# Scilab Textbook Companion for A Textbook Of Machine Design by R. S. Khurmi And J. K. Gupta[1]

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# Book Description

**Title:** A Textbook Of Machine Design

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Scilab numbering policy used in this document and the relation to the above book.

**Exa** Example (Solved example)

**Eqn** Equation (Particular equation of the above book)

**AP** Appendix to Example(Scilab Code that is an Appednix to a particular Example of the above book)

For example, Exa 3.51 means solved example 3.51 of this book. Sec 2.3 means a scilab code whose theory is explained in Section 2.3 of the book.

# Contents

# List of Scilab Codes

# Chapter 3

# Ch3

**Scilab code Exa 3.1** Machine design

```
clc
//solution
//given
lh=25//mm//lower limit of hole
uh=25.02//mm//upper limit of hole
ls=24.95//mm//lower limit of shaft
us=24.97//mm//upper limit of shaft
h=uh-lh//mm//hole tolerance
s=us-ls//mm//shaft tolerance
a=lh-us//mm//alownce
printf("the hole tolerance is,%f mm\n",h)
printf("the shaft tolerance is,%f mm \n",s)
printf("the allowance is,%f mm",a)
```

**Scilab code Exa 3.2** Machine design

```
clc
//solution
//given
//shaft is 40 H8/f7
//since 40 mm lies in the diameter steps of 30 to 50
   mm, therefore the mean diameter ie geometric
   mean of them
D=sqrt(30*50)//mm
i=0.45*((D)^(1/3))+(0.001*D)//mm//standard tolerance
   unit
//therfore,standard tolerance is
x=25*i*0.001//mm//standard tolerance for grade 8
x1=16*i*0.001//mm//standard tolerance for grade 7
//fundamental deviation
es=-5.5*(D)^0.41*0.001//mm
ei=es-0.025//mm
//limit of size
bs=40//mm//basic size
uh=40+0.039//mm//upper limitt of hole=lower limit
   for hole+tolerance for hole
us=40-0.025//mm//uppr limit of shaft is lower limit
   of hole-fundamental deviation
ls=us-0.025//mm
printf("the standard tolernce for IT8 is,%f mm\n",x)
printf("the satndard tolerance for IT7 is,%f mm\n",
   x1)
printf("the fundamental upper deviation for shaft is
   ,%f mm\n",es)
printf("the fundamental lower deavtion for shaft is,
   %f mm\n ",ei)
printf("the basic size is,%f mm\n",bs)
printf("upper limit for hole is,%f mm\n",uh)
printf("the upper limit of shaft is,%f mm\n",us)
printf("the lower limit of shaft is,%f mm\n",ls)
```

**Scilab code Exa 3.3** Machine design

```

//a.)12 mm elctric motion
//12 mm lies between 10 and 18,therefore
D=sqrt(10*18)//mm
i=0.45*(D)^0.33+0.001*D//standard tolrence unit
IT8=25*i*0.001//mm//standard tolerance for IT8
es=-11*(D)^0.41*0.001//mm//upper deviation for shaft
ei=es-IT8//mm//lower deviation for shaft
printf("the standard tolerance for shaft and hole of
    grade 8 is,%f mm\n",IT8)
printf("the upper deviation for shaft is, %f mm",es)
printf("the upper deviation for shaft is,%f mm",ei)
```

---

**Scilab code Exa 3.4** Machine design

```

//solution
//given
//75 mm basic size
//since 75 lies betweenn 50 and 80
D=sqrt(50*80)//mm
i=0.45*(D)^0.33+0.001*D//standard tolerance unit
IT8=25*i*0.001//mm
IT7=16*i*0.001//mm
es=-2.5*(D)^0.34//mm//upper deviation of shaft
ei=es-IT7//mm//lower deviation fot hole
bs=75//mm//basic size
uh=75+IT8//upper limit of hole
us=75-0.01//mm//upper limit of shft
ls=us-0.03//mm
MxC=uh-ls//mm//maximum clearance
miC=75-us//mm
printf("maximum clearance is,%f mm\n",MxC)
```

```
printf("minimum clearance is,%f mm",miC)
```

# Chapter 4

# Ch4

**Scilab code Exa 4.1** Machine design

```
clc
//solution
//given:
P=50000//N//maximum load is P
f=75//(N/mm^2)//stress is given
pi=3.14
d=sqrt(4*P/(f*pi))//manipulating to get the value of
    d
//d=diameter of link stock //using relation f=P/A
printf("\n\nThe diameter of link stock is ,%f mm\n,",
  d)
```

---

**Scilab code Exa 4.2** Machine design

```
clc
//solution
```

```
//given
P=45000//N//load applied
A1=45*20//mm^2//area of cross section at link A-A
//stress in section A-A
f1=P/A1//(N/mm^2)
printf("the stress in section A-A is ,%f N/mm^2\n",f1)
//stress in section B-B
A2=20*(75-40)//mm^2//area of cross section at link B-B
f2=P/A2//(N/mm^2)
printf("the stress in B-B section ,%f N/mm^2",f2)
```

**Scilab code Exa 4.3** Machine design

```
clc
//solution
//given
P=3.5*10^6//N//load applied
f1=85//(N/mm^2)// safe stress
E=210*10^3//(N/mm^2)//young's modulus
l=2.5*10^3//mm
pi=3.14
//1)diameter of rod(d)
//let d be diameter of rods in mm
//since both rods carries equal load ,therefore load on single rod is
P1=P/2//N
d=sqrt(4*P1/(f1*pi))//using f1=P/A//mm
printf("the diameter of rods is,%f mm\n",d)
//2)extension in rod
//let x be extension in rod
//E=(P1*l)/(A*x)
 //P1/A=f1
x=(f1*l)/E
```

```
printf("the extension of rod is ,%f mm",x)
```

**Scilab code Exa 4.4** Machine design

```

clc
//solution
//given
d=20//mm
d1=22//mm
d2=50//mm
d3=22//mm
d4=44//mm
P1=120000//N
P2=5000//N
//1)stress on lower washer before the nuts are tightened
pi=3.14
A1=(pi/4)*(d2^2-d1^2)//(mm^2)
A2=(pi/4)*(d4^2-d3^2)//(mm^2)
//since load is equally distributed on 4 washers, therfore load Q1=P1/4
Q1=P1/4//N
//calculating stress on lower washer
f2=Q1/A1//(N/mm^2)
printf("\n the stress on lower washer when nuts are not tightened is ,%f N/mm^2\n",f2)
//2)
//stres on upper washers
P2=5000//N
f3=P2/A2//stress//(N/mm^2)
printf("the stress on upper washer is ,%f N/mm^2\n",f3)
//stress on lower washer when nuts are tightened
f4=(Q1+P2)/A1//(N/mm^2)
```

```
printf("the stress on lower washer when nuts are tightened is ,%f N/mm^2",f4)
```

**Scilab code Exa 4.5** Machine design

```

clc
//solution
//given
d=50//mm//diameter of rod
l=600//mm//length of rod
D=400//mm//diameter of piston
p=0.9//(N/mm^2)//maximum steam pressure
E=210*10^3//(N/mm^2)//young's modulus
pi=3.14
A=(pi/4)*D^2//(mm^2)//area of cross section of piston
P=A*p//N//max load acting on piston
a=(pi/4)*d^2//(mm^2)//area of cross section of piston rod
//let x be the compression
x=(P*l)/(E*a)//mm
printf("the compression in piston rod is ,%f mm",x)
```

**Scilab code Exa 4.6** Machine design

```

clc
//solution
//given
d=60//mm
t=5//mm
u=350//(N/mm^2)//ultimate stress
```

```
pi=3.14
A=pi*d*t//(mm^2)//area under shear
//force required to punch a hole
P=A*u
printf("the force required is,%f N",P)
```

**Scilab code Exa 4.7** Machine design

```

clc
//solution
//given
P=80000//N//tensile force applied
f1=100//(N/mm^2)
f2=80//(N/mm^2)
//diameter of bars in mm
//A1=(pi/4)*D1^2//Area of bar
//P=f1*(pi/4)*D1^2
D1=sqrt((4*P)/(f1*pi))
printf("\nthe diameter of bars is,%f mm\n",D1)
//diameter of pin
//A2=(2*pi/4)*D2^2//area of pin
D2=sqrt((4*P)/(2*pi*f2))
printf("\n the diameter of pin is,%f mm \n",D2)
```

**Scilab code Exa 4.8** Machine design

```

clc
//solution
//given
t=16//thickness//mm
P=48*10^3//N
```

```
n=2//two plates are given
d=25//mm
//stress acting
f=(P/(d*t*n))//(N/mm^2)
printf("the stress acting is,%f N/mm^2",f)
```

**Scilab code Exa 4.9** Machine design

```

clc
//solution
//given
d=25//mm/diameter
P=2500//N/force
p=5//(N/mm^2)//bearing pressure
//A=l*d =l*25//(mm^2)//projected area of bearing
//p=P/A//pressure=force/area
//therefore
l=(P/(25*5))//mm//length
printf("the required length is,%f mm",l)
```

**Scilab code Exa 4.10** Machine design

```

clc
//solution
//given
D=12//mm//initial diameter
l=60//mm//initial length
L=80//mm//final length
d=7//mm//final diameter
Wy=3400//N//yield load
Wu=6100//N//ultimate load
```

```
pi=3.14
A=pi*D^2/4//mm^2//initial area of rod
a=pi*d^2/4//mm^2//final area of rod
Fy=Wy/A//N/mm^2//yield stress
Fu=Wu/A//N/mm^2//ultimate stress
%ria=(A-a)/A*100//percentage reduction in area
%eil=(L-l)/L*100//percentage elongation in length
printf("the yield stress is,%f N/mm^2\n",Fy)
printf("the ultimate stress is ,%f N/mm^2\n",Fu)
printf("the percentage reduction in area is,%f\n",
    %ria)
printf("the percentage increase in length is,%fn",
    %eil)
```

**Scilab code Exa 4.11** Machine design

```

clc
//solution
//given
lc=3000//mm//length of steel and copper bar
lst=3000//mm//length of steel bar
Ec=105//kN/mm^2//young's modulus of copper
Est=210//kN/mm^2//young's modulus of steel
b=25//mm//width
t=12.5//mm//thickness
P=50//kN//load applied
//refer fig 4.14 in book
//let dl be increace in length of compound bar
Ast=b*t//mm^2//area of steel bar
Ac=b*t//mm^2//area of copper bar
Pc=(P*Ec)/(Ec+Est)//kN//load taken by copper bar
Pst=P-Pc//kN//load taken by steel bar
dl=(Pc*lc)/(Ac*Ec)//mm//change in length
//stresses produced in individual bars are
```

```
//since strain produced are same therefore
//(Fst/Est)=(Fc/Ec)//since Est=2Ec,therefore Fst(
    stress in steel)=2*Fc(stress in copper)
P=Pst+Pc//(Fst*Ast)+(Fc*Ac)//Ast=Ac//Fst=2Fc,
    therefore gievn equation can ve written as
//50=2*Fc*Ac+(Fc*Ac)
Fc=50/(3*Ac)//N/mm^2//stress in copper bar
Fst=2*Fc//N/mm^2//stress in steel bar
printf("the change in lentgth of compound bar is,%f
    mm\n",dl)
printf("the stress in copper bar is ,%f kN/mm^2\n",
    Fc)
printf("the stress in steel bar is , %f kN/mm^2",Fst
    )
```

**Scilab code Exa 4.12** Machine design

```

clc
//soluton
//given
Ds=18//mm//diameter of steel
Dc1=24//mm//inner  diameter of copper rod initially
Dc2=40//mm//outer diametr of copper
Fs=10//N/mm^2//stress in steel rod
pi=3.14
As=(pi*Ds^2)/4//mm^2//area of steel rod
Ac=(pi*(Dc2^2-Dc1^2))/4//mm^2//area of copper rod
//since tensile load on steel rod is equal to
    compressive load on copper rod,therefore
//Fs*As=Fc*Ac,therefore
Fc=Fs*As/Ac//stress in copper rod//N/mm^2
//when copper rod is reduced outside diametr changes
     to 40-1.5*2=37mm,therefore new area is
Ac1=(pi*(37^2-24^2))//mm^2
```

```
//cross section of other half remain same//if Ac2 is the area of remainder then Ac2=Ac
//let Fc1 be stress in reduced section ,Fc2 be stress in remainder ,Fs1 stress in rod aftre turning
//since load on copper tube is equal to load on steel tube, therefore Ac1*Fc1=Ac2*Fc2=As*Fs1
//from above equations Fc1=0.41*Fs1,Fc2=0.32*Fs1
//let L be the length of steela nd copper  rod , since total change in length is equal to change inlength of rduced section before and aftr turning adn change in length of remainder section beofre and aftre turning
//dl=dl1+dl2
//(Fs-Fs1)*L/Es=(Fc1-Fc)*L/(2*Ec)+(Fc2-Fc)*(L)/(2*Ec)
//given Es=2Ec
//10-Fs1=0.41*Fs1-3.16+0.32*Fs1-3.16
Fs1=(10+3.16+3.16)/(1+0.41+0.32)
printf("the stress in the rod is,%f N/mm^2",Fs1)
```

**Scilab code Exa 4.13** Machine design

```

clc
//solution
//given
D=1200//mm//diameter of wheel
f=100//N/mm^2//stress
E=200*10^3//N/mm^2//young's modulus
a=6.5*10^-6//per degree celcius
//we know stress/strain=E
//100/x=E
x=100/E//
//x=(D-d)/d
//x=D/d-1
```

```
d=D/(x+1)//mm
//let t be least temp to which tyre must be heated
//pi*D=Pi*d(!+at)
t=(D-d)/(d*a)
printf("the internal diameter is , %f mm\n",d)
printf("the least temp is ,%f degree celcius",t)
```

**Scilab code Exa 4.14** Machine design

```

clc
//solution
//given
t1=37//deg celcius
t2=20//deg celcius
Es=210*10^9//N/m^2
Ed=74*10^9//N/m^2
as=11.7*10^-6//per degree celcius
aa=23.4*10^-6//per degree celcius
ds=0.05//m
da=0.025//m
ls=0.6//m
la=0.3//m
pi=3.14
//refer fig4.16 in book
t=t1-t2//degree celcius
x1=as*ls*t//contraction in steel bar
x2=aa*la*t//contaction in aluminium bar
x=x1+x2//total contraction
//assume support B is removed,therefore there will
   no stress in bar,let us assume P force is applied
    to the right end to brougth in contact with
   support B..refer ffig 4.17
As=(pi/4)*ds^2//m^2//area of steel bar
Aa=(pi/4)*da^2//m^2
```

```
//we know dls=change in length=(P*ls)/(As*Es), therefore dls=P*1.455*10^-9//m
//dla=P*8.257*10^-9//m
//threfore total dl=dls + dla=9.712*10^-9 *P//m
//P*9.712*10^-9=x
P=x/(9.712*10^-9)
fs=P/As//stress in steel bar//N/m^2
fa=P/Aa//stress in aluminiumbar//N/m^2
//when supports are yielding by 0.1 mm
X=x-10^-4//m
P1=X/(9.712*10^-9)//N
fs1=P1/As//N/m^2
fa1=P1/Aa//N/m^2
printf(" the  initial stress in steel bar is, %f N/m^2\n",fs)
printf("the initial stress in aluminium bar is,%f N/m^2\n",fa)
printf("the final stress in steel bar is,%f N/m^2\n",fs1)
printf("the final stress in alu bar is,%f N/m^2",fa1)
```

**Scilab code Exa 4.15** Machine design

```

clc
//solution
//given
dc=0.050//m
dse=0.075//m
dsi=0.050//m
dp=0.018//m
t=50//degree celcius
Es=210*10^9//N/m^2
Ec=105*10^9//N/m^2
```

```
as=11.5*10^-6//per degree celcius
ac=17*10^-6//per degree celcius
//refer fig 4.18
pi=3.14
Ac=(pi/4)*dc^2//m^2
As=(pi/4)*(dse^2-dsi^2)//m^2
Ap=(pi/4)*(dp)^2
//let l be the length of rods
//dlc=l*ac*t=850*10^-6*l
//dls=l*as*t=575*10^-6*l
//x=dlc-dls=275*10^-6*l
//x1=(P*l)/(Ac*Ec)=(P*l)/(206.22*10^6)//m
//x2=(P*l)/(As*Es)=(P*l)/(515.55*10^6)//m
//therefore X=x1+x2=(6.79*10^-9*P*l)
//x=X
P=(275*10^-6)/(6.79*10^-9)//N
fc=P/Ac//N/m^2
fs=P/As//N/m^2
tp=P/(2*Ap)//N/m^2
printf("the stress in coper bar is, %f N/m^2\n",fc)
printf("the stress in steel bar is, %f N/m^2\n",fs)
printf("the stress is pin is,%f N.m^2",tp)
```

**Scilab code Exa 4.16** Machine design

```

clc
//solution
//given
P=50*10^3//N//load
ft=100//N/mm^2//stress
//let d be diameter in mm
pi=3.14
//A=(pi/4)*d^2//area
//P=ft*A=100*A
```

```
//d^2=(50*1000/78.54)
d=sqrt(50000/78.54)//mm
//let x be side if rod is square
//P=ft*A=100*x^2
x=sqrt(500)//mm
//if rod s rectangular
//A=b*t//b=3t,therfore
//A=3*t^2//m^2
//P=ft*A
t=sqrt(50000/300)//mm
b=3*t//mm
printf("the diameter if rod is cylindrical is,%f mm\
   n",d)
printf("the side is rod is square is,%f mm\n",x)
printf("the length if rod is rectangular is ,%f mm \
   n",t)
printf("the width if rod is rect is ,%f mm",b)
```

**Scilab code Exa 4.17** Machine design

```

clc
//solution
//given
l=2400//mm//length
A=900//mm^2//area
P=500000//N//load
m=1/0.25
E=0.2*10^6//N/mm^2//young's modulus
//let dV be change in volume
V=A*l//mm^3//volume of rod
st=P/(A*E)//strain
//dV/V=st*(1-(2/m))
dV=V*st*(1-(2/m))//mm^3
printf("the change in volume is approximately,%f mm
```

```
^3",dV)
```

**Scilab code Exa 4.18** Machine design

```

clc
//solution
//given
h=10//mm//height thru which weigth fall
l=3000//mm//length of bar
A=600//mm^2//xsection area of bar
dl=2//mm//change in length of bar
E=200*10^3//N/mm^2
//let f be stress
f=(E*dl)/l//N/mm^2
//let w be value of unknown weigth
//we know f=(W/A)*[1+sqrt{1+(2*h*A*E/W/l)}]
//400/3=(W/600)*[1+sqrt{1+(2*10*600*200*1000/W/3000)
    }]
W=6400*100/96//N
printf("the stress induces is,%f N/mm^2\n",f)
printf("the unknown weigth is,%f N",W)
```

**Scilab code Exa 4.19** Machine design

```

clc
//solution
//given
d=50//mm//diameter of rod
l=2500//mm//length of bar
u=100*10^3//N-mm//shock energy
E=200*10^3//N/mm^2
```

```
//let f be stress
pi=3.14
V=(pi/4)*d^2*l//mm^3
//u=(f^2*V)/(2*E)
f=sqrt(u*2*E/V)//N/mm^2
//let dl be elongation produced
dl=f*l/E//mm
printf("the stress produced is ,%f N/mm^2\n",f)
printf("elongation priduces is , %f mm",dl)
```

# Chapter 5

# Ch5

**Scilab code Exa 5.1** Machine design

```
//find diameter of shaft
clc
//solution
//given
P=100000//W//power
N=160//rpm
//Tmax=1.25 Tmean
t=70//N/mm^2//shear stress
pi=3.14
//P=2*pi*N*Tmean/60
Tmean=(60*P)/(2*pi*N)//Nm
Tmax=1.25*Tmean//Nm
//Tmax=(pi/16)*t*d^3
d=(Tmax*1000*16/(pi*t))^0.33
printf("the mean torques is,%f Nm\n",Tmean)
printf("the max torques is,%f Nm\n",Tmax)
printf("the diametr of shaft is,%f mm",d)
```

**Scilab code Exa 5.2** Machine design

```
//find 1.)load applied 2.) twist angle(q)
clc
//solution
//given
d=35//mm//diametr of shaft
r=17.5//mm
l=1200//mm//length of rod
D=500//mm
R=250//mm
C=80*10^3//N/mm^2//modulus of rigidity
t=60//N/mm^2//tortionsl streess
//let W bw load applied
//T=R*W //torque
//T=250*W//N-mm
pi=3.14
J=(pi/32)*(d)^4//mm^4
//T/J=t/r
//(250*W)/J=(t/r)
W=(t/r)*J/250//N
T=R*W
q=(T*l)/(C*J)//degree
printf("load applied is,%f N\n",W)
printf("the angle of twist is,%f degree",q)
```

**Scilab code Exa 5.3** Machine design

```
//find daimeter of shaft
clc
//solution
//given
P=97.5*10^3//W//power
N=180//rpm
t=60//N/mm^2//tortional stress
l=3000//mm//length of shaft
C=80*10^3//N/mm^2
```

```
//let T be torque in N-m
pi=3.14
q=0.0174//rad//angle
//P=2*pi*N*T/60
T=P*60/(2*pi*N)//N-m
//we will find diameter of shaft using stiffness and strength
//using strength
//T*1000=(pi/16)*t*d^3
d=(16*T*1000/pi/t)^0.33//mm
//using stiffness
//J=(pi/32)*d^4
//T/J=C*q/l
d1=(l*T*1000/C/q/0.0982)^(1/4)
printf("the diameter using strength is,%f mm\n",d)
printf("the diameter using stiffness is,%f mm\n",d1)
```

**Scilab code Exa 5.4** Machine design

```
//find exteranal diameter  of shaft
clc
//solution
//given
P=600*10^3//W//power
N=110//rpm
//Tmax=1.2 Tmean
t=63//N/mm^2
l=3000//mm
q=0.024 //rad//angle of twist
//k=di/do=3/8//ratio of inner adn outer diameter
C=84*10^3//N/mm^2
pi=3.14
//P=2*pi*N*Tmean/60
Tmean=60*P/(2*pi*N)//N-m
Tmax=1.2*Tmean//N-m
```

```
//Tmax*1000=(pi/16)*t*(do)^3(1-k^4)
do=[{16*Tmax*1000/pi/t}/{1-(3/8)^4}]^0.33//mm
//J=(pi/32)*{do1^4-di^4}
//J=(pi/32)*(do1)^4*{1-(3/8)^4}=0.0962*do1^4
//we know T/J=C*q/l
do1={Tmax*1000*l/(C*q*0.0962)}^(1/4)//mm
printf("the mean torque is ,%f N-m\n",Tmean)
printf("the maximum torque is,%f N-m\n",Tmax)
printf("the outer diameter using strength is,%f mm\n",do)
printf("the outer diameter using stiffness is,%f mm",do1)
```

**Scilab code Exa 5.5** Machine design

```
// find torque applied and tatal twist angle
clc
//solution
//given
L=3500//mm//total length
//l1+l2+l3=3500
do=100//mm
di=62.5//mm
d2=100//mm
d3=87.5//mm
t=47.5//N/mm^2//shear stress
C=82.5*10^3//N/mm^2
//refer fig 5.3
pi=3.14
J1=(pi/32)*[do^4-di^4]
J2=(pi/32)*[d2]^4
J3=(pi/32)*[d3]^4//mm^4
//we know q=(T*l)/(C*J)//twist angle
//q1=q2
//(T*l1)/(C*J1)=(T*l2)/(C*J2)
```

```
//therefore l1/l2=(J1/J2)=0.847
//q1=q3
//therefore (l1/l3)=(J1/J3)=1.447
//l1+l2+l3=L=3500
//l1+l1/0.847+l1/1.447=3500
//l1(1+(1/0.847)+(1/1.447))=3500
l1=3500/{1+(1/0.847)+(1/1.447)}
l2=l1/0.847
l3=l1/1.447
//T/J=t/r
T=(pi/16)*t*[(do^4-di^4)/do]//torque//N-mm
//q=q1+q2+q3//total angle of twist
q=(T/C)*[{l1/J1}+{l2/J2}+{l3/J3}]
printf("the torque applied is,%f N-mm\n",T)
printf("the total angle of twist is,%f radians",q)
```

