Scilab code Exa 26.3 HG3

```
1  // sum 26-3
2  clc;
3  clear;
4  Zp=24;
5  Zg=72;
6  alphan=20*%pi/180;
7  phi=24*%pi/180;
8  N=720;
9  mn=5;
10 b=50;
11 sigut=600;
12 BHN=360;
13 Cs=1.4;
14 FOS=2;
15 sigb=sigut/3;
16 dp=mn*Zp/cos(phi);
17 Zp=Zp/(cos(phi))^3;
18 Zg=Zg/(cos(phi))^3;
19 Y=0.358+((0.364-0.358)*1.48/2);
20 Sb=b*mn*sigb*Y;
21 Q=(2*Zg)/(Zp+Zg);
22 K=0.16*(BHN/100)^2;
23 Sw=b*dp*Q*K/(cos(phi)^2);
24 v=2*%pi*N*dp/(60*2*1000);
25 Cv=5.6/(5.6+sqrt(v));
26 Peff=Sb/FOS;
27 Pt=Peff*Cv/Cs;
28 P=Pt*v;
29 P=P*10^-3;
30
31   // printing data in scilab o/p window
```

```
32   printf("P is %0.3f kW    ",P);
33
34 //The difference in the value is due to rounding-off
       of the values.
```

Scilab code Exa 26.4 HG4

```
1  // sum 26-4
2  clc;
3  clear;
4  Zp=25;
5  Zg=100;
6  P=5000;
7  N=2000;
8  alphan=20*%pi/180;
9  phi=15*%pi/180;
10 sigut=660;
11 Cs=1.5;
12 FOS=1.8;
13 v=10;
14 Zp1=Zp/(cos(phi))^3;
15 Zg1=Zg/(cos(phi))^3;
16 Y=0.348+(0.74*0.004);
17 sigb=sigut/3;
18 Cv=5.6/(5.6+sqrt(v));
19 //Sb=FOS*Peff
20 mn=FOS*P*Cs*60*1000*2*cos(phi)/(2*%pi*N*Cv*Zp*12*
       sigb*Y);
21 mn=mn^(1/3);
22 mn=2.5;
23 dp=mn*Zp/cos(phi);
24 Q=(2*Zg)/(Zp+Zg);
25 b=12*mn;
26 Sb=12*sigb*Y;
27 K=Sb*(cos(phi)^2)/(dp*Q*b);
```

```
28 BHN=sqrt(K/0.16)*100;
29 dg=mn*Zg/cos(phi);
30 phip=mn+(0.25*sqrt(dp));
31 ep=16+(1.25*phip);
32 phig=mn+(0.25*sqrt(dg));
33 eg=16+(1.25*phig);
34 e=ep+eg;
35 e=e*10^-3;
36 r1=dp/2;
37 r2=dg/2;
38 Pd=e*N*Zp1*b*r1*r2/(2530*sqrt(r1^2+r2^2));
39 v=2*%pi*N*dp/(60*2*1000);
40 //Let tangential component be TC
41 TC=(Cs*1845/mn)+(Pd*cos(alphan)*cos(phi));
42
43 Sb=b*mn*sigb*Y;
44
45   // printing data in scilab o/p window
46   printf("mn is %0.1f mm   ",mn);
47   printf("\n TC is %0.0f N   ",TC);
48   printf("\n Sb is %0.1f N   ",Sb);
49
50   //The difference in the value  of Sb is due to
       rounding-off of t
```

Chapter 27

STRAIGHT BEVEL GEARS

Scilab code Exa 27.1 SBG1

```
1  // sum 27-1
2  clc;
3  clear;
4  P=8000;
5  N1=400;
6  N2=200;
7  i=N1/N2; //i=Zg/Zp=dg/dp
8  gamma1=atan(1/i);
9  gamma2=90-gamma1;
10 rp=200;
11 R=rp/sin(gamma1);
12 b=0.2*R;
13 rm1=rp-(b*sin(gamma1)/2);
14 Pt=P*1000*60/(2*%pi*N1*rm1);
15 alpha=20*%pi/180;
16 Ps=Pt*tan(alpha);
17 Pr=Ps*cos(gamma1);
18 Pa=Ps*sin(gamma1);
19
20   // printing data in scilab o/p window
21   printf("Pt is %0.0f N  ",Pt);
```

```
22    printf("\n Ps is %0.2f N  ",Ps);
23    printf("\n Pr is %0.2f N  ",Pr);
24    printf("\n Pa  is %0.2f N  ",Pa);
25
26 //The difference in the values is due to rounding-
     off of the values.
```