**Scilab code Exa 5.6** Machine design

```
//find diameter of shaft
clc
//solution
//given
f=100//N/mm^2
//let Ra and Rb be reaction at A and B
//taking moment about A
Rb={(35*750)+(25*150)}/950//kN
Ra=25+35-Rb//kN
//since maximum stress is taken into account,
    therfore maximum moment will be taken into
    calculations...
Mc=Ra*150//N-mm
Md=Rb*200//N-mm
//Z=(pi/32)*d^3=0.0982*d^3
//100=Md/Z//because Md>Mc
d=[Md*1000/(100*0.0982)]^0.33
```

```
printf("the diametr is ,%f mm",d)
```

**Scilab code Exa 5.7** Machine design

```
//find diameter of axle
clc
//solution
//given
L=1000//mm
W=30*10^3//N
f=60//N/mm^2//stress
//let d be diameter
pi=3.14
//Z=(pi/32)*d^3
M=W*L/4//N-mm
//f=M/Z
d=[M/(60*0.09982)]^(1/3)//mm
printf("the diameter of axle is ,%f mm",d)
```

**Scilab code Exa 5.8** Machine design

```
//find width and depth of beam
//refer fig 5.7
clc
W=400//N
L=300//mm
f=40//N/mm^2
//h=2*b
//Z=b*h^2/6=2b^3/3//mm^3
M=W*L//N-mm
//f=M/Z
b=[M*1.5/(f)]^(1/3)//mm
h=2*b//mm
```

```
printf("the width of beam is ,%f mm\n",b)
printf("the height of beam is ,%f mm\n",h)
```

**Scilab code Exa 5.9** Machine design

```
//determine dimensions of arm
clc
//solution
//given
P=10*10^3//W
N=400//rpm
D=1200//mm//
R=600//mm//
f=15//N/mm^2
//let T be torque transmitted by pulley
pi=3.14
//P=2*pi*N*T/60
T=(P*60)/(2*pi*N)//N-m
L=T*1000/R//load transmitted//N
//since pulley has 4 arms, therefore weigth on each arm is
W=L/4//N
M=W*R//N-mm
//let 2a be length of minor axis and 2b be length of major axis,2a=4b//given
//Z=(pi/4)*a^2*b=pi*b^2
//f=M/Z
b=[M/(15*pi)]^(1/3)//mm
a=2*b//mm
printf("the length of major axis is,%f mm\n",2*a)
printf("the length of minor axis is,%f mm",2*b)
```

**Scilab code Exa 5.10** Machine design

```
//find stress at inner and outer surface
clc
//solution
//given
//refer fig 5.9
W=5000//N
bi=18//mm
bo=6//mm
h=40//mm
Ri=25//mm
Ro=25+40//mm
A=0.5*{18+6}*40//are of section X-X//mm^2
Rn=[{(bi+bo)/2}*h]/[{{{(bi*Ro)-(bo*Ri)}/h}*log(Ro/Ri
    )}-(bi-bo)]//mm//radius of curvature of neutral
    axis
R=Ri+[(h*(bi+2*bo))/{3*(bi+bo)}]//mm//radius of
    curvature of centroidal axis
e=R-Rn//distance between centroidal and neutral axis
x=100+R//distance between load and central axis//mm
M=W*x//N-mm//moment abt centroidal axis
f=W/A//stress//N/mm^2
yi=Rn-Ri//distance from neutral axis to inner
    surface
yo=Ro-Rn//distance from neutral axis to outer
    surface
fbi=(M*yi)/(A*e*Ri)//N/mm^2//maximum bending stress
    at inner surafce
fbo=(M*yo)/(A*e*Ro)//N/mm^2//max bending strss at
    outr srface
Fi=f+fbi//N//mm^2//resultant stress on inner surafce
Fo=f+fbo//N/mm^2//resultant stress o outer surafce
printf("the value of Rn is,%f mm\n",Rn)
printf("the stress on section X-X is,%f N/mm^2\n",f)
printf("the max bedning stress on inner surafce,%f N
    /mm^2\n",fbi)
printf("the max bending stress on outer surface is,
    %f N/mm^2\n",fbo)
printf("the resultant streess on inner surface is,%f
```

```
    N/mm^2\n",Fi)
printf("the resultant stress on outer surface is,%f
    N/mm^2\n",Fo)
```

**Scilab code Exa 5.11** Machine design

```
//find stresses in inner and outer fibres
clc
//refer fig 5.11 and gfig 5.12
//solution
//given
W=20*10^3//N
Ri=50//mm
Ro=150//mm
h=100//mm
b=20//mm
A=b*h//mm^2//area
Rn=h/{log(Ro/Ri)}//mm//rad of neutral axis
R=Ri+h/2//rad of centroidal axis
e=R-Rn
x=R//mm//distnce btw load and centroidal axis
M=W*x//N-mm
f=W/A//N/mm^2
yi=Rn-Ri
yo=Ro-Rn
fbi=(M*yi)/(A*e*Ri)//N/mm^2
fbo=(M*yo)/(A*e*Ro)//N/mm^2
Fi=f+fbi//N/mm^2
Fo=f-fbo//N/mm^2
printf("the value of e is,%f mm\n",e)
printf("the value of Rn is,%f mm\n",Rn)
printf("the stress on section X-X is,%f N/mm^2\n",f)
printf("the max bedning stress on inner surafce,%f N
    /mm^2\n",fbi)
printf("the max bending stress on outer surface is,
```

```
%f N/mm^2\n",fbo)
printf("the resultant streess on inner surface is,%f N/mm^2\n",Fi)
printf("the resultant stress on outer surface is,%f N/mm^2\n",Fo)
```

**Scilab code Exa 5.13** Machine design

```
//find the load
clc
//refer fig 5.13
//solution
//given
f=140//N/mm^2
Ri=25//mm
Ro=50//mm
bi=19//mm
ti=3//mm
t=3//mm
h=25//mm
A=(3*22)+(3*19)//mm^2
Rn={ti*(bi-t)+t*h}/{[(bi-t)*log((Ri+t)/Ri)]+[t*log(Ro/Ri)]}//mm
R=Ri+{[(0.5*h^2*t)+(0.5*ti^2*(bi-t))]/{(h*t)+(ti*(bi-t))}}//mm
e=R-Rn//mm
x=50+R//mm
//M=W*x//N-mm
yi=Rn-Ri//mm
//f1=W/A=0.008*W//N/mm^2//direct tensile stress
//fbi=(M*yi)/(A*e*Ri)=0.115*W//N/mm^2
//f=f1+fbi
//0.123*W=140
W=140/0.123//N
printf("the value of e is,%f mm\n",e)
```

```
printf("the value of Rn is ,%f mm\n",Rn)
printf("the load acting is ,%f N",W)
```

**Scilab code Exa 5.14** Machine design

```
//cal stress at A and B
clc
//solution
//given
W=3000//N
T=10^6//N-mm
P=15000//N
d=50//mm
x=250//mm
pi=3.14
A=(pi/4)*d^2//mm^2//area of shaft
f1=P/A//tensile stress at A and B
M=W*x//N-mm
Z=(pi/32)*d^3//mm^3
f2=M/Z//N/mm^2
fa=f1+f2//N/mm^2
fb=f2-f1//N/mm^2//tensile stress at B
fs=16*T/(pi*d^3)//N/mm^3
Fama=(fa/2)+0.5*sqrt((fa)^2+4*(fs)^2)//max stress at
    A
Fami=(fa/2)-0.5*sqrt((fa)^2+4*(fs)^2)//min stress at
    A
Tama=0.5*[sqrt(((fa)^2)+(4*(fs)^2))]// max shear
   stress at A
Fbma=(fb/2)+0.5*sqrt((fb)^2+4*(fs)^2)//max stress at
    B
Fbmi=(fb/2)-0.5*sqrt((fb)^2+4*(fs)^2)//min stress at
    B
Tbma=0.5*[sqrt(((fb)^2)+(4*(fs)^2))]//max shear
   stress at B
```

```
printf("the max stress at A is,%f N/mm^2\n",Fama)
printf("the min stress at A is,%f N/mm^2\n",Fami)
printf("the max stress at B is,%f N/mm^2\n",Fbma)
printf("the max stress at B is,%f N/mm^2\n",Fbmi)
printf("the max shear stress at A is,%f N/mm^2\n",
    Tama)
printf("the max shear stress at B is,%f N/mm^2",Tbma
    )
```

**Scilab code Exa 5.15** Machine design

```
//detrmin max principasl stress and max shear stress
    at centre of shaft bearing
clc
//solution
//given
//refer fig 5.18
W=15000//N
d=80//mm
y=140//mm
x=120//mm
pi=3.14
M=W*x//N-mm
T=W*y//N-mm
Z=(pi/32)*d^3//mm^3
f1=M/Z//N/mm^2//stress due to bending
f2=16*T/(pi*d^3)//N/mm^2//stress due torsion
Fm=(f1/2)+(0.5*sqrt(f1^2+4*f2^2))//Max stress
Fs=0.5*(sqrt(f1^2+4*f2^2))//max shear stress
printf("the max prin stress is,%f N/mm^2\n",Fm)
printf("the max shear stress is ,%f N/mm^2",Fs)
```

**Scilab code Exa 5.16** Machine design

```
//find dia of bolt using all theories
clc
//solution
//given
Pt1=10000//N
Ps=5000//N
fs=100//N/mm^2
m=10/3
pi=3.14
//let d be diameter of bolt in mm
//A=(pi/4)*d^2=0.7854*d^2//mm^2
//f1=Pt1/A=12.73/d^2//kN/mm^2
//t=Ps/A=6.365/d^2//kN/mm^2
//fs=[(f1^2)+(0.5*sqrt(f1^2 + 4*t^2))]//acc to max
    principal stress theory
//fs=15.365/d^2//kN/mm^2
d=sqrt(15365/fs)//mm
//using max shear stres theory
Tm=fs/2//N/mm^2
//Tm=0.5*[f1^2+ 4*t^2]
//Tm=9000/d1^2//N/mm^2
d1=sqrt(9000*2/fs)//mm
//using max principal strain theory
//we know
//fs=[(f1^2)+(0.5*sqrt(f1^2 + 4*t^2))]//
//fs=15365/d2^2//N/mm^2//max pricipla stress
//fs2=[(f1^2)-(0.5*sqrt(f1^2 + 4*t^2))]//min
    principal stress
//fs2=-2635/d2^2//N/mm^2
//fs/E-(fs2/(m*E))=fs/E
//15365/d2^2+2635/(3.33*d2^2)=100
d2=sqrt(16156/100)//mm
//using max strain energy theory
//fs^2+fs^2-2*fs*fs2/m=fs^2
//[15365/d3^2]^2+[-2635/d3^2]^2+(2*15365*2635/d3
    ^4/3.33)=100^2
//[23600/d3^4]+[694/d3^4]+[2430/d3^4]=1
d3=[26724]^(1/4)//mm
```

```
//using max distortion energy theory
//(fs^2)+(fs2)^2-(2*fs*fs2)=fs^2
//[15365/d4^2]^2+[2635/d4^2]^2+(2*15365*2635/d4^4)
    =100^2
//32391/d4^4=1
d4=(32391)^(1/4)//mm
printf("the dia og bolt using max prin stress theory
     is,%f mm\n",d)
printf("the dia of bolt using max shear stress
    thewory is,%f mm\n",d1)
printf("the dia of bolt using max prin strain theory
     is ,%f mm\n",d2)
printf("the dia of bolt using max strain energy
    theory is,%f mm\n",d3)
printf("the dia of boltusing distortion energy is,%f
     mm\n",d4)
```

**Scilab code Exa 5.17** Machine design

```
//find dia using two diffrnt theories
clc
//soltion
//given
fs=700//N/mm^2
M=10*10^6//N-mm
T=30*10^6//N-mm
Fs=2//factor of safety
E=210*10^3//N/mm^2
m=4
pi=3.14
//let d be dia of shaft in mm
//Z=(pi/32)*d^3//mm^3
//f1=M/Z=101.8*10^6/d^3//N/mm^2
//t=16*T/(pi*d^3)=152.8*10^6/d^3//N/mm^2
//ft1=(f1/2)+(0.5*sqrt((f1^2)+(4*t^2)))
```

```
//ft1=211.9*10^6/d^3//N/mm^2/max prin stress
//ft2=(f1/2)-(0.5*sqrt((f1^2)+(4*t^2)))//min prin stress
//ft2=-110.1*10^6/d^3//N/mm^2
//acc to max shear stress theory
//Tmax=(ft1-ft2)/2=161*10^6/d^3//max shear stress theory
//Tmax=fs/(2*Fs)
//161*10^6/d^3=700/(2*2)
d=(161*10^6/175)^(1/3)//mm
//acc to max strain energy theory
//1/(2*E)*[ft1^2+ft2^2-(2*ft1*ft2/m)]=1/(2*E)*[fs/Fs]^2
//ft1^2 + ft2^2- (2*ft1*ft2/m)=[fs/Fs]^2
//[211.9*10^6/d2^3]^2 + [-110.1*10^6/d2^3]^2 + [2*211.9*10^6*110.1*10^6*0.25/d2^6]=[700/2]^2
//68689*10^12/d2^6=122500
d2=(68689*10^12/122500)^(1/6)//mm
printf("the dia of shaft using max shear stress theory is,%f mm\n",d)
printf("the dia of shaft using max strain energy theory is,%f mm",d2)
```

**Scilab code Exa 5.18** Machine design

```
//find max value of torque
clc
//solution
//given
d=50//mm
M=2000*10^6//N-mm
fs=200//N/mm^2
//let T be torque
pi=3.14
Z=(pi/32)*d^3//mm^3
```

```
//acc to max principal stress theory
f1=M/Z//N/mm^2//bending stress
//t=16*T/(pi*d^3)//shear stress due to torque/
//ft1=(f1/2)+(0.5*sqrt((f1^2)+4*t^2)//N/mm^2
//ft2=(ft1/2)-(0.5*sqrt((f1^2)+4*t^2)//N/mm^2
//Tmax=0.5*sqrt(f1^2 + 4*t^2)
//ft1=fs
//81.5+sqrt(6642.5+(1.65*10^-9*T^2))=200
//6642.5+(1.65*10^-9*T^2)=14042
//T^2=(14042-6642.5)/(1.65*10^-9)
T=sqrt((14042-6642.5)/(1.65*10^-9))//N-mm
//acc to max shear stress theory
//Ty=fs/2//max shear stress=0.5*yield stress
Ty=100//N/mm^2
//sqrt(6642.5+(1.65*10^-9*T1^2))=100
//T1^2=(10000-6642.5)/(1.65*10^-9)
T1=sqrt(2035*10^9)//N-mm
//acc to max distortion energy theory
//ft1^2+ft2^2-ft1*ft2=fs^2
//[81.5+sqrt(6642.5+1.65*10^-9*T1^2)]^2+[81.5-sqrt
    (6642.5+1.65*10^-9*T1^2)]^2-[81.5+sqrt
    (6642.5+1.65*10^-9*T1^2)]^2*[81.5-sqrt
    (6642.5+1.65*10^-9*T1^2)]^2=200^2
//81.5^2+3*6642.5+3*1.65*10^-9*T1^2=200^2
//T1^2=(40000-26570)/(4.95*10^-9)
T1=sqrt((40000-26570)/(4.95*10^-9))//N-mm
printf("the torque acting acc to max shear theory is
    ,%f N-mm\n",T)
printf("the torque acting acc to max distortion
    theoyr is,%f N-mm",T1)
```

**Scilab code Exa 5.19** Machine design

```
//find max and min intensties of stress in the
    section
```

```
clc
//solution
//given
//refer fig 5.21
b=150//mm
d=120//mm
P=180*10^3//N
e=10//mm
A=b*d//mm^2
fo=P/A//N/mm^2//direct compressive stress
//Z=Iyy/y
Z=d*b^2/6//mm^3
M=P*e//N-mm
fb=M/Z//bending stress//N/mm^2
Fm=fo+fb//max stress
Fmi=fo-fb//min stress
printf("the max stress is ,%f N/mm^2\n",Fm)
printf("the min stress is ,%f N/mm^2",Fmi)
```

**Scilab code Exa 5.20** Machine design

```
//find stresses at the sides of the column
clc
//solution
//given
D=250//mm
d=200//mm
P=20000//N
e=500//mm
pi=3.14
A=(pi/4)*[D^2-d^2]//mm^2
fo=P/A//N/mm^2//direct compressive stress
Z=(pi/64)*[D^4-d^4]*(1/125)//mm^3
M=P*e//N-mm
fb=M/Z//N/mm^2
```

```
Fm=fb+fo//N/mm^2//max comprssive stress
Fmi=fb-fo//max tensile stress//N/mm^2
printf("the max comprssive stress is ,%f N/mm^2\n",
   Fm)
printf("the max tensile stress is ,%f N/mm^2",Fmi)
```

**Scilab code Exa 5.21** Machine design

```
//find stresses developed at each corner of the pier
clc
//solution
//given
//refer fig 5.23
b=4//m
d=3//m
A=b*d//m^2
P=30//kN
ex=0.5//m
ey=1//m
Ixx=b*d^3/12//m^4
Iyy=d*b^3/12//m^4
x=3/2//m
y=4/2//m
//at A
fa=(P/A)+(P*ex*x/(Ixx))+(P*ey*y/(Iyy))//kN/m^2
//at B
fb=(P/A) +(P*ex*x/(Ixx))-(P*ey*y/(Iyy))//kN/m^2
//at C
fc=(P/A)-(P*ex*x/(Ixx))+(P*ey*y/(Iyy))//kN/m^2
//at D
fd=(P/A)-(P*ex*x/(Ixx))-(P*ey*y/(Iyy))//kN/m^2
printf("the stress at A is,%f N/m^2\n",fa)
printf("the stress at B is,%f N/m^2\n",fb)
printf("the stress at B is,%f N/m^2\n",fc)
printf("the stress at D is ,%f N/m^2",fd)
```

**Scilab code Exa 5.22** Machine design

```
//find b1 in fig 5.24
clc
//solution
//given
P=80000//N
ft=70//N/mm^2//stress
//b=3*t
//A=b*t
//A=3t*t
//P=ft*A
//t^2=80000/210
t=sqrt(80000/210)//mm
b=3*t//mm
////when the link is shown by dotted line, it will be subjected to direct stress as we;; as bending stress
//A1=b1*t
//fo=P/A
//fo=P/(b1*t)
//fb=M/Z//=P*e/(t*b1^2)
//f=fo+fb//total stress
//f=P/(t*b1)*[(6*e/b1)+1]
//70=(80000/(20*b1))*[4]
b1=16*10^3/70//mm
printf("the thickness is,%f mm\n",t)
printf("the width is,%f mm\n",b)
printf("the new width is,%f mm\n",b1)
```

**Scilab code Exa 5.24** Machine design

```
//find b1 in fig 5.24
clc
//solution
//given
P=80000//N
ft=70//N/mm^2//stress
//b=3*t
//A=b*t
//A=3t*t
//P=ft*A
//t^2=80000/210
t=sqrt(80000/210)//mm
b=3*t//mm
////when the link is shown by dotted line, it will be subjected to direct stress as we;; as bending stress
//A1=b1*t
//fo=P/A
//fo=P/(b1*t)
//fb=M/Z//=P*e/(t*b1^2)
//f=fo+fb//total stress
//f=P/(t*b1)*[(6*e/b1)+1]
//70=(80000/(20*b1))*[4]
b1=16*10^3/70//mm
printf("the thickness is,%f mm\n",t)
printf("the width is,%f mm\n",b)
printf("the new width is,%f mm\n",b1)
```

**Scilab code Exa 5.25** Machine design

```
//find x-sectional dimensions of the bracket
clc
//solution
//given
//refer fig 5.28
```

```
P=6000//N
q=45//deg
f=60//N/mm^2
//let t be thickness and b=2*t//gevin
//A=b*t//mm^2
//A=2t^2//mm^2
//Z=t*b^2/12
//Z=4*t^3/6//mm^3
Ph=6000*cos(45)//N//horizontal component of P
Mh=Ph*75//N-mm
//fh=Mh/Z
//fh=477225/t^3//N/mm^2
Pv=6000*sin(45)//N
Mv=Pv*130//N-mm
//fov=Pv/A//dirct stress due vertical component
//fov=2121/t^2//N/mm^2
//fbv=Mv/Z//max bednding stress
//fbv=827190/t^3//N/mm^2
//f=477225/t^3+2121/t^2+827190/t^3
//60=1304415/t^3 + 2121/t^2
//using hit and trial ,we get t=28.4 mm
t=28.4//mm
b=2*t
printf("the value of thickness is ,%f mm\n ",t)
printf("the value of thickness is ,%f mm",b)
```

**Scilab code Exa 5.26** Machine design

```
//find max stress intensity and shear stress at
   joint
clc
//given
//solution
//refer figure 5.33
H=500//mm
```

```
B=200//mm
h=450//mm
b=15//mm
F=400000//N
I=645*10^6//mm^4
Tmax=(F/(I*b))*[(B/8)*(H^2-h^2)+(b*h^2/8)]//N/mm^2//
    max intensity of shear stress
Fj=F/(8*I)*(H^2-h^2)//stress at joint
FJ=F/(8*I)*(H^2-h^2)*(B/b)//stress at ujnction
printf("the stress at jointf is ,%f N/mm^2\n",Fj)
printf("the stress at junction is ,%f N/mm^2\n",FJ)
printf("the max shear stress is ,%f N/mm^2 ",Tmax)
```

# Chapter 6

# Ch6

**Scilab code Exa 6.1** Machine design

```
b=60// b=60mm
t=10//t=10mm
d=12//d=12mm
A=(b-d)*t
disp(A,"Area=")
W=12000//W=12kN
Ns=W/A
disp(Ns,"Nominal Stress=")
x=d/b//ratio of diameter of hole to plate width
// for d/b=0.2, Kt=2.5
Kt=2.5
Ms=Kt*Ns
disp(Ms,"Maximum stress=")
```

**Scilab code Exa 6.2** Machine design

```
D=50//D=50mm
d=25//d=12mm
r=5
A=(%pi*d^2)/4
disp(A,"Area=")
W=12000//W=12kN
Ns=W/A
disp(Ns,"Nominal Stress=")
x=D/d//ratio of maximum diameter to minimum diameter
y=r/d//ratio of radius of fillet to minimum diameter
Kt=1.64
Ms=Kt*Ns
disp(Ms,"Maximum stress=")
```

**Scilab code Exa 6.3** Machine design

```

s=%s
sigma1=300
sigma2=-150
sigmay=0.55*s
sigmae=0.5*s
FS=2
sigmam=(sigma1+sigma2)/2
sigmav=(sigma1-sigma2)/2
disp(sigmam,"Mean stress=")
disp(sigmav,"Variable stress=")
p=s^2-900*s-22500
sigmau=roots(p)
sigmau1=924.35
disp(sigmau1,"Minimum ultimate strength according to
    gerber equation=")
0=(sigmam/s)+(sigmay/sigmae)-(1/FS)//Modified
   Goodman relation
sigmau=2*525
```

```
disp(sigmau,"Minimum ultimate strength according to
    Modified Goodman Relation is=")
0=(sigmam/sigmay)+(sigmav/sigmae)-(1/FS)//Soderberg
    equation
sigmau=2*586.36
disp(sigmau,"Minimum ultimate strength according to
    Soderberg equation=")
```

**Scilab code Exa 6.4** Machine design

```
syms d
Wmax=500
Wmin=200
sigmau=900
sigmae=700
FSu=3.5
FSe=4
Kf=1.65
A=(%pi/4)*d^2
Wm=(Wmax+Wmin)/2
sigmam=(Wm*10^3)/A
disp(sigmam,"Mean stress=")
Wv=(Wmax-Wmin)/2
sigmav=(Wv*10^3)/A
disp(sigmav," Variable stress=")
0=1-((sigmam*Kf)/(sigmau/FSu))-(sigmav/(sigmae/FSe))
    //according to goodman relation
d=sqrt(3960)
disp(d,"d=")
```

**Scilab code Exa 6.5** Machine design

```
syms t
```

```
b=120
Wmax=250
Wmin=100
sigmay=300
sigmae=225
FS=1.5
A=b*t
Wm=(Wmax+Wmin)/2
sigmam=(Wm*10^3)/A
disp(sigmam,"Mean stress=")
Wv=(Wmax-Wmin)/2
sigmav=(Wv*10^3)/A
disp(sigmav,"Variable stress=")
0=(sigmam/sigmay)-(sigmav/sigmae)-(1/FS)//according
    to Soderberg's relation
t=7.64*FS
disp(t,"t=")
```

**Scilab code Exa 6.6** Machine design

```
syms d
Wmax=500
Wmin=200
sigmau=900
sigmae=700
FSu=3.5
FSe=4
Kf=1.65
A=(%pi/4)*d^2
Wm=(Wmax+Wmin)/2
sigmam=(Wm*10^3)/A
disp(sigmam,"Mean stress=")
Wv=(Wmax-Wmin)/2
sigmav=(Wv*10^3)/A
disp(sigmav,"Variable stress=")
```

```
0=1-((sigmam*Kf)/(sigmau/FSu))-(sigmav/(sigmae/FSe)) //according to Soderberg's relation
d=sqrt(3960)
disp(d,"d=")
```

**Scilab code Exa 6.7** Machine design

```
syms d
Wmax=180
Wmin=-180
sigmau=1070
sigmay=910
sigmae=0.5*sigmau
Ka=0.7
Ksur=0.8
Ksz=0.85
Kf=1
A=(%pi/4)*d^2
Wm=(Wmax+Wmin)/2
sigmam=(Wm)/A
disp(sigmam,"Mean stress=")
Wv=(Wmax-Wmin)/2
sigmav=(Wv*10^3)/A
disp(sigmav,"Variable stress=")
sigmaea=sigmae*Ka
disp(sigmaea,"Endurance limit in reverse axial loading=")
0=(sigmam/sigmay)-((sigmav*Kf)/(sigmaea*Ksur*Ksz)-(1/FS)//according to Soderberg's relation
d=sqrt(1800)
disp(d,"d=")
```

**Scilab code Exa 6.8** Machine design

```
Wmin=20*10^3
Wmax=50*10^3
l=500
FS=1.5
Kf=1
Ksz=0.85
Ksur=0.9
sigmau=650
sigmay=500
sigmae=350
Mmax=(Wmax*l)/4
disp(Mmax,"Maximum bending moment=")
Mmin=(Wmin*l)/4
disp(Mmin,"Minimum bending moment=")
Mm=(Mmax+Mmin)/2
disp(Mm,"Mean bending moment=")
Mv=(Mmax-Mmin)/2
disp(Mv,"Variable bending moment=")
syms d
Z=(%pi/32)*d^3
sigmam=Mm/Z
0=(sigmam/sigmay)-((sigmav*Kf)/(sigmae*Ksur*Ksz)-(1/FS)//according to Soderberg's relation
d=59.3
disp(d,"According to sodebergs formula, d=")
0=(sigmam/sigmau)-((sigmav*Kf)/(sigmae*Ksur*Ksz)-(1/FS)//according to Soderberg's relation
d=62.1
disp(d,"According to Goodmans formula, d=")
printf("Taking larger of the two values, d=62.1mm")
```

**Scilab code Exa 6.9** Machine design

```
d=50
sigmau=630
```

```
Tmax=2000
Tmin=-800
Tm=(Tmax+Tmin)/2
taum=(16*Tm)/(%pi*d^3)
disp(taum,"Mean shear stress=")
Tv=(Tmax-Tmin)/2
tauv=(16*Tv)/(%pi*d^3)
taue=0.55*0.5*sigmau
disp(taue,"Endurance limit=")
sigmay=510
Ksur=0.87
Ksz=0.85
Kf=1
tauy=o.5*sigmay//yield stress in shear loading is taken as one half of yield stress in reverse bending
0=(taum/tauy)-((tauv*Kf)/(taue*Ksur*Ksz)-(1/FS)//according to Soderberg's relation
FS=1/0.541
disp(FS,"Factor of safety=")
```

**Scilab code Exa 6.10** Machine design

```
syms F
Wmin=-F
Wmax=3*F
d=13
FS=2
q=0.9
Kt=1.42
Ksz=0.85
Ksur=0.89
Kf=1.378
sigmau=550
sigmay=470
```

```
sigmae=275
Mmax=Wmax*125
disp(Mmax,"Maximum bending moment=")
Mmin=Wmin*125
disp(Mmin,"Minimum bending moment=")
Mm=(Mmax+Mmin)/2
disp(Mm,"Mean bending moment=")
Mv=(Mmax-Mmin)/2
disp(Mv,"Variable bending moment=")
syms d
Z=(%pi/32)*d^3
disp(Z,"Section modulus=")
sigmam=Mm/Z
disp(sigmam,"Mean bending stress=")
sigmav=Mv/Z
disp(sigmav,"Variable bending stress=")
0=(sigmam/sigmay)-((sigmav*Kf)/(sigmae*Ksur*Ksz)-(1/FS)//according to Soderberg's relation
F=1/(2*0.00891)
disp(F,"According to soderbergs formula, F=")
0=(sigmam/sigmau)-((sigmav*Kf)/(sigmae*Ksur*Ksz)-(1/FS)//according to goodman's relation
F=1/(2*0.00873)
disp(F,"According to Goodman formula, F=")
```

**Scilab code Exa 6.11** Machine design

```
syms P
Wmin=P
Wmax=4*P
l=500
d=60
FS=1.3
Ksz=0.85
Ksur=0.9
```

```

sigmau=700
sigmay=500
sigmae=330
Mmax=(Wmax*l)/4
disp(Mmax,"Maximum bending moment=")
Mmin=(Wmin*l)/4
disp(Mmin,"Minimum bending moment=")
Mm=(Mmax+Mmin)/2
disp(Mm,"Mean bending moment=")
Mv=(Mmax-Mmin)/2
disp(Mv,"Variable bending moment=")
syms d
Z=(%pi/32)*d^3
disp(Z,"Section modulus=")
sigmam=Mm/Z
disp(sigmam,"Mean bending stress=")
sigmav=Mv/Z
disp(sigmav,"Variable bending stress=")
0=(sigmam/sigmay)-((sigmav*Kf)/(sigmae*Ksur*Ksz)-(1/
    FS)//according to Soderberg's relation
P=11982
disp(F,"According to sodebergs formula, F=")
0=(sigmam/sigmau)-((sigmav*Kf)/(sigmae*Ksur*Ksz)-(1/
    FS)//according to goodman's relation
P=13785
disp(F,"According to Goodman formula, F=")
```

**Scilab code Exa 6.12** Machine design

```
l=200
Wamax=450
Wamin=-150
Wtmax=120
Wtmin=-80
```

```
FS=2
sigmay=330
sigmae=300
Ka=0.7
Kb=1
Ktb=1.44
Kta=1.64
Ksz=0.85
Ksur=0.90
q=0.90
//consider the reversed axial loading
Wm=(Wamax+Wamin)/2
disp(Wm,"Average axial load=")
Wv=(Wamax-Wamin)/2
disp(Wv,"Variable axial load=")
syms d
A=(%pi*d^2)/4
sigmam=Wm/A
disp(sigmam,"Average axial stress=")
sigmav=Wv/A
disp(sigmav,"Variable axial stress=")
Kfa=1.576
sigmaea=sigmae*Ka
disp(sigmaea,"Endurance limit stress for reversed axial loading=")
sigmanea=sigmam+(sigmav*sigmay*Kfa)/(sigmaea*Ksur*Ksz)
Wm=(Wtmax+Wtmin)/2
disp(Wm,"Mean bending load=")
Wv=(Wtmax-Wtmin)/2
disp(Wv,"Variable bending load=")
Mm=Wm*(l-50)
disp(Mm,"Mean bending moment at point A=")
Mv=Wv*(l-50)
disp(Mv,"Variable bending moment at point A=")
Z=(%pi*d^3)/32
disp(Z,"section modulus=")
sigmam=Mm/Z
```

```
disp(sigmam,"Mean bending stress=")
sigmav=Mv/Z
disp(sigmav,"Variable bending stress=")
Kfb=1.396
Kb=1
sigmaeb=sigmae*Kb
disp(sigmaeb,"Endurance limit for reverse bending load=")
sigmaneb=sigmam+(sigmav*sigmay*Kfb)/(sigmaeb*Ksur*Ksz)
sigmane=sigmanea+sigmaneb
disp(sigmane,"Total equivalent normal stress at point A=")
sigmane=sigmay/FS
disp(sigmane,"Total equivalent normal stress at point A=")
s=%s
p=165*s^3-1428*s-337168
x=roots(p)
disp(x,"d=")
//taking the real value of d
d=12.9
disp(d,"d=")
```

**Scilab code Exa 6.13** Machine design

```
Mmax=440
Mmin=-220
sigmay=410*10^6
sigmau=550*10^6
sigmae=0.5*sigmau
FS=2
syms d
Tmax=330
Tmin=-110
```

```
Tm=(Tmax+Tmin)/2
taum=(16*Tm)/(%pi*d^3)
disp(taum,"Mean shear stress=")
Tv=(Tmax-Tmin)/2
tauv=(16*Tv)/(%pi*d^3)
disp(tauv,"Variable shear stress=")
taue=0.55*sigmae
Ksur=0.62
Ksz=0.85
Kfs=1
tauy=o.5*sigmay//yield stress in shear loading is
   taken as one half of yield stress in reverse
   bending
taues=taum+((tauv*tauy*Kfs)/(taue*Ksur*Ksz))
Mm=(Mmax+Mmin)/2
disp(Mm,"Mean bending moment=")
Mv=(Mmax-Mmin)/2
disp(Mv,"Variable bending moment=")
syms d
Z=(%pi/32)*d^3
disp(Z,"Section modulus=")
sigmam=Mm/Z
disp(sigmam,"Mean bending stress=")
sigmav=Mv/Z
disp(sigmav,"Variable bending stress=")
Kfb=1
sigmaeb=sigmae
sigmane=sigmam+((sigmav*sigmay*Kfb)/(sigmaeb*Ksur*
   Ksz))
taues=(205*10^6)/2
d=39.5
disp(d,"d=")
```

**Scilab code Exa 6.14** Machine design

```
sigmau=550
sigmay=400
Mmin=-150
Mmax=400
Tmin=-50

Tmax=150
Kfb=1.6
Kfs=1.3
FS=1.5
Kb=1
Ks=0.6
Ksz=0.85
Ksur=0.88
Mm=(Mmax+Mmin)/2
disp(Mm,"Mean bending moment=")
Mv=(Mmax-Mmin)/2
disp(Mv,"Variable bending moment=")
syms d
Z=(%pi/32)*d^3
disp(Z,"Section modulus=")
sigmam=(Mm*10^3)/Z
disp(sigmam,"Mean bending stress=")
sigmav=(Mv*10^3)/Z
disp(sigmav,"Variable bending stress=")
sigmaeb=sigmau/2
sigmaneb=sigmam+(sigmav*sigmay*Kfb)/(sigmaeb*Ksur*
    Ksz)

Tm=(Tmax+Tmin)/2
taum=(16*Tm*10^3)/(%pi*d^3)
disp(taum,"Mean shear stress=")
Tv=(Tmax-Tmin)/2
tauv=(16*Tv*10^3)/(%pi*d^3)
disp(tauv,"Variable shear stress=")
taue=sigmae*Ks
disp(taue,"Endurance limit for reversed torsional
    loading=")
```

```
tauy=0.5*sigmay
disp(tauy,"Yield strength in shear=")
//yield stress in shear loading is taken as one half
    of yield stress in reverse bending
taues=taum+((tauv*tauy*Kfs)/(taue*Ksur*Ksz))
d=33.84
disp(d,"Diameter of shaft in mm is=")
```

# Chapter 7

# Ch7

**Scilab code Exa 7.1** Machine design

```
d=1200
p=1.75
sigmat2=28
sigmat1=42
//when longitudinal stress does not exceed 28Mpa
t2=(p*d)/(4*sigmat2)
disp(t,"Minimum wall thickness in mm=")
//when circumferential stress does not exceed 42MPa
t1=(p*d)/(2*sigmat1)
disp(t,"Minimum wall thickness in mm=")
```

---

**Scilab code Exa 7.2** Machine design

```
d=500
p=2
t=20
//hoop stress
sigmat1=(p*d)/(2*t)
```

```
disp(sigmat1,"Hoop stress in MPa=")
sigmat2=(p*d)/(4*t)
disp(sigmat2,"Longitudinal stress in MPa=")
tau=(sigmat1-sigmat2)/2
disp(tau,"Maximum stress=")
```

**Scilab code Exa 7.3** Machine design

```
p=3
d=800
n=1
sigmat1=50
F=25*10^3
sigmatc=30
nH=0.8
nP=0.6
t=(p*d)/(2*sigmat1*n)
disp(t,"Thickness of pressure tank in mm=")
F1=F+0.1*F
p1=3-0.2//p1=pressure in tank-pressure drop
D=sqrt(27500/2.2)
t1=(p1*D)/(2*sigmatc)
disp(t1,"Thickness of cylinder in mm=")
// Power o/p of cylinder
sp=0.45//stroke of piston=450mm
ts=5//time req for working stroke=5s
dp=sp/ts//distance moved by piston/sec=0.45/5
w=F1*dp
disp(w,"Power output of the cylinder in watts=")
pp=(w*10^3*5)/(nH*nP*30)
disp(pp,"Power of the motor in kW=")
```

**Scilab code Exa 7.4** Machine design

```
syms sigmat1;
p=(5/8)*sigmat1
d=100//diameter=100mm
p1=90//N/mm^2
E=205*10^3//N/mm^2
mu=0.29
t=(p*d)/(2*sigmat1)//thickness of a tube
disp(t,"Thickness of a tube in mm")
deltad=((p1*d^2)*(2-mu))/(2*t*E*2)
disp(deltad,"Increase in diameter of tube in mm")
```

**Scilab code Exa 7.5** Machine design

```
d=3000//mm
p=1.5//N-mm^2
sigmat=90//Mpa
n=0.75
t=(p*d)/(4*sigmat*n)//mm
disp(t,"Thickness of the vessel in mm")
```

**Scilab code Exa 7.6** Machine design

```
d=900//mm
t=10//mm
deltav=150*10^3//mm^3
E=200*10^3//N/mm^2
mu=0.3
p=(deltav*8*t*E)/(%pi*d^4*(1-mu))
disp(p,"Pressure exerted by the fluid on the shell
    in N/mm^2")
```

# Chapter 8

# Ch8

**Scilab code Exa 8.1** Machine design

```

clc
//solution
//given
di=200//mm
ri=100//mm
t=50//mm
p=5//N/mm^2
ro=ri+t//mm
//f=[p*(ri)^2]*[1+ro^2/x^2]*[1/(ro^2-ri^2)]
//x is radius at which stress is found out
//f=4*[1+(ro^2/(x^2))]//N/mm^2//tangential stress at
    distance x
f1=4*[1+(150^2/(100^2))]//N/mm^2
f2=4*[1+(150^2/(110^2))]//N/mm^2
f3=4*[1+(150^2/(120^2))]//N/mm^2
f4=4*[1+(150^2/(130^2))]//N/mm^2
f5=4*[1+(150^2/(140^2))]//N/mm^2
f6=4*[1+(150^2/(150^2))]//N/mm^2
//f=4*[1-(ro^2/(x^2))]//radial stress at distance x
r1=4*[1-(150^2/(100^2))]//N/mm^2
```

```
r2=4*[1-(150^2/(110^2))]//N/mm^2
r3=4*[1-(150^2/(120^2))]//N/mm^2
r4=4*[1-(150^2/(130^2))]//N/mm^2
r5=4*[1-(150^2/(140^2))]//N/mm^2
r6=4*[1-(150^2/(150^2))]//N/mm^2
printf("the tangential stress at distance x=100mm is ,%f N/mm^2\n",f1)
printf("the tangential stress at distance x=110mm is ,%f N/mm^2\n",f2)
printf("the tangential stress at distance x=120mm is ,%f N/mm^2\n",f3)
printf("the tangential stress at distance x=130mm is ,%f N/mm^2\n",f4)
printf("the tangential stress at distance x=140mm is ,%f N/mm^2\n",f5)
printf("the tangential stress at distance x=150mm is ,%f N/mm^2\n",f6)
printf("the radial stress at distance x=100mm is ,%f N/mm^2\n ",r1)
printf("the radial stress at distance x=110mm is ,%f N/mm^2\n ",r2)
printf("the radial stress at distance x=120mm is ,%f N/mm^2\n ",r3)
printf("the radial stress at distance x=130mm is ,%f N/mm^2\n ",r4)
printf("the radial stress at distance x=140mm is ,%f N/mm^2\n ",r5)
printf("the radial stress at distance x=150mm is ,%f N/mm^2\n ",r6)
```

**Scilab code Exa 8.2** Machine design

```

//solution
//given
```

```
Q=40//m^3/min
p=1.4//N/mm^2
v=1800//m/min
f=40//N/mm^2
D=1.13*sqrt(40/1800)//m
t=(p*D)/(2*f)+0.003//m
printf("the inside diameter is,%f m\n ",D)
printf("the wall thickness is,%f m",t)
```

**Scilab code Exa 8.3** Machine design

```

clc
//solution
//given
D=250//mm
p=0.7//N/mm^2
//ref table 8.1,foa cast iron ft=14//N/mm^2
ft=14//N/mm^2
//table 8.2,C=9 mm//
C=9//mm
pi=3.14
t=(p*D)/(2*ft)+C//mm
d=0.75*t + 10//mm//nominal dia of bolts
n=0.0275*D+1.6//mm//numbr of bolts
tf=1.5*t+3//mm//thickness of flanges
B=2.3*d//mm//width of flange
Do=D+2*t+2*B//mm//outside dia of flange
Dp=D+2*t+2*d+12//mm
Pc=pi*Dp/n//mm
printf("the thickness of pipe is,%f mm\n",t)
printf("the nominal diameter of bolts is,%f mm\n",d)
printf("the number of bolts is,%f \n",n)
printf("the thickness of flanges is,%f mm\n",tf)
printf("the width of flange is,%f mm\n",B)
```

```
printf("the outside dia of flange is ,%f mm\n",Do)
printf("the pitch circle diameter is ,%f mm\n",Dp)
printf("the circumferencial pitch is ,%f mm",Pc)
```

**Scilab code Exa 8.4** Machine design

```

clc
//solution
//given
//refer fig 8.12
D=200//mm
p=0.35//N/mm^2
n=8
d=16//mm
Dp=290//mm
tf=20//mm
//using table ft=14//N/mm^2 ,table 8.2 gives C=9mm
C=9//mm
ft=14//N/mm^2
t=(p*D/(2*ft))+C//mm
d1=d+2//mm//dia of bolts
D1=Dp-d1//mm
pi=3.14
F=(pi/4)*[D1]^2*p//N//force acting to separate flanges
x=90//mm
y=[Dp/2]-[D/2+t]//mm
//let fb be working stress
M=F*y/n//N-mm
//Mr=fb*Z=(1/6)*x*(tf)^2=6000*fb
//M=6000*fb
fb=M/6000//N/mm^2
printf("the working stress is ,%f N/mm^2",fb)
```

**Scilab code Exa 8.5** Machine design

```
clc
//solution
//given
D=50//mm
R=25//mm
p=7//N/mm^2
pi=3.14
ft=20//N/mm^2
fb=60//N/mm^2
//t=R*[sqrt[(ft+p)/(ft-p)]-1]//mm//thickneess of
    pipe
t=R*{sqrt[27/13]-1}//mm
w=10//mm//width of packing
D1=D+(2*w)//mm
F=(pi/4)*(D1)^2*p//N
Fb=F/2//force on bolts
//let dc be diameter of bolts
//Fb=(pi/4)*(dc)^2*fb
dc=sqrt(13471.5/47.2)//mm
d=dc/0.84//mm
Do=D+(2*t)+(4.6*d)//mm//outer diameter of flange
Dp=Do-(3*t+20)//mm//pitch dia of bolts
b=89//mm
e=33//mm
Mxx=Fb*e//N-mm
//Z=(1/6)*b*(tf)^2
//Mxx=ft*14.83*tf^2
tf=sqrt(444560/296.6)//mm
printf("the thickness of pipe is,%f mm\n",t)
printf("the nominal dia is,%f mm\n",d)
printf("the outer diameter of flange is,%f mm\n",Do)
```

```
printf("the thickness of flange is ,%f mm",tf)
```

# Chapter 9

# Ch9

**Scilab code Exa 9.1** Machine design

```

clc
//solution
//given
t=15//mm
d=25//mm
p=75//mm
ftu=400//N/mm^2
tu=320//N/mm^2
fcu=640//N/mm^2
pi=3.14
n=2
FS=4//factor of safety
//min foce per pitch which will rupture the joint
Ptu=(p-d)*t*ftu//N//ultimate teraing reisistance
Psu=n*(pi/4)*d^2^tu//N//ultimate shear stress
Pcu=n*d*t*fcu//N//ultimate crushing stress
//actual stress produced in plates and rivets
Ac=Ptu/4//N
//we know
//Ac=(p-d)*t*fta
```

```
fta=Ac/((p-d)*t)//N/mm^2
Ta=Ac*4/(n*pi*d^2)//N/mm^2
fca=Ac/(n*d*t)//N/mm^2
printf("the min force required is ,%f N\n",Ptu)
printf("the actual tearing stress acting is ,%f N/mm^2\n",fta)
printf("the actual shering stress acting is ,%f N/mm^2\n",Ta)
printf("thr crushing resistance stress is ,%f N/mm^2",fca)
```

**Scilab code Exa 9.2** Machine design

```

clc
//solution
//given
t=6//mm
d=20//mm
ft=120//N/mm^2
T=90//N/mm^2
fc=180//N/mm^2
p=50//mm
pi=3.14
Pt=(p-d)*t*ft//N//tearing resistance of plate
Ps=(pi/4)*d^2*T//N//shearing resistance of rivet
Pc=d*t*fc//N//crushing resistance of rivet
P=p*t*ft//N//strength of the unriveted
//eff=(least of Pt,Ps,Pc)/P
eff=Pt/P//least is Pt
p1=65//mm
Pt1=(p1-d)*t*ft//N
Ps1=(2*pi/4)*d^2*T//N
Pc1=2*d*t*fc//N
P2=p1*t*ft//N
```

```
printf("the value of forces are,%f N\n,%f N\n,%f N\n
    ",Pt1,Ps1,Pc1)
//eff1=least of Pt1,Ps1,Pc1/P2
eff1=Pt1/P2//least is Pt1
printf("the efficiency is first case is,%f\n",eff)
printf("the eff is second case is,%f",eff1)
```

**Scilab code Exa 9.3** Machine design

```

clc
//solution
//given
t=10//mm
d=25//mm
p=100//mm
ft=120//N/mm^2
T=100//N/mm^2
fc=150//N/mm^2
pi=3.14
Pt=(p-d)*t*ft//N//tearing resistance of plate
Ps=(2*pi/4)*d^2*T//N//shearing resistance of rivet
Pc=2*d*t*fc//N//crushing resistance of rivet
P=p*t*ft//N//strength of the unriveted
//eff=(least of Pt,Ps,Pc)/P
eff=Pc/P//least is Pc
printf("the eff is,%f",eff)
```

**Scilab code Exa 9.4** Machine design

```

clc
//solution
```

```
//given
t=13//mm
ft=80//N/mm^2
T=60//N/mm^2
fc=120//N/mm^2
pi=3.14
d=6*sqrt(t)//mm//dia of rivet
//use standard value from table 9.3
//let p be the picth of rivets
//Pt=(p-d)*t*ft=(p-23)*1040//N//tearing resistance of plate
Ps=2*(pi/4)*d^2*T//N//shearing resistance of rivet
//p-23=Ps/1040
p=23+(Ps/1040)//mm
//check the limits, if p&lt;=pmax..then it is safe design
//pmax=C*t+41.28//mm=75.28mm which is more then p
pb=0.33*p+ 0.67*d//distance btw rivets
m=1.58*d//margin
Pt=(p-d)*t*ft//N//tearing resistance of plate
Ps=(2*pi/4)*d^2*T//N//shearing resistance of rivet
Pc=2*d*t*fc//N//crushing resistance of rivet
P=p*t*ft//N//strength of the unriveted
//eff=(least of Pt,Ps,Pc)/P
printf("the value of forces are,%f N\n,%f N\n,%f N\n",Pt,Ps,Pc)
eff=Ps/P//least is Ps
printf("the eff is,%f",eff)
```

**Scilab code Exa 24.5** Machine design

```

clc
//solution
//given
```

```
P=15000//W
N=900//rpm
n=4
R=0.15//m
u=0.25
//let m be the mass
w=2*%pi*N/60//rad/s
w1=(3/4)*w//rad/s
r=0.12//m
//Pc=m*w^2*r=1066*m//N
//Ps=m*w1^2*r=600m//N
T=P*60/(2*%pi*N)//N-m
//T=u*(Pc-Ps)*R*n=70m
m=T/70//kg
printf("mass of shoes is,%f kg\n",m)
a=%pi/3
l=R*a*1000//mm
//A=l*n=157*b//mm^2
//F=A*p=15.7*b//N
//15.7*b=Pc-Ps=466m
b=466*m/(15.7)//mm
printf("face width is,%f mm\n",b)
```