Scilab code Exa 27.2 SBG2

```
1  // sum 27-2
2  clc;
3  clear;
4  alpha=20*%pi/180;
5  Zp=20;
6  Zg=36;
7  m=4;
8  sigut=600;
9  b=25;
10 dp=m*Zp;
11 rp=dp/2;
12 dg=m*Zg;
13 rg=dg/2;
14 gamma1=atan(rp/rg);
15 Zpv=Zp/cos(gamma1);
16 Y=0.33+0.003*0.88;
17 sigb=sigut/3;
18 Sb=m*b*sigb*Y;
19
20   // printing data in scilab o/p window
21   printf("Zpv is %0.2f   ",Zpv);
22   printf("\n Sb is %0.0f N  ",Sb);
```

Scilab code Exa 27.3 SBG3

```
// sum 27-3
clc;
clear;
m=6;
Zp=30;
Zg=45;
dp=m*Zp;
rp=dp/2;
dg=m*Zg;
rg=dg/2;
R=sqrt(rg^2+rp^2);
gamma1=180/%pi*asin(rp/R);
gamma2=(90-gamma1);
ha=6;
hf=1.25*ha;
phi=180/%pi*atan(ha/R);
beta=180/%pi*atan(hf/R);
//let Face Cone Angle be FCA
FCA=(gamma1+phi);
//Let Root cone angle be RCA
RCA=(gamma1-beta);

  // printing data in scilab o/p window
  printf(" gamma1 is %0.1f deg  ",gamma1);
  printf("\n gamma2 is %0.1f deg  ",gamma2);
  printf("\n R  is %0.2f mm  ",R);
  printf("\n FCA  is %0.3f deg  ",FCA);
  printf("\n RCA  is %0.2f deg  ",RCA);
```

Scilab code Exa 27.4 SBG4

```
// sum 27-4
clc;
clear;
alpha=20*%pi/180;
```

```
Zp=25;
Zg=40;
m=5;
b=30;
BHN=400;
dp=m*Zp;
rp=dp/2;
dg=m*Zg;
rg=dg/2;
gamma1=atan(rp/rg);
gamma1=180/%pi*gamma1;
gamma2=(90-gamma1);
a=cosd(gamma2);
Zp1=Zp/cos(gamma1);
Zg1=Zg/a;
Q=(2*Zg1)/(Zp1+Zg1);
K=0.16*(BHN/100)^2;
Sw=0.75*b*dp*Q*K/cosd(gamma1);

  // printing data in scilab o/p window
  printf("Sw is %0.1f N  ",Sw);

  //The difference in the value of Sw is due to
     rounding-off of the value of Q.
```

Scilab code Exa 27.5 SBG5

```
// sum 27-5
clc;
clear;
Zp=20;
Zg=36;
m=4;
b=25;
BHN=360;
```

```
Np=750;
FOS=1.75;
dp=m*Zp;
rp=dp/2;
dg=m*Zg;
rg=dg/2;
gamma1=atan(dp/dg);
gamma1=180/%pi*gamma1;
gamma2=(90-gamma1);
a=cosd(gamma2);
Zp1=Zp/cosd(gamma1);
Zg1=Zg/a;
Q=(2*Zg1)/(Zp1+Zg1);
K=0.16*(BHN/100)^2;
R=sqrt(rp^2+rg^2);
Y=0.33+0.003*0.86;
sigut=600;
sigb=sigut/3;
Sb=m*b*Y*sigb*(1-(b/R));
Sw=0.75*b*dp*Q*K/cosd(gamma1);

  // printing data in scilab o/p window
  printf("Sb is %0.0f N   ",Sb);
  printf("\n Sw is %0.1f N   ",Sw);

//The answwer to Sb is calculated incorrectly in the
    book.
```