**Scilab code Exa 9.5** Machine design

```

clc
//solution
//given
t=7//mm
pi=3.14
ft=90//N/mm^2
T=60//N/mm^2
fc=120//N/mm^2
//let d be dia,since t&lt;=8mm therefore d will be
```

```
   obtainned by equating shearing resistance to
   crushing
//Ps=Pc
//Ps=3*(pi/4)*d^2*T//N//shearing resistance of rivet
//Pc=3*d*t*fc//N//crushing resistance of rivet
//Ps=Pc
//141.4*d^2=2520*d
d=2520/141.4//mm
//let p is pitch
Ps=141.4*d^2//N
//Pt=(p-d)*t*ft//N//tearing resistance of plate
//Ps=Pt
//630*(p-19)=51045
//p=(51045/630)+19//mm
//pmax=C*t+41.28//mm=66mm, since pmax<p..therefore p
   ="pmax=66mm" pb="0.33*p+0.67*d//distance" btw=""
   the="" rivets="" pt="(p-d)*t*ft" ps="141.4*d^2//N
   " pc="3*d*t*fc//N" printf("the="" pitch="" is,%f
   ="" mm\n",p)="" distance="" mm",pb)<="" div=""></
   p..therefore>
```

**Scilab code Exa 9.6** Machine design

```

clc
//solution
//given
t=10//mm
ft=80//N/mm^2
T=60//N/mm^2
pi=3.14
//d=6*sqrt(t)//mm
//choose standard value of d from table 9.3
d=19//mm
//let p is pitch of rivets
```

```
Ps=1*1.875*(pi/4)*d^2*T//N//shearing resistance of rivet
//Pt=(p-d)*t*ft=(p-19)*800//N//tearing resistance of plate
//Ps=Pt
p=19+(31900/800)//mm
//pmax=C*t+41.28=58.78mm whihc is equal to p
t1=0.625*t//mm
Pt=(p-d)*t*ft//=(p-19)*800//N
P=p*t*ft//N//strength of the unriveted
printf("the value of forces is,%f N\n,%f N\n",Pt,Ps)
//eff=(least of Pt,Ps)/P
eff=Ps/P//least is Ps
printf("the eff is,%f\n",eff)
printf("the pitch is,%f mm\n",p)
printf("the thickness of cover plate is,%f mm\n",t1)
printf("the diameter of rivets is,%f mm",d)
```

**Scilab code Exa 9.7** Machine design

```

clc
//solution
//given
t=10//mm
ft=80//N/mm^2
T=60//N/mm^2
pi=3.14
//d=6*sqrt(t)//mm
//choose standard value of d from table 9.3
d=19//mm
//let p is pitch of rivets
Ps=1*1.875*(pi/4)*d^2*T//N//shearing resistance of rivet
//Pt=(p-d)*t*ft=(p-19)*800//N//tearing resistance of
```

```
plate
//Ps=Pt
p=19+(31900/800)//mm
//pmax=C*t+41.28=58.78mm whihc is equal to p
t1=0.625*t//mm
Pt=(p-d)*t*ft//=(p-19)*800//N
P=p*t*ft//N//strength of the unriveted
printf("the value of forces is,%f N\n,%f N\n",Pt,Ps)
//eff=(least of Pt,Ps)/P
eff=Ps/P//least is Ps
printf("the eff is,%f\n",eff)
printf("the pitch is,%f mm\n",p)
printf("the thickness of cover plate is,%f mm\n",t1)
printf("the diameter of rivets is,%f mm",d)
```

---

**Scilab code Exa 9.8** Machine design

```

clc
//solution
//given
t=10//mm
ft=80//N/mm^2
T=60//N/mm^2
pi=3.14
//d=6*sqrt(t)//mm
//choose standard value of d from table 9.3
d=19//mm
//let p is pitch of rivets
Ps=1*1.875*(pi/4)*d^2*T//N//shearing resistance of rivet
//Pt=(p-d)*t*ft=(p-19)*800//N//tearing resistance of plate
//Ps=Pt
p=19+(31900/800)//mm
```

```
//pmax=C*t+41.28=58.78mm whihc is equal to p
t1=0.625*t//mm
Pt=(p-d)*t*ft//=(p-19)*800//N
P=p*t*ft//N//strength of the unriveted
printf("the value of forces is,%f N\n,%f N\n",Pt,Ps)
//eff=(least of Pt,Ps)/P
eff=Ps/P//least is Ps
printf("the eff is,%f\n",eff)
printf("the pitch is,%f mm\n",p)
printf("the thickness of cover plate is,%f mm\n",t1)
printf("the diameter of rivets is,%f mm",d)
```

**Scilab code Exa 9.9** Machine design

```

clc
//soltuion
//given
D=1250//mm
P=2.5//N/mm^2
ftu=420//N/mm^2
fcu=650//N/mm^2
Tu=300//N/mm^2
eff=0.8
Fs=5//factor of safety
pi=3.14
ft=ftu/Fs
fc=fcu/Fs
T=Tu/Fs
t=P*D/(2*ft*eff)//mm//thickness of plate
d=6*sqrt(t)//mm//DIA
//Pt=(p-d)*t*ft=(p-31.5)*2100//N//tearing resistance
    of plate
Ps=4*1.875*(pi/4)*d^2*T+(pi/4)*d^2*T//=8.5*(pi/4)*d
    ^2*T//N//shearing resistance of rivet//N//
```

```
shearing resistance of rivet
//Pt=Ps
//p-31.5=(397500/2100)
//p=31.5+(397500/2100)//mm
//pmax=C*t+41.28//mm=196mm
//since p&gt;pmax, therefore
//p=pmax
p=196//mm
p'=196/2//mm
d1=0.2*p+1.15*d//mm//diatnce between outtr and row and next row
d2=0.165*p+0.67*d//mm//distance ebtween inner row for zigzag riveting
t1=0.75*t//mm//thickness of wide strap
t2=0.625*t//mm//thickness of narrow strap
m=1.5*d//mm//margin
Pt=(p-d)*t*ft//(p-31.5)*2100//N
Pc=5*d*t*fc//N//crushing resistance of rivet
P=p*t*ft//N//strength of the unriveted
//joint may also fail due to combine teARING AND shearing reistance
Pts=(p-2*d)*t*ft+(pi/4)*d^2*T//N
printf("the value of forces calculted are,%f N\n,%f N\n,%f N\n",Pt,Pc,Pts)
//eff=(least of Pt,Pc,Pts)/P
eff=Pts/P//least is Ps
printf("the eff is,%f\n",eff)
printf("the pitch is,%f mm\n",p)
printf("the thickness of wide strap is,%f mm\n",t1)
printf("the thickness of narrow strap is,%f mm\n",t2)
printf("the diameter of rivets is,%f mm",d)
printf("the margine s,%f mm\n",m)
printf("the distance btw outer and next row is,%f mm\n",d1)
printf("the distance btw inner rows is,%f mm\n",d2)
```

**Scilab code Exa 9.10** Machine design

```

clc
//soltuion
//given
P=2.5//N/mm^2
D=1600//mm
ft=75//N/mm^2
T=60//N/mm^2
fc=125//N/mm^2
//design of longitudinal joint
t=(P*D)/(2*ft)+1//mm
d=6*sqrt(t)//m
pi=3.14
//choose standard avlue fromtable 9.3
//let p be pitch
//Pt=(p-d)*t*ft//N//tearing resistance of plate
//Pt=(p-34.5)*2100//N
Ps=4*1.875*(pi/4)*d^2*T+(pi/4)*d^2*T//N//shearing resistance of rivet//N//shearing resistance of rivet
//Ps=Pt
//2100*(p-34.5)=Ps
//p=Ps/(2100)+34.5//mm
//pmax=C*t+41.28=220//mm
//since p&gt;pmax, therefore
p=220//mm
p'=220/2//mm
d1=0.2*p + 1.15*d//mm/diatnce between outtr and row and next row
d2=0.165*p+0.67*d//mm//distance ebtween inner row for zigzag riveting
t1=0.75*t//mm//thickness of wide strap
```

```
t2=0.625*t//mm//thickness of narrow strap
m=1.5*d//mm//margin
Pt=(p-d)*t*ft//N
Pc=5*d*t*fc//N//crushing resistance of rivet
P=p*t*ft//N//strength of the unriveted
//joint may also fail due to combine teARING AND shearing reistance
Pts=(p-2*d)*t*ft+(pi/4)*d^2*T//N
//eff=(least of Pt,Ps,Pts)/P
eff=Pts/P//least is Ps
//desing for circumferential joint
//let n be number of rivets
//shearign resistance of revets=total shearing load acting on circumferential joint
//n*pi*d^2*T/4=pi*D^2*P/4
//n=D^2*P/(d^2*T)//89.6 say 90
n=90
n1=90/2//number of rivets per row
//p1=pi(D+t)/n'//
//p1=113.7,say 140mm standard value'
p1=140//mm
effj=(p1-d)/(p1)
d3=0.33*p1+0.67*d//dis btw rows of rivets for zigzag
m1=1.5*d
printf("calcultion for longitudinal joint")
printf("the eff is,%f\n",eff)
printf("the pitch is,%f mm\n",p)
printf("the thickness of wide strap is,%f mm\n",t1)
printf("the thickness of narrow strap is,%f mm\n",t2)
printf("the diameter of rivets is,%f mm",d)
printf("the margine s,%f mm\n",m)
printf("the distance btw outer and next row is,%f mm\n",d1)
printf("the distance btw inner rows is,%f mm\n",d2)
printf("calculation for circumferencial joint\n")
printf("the num of rivets is,%f\n",n)
printf("the number of rivets per rwo for
```

```
    cercumferencial joint is,%f\n",n1)
printf("the distance btw rows of rivets for zigzag
    riveting is,%f mm\n",d3)
printf("the margin is,%f mm",m1)
```

**Scilab code Exa 9.11** Machine design

```

//solution
//given
b=200//mm
t=12.5//mm
ft=80//N/mm^2
T=65//N/mm^2
fc=160//N/mm^2
pi=3.14
printf("the value of d is,%f mm\n",6*sqrt(t))
//standard value of d=21.5mm
d=21.5//mm
//let n be number of rivets
Pt=(b-d)*t*ft//N
Ps=1.75*(pi/4)*d^2*T//N
Pc=d*t*fc//N
n=Pt/Ps
t1=0.75*t//mm
Pt1=(b-d)*t*ft//N
Pt2=(b-2*d)*t*ft+Ps//N
Pt3=(b-2*d)*t*ft+(3*Ps)//N
Ps5=5*Ps//N//for 5 rivets
Pc5=5*Pc//N//for 5 rivets
P=b*t*ft//N
printf("the value of forces is,%f N\n,%f N\n,%f N\n,
    %f N\n,%f N\n",Pt1,Pt2,Pt3,Ps5,Pc5)
//eff=least(Pt1.Pt2,Pt3,Ps5,Pc5)/P
eff=Pt1/P//since Pt1 is least
```

```
p=3*d +5//mm//pitch
m=1.5*d//mm
d1=2.5*d//mm//dis btw rows of rivets
printf("the diameter is,%f mm\n",d)
printf("the nuber of rivets is,%f\n",n)
printf("the thickness of strap is,%f mm\n",t1)
printf("the eff is,%f\n",eff)
printf("the pitch is,%f mm\n",p)
printf("the marginl pitch is,%f mm\n",m)
printf("the dis btw row is,%f mm",d1)
```

**Scilab code Exa 9.12** Machine design

```

clc
//solution
//given
b=350//mm
t=20//mm
ft=90//N/mm^2
T=60//N/mm^2
fc=150//N/mm^2
printf("the value of d is,%f mm\n",6*sqrt(t))
//d=26.8//mm
//standard value is d=29mm using table 9.7
d=29//mm
Pt=(b-d)*t*ft//N
Ps=1.75*(pi/4)*d^2*T//N
Pc=d*t*fc//N
n=Pt/Ps
t1=0.75*t//mm
Pt1=(b-d)*t*ft//N
Pt2=(b-2*d)*t*ft+Ps//N
Pt3=(b-3*d)*t*ft+(3*Ps)//N
Pt4=(b-3*d)*t*ft+(6*Ps)//N
```

```
Ps9=9*Ps//N//for 9 rivets
Pc9=9*Pc//N//for 9 rivets
P=b*t*ft//N
printf("the value of forces is ,%f N\n,%f N\n,%f N\n,%f N\n,%f N\n,%f N\n",Pt1,Pt2,Pt3,Pt4,Ps9,Pc9)
//eff=least(Pt1.Pt2,Pt3,Pt4,Ps9,Pc9)/P
eff=Pt1/P//since Pt1 is least
p=3*d +5//mm//pitch
m=1.5*d//mm
d1=2.5*d//mm//dis btw rows of rivets
printf("the diameter is ,%f mm\n",d)
printf("the nuber of rivets is ,%f\n",n)
printf("the thickness of strap is ,%f mm\n",t1)
printf("the eff is ,%f\n",eff)
printf("the pitch is ,%f mm\n",p)
printf("the marginl pitch is ,%f mm\n",m)
printf("the dis btw row is ,%f mm",d1)
```

**Scilab code Exa 9.13** Machine design

```

clc
//solution
//given
b=350//mm
t=20//mm
ft=90//N/mm^2
T=60//N/mm^2
fc=150//N/mm^2
printf("the value of d is ,%f mm\n",6*sqrt(t))
//d=26.8//mm
//standard value is d=29mm using table 9.7
d=29//mm
Pt=(b-d)*t*ft//N
Ps=1.75*(pi/4)*d^2*T//N
```

```
Pc=d*t*fc//N
n=Pt/Ps
t1=0.75*t//mm
Pt1=(b-d)*t*ft//N
Pt2=(b-2*d)*t*ft+Ps//N
Pt3=(b-3*d)*t*ft+(3*Ps)//N
Pt4=(b-3*d)*t*ft+(6*Ps)//N
Ps9=9*Ps//N//for 9 rivets
Pc9=9*Pc//N//for 9 rivets
P=b*t*ft//N
printf("the value of forces is,%f N\n,%f N\n,%f N\n,
    %f N\n,%f N\n,%f N\n",Pt1,Pt2,Pt3,Pt4,Ps9,Pc9)
//eff=least(Pt1.Pt2,Pt3,Pt4,Ps9,Pc9)/P
eff=Pt1/P//since Pt1 is least
p=3*d +5//mm//pitch
m=1.5*d//mm
d1=2.5*d//mm//dis btw rows of rivets
printf("the diameter is,%f mm\n",d)
printf("the nuber of rivets is,%f\n",n)
printf("the thickness of strap is,%f mm\n",t1)
printf("the eff is,%f\n",eff)
printf("the pitch is,%f mm\n",p)
printf("the marginl pitch is,%f mm\n",m)
printf("the dis btw row is,%f mm",d1)
```

**Scilab code Exa 9.14** Machine design

```

clc
//refer fig 9.24,9.25
//solution
//given
t=25//mm
P=50000//N
e=400//mm
```

```
n=7
T=65//N/mm^2
fc=120//N/mm^2
//let xb and yb be center of gravity
//xb=(x1+x2+x3+x4+x5+x6+x7)/7
xb=(100+200+200+200)/7//mm
//yb=(y1+y2+y3+y4+y5+y6+y7)/7
yb=(200+200+200+100+100)/7//mm
Ps=P/n
T1=P*e//turning moment due to P//N-mm
//l1=l3
l1=sqrt(100^2+(200-yb)^2)//mm
l3=sqrt(100^2+(200-yb)^2)//mm
l2=200-yb//mm
//l4=l7
l4=sqrt(100^2+(yb-100)^2)//mm
l7=sqrt(100^2+(yb-100)^2)//mm
//l5=l6
l5=sqrt(100^2+yb^2)//mm
l6=sqrt(100^2+yb^2)//mm
//eqauting the moments equal to each other
//P*e=(F1/l1)*[l1^2+l2^2+l3^2+l4^2+l5^2+l6^2+l7^2]
F1=(P*e*l1)/(l1^2+l2^2+l3^2+l4^2+l5^2+l6^2+l7^2)//N
F2=F1*l2/l1//N
F3=F1*l3/l1//N
F4=F1*l4/l1//N
F5=F1*l5/l1//N
F6=F1*l6/l1//N
F7=F1*l7/l1//N
//cos(q1)=100/l3=0.76=a
//cos(q4)=100/l4=0.99=b
//cos(q5)=100/l5=0.658=c
a=0.76
b=0.99
c=0.658
R3=sqrt(Ps^2+F3^2+2*F3*Ps*a)
R4=sqrt(Ps^2+F4^2+2*F4*Ps*b)
R5=sqrt(Ps^2+F5^2+2*F5*Ps*c)
```

```
printf("the value R3,R4,R5 are respctively ,%f N\n,%f N\n,%f N\n",R3,R4,R5)
//let d be diameter
pi=3.14
//from above we see that max lod is R5,therefore R5=P
//R5=(pi/4)*d^2*T
d=sqrt(R5*4/(pi*T))//mm
Lc=R5/(d*t)//max crushing load
printf("the  cordinates of centre of gravity are,%f mm\n,%f mm \n",xb,yb)
printf("the direct load is,%f N\n",Ps)
printf("the turning moment is,%f N-mm\n",T1)
printf("the values of Li respectively is,%f mm\n,%f mm\n,%f mm\n,%f mm\n,%f mm\n,%f mm\n,%f mm\n",l1,l2,l3,l4,l5,l6,l7)
printf("the shear loads(Forces F) acting are,%f mm\n,%f mm\n,%f mm\n,%f mm\n,%f mm\n,%f mm\n,%f mm\n",F1,F2,F3,F4,F5,F6,F7)
printf("the crushing stress is,%f N/mm^2\n ",Lc)
printf("the diameter is ,%f mm\n",d)
printf("since crushing load calculted is less then 120 N/mm^2,therefore desing is safe ")
```

**Scilab code Exa 9.15** Machine design

```

clc
//refer fig 9.24,9.25
//solution
//given
t=25//mm
P=50000//N
e=400//mm
n=7
```

```
T=65//N/mm^2
fc=120//N/mm^2
//let xb and yb be center of gravity
//xb=(x1+x2+x3+x4+x5+x6+x7)/7
xb=(100+200+200+200)/7//mm
//yb=(y1+y2+y3+y4+y5+y6+y7)/7
yb=(200+200+200+100+100)/7//mm
Ps=P/n
T1=P*e//turning moment due to P//N-mm
//l1=l3
l1=sqrt(100^2+(200-yb)^2)//mm
l3=sqrt(100^2+(200-yb)^2)//mm
l2=200-yb//mm
//l4=l7
l4=sqrt(100^2+(yb-100)^2)//mm
l7=sqrt(100^2+(yb-100)^2)//mm
//l5=l6
l5=sqrt(100^2+yb^2)//mm
l6=sqrt(100^2+yb^2)//mm
//eqauting the moments equal to each other
//P*e=(F1/l1)*[l1^2+l2^2+l3^2+l4^2+l5^2+l6^2+l7^2]
F1=(P*e*l1)/(l1^2+l2^2+l3^2+l4^2+l5^2+l6^2+l7^2)//N
F2=F1*l2/l1//N
F3=F1*l3/l1//N
F4=F1*l4/l1//N
F5=F1*l5/l1//N
F6=F1*l6/l1//N
F7=F1*l7/l1//N
//cos(q1)=100/l3=0.76=a
//cos(q4)=100/l4=0.99=b
//cos(q5)=100/l5=0.658=c
a=0.76
b=0.99
c=0.658
R3=sqrt(Ps^2+F3^2+2*F3*Ps*a)
R4=sqrt(Ps^2+F4^2+2*F4*Ps*b)
R5=sqrt(Ps^2+F5^2+2*F5*Ps*c)
printf("the value R3,R4,R5 are respctively ,%f N\n,%f
```

```
    N\n,%f N\n",R3,R4,R5)
//let d be diameter
pi=3.14
//from above we see that max lod is R5,therefore R5=
   P
//R5=(pi/4)*d^2*T
d=sqrt(R5*4/(pi*T))//mm
Lc=R5/(d*t)//max crushing load
printf("the  cordinates of centre of gravity are,%f
   mm\n,%f mm \n",xb,yb)
printf("the direct load is,%f N\n",Ps)
printf("the turning moment is,%f N-mm\n",T1)
printf("the values of Li respectively is,%f mm\n,%f
   mm\n,%f mm\n,%f mm\n,%f mm\n,%f mm\n,%f mm\n",l1,
   l2,l3,l4,l5,l6,l7)
printf("the shear loads(Forces F) acting are,%f mm\n
   ,%f mm\n,%f mm\n,%f mm\n,%f mm\n,%f mm\n,%f mm\n"
   ,F1,F2,F3,F4,F5,F6,F7)
printf("the crushing stress is,%f N/mm^2\n ",Lc)
printf("the diameter is ,%f mm\n",d)
printf("since crushing load calculted is less then
   120 N/mm^2,therefore desing is safe ")
```

**Scilab code Exa 9.16** Machine design

```

clc
//solution
//given
//refer fig 9.29 and 9.30
T=100//N/mm^2
n=4
d=20//mm
//Ps=P/4=0.25*P//N
e=100//mm
```

```
//T1=P*e//turning moment
//la=ld=200=100//mm
//lb=lc=100//mm
//eqauting the moments equal to each other
//P*e=(Fa/la)*[la^2+lb^2+lc^2+ld^2]
//P*e=(Fa/la)*[2*300^2+2*100^2]
//Fa=P*100*3/2000//N
//Fa=0.15*P//N
//Fb=Fa*lb/la=0.05*P//N
//Fc=Fa*lc/la=0.05*P//N
//Fd=Fa*ld/la=0.15*P//N
//Ra=Ps-Fa=0.1*P
//Rb=Ps-Fb=0.20*P
//Rc=Ps+Fc=0.30*p
//Rd=Ps+Fd=0.40*P//N
//max load is Rd
//therfore
pi=3.14
//Rd=(pi/4)*T*d^2
//0.40*P=(pi/4)*T*d^2
P=(pi/4)*T*d^2/0.40
printf("the value of force P is,%f N",P)
```

**Scilab code Exa 9.17** Machine design

```

clc
//solution
//given
n=6
P=60000//N
e=200//mm
T=150//N/mm^2
Ps=P/n
//l1=l3=l4=l6
```

```
l1=sqrt(75^2+50^2)//mm
l3=sqrt(75^2+50^2)//mm
l4=sqrt(75^2+50^2)//mm
l6=sqrt(75^2+50^2)//mm
l2=50//mm
l5=50//mm
//eqauting the moments equal to each other
//P*e=(F1/l1)*[l1^2+l2^2+l3^2+l4^2+l5^2+l6^2]
//P*e=(F1/l1)*[4*l1^2+2*l2^2]
F1=(P*e*l1)/(4*l1^2+2*l2^2)//N
F2=F1*l2/l1//N
F3=F1*l3/l1//N
F4=F1*l4/l1//N
F5=F1*l5/l1//N
F6=F1*l6/l1//N
//cos(q1)=50/l1=0.555=a
a=0.555
R3=sqrt(Ps^2+F3^2+2*F3*Ps*a)
R2=Ps+F2//N
printf("the value of forces is,%f N\n,%f N\n",R2,R3)
//R3&gt;R2
pi=3.14
P=(pi/4)*d^2*T
//R3=P
d=sqrt(R3/117.8)//mm
printf("the value of diameter is,%f mm\n",d)
printf("the standard diameter of is 19.5 mm ")
```

**Scilab code Exa 9.18** Machine design

```

clc
//solution
//given'
n=4
```

```
Ab=60//mm
Cd=60//mm
Bc=60//mm
P=100000//N
Ef=150//mm
q=30//deg
Ty=240//N/mm^2
Fs=1.5
Fb=125//N/mm^2
b=240//mm
//let d be diameter of rivet
Ps=P/n//N
e=Ef*sin(q)//mm
la=60+30//mm
ld=90//mm
//la=ld
//lb=lc
lb=30//mm
lc=30//mm
//eqauting the moments equal to each other
//P*e=(Fa/la)*[la^2+lb^2+lc^2+ld^2]
//10000*75=(Fa/la)*[2*90^2+2*30^2]
Fa=7500*1000*la/(2*90^2+2*30^2)//N
Fb=Fa*lb/la//N
Fc=Fa*lc/la//N
Fd=Fa*ld/la//N
a=-sqrt(3)/2//deg
b=-sqrt(3)/2//deg
c=sqrt(3)/2
d=sqrt(3)/2
Ra=sqrt(Ps^2+ Fa^2+ 2*Fa*Ps*a)
Rb=sqrt(Ps^2+ Fb^2+ 2*Fb*Ps*b)
Rc=sqrt(Ps^2+ Fc^2+ 2*Fc*Ps*c)
Rd=sqrt(Ps^2+ Fd^2+ 2*Fd*Ps*d)
printf("the value of Ps is ,%f N\n ",Ps)
printf("the value fo forces  rae ,%f N\n,%f n\n,%f n\n,%f N\n",Fa,Fb,Fc,Fd)
printf("the value of Ra,Rb,Rc and Rd are ,%f N\n,%f N
```

```
\n,%f N\n,%f N\n",Ra,Rb,Rc,Rd)
//since greatest is Rd,therfore Rd=P
pi=3.14
//P=(pi/4)*d^2*Ty/Fs//N
d1=sqrt(Rd/125.7)
printf("the diametr of rivet is %f mm\n",d1)
printf("choosing th standard value od d as 23.5 mm\n
")
```

# Chapter 10

# Ch10

**Scilab code Exa 10.1** Machine design

```

clc
//soltion
//given
b=100//mm//width
t=10//mm//thickness
P=80*10^3//N
T=55//N/mm^2
//let l and s be length of wled and size of weld
//s=t
s=10//mm
//P=1.414*s*l*T
l=P/(1.414*s*T)//mm
printf("the length of weld is ,%f mm",l+12.5)
```

**Scilab code Exa 10.2** Machine design

```

```

```
clc
//solution
//given
d=50//mm
s=10//mm
Imax=80//N/mm^2
pi=3.14
//let T be max toque
//Imax=(2.83*T)/(pi*s*d^2)
T=Imax*pi*s*d^2/(2.83)//N-mm
printf("the value of max torque is ,%f N-mm",T)
```

**Scilab code Exa 10.3** Machine design

```

//solution
//given
l=1000//mm
Imax=80//N/mm^2
s=15//mm
//let T be max toque
T=Imax*s*l^2/(4.242)//N-mm
printf("the value of max torque is ,%f N-mm",T)
```

**Scilab code Exa 10.4** Machine design

```

clc
//solution
//given
b=100//mm//width
t=12.5//mm//thickness
P=50*10^3//N
```

```
T=56//N/mm^2
//let l and s be length of wled and size of weld
//s=t
s=12.5//mm
//P=1.414*s*l*T
l=P/(1.414*s*T)//mm
printf("the value of length of static weld is ,%f mm\n",l+12.5)
T1=T/2.7//N
//P=1.414*s*l*T1
l1=P/(1.414*s*T1)//mm
printf("the value of length of static weld is ,%f mm",l1+12.5)
```

---

**Scilab code Exa 10.5** Machine design

```

clc
//solution
//given
//ref fig 10.15
b=75//mm//width
t=12.5//mm//thickness
ft=70//N/mm^2
T=56//N/mm^2
l1=b-t//mm
s=12.5//mm
//let l2 be length of each parallel fillet for static loading
//P=A*ft
P=b*t*ft//N//max load
P1=0.707*s*l1*ft//N
//P2=1.414*s*l2*T=990*l2//N
//P=P1+P2
l2=(P-P1)/990//mm
```

```
printf("the value of length of static weld is,%f mm\n",l2+12.5)
//length of parallel fillet for fatique loading
ft1=ft/1.5//N/mm^2
T1=T/2.7//N/mm^2
P11=0.707*s*l1*ft1//N
//P2=1.414*s*l2*T1=366*l22//N
//P=P1+P2
l22=(P-P11)/366//mm
printf("the value of length of static weld is,%f mm\n",l22+12.5)
```

**Scilab code Exa 10.6** Machine design

```

clc
//solution
//given
//refer fig 10.16
b=120//mm//width
t=15//mm//thickness
l1=b-12.5//mm
s=15//mm
ft1=70//N/mm^2//tensile stress
ft2=56//N/mm^2//shear stress
//let l2 be length of weld
//P=A*ft
P=120*15*ft1//N
ft11=ft1/1.5//N/mm^2
ft22=ft2/2.7//N/mm^2
P1=0.707*s*l1*ft11//N
//P2=0.707*s*l2*ft22=440*l2//N
//P=P1+P2//N
l2=(P-P1)/440//mm
printf("the value of length of static weld is,%f mm\
```

```
   n",l2+12.5)
```

**Scilab code Exa 10.7** Machine design

```

clc
//solution
//given
//refer fig 10.16
b=120//mm//width
t=15//mm//thickness
l1=b-12.5//mm
s=15//mm
ft1=70//N/mm^2//tensile stress
ft2=56//N/mm^2//shear stress
//let l2 be length of weld
//P=A*ft
P=120*15*ft1//N
ft11=ft1/1.5//N/mm^2
ft22=ft2/2.7//N/mm^2
P1=0.707*s*l1*ft11//N
//P2=0.707*s*l2*ft22=440*l2//N
//P=P1+P2//N
l2=(P-P1)/440//mm
printf("the value of length of static weld is ,%f mm\
   n",l2+12.5)
```

**Scilab code Exa 10.8** Machine design

```

clc
//solution
//given
```

```
//ref fig 10.21
P=200*10^3//n
T=75//N/mm^2
s=10//mm
//a+b=200//mm
//let la=length of weld at top
//lb=length of weld at bottom
//l=la+lb//total length of belt
//P=0.707*s*l*T
l=P/(0.707*s*T)//mm
b=[(200-10)*10*95+(150*10*5)]/(190*10+1500)//mm
a=200-b//mm
la=l*b/(a+b)//mm
lb=l-la//mm
printf("the value of length at top and bottom is ,%f
   mm\n,%f mm",la,lb)
```

**Scilab code Exa 10.9** Machine design

```

clc
//solution
//given
P=2000//N
e=120//mm
l=40//mm
Tmax=25//N/mm^2
//let s be size of weld and t be throat thickness
//ref fig 10.24
//A=2*t*l
//A=2*0.707*s*l
//A=2*0.707*s*40
//A=56.56*s//mm^2
//t=P/A
//t=35.4/s//N/mm^2
```

```
M=P*e//N-mm
//Z=s*l^2/(4.242)//section modulus//mm^3
//fb=M/Z//
//fb=P*e/Z//
//fb=636.6/s
//Tmax=0.5*[sqrt(fb^2+4*t^2)]
//25=320.3/s
s=320.3/25//mm
printf("the sieze of weld is,%f mm",s)
```

**Scilab code Exa 10.10** Machine design

```

clc
//solution
//given
//ref fig 10.25
D=50//mm
s=15//mm
P=10000//N
e=200//mm
//let t is thickness of throat
//A=t*pi*D
pi=3.14
A=0.707*s*pi*D//mm^2
t=P/A//N/mm^2
M=P*e//N-mm
Z=pi*.707*s*D^2/4//mm^3
fb=M/Z//N/mm^2
ftmax=(0.5*fb)+(0.5*sqrt(fb^2+4*t^2))//N/mm^2
Tmax=(0.5*sqrt(fb^2+4*t^2))//N/mm^2
printf("the max normal stress and shear stress are,
    %f N/mm^2\n,%f N/mm^2 respectively",ftmax,Tmax)
```

**Scilab code Exa 10.11** Machine design

```

clc
//solution
//given
//ref fig 10.26
P=25*10^3//N
Tmax=75*10^3//N
l=100//mm
b=150//mm
e=500//mm
//let t is thickness of throat and s size
//t=0.707*s
//A=t*(2*b+2*l)=353.5*s//mm^2
//t=P/A
//t=70.72/s//N/mm^2
M=P*e//N-mm
//Z=t*[b*l+ b^2/3]=15907.5*s//mm^3
//fb=M/Z//
//fb=P*e/Z//
//fb=785.8/s//N/mm^2
//Tmax=0.5*[sqrt(fb^2+4*t^2)]
//75=399.2/s
s=399.2/75//mm
printf("the sieze of weld is,%f mm",s)
```

**Scilab code Exa 10.12** Machine design

```

clc
//solution
```

```
//given
//ref fig 10.27
P=15*10^3//N
Tmax=120//N/mm^2
d=80//mm
//let s be size of weld
T=P*240//N-mm//torque
//t=(2.83*T)/(pi*s*80^2)=506.6/s
M=P*175//N-mm
//fb=(5.66*M)/(pi*s*80^2)=(738.8/s)//N/mm^2
//Tmax=0.5*(sqrt(fb^2+t^2))
//Tmax=627/s
s=627/Tmax//mm
printf("the sieze of weld is ,%f mm",s)
```

**Scilab code Exa 10.13** Machine design

```

clc
//solution
//given
//ref fig 10.28
P=15000//N
T=80//N/mm^2
b=80//mm
l=50//mm
e=125//mm
//let s be size of weld
//A=2*t*l//70.7*s//mm^2
//T1=P/A//N/mm^2//direct stress
//T1=212/s
//J=t*l*(3*b^2+l^2)/6//mm^4
//J=127850*s//mm^4
ab=40//mm
bg=25//mm=r1
```

```
r2=(sqrt(ab^2+bg^2))//mm
printf("the value of r2 is ,%f mm\n",r2)
//T2=P*e*r2/J
//T2=689.3/s//N/mm^2
//cos(q)=r1/r2=25/47=0.532
a=0.532
//T=sqrt(T1^+T2^2+2*T1*T2*a)
//80=822/s
s=822/80//mm
printf("the sieze of weld is ,%f mm",s)
```

**Scilab code Exa 10.14** Machine design

```

clc
//solution
//given
//ref fig 10.28
P=15000//N
T=80//N/mm^2
b=80//mm
l=50//mm
e=125//mm
//let s be size of weld
//A=2*t*l//70.7*s//mm^2
//T1=P/A//N/mm^2//direct stress
//T1=212/s
//J=t*l*(3*b^2+l^2)/6//mm^4
//J=127850*s//mm^4
ab=40//mm
bg=25//mm=r1
r2=(sqrt(ab^2+bg^2))//mm
printf("the value of r2 is ,%f mm\n",r2)
//T2=P*e*r2/J
//T2=689.3/s//N/mm^2
```

```
//cos(q)=r1/r2=25/47=0.532
a=0.532
//T=sqrt(T1^+T2^2+2*T1*T2*a)
//80=822/s
s=822/80//mm
printf("the sieze of weld is ,%f mm",s)
```

**Scilab code Exa 10.15** Machine design

```

clc
//solution
//given
//ref fig 10.32 and 33
s=6//mm
P=20*10^3//N
l=40//mm
b=90//mm
//let t throat thickness
//let x is distance of Cg from left edge
x=l^2/(2*l+b)//mm
//J=t*[(b+2*l)^3/12-(l^2*(b+l)^2/(b*2*l))]
J=0.707*s*[{(b+2*l)^3/12}-{(l^2*(b+l)^2)/(b+2*l)}]//mm^4
printf("the value of J is ,%f mm^4\n",J)
Bg=40
e=200-x//mm
r1=Bg-x//mm
Ab=(90/2)//mm
r2=sqrt(Ab^2+Bg^2)//mm
//cos(q)=r2/r1=0.5625
a=0.5625
A=2*0.707*s*l+(0.707*s*b)//mm^2
t1=P/A//N/mm^2'
t2=P*e*r2/J//N/mm^2
```

```
T=sqrt(t1^2 + t2^2 + 2*t1*t2*a)//N/mm^2'
printf( "the value of x is ,%f mm\n",x)
printf("the value of direct shear stress is ,%f N/mm^2\n",t1)
printf("the value of secondary shear stress is ,%f N/mm^2\n",t2)
printf("the max shera stress is ,%f N/mm^2",T)
```

**Scilab code Exa 10.16** Machine design

```

clc
//solution
//given
//ref fig 10.34
P=15000//N
t=150//N/mm^2
l=25//mm
//Pva+Pvb=P,Pva=Pvb
Pva=P/2//N
Pvb=P/2//N
//balnce moments abt B
Pha=(P*50)/75//N
//let s1 be size at top
Pa=sqrt(Pva^2+Pha^2)//N
printf("the value of force at A is ,%f N\n",Pa)
//Pa=thorat area* permissible stress
//Pa=0.707*s1*l*t=0.707*s1*25*150=2650*s1
s1=Pa/2650//mm
printf("the size of weld at top is ,%f mm\n",s1)
//let s2 be size at bottom
//Pvb=0.707*s2*l*t
//Pvb=2650*s2
s2=Pvb/2650//mm
printf("the size of weld at bottom is ,%f mm\n",s2)
```

# Chapter 11

# Ch11

**Scilab code Exa 11.1** Machine design

```
//find safe tensile load
clc
//soltuion
//given
d=30//mm
ft=42//N/mm^2
//using table 11.1,area corresponding to d=30mm is A
    =561//N/mm^2
A=561//mm^2
F=A*ft//N
printf("the value of force is,%f N",F)
```

**Scilab code Exa 11.2** Machine design

```
//find stress
clc
//solution
//given
```

```
d=24//mm
//using table 11.1,area corresponding to d=24mm ,
   core diameter dc is=20.32//mm
dc=20.32//mm
//let ft is stress
P=2840*d//N
pi=3.14
//P=A*ft
A=(pi/4)*dc^2
ft=P/(A)//N/mm^2
printf("the stress acting is,%f N/mm^2",ft)
```

**Scilab code Exa 11.3** Machine design

```
//find nominal diameter of bolt
clc
//solution
//given
//ref fig 11.22
P=60000//N
ft=100//N/mm^2
//let d nominal diameter and dc core dia
//P=ft/A
//A=(pi/4)*dc^2
pi=3.14
dc=sqrt(P*4/(pi*ft))
printf("the value of dc is,%f mm\n",dc)
printf("the nominal value of d is 33 mm fron T11.1")
```

**Scilab code Exa 11.4** Machine design

```
//find size of bolts
clc
```

```
//solution
//given
T=25*10^3//N-mm
n=4
Rp=30//mm
t=30//N/mm^2
Ps=T/Rp//N//shearing load
//let dc be core dia
//P=t*n*A
//A=(pi/4)*dc^2
pi=3.14
//P=t*n*(pi/4)*dc^2=94.26*dc^2
//P=Ps
dc=sqrt(Ps/94.26)//mm
printf("the value of dc is,%f mm\n",dc)
printf("the standard value of core diametr  is 3.141 mm fron T11.1")
```

---

**Scilab code Exa 11.5** Machine design

```
//find dia meter of threaded part
clc
//solution
//given
D=100//mm
p=1.6//N/mm^2
ft=50//N/mm^2
pi=3.14
A=(pi/4)*D^2
F=A*p//N
printf("the value of force is,%f N\n",F)
//since leverage is 8,therfor
W=F/8//N
P=F-W
//let dc be core dia'
```

```
//P=(pi/4)*dc^2*ft
dc=sqrt(P*4/(pi*ft))//mm
printf("the value of core dai is ,%f mm\n",dc)
printf("the standard value of core diametr  is 18.376 mm fron T11.1")
```

---

**Scilab code Exa 11.6** Machine design

```
//caLCULATE the nmber ans size of studs
clc
//soltuion
//given
D=350//mm
p=1.25//N/mm^2
ft=33//N/mm^2
//let d be diameter of studs and dc be core daimeter of studs
pi=3.14
P=(pi/4)*D^2*p//N
//assuming nominal dia of studs =24, corrsponding dc =20.32//mm
d=24//mm
dc=20.32//mm
//P1=(pi/4)*dc^2*ft*n
n=P*4/(pi*dc^2*ft)
printf("the value of nukmber of studs is ,%f \n",n)
printf("let us assume the value of nukmber of studs is 12\n" )
d1=25//mm//dia of stid hole
t=10//mm//assume
Dp=D+2*t+3*d1//mmm
printf("the value of pitch dia is ,%f mm\n",Dp)
Pc=(pi*Dp)/(12)//n=12//mm//circumferential pitch
printf("the value of circumferential pitch is ,%f mm\n",Pc)
```

```
x1=20*sqrt(d1)//mm
x2=30*sqrt(d1)//mm
printf("the lower and upper limet of circumferential pitch is ,%f mm\n and ,%f mm",x1,x2)
printf("since Pc lies btw x1 and x2,hence design is safe")
printf("the size of stud is M24")
```

**Scilab code Exa 11.7** Machine design

```
//desing th cover plate
clc
//solution
//given
D=120//mm
r=60//mm
p=6//N/mm^2
ft=60//N/mm^2
ftb=40//N/mm^2
t=r*[sqrt((ft+p)/(ft-p))-1]//mm
printf("the value of thicness is ,%f mm\n",t)
printf("let us consider t=10mm\n")
//let d be nominal dia,dc core dia,nnumber of bolts
pi=3.14
P=(pi/4)*D^2*p//N
//let us assume d=24//mm, corrsponding dc=20.32/
d=24//mm
dc=20.32//mm
//P1=(pi/4)*dc^2*ftb*n//resistance offered by n bolts
//P1=12973*n//N
//P=P1
n=P/12973
printf("the value of number of studs is ,%f \n",n)
printf("let us assume the value of number of studs
```

```
    is 6\n" )
d1=25//mm//dia of stid hole
t=10//mm//assume
Dp=D+2*t+3*d1//mmm
printf("the value of pitch dia is,%f mm\n",Dp)
Pc=(pi*Dp)/(6)//n=12//mm//circumferential pitch
printf("the value of circumferential pitch is,%f mm\
    n",Pc)
x1=20*sqrt(d1)//mm
x2=30*sqrt(d1)//mm
printf("the lower and upper limet of circumferential
     pitch is,%f mm\n and ,%f mm\n",x1,x2)
printf("since Pc lies btw x1 and x2,hence design is
    safe\n")
printf("the size of bolt is M24")
```

**Scilab code Exa 11.8** Machine design

```
//find size of bolt required
clc
//soltuion
//given
D=300//mm
p=1.5//N/mm^2
n=8
fy=330//N/mm^2
fe=240//n/mm^2
//P1=1.5*P2
Fs=2
K=0.5
pi=3.14
P2=(pi/4)*D^2*p//N
P1=1.5*P2//N
Pmax=P1+K*P2//N
printf("the max force on head  is,%f N\n",Pmax)
```

```
Pmax1=Pmax/n//N//load on each bolt
Pmin=P1/n//N
Pm=(Pmin+Pmax1)/2//N//average load
Pv=(Pmax1-Pmin)/2//N//variable load
printf("the mean and vaiable load acting are Pm and Pv,%f N\n,%f N\n",Pm,Pv)
//let dc core diametr of bolt in mm
//As=(pi/4)*dc^2//mm^2//stress area of bolt
//fm=Pm/As=29534/dc^2//N/mm^2
//fv=Pv/As=4220/dc^2//N/mm^2
//acc to soderberg's formula ,
//fv=fe[(1/Fs)-(fm/fy)]
//4420/dc^2=240*[(1/2)-29534/(dc^2*330)]
dc=sqrt(25700/120)//mm
printf("the value of core dai is,%f mm\n",dc)
printf("the standard value of core diametr  is 14.933 mm fron T11.1")
```

**Scilab code Exa 11.9** Machine design

```
//find size of bolt required
clc
//soltuion
//given
D=300//mm
p=1.5//N/mm^2
n=8
fy=330//N/mm^2
fe=240//n/mm^2
//P1=1.5*P2
Fs=2
K=0.5
pi=3.14
P2=(pi/4)*D^2*p//N
P1=1.5*P2//N
```

```
Pmax=P1+K*P2//N
printf("the max force on head  is,%f N\n",Pmax)
Pmax1=Pmax/n//N//load on each bolt
Pmin=P1/n//N
Pm=(Pmin+Pmax1)/2//N//average load
Pv=(Pmax1-Pmin)/2//N//variable load
printf("the mean and vaiable load acting are Pm and
   Pv,%f N\n,%f N\n",Pm,Pv)
//let dc core diametr of bolt in mm
//As=(pi/4)*dc^2//mm^2//stress area of bolt
//fm=Pm/As=29534/dc^2//N/mm^2
//fv=Pv/As=4220/dc^2//N/mm^2
//acc to soderberg's formula ,
//fv=fe[(1/Fs)-(fm/fy)]
//4420/dc^2=240*[(1/2)-29534/(dc^2*330)]
dc=sqrt(25700/120)//mm
printf("the value of core dai is,%f mm\n",dc)
printf("the standard value of core diametr  is
   14.933 mm fron T11.1")
```

**Scilab code Exa 11.10** Machine design

```
//find size mild steel
clc
//solution
//given
p=0.84//N/mm^2
ft=56//N/mm^2
//ref fig 11.29
//since pince is 350 mm,therfor area ia A
A=350*350//mm^2
P=A*p//N
printf("the value of force acting is,%f N\n",P)
//let dc be core diameter
pi=3.14
```

```
//P=(pi/4)*dc^2*ft//N
dc=sqrt((P*4)/(pi*ft))
printf("the value of dc is,%f mm\n",dc)
printf("the standard value of core diametr  is
   49.177 mm fron T11.1")
```

**Scilab code Exa 11.11** Machine design

```
//determine diameter of hole
Do=48//mm
//from table 11.1 ,core dia Do=48//mm,Dc=41.795//mm
Do=48//mm
Dc=41.795//mm
D=sqrt(Do^2-Dc^2)//mm
printf("the dia of bolt is,%f mm",D)
```

**Scilab code Exa 11.12** Machine design

```
//determine the size of bolts
clc
//solution
//given
//ref fig 11.31
W=30000//N
ft=60//N/mm^2
L1=80//mm
L2=250//mm
L=500//mm
Wt1=W/4//N
printf("the value of Wt1 is,%f N\n",Wt1)
w=(W*L)/(2*(L1^2+L2^2))//N/mm
printf("the value of w is,%f N/mm\n",w)
Wt2=w*L2//N
```

```
printf("the value of Wt2 is,%f N\n",Wt2)
Wt=Wt1+Wt2//N
printf("the value of Wt is,%f N\n",Wt)
pi=3.14
//klet dc be coire dia
dc=sqrt((Wt*4)/(pi*ft))//mm
printf("the core diameter of bolt is,%f mm",dc)
```

**Scilab code Exa 11.13** Machine design

```
//determine the size of bolts
clc
//solution
//given
//ref fig 11.31
W=30000//N
ft=60//N/mm^2
L1=80//mm
L2=250//mm
L=500//mm
Wt1=W/4//N
printf("the value of Wt1 is,%f N\n",Wt1)
w=(W*L)/(2*(L1^2+L2^2))//N/mm
printf("the value of w is,%f N/mm\n",w)
Wt2=w*L2//N
printf("the value of Wt2 is,%f N\n",Wt2)
Wt=Wt1+Wt2//N
printf("the value of Wt is,%f N\n",Wt)
pi=3.14
//klet dc be coire dia
dc=sqrt((Wt*4)/(pi*ft))//mm
printf("the core diameter of bolt is,%f mm",dc)
```

**Scilab code Exa 11.14** Machine design

```
//find the size of the bolts
clc
//solution
//given
//ref fig 11.35
W=12000//N
L=400//mm
L1=50//mm
L2=375//mm
ft=84//N/mm^2
n=4
Ws=W/n//shear load on each bolt
Wt=0.5*[[W*L*L2]/[L1^2 +L2^2]]//N
Wte=0.5*[Wt + sqrt(Wt^2 +4*(Ws)^2)]//N//equivalent
    tensile load
//let dc be core dia
pi=3.14
//A=(pi/4)*dc^2*ft=66*dc^2
dc=sqrt(Wte/66)//mm
//let tabd b be thickness and depth of arm
//Z=(1/6)*t*b^2
M=W*L//N-mm
Z=M/84//
//asume b=250
b=250//mm
//Z=b^2*t/6
t=(M*6)/(ft*b^2)
printf("the value of core diameteris , %f mm\n",dc)
printf("the standard value of core diametr  is
    11.546 mm fron T11.1\n")
printf("the value of equivalent tensile load is,%f N
    \n",Wte)
printf("the value tensile load is,%f N\n",Wt)
printf("the value of load actiung on each bolt is,%f
     N\n",Ws)
printf("the moment acting is,%f N-mm\n",M)
```

```
printf("the value of thickness is ,%f mm",t)
```