Scilab code Exa 27.6 SBG6

```
// sum 27-6
clc;
clear;
Dp=300;
rp=150;
```

```
6  //Let the angular velocity ratio be i
7  i=2/3;
8  rg=rp/i;
9  Dg=2*rg;
10 R=sqrt(rp^2+rg^2);
11 P=15000;
12 N=300;
13 Cs=1.5;
14 FOS=2;
15 sigb=100;
16 gamma1=atan(Dp/Dg);
17 gamma1=180/%pi*gamma1;
18 gamma2=(90-gamma1);
19 v=2*%pi*N*rp/(60*1000);
20 Cv=5.6/(5.6+sqrt(v));
21 Pt=P/v;
22 Peff=Pt*Cs/Cv;
23 Sb=Peff*FOS;
24 b=R/4;
25 //let x=m*Y
26 x=Sb/(b*sigb*(1-(b/R)));
27 m=6;
28
29   // printing data in scilab o/p window
30   printf("m*Y is %0.3f mm^2  ",x);
31   printf("\n m is %0.0f mm  ",m);
```

Scilab code Exa 27.7 SBG7

```
1 // sum 27-7
2 clc;
3 clear;
4 Zp=24;
5 Zg=36;
6 N=1400;
```

```
P=11600;
Cs=1.4;
FOS=2;
sigut=600;
sigb=sigut/3;
gamma1=atan(Zp/Zg);
gamma1=180/%pi*gamma1;
gamma2=(90-gamma1);
a=cosd(gamma2);
Zp1=Zp/cosd(gamma1);
Zg1=Zg/a;
Q=(2*Zg1)/(Zp1+Zg1);
v=1.76;
Pt=P/v;
Cv=5.6/(5.6+sqrt(v));
Peff=Pt*Cs/Cv;
x=Peff*FOS;
Y=0.352+(0.003*0.85);
y=2*sigb*Y*(1-(6/21.63));
m=sqrt(x/y);
// Design is safe for m=4
m=4;
b=6*m;
dp=24*m;
rp=48;
dp=dp/cosd(gamma1);
v=2*%pi*N*rp/(60*1000);
Cv=5.6/(5.6+sqrt(v));
Sb=y*m^2;
//Sw=Sb;
K=Sb/(0.75*b*dp*Q);
BHN=sqrt(K/0.16)*100;

  // printing data in scilab o/p window
  printf("m is %0.0f mm  ",m);
  printf("\n BHN is %0.0f    ",BHN);

  //The answwer to BHN is calculated incorrectly in
```

the book.

Scilab code Exa 27.8 SBG8

```
1  // sum 27-8
2  clc;
3  clear;
4  Zp=40;
5  Zg=60;
6  P=3500;
7  N=600;
8  Cs=1.5;
9  sigb=55;
10 gamma1=atan(Zp/Zg);
11 gamma1=180/%pi*gamma1;
12 gamma2=(90-gamma1);
13 a=cosd(gamma2);
14 Zp1=Zp/cosd(gamma1);
15 Zg1=Zg/a;
16 Q=(2*Zg1)/(Zp1+Zg1);
17 // Design is safe for m=6
18 m=6;
19 b=6*m;
20 dp=Zp*m;
21 rp=dp/2;
22 dg=Zg*m;
23 rg=dg/2;
24 R=sqrt(rp^2+rg^2);
25
26   // printing data in scilab o/p window
27   printf("m is %0.0f mm  ",m);
28   printf("\n b is %0.0f mm  ",b);
29   printf("\n R is %0.0f mm  ",R);
```

Chapter 28

WORM AND WORM WHEEL SET

Scilab code Exa 28.1 WWS1

```
1  // sum 28-1
2  clc;
3  clear;
4  Z1=1;
5  Z2=30;
6  q=10;
7  m=5;
8  d=q*m;
9  D=m*Z2;
10 //let the speed reduction ratio be G
11 G=Z2/Z1;
12 CD=(d+D)/2;
13
14   // printing data in scilab o/p window
15   printf("G is %0.0f    ",G);
16   printf("\n CD is %0.0f mm  ",CD);
17   printf("\n d  is %0.0f mm  ",d);
18   printf("\n D  is %0.0f mm  ",D);
```

Scilab code Exa 28.2 WWS2

```
// sum 28-2
clc;
clear;
Z1=1;
Z2=52;
q=10;
m=8;
i=Z2/Z1;
CD=((m*q)+(m*Z2))/2;
lambda=atan(Z1/q);
d=q*m;
da=m*(q+2);
df=m*(q+2-(4.4*cos(lambda)));
pa=m*%pi;
D=m*Z2;
Da=m*(Z2+(4*cos(lambda))-2);
Df=m*(Z2-2-(0.4*cos(lambda)));

  // printing data in scilab o/p window
  printf(" i is %0.0f   ",i);
  printf("\n CD is %0.0f mm  ",CD);
  printf("\n pa is %0.2f mm  ",pa);
  printf("\n da is %0.0f mm  ",da);
  printf("\n df is %0.3f mm  ",df);
  printf("\n Da is %0.3f mm  ",Da);
  printf("\n Df is %0.3f mm  ",Df);
```

Scilab code Exa 28.3 WWS3

```
// sum 28-3
```

```
clc;
clear;
Z1=2;
Z2=60;
q=10;
m=5;
P=6000;
N=1440;
u=0.08;
alpha=20*%pi/180;
lambda=atan(Z1/q);
d=m*q;
w=2*%pi*N/60;
T=P/w;
Ptw=T*10^3/(d/2);
a=cos(alpha);
b=cos(lambda);
x=sin(alpha);
y=sin(lambda);
Paw=Ptw*(((a*b)-(u*y))/((a*y)+(u*b)));
Prw=Ptw*y/((a*y)+(u*b));
//Paw=Ptw*((cos(alpha)*cos(lambda))-(u*sin(lambda)))
   /((cos(alpha)*sin(lambda))+(u*cos(lambda)));
//Prw=Ptw*((sin(alpha))/((cos(alpha)*sin(lambda))+(u
   *cos(lambda))));

  // printing data in scilab o/p window
  printf("Ptw=Pag is %0.1f N  ",Ptw);
  printf("\n Paw=Ptg is %0.0f N  ",Paw);
  printf("\n Prw=Prg  is %0.0f N  ",Prw);

//The difference in the value is due to rounding-off
    the values.
```

Scilab code Exa 28.4 WWS4

```
// sum 28-4
clc;
clear;
Z1=2;
Z2=40;
q=8;
m=5;
d=q*m;
P=1.2;
lambda=atan(Z1/q);
N=1000;
Vt=2*%pi*N*20/(60*1000);
Vs=Vt/cos(lambda);
u=0.032;
alpha=20*%pi/180;
x=cos(alpha);
y=tan(lambda);
z=(cos(lambda))/sin(lambda);
n=(x-(u*y))/(x+(u*z));
//Let power output be Po
Po=P*n;
//Let power lost in friction be Pf
Pf=P-Po;

  // printing data in scilab o/p window
  printf("P is %0.1f kW  ",P);
  printf("\n Po is %0.3f kW  ",Po);
  printf("\n Pf is %0.3f kW  ",Pf);
```

Scilab code Exa 28.5 WWS5

```
// sum 28-5
clc;
clear;
Z1=2;
```

```
Z2=54;
q=10;
m=8;
P=4000;
A=1.8;
K=16;
N=1000;
u=0.028;
lambda=atan(Z1/q);
alpha=20*%pi/180;
d=m*q;
Vt=2*%pi*N*d/(2*60*1000);
Vs=Vt/cos(lambda);
x=cos(alpha);
y=tan(lambda);
z=(cos(lambda))/sin(lambda);
n=(x-(u*y))/(x+(u*z));
delT=P*(1-n)/(K*A);

  // printing data in scilab o/p window
  printf("n is %0.3f    ",n);
  printf("\n delT is %0.2f deg   ",delT);
```