**Scilab code Exa 11.15** Machine design

```
//find the size of the bolts
clc
//solution
//given
//ref fig 11.35
W=12000//N
L=400//mm
L1=50//mm
L2=375//mm
ft=84//N/mm^2
n=4
Ws=W/n//shear load on each bolt
Wt=0.5*[[W*L*L2]/[L1^2 +L2^2]]//N
Wte=0.5*[Wt + sqrt(Wt^2 +4*(Ws)^2)]//N//equivalent
    tensile load
//let dc be core dia
pi=3.14
//A=(pi/4)*dc^2*ft=66*dc^2
dc=sqrt(Wte/66)//mm
//let tabd b be thickness and depth of arm
//Z=(1/6)*t*b^2
M=W*L//N-mm
Z=M/84//
//asume b=250
b=250//mm
//Z=b^2*t/6
t=(M*6)/(ft*b^2)
printf("the value of core diameteris , %f mm\n",dc)
printf("the standard value of core diametr  is
    11.546 mm fron T11.1\n")
printf("the value of equivalent tensile load is ,%f N
```

```
    \n",Wte)
printf("the value tensile load is,%f N\n",Wt)
printf("the value of load actiung on each bolt is,%f
    N\n",Ws)
printf("the moment acting is,%f N-mm\n",M)
printf("the value of thickness is,%f mm",t)
```

**Scilab code Exa 11.16** Machine design

```
//find a.)dia of fixing bolts,b.)dimension of arms
clc
//soltuion
//given
//refer fig 11.39
W=10000//N
q=60//deg
f1=100//N/mm^2
t=60//N/mm^2
Wh=W*sin(%pi/3)//N
printf("the horizontal component is,%f N\n",Wh)
Wv=W*cos(pi/3)//N
printf("the vertical component is,%f N\n",Wv)
Wt1=Wh/4//force on each bolt//N
printf("the direct tensile load on each bolt is,%f N
    \n",Wt1)
x1=0.05//m//distance of horizontal component from CG
Th=Wh*x1//N-m//torque due to horizntl compnt
Ws=Wv/4//N//shear load on each bolt
printf("shear load on each boltis,%f N\n",Ws)
x2=0.3//m
Tv=Wv*x2//N-m
Tn=Tv-Th//N-m//net moment
printf("net moment is,%f N-m\n",Tn)
L1=(250-175)/2000//m//dis btw 1 and 2 bolt
L3=L1+0.175//m//dis btw 3 and 4 bolt
```

```
printf("the value of L3 is ,%f m\n",L3)
//let w be load  on each bolt
//Te=2*(w*L1)*L1 + 2*(w*L2)*L2=2*w(L1^2 +L2^2)// total moment abt E
//Te=0.093*w//N-m
w=Tn/0.093//N/m
printf("the laod on each per meter distance from E is ,%f N/m\n",w)
L2=180//mm
Wt2=w*L3//N
printf("the value of Wt1 is  ,%f N\n",Wt1)
printf("the value of Wt2 is ,%f N\n",Wt2)
Wt=Wt1+Wt2//N
printf("the value of total force is ,%f N\n",Wt)
Wte=0.5*[Wt + sqrt(Wt^2 + 4*Ws^2)]//N
printf("the value of equivalent force is ,%f N\n",Wte)
//let dc be core dia
dc=sqrt((4*Wte)/(pi*f1))//mm
printf("the value of core dia is ,%f mm\n",dc)
printf("the valuf of core dia from tabl 11.1 instandard condition is 8.18mm\n")
//let t be thickness and b be the width ,b=3*t
//A=3*b*t=9*t^2//mm^2
//I={[b*(2*t +b)^3]/12}-{(b-t)*b^3/12}
//I=321*t^4/12
//Z=I/(t+0.5*b)=10.7*t^3//mm^3
//ft1=Wh/A=962/t^2//N/mm^2
Mh=Wh*0.05//N-m
//ft2=Mh/Z=40.5*10^3/t^3//N/mm^2
//Ty=Wv/A=556/t^3//N/mm^2
Mv=Wv*0.3//N-m
//ft3=Mv/Z=140.2*10^3/t^3//N/mm^2
//Ftnet=ft1-ft2+ft3 //N/mm^2
//Ftnet=(962/t^2)-(40.5*10^3/t^3)+(140.210^3/t^3)
//Ftnet=(962/t^2)+(99.7*10^3/t^3)
Ftnet=100//N/mm^2
//by hit and trial
```

```
//'Ftnet=100=(962/t^2)+(99.7*10^3/t^3)
t=10.4//mm
b=3*t//mm
printf("the thickness is,%f mm\n",t)
printf("the width is,%f mm",b)
```

**Scilab code Exa 11.17** Machine design

```
//find size of bolts
clc
//solution
//given
//ref fig 11.42
n=8
d=1.6//m
r=0.8//m
D=2//m
R=1//m
W=100000//N
e=5//m
ft=100//N/mm^2
L=e-R//m
//let dc be core dia
pi=3.14
Wt=(2*W*L*(R+r))/(n*(2*R^2+r^2))//N
printf("the max load acting is,%f N\n",Wt)
dc=sqrt((W*4)/(pi*ft))//mm
printf("the core dia is,%f mm\n",dc)
printf("the standard value of core dia is 31.093
   from table 11.1")
```

**Scilab code Exa 11.18** Machine design

```
//find size of bolts
clc
//solution
//given
n=4
d=500//mm
r=250//mm
D=650//mm
R=325//mm
W=400*10^3//N
L=350//mm
ft=60//N/mm^2
//let dc be core dia
pi=3.14
Wt=[(2*W*L)*{R+r*cos(pi/n)}]/{n*(2*R^2 +r^2)}
printf("the value of load acting is,%f N\n",Wt)
```

**Scilab code Exa 11.19** Machine design


```
//find size of bolts
clc
//solution
//given
n=4
d=500//mm
r=250//mm
D=650//mm
R=325//mm
W=400*10^3//N
L=350//mm
ft=60//N/mm^2
//let dc be core dia
pi=3.14
Wt=[(2*W*L)*{R+r*cos(pi/n)}]/{n*(2*R^2 +r^2)}
printf("the value of load acting is,%f N\n",Wt)
```

# Chapter 12

# Ch12

**Scilab code Exa 12.1** Machine design

```
//desing cotter joint
clc
//solution
//given
P=30*10^3//N
ft=50//N/mm^2
t=35//N/mm^2
fc=90//N/mm^2//crushing stress
//let d be diameter of rods
pi=3.14
//P=A*ft
//P=(p1/4)*d^2*ft
d=sqrt((P*4)/(pi*ft))
printf("the dia nof cotter jont is ,%f mm\n",d)
//let d2 be dia of spigot and t11 be thickness
//t11=d2/4
//P=[{(pi/4)*d2^2}-(d2*t)]*ft=26.8*d2^2
d2=sqrt(P/26.8)//mm
t11=d2/4//mm
//let fc1 be induced crushing stress
fc1=P/(d2*t11)//N/mm^2
```

```
printf("the induced crushing stress is,%f N/mm^2\n ",fc1)
printf("since induced stress is greater then 90 N/mm^2,therefore d2 an t are not safe limits,let us find d2 and t by substituitn fc1=90\n")
//let d2=d21 and t=t1
//P=d21*t1*fc
//P=22.5*d2^2
d21=sqrt(P/22.5)//mm
t1=d21/4//mm
printf("the safe values od d2 and t are ,%f mm\n,%f mm\n",d21,t1)
//let b be width of cotter
//P=2*b*t1*t=(2*9.12*35)*b
b=P/(2*9.12*35)//mm
printf("the width of cotter is,%f mm\n ",b)
//let d4 be dia of socket collar
//P=(d4-d2)*t1*fc
d4=d21+(P/(t1*fc))//mm
printf("the diametr of socket collar is,%f mm\n",d4)
//let c be the thickness of socket collar
//P=2*(d4-d2)*c*t
c=P/(2*(d4-d21)*t)//mm
printf("the thicknes of socket collar is,%f mm\n",c)
//let a be distance from end of slot to end of the rod
//P=2*a*d21*t
a=P/(2*d21*t)//mm
printf("distance from end of slot to end of the rod is,%f mm\n",a)

//let d3 be dia of spigot collar
//P=(pi/4)*[d3^2-d21^2]*fc
//d3^2=d21^2 + (P*4)/(90*pi)
d3=sqrt(d21^2 + (P*4)/(90*pi))//mm
printf("dia of spigot collar is,%f mm\n",d3)
//let T1 be thickness of spigot collar
//P=pi*d21*T1*t
```

```
T1=P/(pi*d21*t)//
printf("thickness of spigot collar is,%f mm\n",T1)
printf("let thickness of spigot collar be T1=8mm=T12")
//let l be lengt of cotter
T12=8//mm
printf("the thicness of spigot colar is,%f mm\n",T12)
l=4*d//mm
e=1.2*d//mm
printf("the length of cotter and e is,%f mm\n,%f mm\n",l,e)
```

**Scilab code Exa 12.2** Machine design

```

clc
//solution
//given
P=60*10^3//N
ft=60//N/mm^2
t=70//N/mm^2
fc=125//N/mm^2
pi=3.14
//let d be diameter of rods
//P=A*ft
//P=(p1/4)*d^2*ft
printf("the dia of cotter jont is,%f mm\n",sqrt((P*4)/(pi*ft)))
printf("the standard dia of cotter jont is d=26mm\n")
d=36//mm
//let d2 be dia of spigot and t11 be thickness
//t11=d2/4
//P=[{(pi/4)*d2^2}-(d2*t)]*ft=32.13*d2^2
```

```
//d2=sqrt(P/32.13)//mm
//t11=d2/4//mm
printf("the dia d2 is ,%f mm\n",sqrt(P/32.13))//mm)
printf("the dia d2 is 44mm\n")
d2=44//mm
printf("the thickness is ,%f mm\n",d2/4)
printf("the thckness is ,11mm\n")
t11=11//mm
//let fc1 be induced crushing stress
//fc1=P/(d2*t11)//N/mm^2
printf("the value of d2 is ,%f mm\n",d2)
printf("the induced crushing stress is ,%f N/mm^2\n ",P/(d2*t11))
printf("the induced crushing stress is say 124 N/mm^2 whihc is less then 125,hence d2 and t11 is correct\n")
//let b be width of cotter
//P=2*b*t11*t=(2*11*70)*b
//b=P/(2*11*70)//mm
printf("the width of cotter is ,%f mm\n ",P/(2*11*70))
printf("the width of cotter is say 40mm\n")
//let a be distance from end of slot to end of the rod
//P=2*a*d21*t
//a=P/(2*d2*t)//mm
printf("distance from end of slot to end of the rod is ,%f mm\n",P/(2*d2*t))
printf("distance from end of slot to end of the rod is say 10mm")
//let c be distance of rod end from its end to cottre hole
//P=2*(d1-d2)*c*t=2240*c
c=P/(2240)//mm
printf("istance of rod end from its end to cottre hole is ,%f mm",c)
```

**Scilab code Exa 12.3** Machine design

```

//solution
//given
P=50*10^3//N
d=75//mm
ft=25//N/mm^2
t=20//N/mm^2
//let B1 be the width of strap
//B1=d
B1=75//mm
//t11=B1/4//mm
printf("the thickness is ,%f mm\n",B1/4)
printf("the thickness can be taken as 20mm\n ")
t11=20//mm
//let t1 be thickness of strap at thnner side
//P=2*B1*t1*ft//N
//t1=P/(2*B1*ft)//mm
printf("the thickness of strap at thinner side is ,%f
    mm\n ",P/(2*B1*ft))
printf("the thickness can be takn as 15 mm\n")
t1=15//mm
//let t3 be thickness of strap at cotter
//2*t3*(B1-t)=2*t1*B1
//t3=(2*t1*B1)/(2*(B1-t))//mm
printf("thickness of strap at cotter is ,%f mm\n",(2*
    t1*B1)/(2*(B1-t)))
printf("thickness of strap at cotter  say 21mm\n")
t3=21//mm
//let B be total width of gib and cotter
//P=2*B*t11*t
//B=P/(2*t11*t)//mm
printf("the total width of gib and cotter is ,%f mm\n
```

```
",P/(2*t11*t))
printf("the total width of gib and cotter is say 65 mm")
```

**Scilab code Exa 12.4** Machine design

```

clc
//solution
//given
P=35*10^3//N
ft=20//N/mm^2
t=15//N/mm^2
fc=50//N/mm^2
//let x be side of square rod
//P=x^2*ft//N
//x=sqrt(P/ft)//mm
printf("the side of square is ,%f mm\n",sqrt(P/ft))
printf("the side of square is ,say x=42mm\n")
//B1=x=42mm
x=42//mm
B1=42//mm//width of strap
//let t1 be thickness
//t1=B1/4//mm
printf("the width of strap is ,%f mm\n",B1)
printf("the thickness of cottar is ,%f mm\n",B1/4)
printf("the thickness of cottar is ,say 12mm\n")
t1=12//mm
//let B be width of gib and cotter
//P=2*B*t*t1=360*B
//B=P/360//mm
printf("the width of gib and cotter is ,%f mm ",P
    /360)
printf("The width of gib and cotter is ,say100mm\n")
B=100//mm
```

```
b1=0.55*B//mm//width of gib
b=0.45*B//mm//width of cotter
printf("the width of cotter and gib is,%f mm\n,%f mm\n respctively",b,b1)
//let t2 be thickness of strap
//P=2*((x*t2)-(t2*t1))*ft=1200*t2
//t2=P/1200//mm
printf("the thickness of strap is,%f mm\n",P/1200)
printf("the thickness of strap is,Say 30mm\n")
t2=30//mm
//P=2*t2*t*fc1=720*fc1
fc1=P/720//N/mm^2
printf("the induced crushing stress is,%f N/mm^2\n ",fc1)
printf("since induced stress is less then  safe limits\n")
//let l1 be length of rod
//P=2*l1*x*t
l1=P/(2*x*t)//mm
printf("the value of be length of rod is,%f mm\n",l1)
//let l2 be length of rod in double shear
//P=2*2*l2*t2*t=1800*l2
l2=P/1800//mm
printf("the length of rod in double shear is,%f mm\n",l2)
```

**Scilab code Exa 12.5** Machine design

```

clc
//solution
//given
P=50*10^3//N
ft=80//N/mm^2
```

```
t=50//N/mm^2
fc=100//N/mm^2
pi=3.14
//P=(pi/4)*d^2*ft=62.84*d^2
//d=sqrt(P/62.84)//mm
printf("the diameter of bolt is,%f mm\n",sqrt(P/62.84))
printf("the diameter of bolt is,say 30mm\n")
d=30//mm
//let d1 be dia of enlarged end of bolt
//t1 be thickness of cotter
//t1=d1/4
//P=[((pi/4)*d1^2)-(d1*t1)]*ft
//P=42.84*d1^2
//d1=sqrt(P/42.84)//mm
printf("the dia of enlarged end of bolt is,%f mm\n ",sqrt(P/42.84))
printf("the dia of enlarged end of bolt is,say 36mm\n")
d1=36//mm
t1=d1/4//mm
printf("the thickness is,%f mm\n",t1)
//let b width of cotter
//P=2*b*t1*t==900*b
b=P/(900)//mm
printf("the width of cotter is,%f mm\n",b)
```

**Scilab code Exa 12.6** Machine design

```

clc
//solution
//given
P=150*10^3//N
ft=75//N/mm^2
```

```
t=60//N/mm^2
fc=150//N/mm^2
pi=3.14
//let d be dia of rod
//P=(pi/4)*d^2*ft=59*d^2
//d=sqrt(P/59)//mm
printf("the diameter of bolt is,%f mm\n",sqrt(P/59))
printf("the diameter of bolt is,say 52mm\n")
d=52//mm
//d1=d=52//mm//dia of knuckle pin
d1=52//mm
d2=2*d//mm//dia of outer eye
d3=1.5*d//mm//dia of knucle pin head and collar
T=1.25*d//mm//thickness of single eye
T1=0.75*d//thickness of fork
T2=0.5*d//thickness of pin head
//let t1 be shear stress acting
//P=(pi/4)*2*d1^2*t1//
t1=(P*4)/(2*pi*d1^2)//N//mm^2
printf("the double shear acting is,%f N/mm^2\n",t1)
printf("since the doblue shear acting is 35.3 which is less then 60,hence desing is safe\n")
//let ft1 be failur stress
//P=(d2-d1)*T*ft1
ft1=P/((d2-d1)*T)//N/mm^2
printf("the failure stress in tension acting is,%f N/mm^2\n",ft1)
printf("since the failure stress in tension acting is 44.3 whihc is less then75,hence design is safe\n")
//let t2 be shear stress in shearing
//P=(d2-d1)*T*t2
t2=P/((d2-d1)*T)//N/mm^2
printf("the shear stress in shearing acting is,%f N/mm^2\n",t2)
printf("since the shear stress in shearing acting is 44.3 whihc is less then 60,hence design is safe\n")
```

```
//let fc1 be tension in crushing
//P=d1*T*fc1//N
fc1=P/(d1*T)//
printf("the tension in crushing is,%f N/mm^2\n",fc1)
//let ft2 forked end tension
//P=(d2-d1)*2*T1*ft2
ft2=P/((d2-d1)*2*T1)//
printf("forked end tension si,%f N/mm^2\n",ft2)
//let t3 be forked end shear
//P=(d2-d1)*T*t3*2
t3=P/((d2-d1)*T*2)//N/mm^2
printf("forked end shear is,%f N/mm^2\n",t3)
//let fc2 be stress forked end crushing
fc2=P/(d1*T*2)//N/mm^2
printf("the stress firked end crushing is,%f N/mm^2"
   ,fc2)
```

**Scilab code Exa 12.7** Machine design

```

clc
//solution
//given
P=150*10^3//N
ft=75//N/mm^2
t=60//N/mm^2
fc=150//N/mm^2
pi=3.14
//let d be dia of rod
//P=(pi/4)*d^2*ft=59*d^2
//d=sqrt(P/59)//mm
printf("the diameter of bolt is,%f mm\n",sqrt(P/59))
printf("the diameter of bolt is,say 52mm\n")
d=52//mm
//d1=d=52//mm//dia of knuckle pin
```

```
d1=52//mm
d2=2*d//mm//dia of outer eye
d3=1.5*d//mm//dia of knucle pin head and collar
T=1.25*d//mm//thickness of single eye
T1=0.75*d//thickness of fork
T2=0.5*d//thickness of pin head
//let t1 be shear stress acting
//P=(pi/4)*2*d1^2*t1//
t1=(P*4)/(2*pi*d1^2)//N//mm^2
printf("the double shear acting is,%f N/mm^2\n",t1)
printf("since the doblue shear acting is 35.3 which is less then  60,hence desing is safe\n")
//let ft1 be failur stress
//P=(d2-d1)*T*ft1
ft1=P/((d2-d1)*T)//N/mm^2
printf("the failure stress in tension acting is,%f N/mm^2\n",ft1)
printf("since the failure stress in tension acting is 44.3 whihc is less then75,hence design is safe\n")
//let t2 be shear stress in shearing
//P=(d2-d1)*T*t2
t2=P/((d2-d1)*T)//N/mm^2
printf("the shear stress in shearing acting is,%f N/mm^2\n",t2)
printf("since the shear stress in shearing acting is 44.3 whihc is less then 60,hence design is safe\n")
//let fc1 be tension in crushing
//P=d1*T*fc1//N
fc1=P/(d1*T)//
printf("the tension in crushing is,%f N/mm^2\n",fc1)
//let ft2 forked end tension
//P=(d2-d1)*2*T1*ft2
ft2=P/((d2-d1)*2*T1)//
printf("forked end tension si,%f N/mm^2\n",ft2)
//let t3 be forked end shear
//P=(d2-d1)*T*t3*2
```

```
t3=P/((d2-d1)*T*2)//N/mm^2
printf("forked end shear is,%f N/mm^2\n",t3)
//let fc2 be stress forked end crushing
fc2=P/(d1*T*2)//N/mm^2
printf("the stress firked end crushing is,%f N/mm^2"
    ,fc2)
```

**Scilab code Exa 12.8** Machine design

```

clc
//solution
//given
P=70*10^3//N
ftur=420//N/mm^2//for rod//ultimate point stress
ftup=510//N/mm^2//for pin
tu=396//N/mm^2
Fs=6
ftr=ftur/Fs//N/mm^2//yeild
t=tu/Fs//N/mm^2
pi=3.14
//let d be dia of rod
//P=(pi/4)*d^2*ftr=55*d^2
//d=sqrt(P/55)//mm
printf("the diameter of bolt is,%f mm\n",sqrt(P/55))
printf("the diameter of bolt is,say 36mm\n")
d=36//mm
//d1=d=36//mm//dia of knuckle pin
d1=36//mm
d2=2*d//mm//dia of outer eye
d3=1.5*d//mm//dia of knucle pin head and collar
T=1.25*d//mm//thickness of single eye
T1=0.75*d//thickness of fork
////let t1 be double shear stress acting
//P=(pi/4)*2*d1^2*t1//
```

```
t1=(P*4)/(2*pi*d1^2)//N//mm^2
printf("the double shear acting is,%f N/mm^2\n",t1)
//let ft1 be failur stress
//P=(d2-d1)*T*ft1
ft1=P/((d2-d1)*T)//N/mm^2
printf("the failure stress in tension acting is,%f N/mm^2\n",ft1)
//let ft2 forked end tension
//P=(d2-d1)*2*T1*ft2
ft2=P/((d2-d1)*2*T1)//
printf("forked end tension si,%f N/mm^2\n",ft2)
```

**Scilab code Exa 12.9** Machine design

```

clc
//solution
//given
P=50*10^3//N
ft=75//N/mm^2
t=37.5//N/mm^2
pi=3.14
Pd=1.3*P//N//load for threaded section
//let d be dia and dc be core dia
//Pd=(pi/4)*dc^2*ft
//dc=sqrt((4*Pd)/(pi*ft))//mm
printf("the core dia is,%f mm\n",sqrt((4*Pd)/(pi*ft)))
printf("the standard core dai using table 11.1 is 34.093mm\n")
dc=34.093//mm
//corrresponding dia d =39
d=39//mm
printf("the dia of rod is,%f mm\n",d)
//let l be length of coupler nut
```

```
//Pd=pi*dc*l*t
//l=P/(pi*dc*t)//mm
printf("the length of coupler nut is,%f mm\n",P/(pi*
   dc*t))
x1=d//mm
x2=1.25*d//mm
printf("the upper and lower limit of lkength are,%f
   mm\n,%f mm\n",x1,x2)
printf("taking l=x1=d into calculation\n")
l=d//mm
n=1/4//mm
//Pd=(pi/4)*[d^2-dc^2]*n*l*fc=2750*fc
fc=(Pd/[(pi/4)*[d^2-dc^2]*n*l])
printf("the crushing load is,%f N/mm^2\n",fc)
//let D be outer dia
//P=(pi/4)*(D^2-d^2)*ft
D=[{(P*4)/(pi*ft)}+d^2]^0.5//mm
printf("the outer dai is,%f mm\n",D)
//let D1 and D2 be outer and inner dia of coupler
D1=d+6//mm
D2=[{(P*4)/(pi*ft)}+D1^2]^0.5//mm
printf("the outer and inner dia are,%f mm\n,%f mm\n"
   ,D1,D2)
//let L be length of coupler
L=6*d//mm
printf("the length of coupler is,%f mm\n",L)
T1=0.75*d//mm
printf("the thickness of coupler is,%f mm\n ",t1)
T2=0.5*d//mm
printf("the thickness of coupler nut is,%f mm\n",T2)
```

# Chapter 13

# Ch13

**Scilab code Exa 13.1** Machine design

```

clc
//solution
//given
d=50//mm
t=42//N/mm^2
fc=70//N/mm^2
//from tab 13.1,using d=50mm
w=16//mm
T=10//mm
//let l be length of key
//Tq1=l*w*t*d/2=16800*l1//N-mm//torque
pi=3.14
Tq=(pi/16)*t*d^3//
printf("the torsional moment acting is,%f N-mm\n",Tq)
l1=Tq/16800//mm
//Tq2=l2*T*fc*d/4=8750*l2
l2=Tq/8750//mm
printf("since l2 &gt;l1,taking large value l2=l , length of key\n")
```

```
//l=l2//mm
printf("the length of key is,%f mm\n",l2)
printf("the length oif key is,say 120 mm\n")
l=120//mm
```

**Scilab code Exa 13.2** Machine design

```

clc
//solution
//given
d=45//mm
fyts=400//N/mm^2'//for shaft
w=14//mm
t=9//mm
fytk=340//N/mm^2//for key
Fs=2
pi=3.14
//let l be length of key
tmaxs=fyts/(2*Fs)//N/mm^2
tmaxk=fytk/(2*Fs)//N/mm^2
tmax=(pi/16)*tmaxs*d^3//N-mm
//tmax=l*w*tmaxk*d/2
l1=(tmax*2)/(w*tmaxk*d)//
printf("the length of key(l1) is,%f mm\n",l1)
//tmax=l2*t*fytk*d/4=17213*l2
l2=tmax/17213//mm
printf("te length of key(l2) is,%f mm\n",l2)
printf("since l2 &gt;l1,taking large value l2=l ,
   length of key\n")
l=103.89//mm
printf("the length of key(l) is,%f mm\n",l)
```

**Scilab code Exa 13.3** Machine design

```

clc
//soltuion
//given
P=15*10^3//W
N=960//rpm
d=40//mm
l=75//mm
t=56//N/mm^2
fc=112//N/mm^2
Tq=(P*60)/(2*%pi*N)//N-mm
//let w be width of key
//Tq=l*w*t*d/2=84000*w
//w=Tq/84000//mm
printf("the width of keywy is ,%f mm\n",Tq/84000)
printf("this width is too small,it should be atleats w=d/4,so taking w=d/4 as min widht we get w=d/4=10//mm\n")
w=10//mm
T=10//mm//thickness =width=square key
h=T/2
e=1-(0.2*(w/d))-1.1*(h/d)
P1=(pi/16)*t*d^3*e//N//strength of shaft
Ps=l*w*t*d/2//N//shear strength of shaft
x=Ps/P1//
printf("the check value is ,%f",x)
```

**Scilab code Exa 13.4** Machine design

```

clc
//solution
//given
```

```
P=40000//W
N=350//rpm
ts=40//N/mm^2
fcs=80//N/mm^2
tc=15//N/mm^2
//let d be dia
Tq=(P*60*1000)/(2*%pi*N)//N-mm
//Tq=(%pi/16)*ts*d^3=7.86*d^3
//d=(Tq/7.86)^(1/3)//mm
printf("the dia of shaft is ,%f mm\n ",(Tq/7.86)^(1/3))
printf("the dia of shaft is ,say 55mm\n")
d=55//mm
D=2*d + 13//mm
printf("the outer dia of muff is ,%f mm\n",D)
L=3.5*d//mm
printf("the length of muff is ,%f mm\n",L)
//let tc be induced shear stress
//T=(%pi/16)*tc*[(D^4-d^4)/D] =370*10^3*fc
fc=Tq/370000//N/mm^2
printf("the induced shear stress is ,%f N/mm^2 \n",fc)
//from table 13.1,we find that shaft of dia 55mm diametr
w=18//width of diametre
t1=w//mm//thicknessof key
l=L/2//mm//length of key
printf("the widht of key is ,%f mm\n ",w)
printf("the thickness of key is ,%f mm\n",t1)
printf("the length of key is ,%f mm\n",l)
```

**Scilab code Exa 13.5** Machine design

```

clc
```

```
//solution
//given
P=30000//W
N=100//rpm
t=40//N/mm^2
n=6
ft=70//N/mm^2
u=0.3
//let d be dia
Tq=(P*60*1000)/(2*%pi*N)//N-mm
//Tq=(%pi/16)*t*d^3=7.86*d^3
//d=(Tq/7.86)^(1/3)//mm
printf("the dia of shaft is ,%f mm\n ",(Tq/7.86)
    ^(1/3))
printf("the dia of shaft is ,say 75mm\n")
d=75//mm
D=2*d + 13//mm
printf("the outer dia of muff is ,%f mm\n",D)
L=3.5*d//mm
printf("the length of muff is ,%f mm\n",L)
//from table 13.1,we find that shaft of dia 75mm
    diametr
w=22//width of diametre
t1=14//mm//thickness of key
//let db be the root dia
//'Tq=(%pi^2)*u*db^2*n*ft*d
//Tq=5830*db^2
db=sqrt(Tq/5830)
printf("the widht of key is ,%f mm\n ",w)
printf("the thickness of key is ,%f mm\n",t1)
printf("the root dia is ,%f mm\n",db)
```

**Scilab code Exa 13.6** Machine design

```
clc
//soltuion
//given
P=15000//W
N=900//rpm
K=1.35//service factor
//ts=tb=tk=40//N/mm^2
ts=40//N/mm^2
tb=40//N/mm^2
tk=40//N/mm^2
//fcb=fck
fck=80//N/mm^2
fcb=80//N/mm^2
tc=8//N/mm^2
//let d be dia
Tq=(P*60*1000)/(2*%pi*N)//N-mm
Tqmax=Tq*1.35//N-mm
//Tq=(%pi/16)*t*d^3=7.86*d^3
//d=(Tq/7.86)^(1/3)//mm
printf("the dia of shaft is,%f mm\n ",(Tqmax/7.86)^(1/3))
printf("the dia of shaft is ,say 35mm\n")
d=35//mm
D=2*d//mm
printf("the outer dia of muff is,%f mm\n",D)
L=1.5*d//mm
printf("the length of muff is,%f mm\n",L)
//from table 13.1,we find that shaft of dia 75mm diametr
w=12//width of diametre
t1=12//mm//thickness of key
//let tc be induced shear stress
//Tqmax=(%pi/16)*tc*[(D^4-d^4)/D] =63147*fc
fc=Tqmax/63147//N/mm^2
printf("the induced stress acting is,%f N/mm^2\n",fc)
tf=0.5*d//mm
printf("the thicknes of flange is,%f mm\n",tf)
```

```
//let d1 be nominal dia of bolts
n=3
D=3*d
//Tqmax=(%pi/4)*d1^2*tb*n*D1/2
d1=sqrt(Tqmax/4950)//mm
D2=4*d//mm
tp=0.25*d
printf("the nominal dia of bolts is ,%f mm\n",d1)
printf("the outer dia of flange is ,%f mm\n",D2)
printf("the thickness of protective circumferencial
    flange is ,%fmm",tp)
```

**Scilab code Exa 13.7** Machine design

```

clc
//soltuion
//given
P=15000//W
N=200//rpm
ts=40//N/mm^2
tb=30//N/mm^2
//fck=2*tk
tc=14//N/mm^2
Tmean=(P*60*1000)/(2*%pi*N)//N-mm
Tmax=1.25*Tmean//N/mm^2
//Tmax=(%pi/16)*t*d^3=7.86*d^3
//d=(Tq/7.86)^(1/3)//mm
printf("the dia of shaft is ,%f mm\n ",(Tmax/7.86)
    ^(1/3))
printf("the dia of shaft is ,say 50 mm\n")
d=50//mm
D=2*d//mm
printf("the outer dia of muff is ,%f mm\n",D)
L=1.5*d//mm
```

```
printf("the length of muff is,%f mm\n",L)
//from table 13.1,we find that shaft of dia 75mm
    diametr
w=16//width of diametre
t1=16//mm//thickness of key
l=75//mm
//let tc be induced shear stress
//Tmax=(%pi/16)*tc*[(D^4-d^4)/D]  =184100*fc
fc=Tmax/184100//N/mm^2
printf("the induced stress acting is,%f N/mm^2\n",fc
    )
//let tk be induced stress on key
//Tmax=l*w*l*d*tk*0.5=30000*tk
tk=Tmax/30000//N/mm^2
printf("the induced stress in key is,%f mm\n",tk)
tf=0.5*d//mm
printf("the thicknes of flange is,%f mm\n",tf)
//let d1 be nominal dia of bolts
n=4
D1=3*d//mm
//Tqmax=(%pi/4)*d1^2*tb*n*D1/2
d1=sqrt(Tmax/7070)//mm
D2=4*d//mm
tp=0.25*d
printf("the nominal dia of bolts is,%f mm\n",d1)
printf("the outer dia of flange is,%f mm\n",D2)
printf("the thickness of protective circumferencial
    flange is,%fmm",tp)
```

**Scilab code Exa 13.8** Machine design

```

clc
//soltuion
//given
```

```
P=90*10^3//W
N=250//rpm
ts=40//N/mm^2
q=0.0175
tb=30//N/mm^2
//let d be dia
T=(P*60*1000)/(2*%pi*N)//N-mm
//T/J=ts/(d/2)
//T/(%pi*d^4/32)=ts/(d/2)//considering strength iof shaft
d1=(35*10^6/80)^(1/3)//mm
//considering rigidity
//T/J=(C*q/l)
//T/(%pi*d^4/32)=84000*0.0175/(20*d)
d2=(35*10^6/73.5)^(1/3)//mm
printf("the value of d1 and d2 is,%f mm\n,%f mm\n",d1,d2)
printf("taking larger value into consideration i,e d2,we take d=d2=80mm\n")
d=80//mm
D=2*d//mm
printf("the outer dia of muff is,%f mm\n",D)
L=1.5*d//mm
printf("the length of muff is,%f mm\n",L)
//from table 13.1,we find that shaft of dia 70mm diametr
w=25//width of diametre
t1=14//mm//thickness of key
l=120//mm
//let tc be inducesd stress
//Tmax=(%pi/16)*tc*[(D^4-d^4)/D]
tc=T/{(%pi/16)*[(D^4-d^4)/D]}
printf("the induce stres is,%f N/mm^2\n",tc)
printf("the induced shear stress is less then 14,hence it is safe design\n ")
tf=0.5*d//mm
printf("the thicknes of flange is,%f mm\n",tf)
//let d1 be nominal dia of bolts
```

```
n=4
D1=3*d//mm
//Tqmax=(%pi/4)*d1^2*tb*n*D1/2
d1=sqrt(T/11311)//mm
D2=4*d//mm
tp=0.25*d
printf("the nominal dia of bolts is,%f mm\n",d1)
printf("the outer dia of flange is,%f mm\n",D2)
printf("the thickness of protective circumferencial
    flange is,%fmm",tp)
```

**Scilab code Exa 13.9** Machine design

```

clc
//solution
//given
d=35//mm
n=6
D1=125//mm
T=800*10^3//N-mm
N=350//rpm
ts=63//N/mm^2
tb=56//N/mm^2
tc=10//N/mm^2
tk=46//N/mm^2
//let d1 be nominal dia
//T=(%pi/4)*d1^2*tb*n*D1/2
//d1=(T/16495)^(0.5)//mm
printf("the dia of bolt is,%f mm\n",(T/16495)^(0.5))
printf("the dia of bolt is say d1=8mm\n")
d1=8//mm
D=2*d
//let tf be flange thickness
//T=((%pi*D^2)/2)*tc*tf
```

```
//tf=T/[((%pi*D^2)/2)*tc]
printf("the flange thickness is,%f mm\n",T/[((%pi*D
   ^2)/2)*tc])
printf("the flange thicknes is say tf=12mm\n")
tf=12//mm
//from table 13.1,we find that shaft of dia 70mm
   diametr
w=12//width of diametre
t1=8//mm//thickness of key
l=1.5*d//mm
L=1.5*d//mm
//let tk1 be induced stress
//T=l*w*tk1*d/2
tk1=T/11025//N/mm^2
printf("the induces stress is,%f N/mm^2\n",tk1)
printf("since induced stress is gerater then safe
   limits of 46 N/mm^2,therfore,we use limiting case
    by putting tk1=tk=46\n")
//l1=T/(12*46*17.5)//mm
printf("the length of key is,%f mm\n",T/(12*46*17.5)
   )
printf("the length of key is say 85mm\n")
//L1=l1
L1=85//mm
printf("the legth of hub is,%f mm\n",L1)
P=2*%pi*N*T/60//W
printf("the power rtransmitted is,%f W\n",P)
```

**Scilab code Exa 13.10** Machine design

```

clc
//solution
//given
d=35//mm
```

```
n=6
D1=125//mm
T=800*10^3//N-mm
N=350//rpm
ts=63//N/mm^2
tb=56//N/mm^2
tc=10//N/mm^2
tk=46//N/mm^2
//let d1 be nominal dia
//T=(%pi/4)*d1^2*tb*n*D1/2
//d1=(T/16495)^(0.5)//mm
printf("the dia of bolt is ,%f mm\n",(T/16495)^(0.5))
printf("the dia of bolt is say d1=8mm\n")
d1=8//mm
D=2*d
//let tf be flange thickness
//T=((%pi*D^2)/2)*tc*tf
//tf=T/[((%pi*D^2)/2)*tc]
printf("the flange thickness is ,%f mm\n",T/[((%pi*D
    ^2)/2)*tc])
printf("the flange thicknes is say tf=12mm\n")
tf=12//mm
//from table 13.1,we find that shaft of dia 70mm
    diametr
w=12//width of diametre
t1=8//mm//thickness of key
l=1.5*d//mm
L=1.5*d//mm
//let tk1 be induced stress
//T=l*w*tk1*d/2
tk1=T/11025//N/mm^2
printf("the induces stress is ,%f N/mm^2\n",tk1)
printf("since induced stress is gerater then safe
    limits of 46 N/mm^2,therfore ,we use limiting case
     by putting tk1=tk=46\n")
//l1=T/(12*46*17.5)//mm
printf("the length of key is ,%f mm\n",T/(12*46*17.5)
    )
```

```
printf("the length of key is say 85mm\n")
//L1=l1
L1=85//mm
printf("the legth of hub is ,%f mm\n",L1)
P=2*%pi*N*T/60//W
printf("the power rtransmitted is ,%f W\n",P)
```

**Scilab code Exa 13.11** Machine design

```

clc
//solution
//given
P=3*10^6//W
N=100//rpm
tb=60//N/mm^2
ts=60//N/mm^2
n=8
//D1=1.6*d
//let d be dia of shaft
T=(P*60*1000)/(2*%pi*N)//N-mm
//T=(%pi/16)*t*d^3=11.78*d^3
//d=(T/11.78)^(1/3)//mm
printf("the dia of shaft is ,%f mm\n ",(T/11.78)
    ^(1/3))
printf("the dia of shaft is ,say 300 mm\n")
d=300//mm
//let d1 be nominal dia of bolts
//T=(%pi/4)*d1^2*tb*n*D1/2
//d1=(T/90490)^(0.5)//mm
printf("the dia of bolt is ,%f mm\n",(T/16495)^(0.5))
printf("the dia of bolt is say d1=60 mm\n")
d1=60//mm
tf=d/3//mm
printf("the flange thciness is ,%f m\n",tf)
```

```
D2=2.2*d//mm
printf("the diameter of flange is,%f mm",D2)
```

**Scilab code Exa 13.13** Machine design

```

clc
//solution
//given
T=5000*10^3//N-mm
t=60//N/mm^2
t1=28//N/mm^2
//let d be dia
//T=(%pi*t*d^3)/16
d=(T/11.8)^(1/3)//mm
printf("the dia of shaft is,%f mm\n",d)
//let dp diA of pin
//T=2*(%pi/4)*dp^2*t1*d
dp=[T/(3300)]^0.5//mm
printf("the dia of pin is,%f mm",dp)
```

# Chapter 14

# Ch14

**Scilab code Exa 14.1** Machine design

```

clc
//solution
//given
N=200//rpm
P=20*10^3//W
t=42//N/mm^2
//let d be dia
T=P*60000/(2*%pi*200)//N-mm
//T=(%pi/16)*t*d^3=8.25*d^3
d=(T/8.25)^(1/3)//mm
printf("the dia of shaft is ,%f mm",d)
```

**Scilab code Exa 14.2** Machine design

```

clc
//solution
```

```
//given
P=10^6//W
N=2400//rpm
//Tmax=1.2*Tmean
t=60//N/mm^2
//let d be dia of shaft
Tmean=(P*60000)/(2*%pi*N)//N-mm
Tmax=12.*Tmean
//Tmax=(%pi/16)*t*d^3=8.25*d^3
d=(Tmax/11.78)^(1/3)//mm
printf("the dia of shaft is,%f mm",d)
```

**Scilab code Exa 14.3** Machine design

```

clc
//solution
//given
P=20*1000//W
N=200//rpm
tu=360//N/mm^2
Fs=8
k=0.5//k=di/do
t=tu/Fs//N/mm^2
T=P*60000/(2*%pi*200)//N-mm
//T=(%pi/16)*t*d^3=8.25*d^3
d=(T/8.25)^(1/3)//mm
printf("the dia of solid shaft is,%f mm\n",d)
//elt di and do be inside and do be outer dia
//T=(%pi/16)*t*do^3*(1-k^4)
//T=(%pi/16)*t*do^3[1-0.5^4]
//T=8.3*do^3
do=(T/8.3)^(1/3)//mm
di=0.5*do//mm
printf("the inner and outer dia is,%f mm\n,%f mm\n",
```

```
di,do)
```

**Scilab code Exa 14.4** Machine design

```

clc
//solution
//given
//ref fig 14.1
W=50*10^3//N
L=100//mm
x=1.4//m
fb=100//N/mm^2
M=W*L//N-mm
//let d eb dia
//M=(%pi/32)*fb*d^3
d=(M/9.82)^(1/3)//mm
printf("the dia of axle is ,%f mm\n",d)
```

**Scilab code Exa 14.5** Machine design

```

clc
//solution
//given
M=3000*1000//N-mm
T=10000*1000//N-mm
ftu=700//N/mm^2
tu=500//N/mm^2
Fs=6
ft=ftu/Fs//N/mm^2
t=tu/Fs//N/mm^2
//let d eb dia of shaft
```

```
Te=sqrt(T^2 + M^2)//N-mm
//Te=(%pi/16)*t*d^3
d1=(Te/16.36)^(1/3)//mm
printf("the dia of axle is ,%f mm\n",d1)
Me=0.5*[M+ sqrt(M^2 + T^2)]//N-mm
//Me=(%pi/32)*fb*d2^3
d2=(Me/11.46)^(1/3)//mm
printf("the dia oif shaft is ,%f mm\n",d2)
printf("taking large value i.e d=d1=90 mm in
   consideration")
```

**Scilab code Exa 14.6** Machine design

```

clc
//solution
//given
P=7.5*10^3//W
N=300//rpm
D=150//mm
L=200//mm
t=45//N/mm^2
a=(%pi/180)*20//rad
//reff fig 14.2
T=P*60000/(2*%pi*200)//N-mm
Ft=2*T/D//N
W=Ft/(cos(a))//N
M=W*L/4//N-mm
//let d be dia
Te=sqrt(T^2 + M^2)//N-mm
//Te=(%pi/16)*t*d^3
d=(Te/8.84)^(1/3)//mm
printf("the dia of shaft is ,%f mm",d)
```

**Scilab code Exa 14.7** Machine design

```

clc
//solution
//given
//ref fig 14.3
P=100000//W
N=300//rpm
L=3000//mm
W=1500//N
T=P*60000/(2*%pi*200)//N-mm
M=1500*1000//N-mm
Te=sqrt(M^2 + T^2)//N-mm
//Te=(%pi/16)*t*d^3
d=(Te/11.8)^(1/3)//mm
printf("the dia of shaft is ,%f mm",d)
```

**Scilab code Exa 14.8** Machine design

```
//determine dia of the shaft
clc
//solution
//given
//ref fig 14.4
D=1500//mm
R=750//mm
T1=5400//N
T2=1800//N
L=400//mm
t=42//N/mm^2
T=(T1-T2)*R//N-mm
```

```
W=T1+T2//N
M=W*L//N-mm
//let d be dia of shaft
Te=sqrt(M^2 + T^2)//N-mm
//Te=(%pi/16)*t*d^3
d=(Te/8.25)^(1/3)//mm
printf("the dia of shaft is ,%f mm",d)
```

**Scilab code Exa 14.9** Machine design

```

clc
//solution
//given
//ref fig 14.4
D=1500//mm
R=750//mm
T1=5400//N
T2=1800//N
L=400//mm
t=42//N/mm^2
T=(T1-T2)*R//N-mm
W=T1+T2//N
M=W*L//N-mm
//let d be dia of shaft
Te=sqrt(M^2 + T^2)//N-mm
//Te=(%pi/16)*t*d^3
d=(Te/8.25)^(1/3)//mm
printf("the dia of shaft is ,%f mm",d)
```

**Scilab code Exa 14.10** Machine design

```

```

```
clc
//solution
//given
//ref fig 14.6
AB=800//mm
a=(%pi/180)*20
Dc=600//mm
Rc=300//mm
AC=200//mm
Dd=700//mm
Rd=350//mm
DB=250//mm
W=2000//N
T1=3000//N
T2=T1/3//N
t=40//n/mm^2
T=(T1-T2)*Rd//N-mm
Ftc=(T/Rc)//N//tangential force acting oon gear C
//Wc=Ftc/cos(a)//N
Wc=Ftc/0.9397
//Wcv=Wc*cos(a)//veritcal comp
Wcv=Wc*0.9397
//Wch=Wc*sin(a)//hori com
Wcv=Wc*0.342//N
//RAv + RBv=2333+2000
//RAv + RBv=4333//N
RBv=[2000(800-250)+(2333*200)]/800//N
RAv=4333-RBv//N
printf("the value of RAv is ,%f N\n",RAv)
//moment due to veritcal component
MAv=0
MBv=0
MCv=RAv*200//N-mm
MDv=RBv*250//N-mm
//RAh + RBh=4849
RBh=[4000*(800-250)+ (849*200)]/800//N
RAh=4849-RBh//N
//moment due to horizontal component
```

```
MAh=0
MBh=0
MCh=RAh*200//N-mm
MDh=RBh*250//N-mm
Mc=sqrt(MCv^2 + MCh^2)//net moment abt C
Md=sqrt(MDv^2 + MDh^2)//net moment abt D
printf("the moment acting abt D is,%f N-mm\n",Md)
//M=Md//N-mm//max moment
//printf("the moment acting is,%f N-mm\n",M)
//let d be dia
Te=sqrt(Md^2 + T^2)/N-mm
//Te=(%pi/16)*t*d^3
d=(Te/7.86)^(1/3)//mm
printf("the dia of shaft is,%f mm",d)
```

**Scilab code Exa 14.11** Machine design

```

clc
//solution
//given
//ref fig 14.6
AB=800//mm
a=(%pi/180)*20//rad
Dc=600//mm
Rc=300//mm
AC=200//mm
Dd=700//mm
Rd=350//mm
DB=250//mm
W=2000//N
T1=3000//N
T2=T1/3//N
t=40//n/mm^2
T=(T1-T2)*Rd//N-mm
```

```
Ftc=T/Rc//N//tangential force acting oon gear C
Wc=Ftc/cos(a)//N
Wcv=Wc*cos(a)//veritcal comp
Wch=Wc*sin(a)//hori com
//RAv + RBv=2333+2000
//RAv + RBv=4333//N
RBv=[2000(800-250)+(2333*200)]/800//N
RAv=4333-RBv//N
printf("the value of RAv is ,%f N\n",RAv)
//moment due to veritcal component
MAv=0
MBv=0
MCv=RAv*200//N-mm
MDv=RBv*250//N-mm
//RAh + RBh=4849
RBh=[4000*(800-250)+ (849*200)]/800//N
RAh=4849-RBh//N
//moment due to horizontal component
MAh=0
MBh=0
MCh=RAh*200//N-mm
MDh=RBh*250//N-mm
Mc=sqrt(MCv^2 + MCh^2)//net moment abt C
Md=sqrt(MDv^2 + MDh^2)//net moment abt D
printf("the moment acting abt D is ,%f N-mm\n",Md)
//M=Md//N-mm
//printf("the moment acting is ,%f N-mm\n",M)
//let d eb dia
Te=sqrt(Md^2 + T^2)/N-mm
//Te=(%pi/16)*t*d^3
d=(Te/7.86)^(1/3)//mm
printf("the dia of shaft is ,%f mm",d)
```

**Scilab code Exa 14.12** Machine design

```
//determine dia of the shaft
clc
//solution
//given
P=20000//W
N=200//rpm
W=900//N
L=2500//mm
t=42//N/mm^2
fb=56//N/mm^2
T=P*60000/(2*%pi*200)//N-mm
M=W*L/4//N-mm//max monet
Te=sqrt(T^2 + M^2)//N-mm
//Te=(%pi/16)*t*d^3
d1=(Te/8.25)^(1/3)//mm
printf("the dia of shaft is,%f mm",d1)
Me=0.5[M + sqrt(M^2 + T^2)]//N-mm
//Me=(%pi/32)*fb*d2^3
d2=(Me/5.5)^(1/3)//mm
printf("the dia oif shaft is,%f mm\n",d2)
printf("taking large value i.e d=d1=55 mm in
    consideration\n")
//dia by applying gradually applied load
//using table 14.2
Km=1.5
Kl=1
Te1=sqrt((Km*M)^2 + (Kl*T)^2)//N-mm
//Te=(%pi/16)*t*d^3
d1=(Te1/8.25)^(1/3)//mm
printf("the dia of shaft is,%f mm",d1)
Me1=0.5[M*Km + sqrt((Km*M)^2 + (Kl*T)^2)]//N-mm
//Me1=(%pi/32)*fb*d2^3
d2=(Me1/5.5)^(1/3)//mm
printf("the dia oif shaft is,%f mm\n",d2)
printf("taking large value i.e d=d1=60 mm in
    consideration\n")
```