Scilab code Exa 28.6 WWS6

```
//sum 28-6
clc;
clear;
Z1=1;
Z2=30;
q=10;
m=6;
//Let the ultimate strength of gear is sigut
//Let the allowable strenth of wheel is sigb
sigut=450;
```

```
sigb=84;
N=1200;
n=N/Z2;
alpha=20*%pi/180;
d=m*q;
D=Z2*m;
b=3*d/4;
V=2*%pi*n*D/(2*60*1000);
Cv=6/(6+V);
y=0.154-(0.912/Z2);
Y=%pi*y;
Sb=sigb*b*Cv*m*Y;
K=0.415;
Sw=b*D*K;

  // printing data in scilab o/p window
  printf("Sb is %0.0f N  ",Sb);
  printf("\n Sw is %0.0f N  ",Sw);

//The difference in the value of Sb is due to
   rounding-off the values.
```

Chapter 29

GEARBOX

Scilab code Exa 29.1 GB1

```
1  // sum 29-1
2  clc;
3  clear;
4  Ts1=16;
5  Ts2=18;
6  Ts3=20;
7  Ts4=25;
8  Tr1=64;
9  Tr2=63;
10 Tr3=70;
11 Tr4=50;
12 //Let Nr1/Nr2=G1
13 G1=1+(Ts1/Tr1);
14 //Let Nr1/Ni=G2
15 G2=(Ts2/(Tr2*(1-(1/G1)+(Ts2/Tr2))));
16 //Let Ni/No=G3 (third gear)
17 G3=(1+(Ts3/Tr3))/((Ts3/Tr3)+G2);
18
19 //Let Ni/Nr1=G4
20 //The ratio calculations are done as above
21 G4=1.2857/0.2857;
```

```
22 //Let Ni/No =G5(second gear)
23 G5=-20/70;
24 //Let Ni/No=G6(first gear)
25 G6=1.2857/0.2857;
26 //Let Ni/No=G7(reverse gear)
27 G7=-1.7143/0.2857;
28
29   // printing data in scilab o/p window
30   printf("ratio for third gear is %0.3f    ",G3);
31   printf("\n ratio for second gear is %0.4f   ",G5);
32   printf("\n ratio for first gear is %0.1f   ",G6);
33   printf("\n ratio for reverse gear is %0.3f   ",G7)
       ;
```

Scilab code Exa 29.2 GB2

```
1 // sum 29-2
2 clc;
3 clear;
4 //Let reverse speed gear be RSG
5 RSG=5.5;
6 //Let T5/T6 = Z1
7 T1=2;
8 //Let T3/T7 = Z2
9 Z2=2.75;
10 T7=18;
11 T3=Z2*T7;
12 T3=50;
13 //Let T3/T1 =Z3
14 Z3=2.5;
15 T1=T3/Z3;
16 //Let T4/T2 = Z4
17 Z4=2.25/2;
18 T2=(T1+T3)/(Z4+1);
19 T4=T1+T3-T2;
```

```
20 //Let T5/T6=Z5
21 Z5=2;
22 T6=(T1+T3)/3;
23 T5=(T1+T3)-T6;
24 T7=18;
25 //let first gear ratio is G1
26 G1=50*47/(20*23);
27
28 //Let 2nd gear ratio is G2
29 G2=37*47/(33*23);
30 //Let 3rd gear ratio is G3
31 G3=1;
32 //Let reverse gear ratio is R
33 R=50*47/(18*23);
34
35   // printing data in scilab o/p window
36   printf("T1 is %0.0f    ",T1);
37   printf("\n T2 is %0.0f    ",T2);
38   printf("\n T3 is %0.0f    ",T3);
39   printf("\n T4 is %0.0f    ",T4);
40   printf("\n T5 is %0.0f    ",T5);
41   printf("\n T6 is %0.0f    ",T6);
42   printf("\n T7 is %0.0f    ",T7);
43   printf("\n G1 is %0.3f    ",G1);
44   printf("\n G2 is %0.3f    ",G2);
45   printf("\n G3 is %0.1f    ",G3);
46   printf("\n R is %0.3f    ",R);
```

Scilab code Exa 29.3 GB3

```
1 // sum 29-3
2 clc;
3 clear;
4 //Let the constant gear ratio be G
5 G=2;
```

```
x=5.5^(1/3);
G1=1;
G2=x;
G3=x*x;
G4=x^3;
T7=18;
T8=T7*(x^3)/2;
T8=51;
T5=69/2.558;
T6=69-27;
T4=69/1.8825;
T3=69-T4;
T1=23;
T2=46;
T9=18;
G1=T2*T8/(T1*T7);
G2=T2*T6/(T1*T5);
G3=1;
G4=-T2*T8/(T1*T9);

  // printing data in scilab o/p window
  printf("T1 is %0.0f    ",T1);
  printf("\n T2 is %0.0f    ",T2);
  printf("\n T3 is %0.0f    ",T3);
  printf("\n T4 is %0.0f    ",T4);
  printf("\n T5 is %0.0f    ",T5);
  printf("\n T6 is %0.0f    ",T6);
  printf("\n T7 is %0.0f    ",T7);
  printf("\n T8 is %0.0f    ",T8);
  printf("\n T9 is %0.0f    ",T9);
  printf("\n G1 is %0.3f    ",G1);
  printf("\n G2 is %0.3f    ",G2);
  printf("\n G3 is %0.3f    ",G3);
  printf("\n G4 is %0.3f    ",G4);
```

Chapter 30

CHAIN DRIVE

Scilab code Exa 30.1 CD1

```
1  // sum 30-1
2  clc;
3  clear;
4  n1=17;
5  n2=51;
6  C=300;
7  p=9.52;
8  Ln=(2*C/p)+((n1+n2)/2)+((((n2-n1)/(2*%pi))^2)*(p/C))
       ;
9  x=(Ln-((n2+n1)/(2)))^2;
10 y=8*(((n2-n1)/(2*%pi))^2);
11 z=Ln-((n1+n2)/2);
12 C=(p/4)*(z+(sqrt(x-y)))
13
14
15   // printing data in scilab o/p window
16   printf("C is %0.2f mm ",C);
```

Scilab code Exa 30.2 CD2

```
// sum 30-2
clc;
clear;
G=4;
n1=17;
n2=n1*G;
N1=2300;
Kc=1.2; //from table 30-2
p=12.7; //fom table 30-1
D1=p*n1;
D2=p*n2;
phi=2*10.6;
x=tan(phi/2); //phi/2 = 10.6deg, from table 30-3
Da1=(p/x)+(0.6*p);
Da2=(p/x*4)+(0.6*p);
Cmin=Kc*((Da1+Da2)/2);
Ln1=(2*Cmin/p)+((n1+n2)/2)+((((n2-n1)/(2*%pi))^2)*(p
   /Cmin));
Ln1=80;
  // printing data in scilab o/p window
  printf("Ln is %0.0f  ",Ln1);
```

Scilab code Exa 30.3 CD3

```
// sum 30-3
clc;
clear;
N1=1000;
N2=500;
P=2.03*10^3; //from table 30-8
K1=1.26;
Ks=1;
//let Pc be the power transmitting capacity of the
   chain
Pc=P*K1/Ks;
```

```
11 p=9.52;
12 n1=21;
13 n2=42;
14 V=n1*p*N1/(60*10^3);
15 //Let the chain tension be T
16 T=Pc/V;
17 //Let the breaking load be BL
18 BL=10700;
19 FOS=BL/T;
20 C=50*p;
21 Ln=(2*C/p)+((n1+n2)/2)+((((n2-n1)/(2*%pi))^2)*(p/C))
      ;
22 L=Ln*p;
23 Pc=Pc*10^-3;
24
25   // printing data in scilab o/p window
26   printf("Pc is %0.2f KW  ",Pc);
27   printf("\n V is %0.3f m/s  ",V);
28   printf("\n T is %0.1f N  ",T);
29   printf("\n FOS is %0.2f  ",FOS);
30   printf("\n L is %0.2f mm  ",L);
31
32 //The difference in the value of L and T is due to
     rounding-off the values.
```

Scilab code Exa 30.4 CD4

```
1 // sum 30-5
2 clc;
3 clear;
4 G=2;
5 P=5000;
6 Ks=1.7;
7 Pd=P*Ks;
8 K2=1.7;
```

```
p=15.88;
n1=17;
n2=n1*G;
D1=n1*p;
D2=n2*p;
C=40*p;
Ln=(2*C/p)+((n1+n2)/2)+((((n2-n1)/(2*%pi))^2)*(p/C))
   ;
L=Ln*p;

  // printing data in scilab o/p window
  printf("L is %0.2f mm  ",L);
//The difference in the value of L is due to
   rounding-off the values.
```

Chapter 31

SEALS PACKING AND GASKETS

Scilab code Exa 31.1 SPG1

```
1  // sum 31-1
2  clc;
3  clear;
4  d=18;
5  lg=25+25;
6  Eb=210*10^3;
7  Ecl=90*10^3;
8  A=%pi*d^2/4;
9  kb=A*Eb/lg;
10 x=(5*(lg+(0.5*d))/(lg+(2.5*d)));
11 km=%pi*Ecl*d/(2*log(x));
12 C=kb/(kb+km);
13 sigp=600;
14 At=192;
15 Pi=0.75*sigp*At;
16 F=200;
17 C=0.322;
18 Pb=F*C*10^3;
19 FOS=2;
```

```
20 W=At*sigp;
21 N=Pb*FOS/(W-Pi);
22
23   // printing data in scilab o/p window
24   printf("N is %0.2f       ",N);
```

Scilab code Exa 31.2 SPG2

```
1  // sum 31-2
2  clc;
3  clear;
4  d=16;
5  D=1.5*d;
6  t=20;
7  tg=4;
8  //Let Gasket diameter in compression zone be d1
9  d1=D+(2*t)+tg;
10 lg=40;
11 E=207*10^3;
12 kb=%pi*d^2*E/(lg*4);
13 Ecl=90*10^3;
14 x=(5*(lg+(0.5*d))/(lg+(2.5*d)));
15 kp=%pi*Ecl*d/(2*log(x));
16 Ag=%pi*(d1^2-d^2)/4;
17 Eg=480;
18 kg=Ag*Eg/tg;
19 km=kg*kp/(kg+kp);
20 C=kb/(kb+km);
21 At=157;
22 sigp=600;
23 Pi=0.75*At*sigp/2;
24 FOS=2;
25 Pf=At*sigp/FOS;
26 W=Pf-Pi;
27 P=W/C;
```

```
N=5;
F=P*N;
p=F*4/(%pi*120^2);

  // printing data in scilab o/p window
  printf("p is %0.3f N/mm^2      ",p);
```

Scilab code Exa 31.3 SPG3

```
// sum 31-3
clc;
clear;
sigp=600;
FOS=3;
siga=sigp/FOS;
d=16;
D=1.5*d+60;
//Let Gasket diameter in compression zone be d1
d1=(300-160)/2;
//Let compressive stress in gasket for leak proof
   joint be sigl
sigl=12;
At=[1 157; 2 192; 3 245]
d=[1 16; 2 18; 3 20]

n=3;
for (i=1:n)
    Pi(i,2)=At(i,2)*d(i,2)
    Pc(i,2)=3*%pi*(d1^2-d(i,2)^2)
    if (Pi(i,2)>=Pc(i,2)) then
    printf("The Design is safe")
end
end


```

```
26
27    // printing data in scilab o/p window
28    printf("d is %0.0f mm      ",d(i,2));
```