**Scilab code Exa 14.13** Machine design

```
clc
//solution
//given
//ref fig 14.9
W=200//N
L=300//mm
D=200//mm
R=100//mm
P=1000//W
N=120//rpm
u=0.3
Km=1.5
Kl=2
T=79.6*1000
t=35//N/mm^2
//T=(T1-T2)*R
//T1-T2=796.....eq 1
//log(T1/T2)*2.3=u*%pi
//T1/T2=2.57.....eq 2
//from 1 and 2
T1=1303//N
T2=507//N
Wt=T1+T2+W//N
M=Wt*L//N-mm
Te=sqrt((Km*M)^2 + (Kl*T)^2)//N-mm
//Te=(%pi/16)*t*d^3
d=(Te/6.87)^(1/3)//mm
printf("the dia of shaft is,%f mm",d)
```

# Chapter 15

# Ch15

**Scilab code Exa 15.1** Machine design

```

clc
//soltuion
//given
//ref fig 15.5
L=450//mm
P=400//N
ft=100//N/mm^2
t=55//N/mm^2
//let d1 be mean dia of pin and d be dia of spindle
d=50//mm
T=P*2*L//N-mm
//T=2*(%pi/4)*d1^2*t*(d/2)
//T=2160*d1^2
d1=sqrt(T/2160)//mm
printf("the dia of pin is ,%f mm\n",d1)
//let D be dia of handle
M=P*L//N-mm
T1=400*100//N-mm
Te=sqrt(T1^2 + M^2)//N-mm
//Te=(%pi/16)*t*D^3=10.8^D1^3
```

```
D1=(Te/10.8)^(1/3)//mm
printf("the dia using twisting moment is,%f mm\n",D1)
Km=1
Kl=1
Me=0.5*[M + sqrt((M)^2 + (T1)^2)]//N-mm
//Me=(%pi/32)*fb*D^3=9.82*D^3....(fb=ft)
D2=(Me/9.82)^(1/3)
printf("the dia using bending moment is,%f mm\n ",D2)
printf("taking larger value into consideration")
```

**Scilab code Exa 15.2** Machine design

```

clc
//solution
//given
t=15//mm
Fp=900//N
//let Rq and Rr be rxn at  Q and R
///tkaing monnt abt R
Rq=900*950/150//N
Rr=Rq-900//N
printf("the rxn at Q and R are ,%f N\n,%f N\n",Rq,Rr)
d1=12//mm//dia of tie rod
A=(%pi/4)*d1^2//mm^2
ft=Rq/A//N/mm^2
printf("the stress acting is,%f  N/mm^2\n",ft)
//dp=dq=dr=12//mm
dp=12//mm
Ap=(%pi/4)*dp^2//mm^2
Aq=Ap
Ar=Ap
```

```
tp=Fp/Ap
tq=Rq/(2*Aq)
tr=Rr/(2*Ar)
printf("the shear stressa cxting at P,Q,R are ,%f N/
    mm^2\n, %f N/mm^2\n, %f N/mm^2\n",tp,tq,tr)
```

**Scilab code Exa 15.3** Machine design

```

clc
//solution
//given
L=1000//mm
P=800//N
ft=73//N/mm^2
t=70//N/mm^2
//ref fig 15.9
//let d be dia of shaft
T=P*L//N-mm
//T=(%pi/6)*t*d^3=58.2*1000*d^3
//d=[T/(13.75)]^(1/3)
printf("the dia of shfat is,%f mm\n",[T/(13.75)
    ]^(1/3))
printf("the dia of shaft is say 40mm\n")
d=40//mm
//for boss
d2=1.6*d//mm
t2=0.3*d
l2=1.25*d
//using table,corrsponding to d=40mm,we get
w=12//mm
t1=8//mm
//let l1 be length of key
//T=l1*w*t*d/2=16800*l1
l1=T/16800//mm
```

```
printf("the width ,thickness and length of key are,
    %f mm\n,%f mm\n,%f mm\n",w,t1,l1)
//let t2 be thickness and B be width of arm
//B=3*t2
M=800*(1000-60)//N-mm
//Z=(1/6)*t*B^2=1.5*t^3
//ft=M/Z
t2=(M/(1.5*73))^(1/3)//mm
B=3*t2//mm
printf("the thickness ,width of arm are,%f mm\n,%f
    mm\n",t2,B)
```

**Scilab code Exa 15.4** Machine design

```

clc
//solution
//given
l=300//mm
L=400//mm
x=100//mm
P=400//N
ft=50//N/mm^2
t=40//N/mm62
//let d eb dia
M=(1-1/3)*P*l//N-mm
//Z=(%pi/32)*d^3=0.0982*d^3
//M=fb*Z=4.91*d^3
d=(M/4.91)^(1/3)//N-mm
printf("the dia of handle is,%f mm\n",d)
//let t1 be thicnes and B eb width of lvever arm
M1=1.25*P*L//N-mm
//B=2t
//Z1=(1/6)*t*B^2=0.6677*t^3
//ft=M/Z
```

```
//t1=(M1/(0.667*50))^(1/3)//mm
printf("the thcikness  is ,%f mm\n",(M1/(0.667*50))^(1/3))
//let D be dia of journal
printf("the thickness of lever arm is say 20 mm\n")
t1=20//mm
B=2*t1//mm
printf("the width of lever arm is ,%f mm\n",B)
Te=P*(sqrt((2*(l/3) + x)^2 + L^2 ))//N-mm
//Te=(%pi/16)*t*D^3=7.86*D^3
D=(Te/7.86)^(1/3)//mm
printf("the dia met of journal is ,%f mm\n",D)
```

**Scilab code Exa 15.5** Machine design

```

clc
//solution
//given
l=300//mm
L=400//mm
x=100//mm
P=400//N
ft=50//N/mm^2
t=40//N/mm62
//let d eb dia
M=(1-1/3)*P*l//N-mm
//Z=(%pi/32)*d^3=0.0982*d^3
//M=fb*Z=4.91*d^3
d=(M/4.91)^(1/3)//N-mm
printf("the dia of handle is ,%f mm\n",d)
//let t1 be thicnes and B eb width of lvever arm
M1=1.25*P*L//N-mm
//B=2t
//Z1=(1/6)*t*B^2=0.6677*t^3
```

```
//ft=M/Z
//t1=(M1/(0.667*50))^(1/3)//mm
printf("the thcikness  is,%f mm\n",(M1/(0.667*50))^(1/3))
//let D be dia of journal
printf("the thickness of lever arm is say 20 mm\n")
t1=20//mm
B=2*t1//mm
printf("the width of lever arm is,%f mm\n",B)
Te=P*(sqrt((2*(l/3) + x)^2 + L^2 ))//N-mm
//Te=(%pi/16)*t*D^3=7.86*D^3
D=(Te/7.86)^(1/3)//mm
printf("the dia met of journal is,%f mm\n",D)
```

**Scilab code Exa 15.6** Machine design

```

//soltuion
//given
//ref fig 15.14
FB=500//mm
W=4500//N
FA=150//mm
ft=75//N/mm^2
t=60//N/mm^2
pb=10//N/mm^2
P=(W*500)/150//N
Rf=sqrt(P^2 + W^2)//N
//desing of uflcrum pin
//let d be dia and l be thickness of fulcrum
//l=1.25d
//P=d*l*pb=12.5*d^2
//d=sqrt(P/12.5)//mm
printf("the diameter is,%f mm\n",sqrt(P/12.5))
printf("the dia is say,d=36mm\n")
```

```
d=36//mm
l=1.25*d//mm
printf("the length of fulcrum pin is,%f \n",l)
d1=d+ 2*3
printf("the dia of hole in leverr is,%f mm\n",d1)
printf("the dia of boss at fulcrum is,%f mm\n",2*d)
printf("the bending moment at fulcrum is,%f N-mm\n",
   W*FB)
//design of pin at A
//since force acting at A is not very much different
    from rxn at fulcrum ,therfore same dimenion of
   pin and boss may be used as for fulcrum pin
da=36//mm
la=45//mm
dba=72//mm
printf("diameter,length and dia of boss at A is ,%f
   mm\n,%f mm\n,%f mm\n",da,la,dba)
//desig of pin at B
//let db and lb be dia and length
//W=db*lb*pb
//lb=1.25db
//w=12.5 *db^2
db=sqrt(W/12.5)
lb=1.25*db
printf("the dia and length at B is,%f mm\n,%f mm\n",
   db,lb)
printf("the inner dia is,%f mm\n",db+6)
printf("the outer dia is,%f mm\n",2*db)
//desig of lever
//let tl and bl be thioknes and dia at lever
//bl=3tl
Ml=4500*(500-50)//N-mm
//Z=(1/6)*t*b^2=1.5*t^3
//ft=Ml/Z
tl=(Ml/(1.5*75))^(1/3)//mm
printf("the thcikness and width of lever is,%f mm\n,
   %f mm\n ",tl,3*tl)
```

**Scilab code Exa 15.7** Machine design

```

clc
//solution
//given
//refer fig 15.17
x=190//mm
y=140//mm
m=2.7//kg
r2=170//mm=0.17//m
N2=300//rpm
h=12//mm
ft=80//N/nn^2
pb=8//N/mm^2
w2=(2*%pi*N2)/60//rad/s
w1=w2+(0.6/100)*w2//rad/s
r1=r2+(h*x/y)//mm
Fc1=m*w1^2*r1/1000
Fc2=m*w2^2*r2/1000
//s1 is spring force at max speed w1
//s2 is spring force at max speed w2
//ref 15.18
S1=2*Fc1*x/y//2*m*w1^2*r1*x/y
printf("the fore on speed w1 is ,%f N\n",S1)
S2=2*Fc2*x/y//N
printf("the force acting at speed w2 is ,%f N\n",S2)
//S1-S2=h*s1
s1=(S1-S2)/h//N/mm
printf("the stiffness is ,%f N/mm\n",s1)
//design bell crank lever
//max load at A is
W=S1/2//N
//taking mont abt F
```

```
P=W*y/x//N
Rf=sqrt(W^2 + P^2)//N
//let d1 and l1 be dia and length of fulcrum pin
//l=1.25*d
//Rf=d*l*pb=10*d^2
//d=sqrt(Rf/10)//mm
printf("the dia is ,%f mm\n",sqrt(Rf/10))
printf("the dia is say d=10mm\n")
d1=10//mm
l=1.25*d1
printf("the inner dia of bolts is ,%f mm\n",d1+6)
printf("the outer dia of bolts is ,%f mm\n",2*d1)
//design for lever
M=682*(140-40)//N-mm
//let t2 and B be thickness and depth
//B=3t
//Z=(1/6)*t*B^2=1.5t2^3
//ft=M/Z
//t2=(M/(1.5*ft))^(1/3)//mm
printf("the thickness of lever is ,%f mm\n",(M/(1.5*
    ft))^(1/3))
printf("the thickness of lever is ,say 10 mm\n")
t2=10//mm
B=3*t2//mm
printf("the depth of levr is ,%f mm\n",B)
//design for ball
//let r be th rad of ball
rho=7200//kg/m^3
//m=vol*rho
//2.7=(4/3)*%pi*r^3*rho
r=(2.7/30163)^(1/3)*1000//mm
printf("the rad of a ball is ,%f mm\n",r)
M1=P*r//N-mm
//let dc be core dia
//Z=(%pi/32)*dc^3=0.0982*dc^3
//dc=(M1/(80*0.0982))^(1/3)
printf("the core dia is ,%f mm\n",(M1/(80*0.0982))
    ^(1/3))
```

```
printf("the nominal dia corresponding to dc is 16 mm
   \n")
//design of roller end A
//let d3 be dia and l3 be length of pin at A
W=S1/2//N
//l3=1.25*d3
//W=d3*l3*pb=10*d3^2
//d3=(W/10)^0.5//MM
printf("the dia is ,%f mm\n",(W/10)^0.5)
printf("the dia is ,say 10 mm\n")
d3=10//mm
l3=1.25*d3//mm
printf("the length of pin is ,%f mm\n",l3)
```

**Scilab code Exa 15.8** Machine design

```

clc
//solution
//given
//refer fig 15.17
x=190//mm
y=140//mm
m=2.7//kg
r2=170//mm=0.17//m
N2=300//rpm
h=12//mm
ft=80//N/nn^2
pb=8//N/mm^2
w2=(2*%pi*N2)/60//rad/s
w1=w2+(0.6/100)*w2//rad/s
r1=r2+(h*x/y)//mm
Fc1=m*w1^2*r1/1000
Fc2=m*w2^2*r2/1000
//s1 is spring force at max speed w1
```

```
//s2 is spring force at max speed w2
//ref 15.18
S1=2*Fc1*x/y//2*m*w1^2*r1*x/y
printf("the fore on speed w1 is ,%f N\n",S1)
S2=2*Fc2*x/y//N
printf("the force acting at speed w2 is ,%f N\n",S2)
//S1-S2=h*s1
s1=(S1-S2)/h//N/mm
printf("the stiffness is ,%f N/mm\n",s1)
//design bell crank lever
//max load at A is
W=S1/2//N
//taking mont abt F
P=W*y/x//N
Rf=sqrt(W^2 + P^2)//N
//let d1 and l1 be dia and length of fulcrum pin
//l=1.25*d
//Rf=d*l*pb=10*d^2
//d=sqrt(Rf/10)//mm
printf("the dia is ,%f mm\n",sqrt(Rf/10))
printf("the dia is say d=10mm\n")
d1=10//mm
l=1.25*d1
printf("the inner dia of bolts is ,%f mm\n",d1+6)
printf("the outer dia of bolts is ,%f mm\n",2*d1)
//design for lever
M=682*(140-40)//N-mm
//let t2 and B be thickness and depth
//B=3t
//Z=(1/6)*t*B^2=1.5t2^3
//ft=M/Z
//t2=(M/(1.5*ft))^(1/3)//mm
printf("the thickness of lever is ,%f mm\n",(M/(1.5*
    ft))^(1/3))
printf("the thickness of lever is ,say 10 mm\n")
t2=10//mm
B=3*t2//mm
printf("the depth of levr is ,%f mm\n",B)
```

```
//design for ball
//let r be th rad of ball
rho=7200//kg/m^3
//m=vol*rho
//2.7=(4/3)*%pi*r^3*rho
r=(2.7/30163)^(1/3)*1000//mm
printf("the rad of a ball is ,%f mm\n",r)
M1=P*r//N-mm
//let dc be core dia
//Z=(%pi/32)*dc^3=0.0982*dc^3
//dc=(M1/(80*0.0982))^(1/3)
printf("the core dia is ,%f mm\n",(M1/(80*0.0982))^(1/3))
printf("the nominal dia corresponding to dc is 16 mm\n")
//design of roller end A
//let d3 be dia and l3 be length of pin at A
W=S1/2//N
//l3=1.25*d3
//W=d3*l3*pb=10*d3^2
//d3=(W/10)^0.5//MM
printf("the dia is ,%f mm\n",(W/10)^0.5)
printf("the dia is ,say 10 mm\n")
d3=10//mm
l3=1.25*d3//mm
printf("the length of pin is ,%f mm\n",l3)
```

**Scilab code Exa 15.9** Machine design

```

clc
//soltuion
//given
//ref fig 15.24
p=0.2//N/mm^2
```

```
d=600//mm
ftc=17.5//N/mm^2
fts=52.5//N/mm^2
fcs=52.5//N/mm^2
ts=42//n/mm^2
//let t be thickness of vessel
//t=(p*d)/(2*ftc)//mm
printf("the thickness of vessel si,%f mm\n",(p*d)/(2*ftc))
printf("the thickness can not be less then 6mm, therfore we take 6 as thickness\n")
t=6//mm
//let dc be core dia
W=p*(%pi*d^2)/4//N
//let dc be core dia
//W=(%pi/4)*dc^2*fts=41.24*dc^2
dc=(W/41.24)^(0.5)//mm
printf("we shall use standard size of screw M48 with core dia 41.5mm and outer dia 48mm\n")
//let t1 be thickness and b1 be width
//b1=2*t1
Rc=W/2//N
Rd=W/2//N
l=750//mm
M=W*l/4//N-mm
//Z=(1/6)*t1*b1^2
//Z=0.66*t1^3
//fts=M/Z
t1=(M/(52.5*0.66))^(1/3)
b1=2*t1//mm
printf("thickness and width of beamA is,%f mm\n,%f mm\n",t1,b1)
//let d1 be dia of pi at C and D
//Rc=2*(%pi/4)*d1^2*ts
d1=sqrt(Rc/66)//mm
printf("the dia of pin at C and D is,%f mm\n",d1)
printf("since load at E and F IS SAME AS THAT OF C AND D,therefr dia of pins at E and F is 21 mm\n "
```

```
)
//let d2 be dia at G and H
Rg=W/2//N
//Rg=(%pi/4)*d2^2*fts
d2=(Rg/41)^(0.5)//mm
printf("the dia at G and H is ,%f mm\n",d2)
//let t2 be support thickness and b2 be width of support
x=375-(300+t)
M2=Rc*x//N-mm
//b2=2t2
//Z=(1/6)*t2*b2^2=0.66t2^3
//ftc=M/Z
t2=[M2/(0.66*17.5)]^(1/3)//mm
b2=2*t2
printf("the thickness and wdth of support at E and F is ,%fmm\n,%f mm\n",t2,b2)
```

**Scilab code Exa 15.10** Machine design

```

clc
//soltuion
//given
//ref fig 15.25
Wl=3000//N
Wn=5000//N
t=40//N/mm^2
pb=17.5//N/mm^2
fb=70//N/mm^2
//let P be effort applied at  Q
P=[(5000*300)+(3000*300)]/800//N
Wm=Wn-Wl//N
Rm=sqrt(P^2 +Wm^2 )//N
//let P1 be force acitng in worst condition ,i.e when
```

```
one side of pump odesn't work
P1=5000*300/800//N
Rm1=sqrt(P^2 + Wn^2)//N
//let d be dia and l be length at M and N
//l=1.25*d
//Rm1=d*l*pb=21.87*d^2
//d=sqrt(Rm1/21.87)//mm
printf("the dia of pin is,%f mm\n",sqrt(Rm1/21.87))
printf("the dia of pin is,say 16mm\n")
d=16//mm
l=1.25*d//mm
printf("th length is,%f mm\n",l)
ti=(Rm1*4)/(2*d^2*%pi)//N/mm^2
printf("the induced stress is,%f mm\n",ti)
printf("sinc induced stress is withi safe limits, then design is safe\n")
//let  t2 be thickness and b2 be width at sextion X-X
//b2=3*t2//mm
M3=P*800//N-mm
//Z=(1/6)*t3*b3^2=1.5*t3^2
//fb=M/Z
//t3=[M/(1.5*70)]^(1/3)//mm
printf("the thickness is ,%f mm\n",[M3/(1.5*70)]^(1/3))
printf("thickness is t3=30mm\n")
t3=30//mm
printf("the width is,%f mm\n",3*t3)
//let t4 and b4 be thickness and width of lever
M4=Wn*300//N
//Z=(1/6)*t2*b4^2
//Z=6*b4^2
//fb=M/Z
b4=(M4/(5*70))^0.5//mm'
printf("the widht at lever is,%f mm\n",b4)
```

**Scilab code Exa 15.11** Machine design

```

clc
//solution
//given
//ref fig 15.27
As=15//mm^2
tu=400//N/mm^2
ft=80//N/mm^2
pb=20//N/mm^2
Ps=As*tu//N
//let P1 be force in link LM
P1=(Ps*100)/(350)//N
//taking momnet abt N,we get P
P=(P1*100)/(900)//N
N=P1+P//N
//let d be dia and l be length of pins
//l=1.25d
//N=d*l*pb=25*d^2
//d=sqrt(N/25)//mm
printf("the dia is ,%f mm\n",sqrt(N/25))
printf("the dia is ,say 10 mm\n")
d=10//mm
l=1.25*d//mm
printf("the length of pin is ,%f mm\n",l)
ti=(N*4)/(2*d^2*%pi)//N/mm^2
printf("the induced stress is ,%f mm\n",ti)
printf("sinc induced stress is withi safe limits ,
   then design is safe\n")
printf("the dia of hole is ,%f mm\n",d+6)
printf("the dia of boss is ,%f mm\n",2*16)
//design for link
//let d1 be dia of link
```

```
//N=(%pi/4)*d1^2*ft=62.84*d1^2
d1=sqrt(N/62.84)//mm
printf("the dia of link is,%f mm\n",d1)
//let t3 be thickness and B be width of lever
t3=12.5//mm
M=N*100//N-mm
//Z=(1/6)*t*B^2=2.1*B^2
//fb=M/Z=90762/B^2
B=sqrt(90762/80)//mm
printf("the width of lever is,%f mm",B)
```

# Chapter 16

# Ch16

**Scilab code Exa 16.1** Machine design

```
//calculate cripping load
clc
//solution
//given
//ref fig 16.2
l=4000//mm
E=200*10^3//N/mm^3
a1=150*20//area of flange
y1=20/2
a2=(120-20)*20//area of wewb
y2=20+(100/2)//mm
yb=(a1*y1 + a2*y2)/(a1+a2)//mm//CG
Ixx=[(150*20^3/12)+(3000*(34-10)^2)+(20*(100)^3/12)
   +2000*(70-34)^2]//mm^4
Iyy=((20*(150)^3/12)) +(100*20^3/12)//mm^4
///sinve Iyy is less then Ixx,therfore I-Iyy
I=Iyy//mm^4
L=l//mm
Wcr=%pi^2*E*I/L^2//N
printf("the cripling load acting is,%f N",Wcr)
```

**Scilab code Exa 16.2** Machine design

```
//find euler's crippling load
clc
//solution
//given
//ref fig 16.3
D=400//mm
B=200//mm
t=10//mm
b=200-10//mm
d=400-20
l=6000//mm
E=200*1000//N/mm^2
Ixx=B*D^3/12-b*d^3/12//mm^4
Iyy=2*[t*B^3/12]+(d*t^3/12)//mm^4
//since Iyy <Ixx,therefore it will try to b uckle
   about Y axis
L=l/2
I=Iyy
Wcr=%pi^2*E*I/L^2//N
printf("the cripling load acting is,%f N",Wcr)
```

**Scilab code Exa 16.3** Machine design

```
//cal dia of piston
clc
//soltuion
//given
D=1500//mm
p=0.2//N/mm^2
E=200*1000//N/mm^2
```

```
l=3000//mm
W=(%pi/4)*D^2*p//N
Fs=8
Wcr=W*Fs//N
L=l/2
//let d be dia and I be moment of inertia
I=(%pi/64)*d^4
//acc to euler's formula
//Wcr=%pi^2*E*I/L^2//N
//Wcr=0.043*d^4
d=(Wcr/0.043)^(1/4)//mm
//acc to rankine's formula
//Wcr=(fc*A)/(1+a*(L/k)^2)
fc=320//N/mm^2
a=1/7500
//k=sqrt(I/A)=d/4
//Wcr=(251.4*d1^2)/(d1^2 +4800)
//on solving d2=14885
d1=sqrt(14885)//mm
//taking large rof two values
printf("the dia od piston is,%f\n",d1)
```

**Scilab code Exa 16.4** Machine design

```
//find size of push rod
clc
//solution
//given
l=300//mm
W=1400//N
//D=1.25*d
E=210*1000//N/mm^2
m=2.5
//let d be inner dia nd D be outer dia
//I=(%pi/64)*[D^4-d^4]=0.07*d^4//mm^4
```

```
Wcr=m*W
//Wcr=%pi^2*E*I/L^2=1.6*d^4//N
d=(Wcr/1.6)^(1/4)//mm
D=1.25*d//mm
printf("the inner and outer dia is,%f mm\n,%f mm\n",
   d,D)
```

**Scilab code Exa 16.5** Machine design

```

clc
//soltuion
//given
//ref fig 16.8
//let b be width and h be depth
//Ixx=b*h^3/12
//Iyy=h*b^3/12
//WcrX=%pi^2*E*Ixx/l^2//N
//Wcry=%pi^2*E*I/(l/2)^2//N
//Wcrx=Wcry
//we get h/b =2
printf("the ration of sides are h/b=2")
```

**Scilab code Exa 16.6** Machine design

```

clc
//soltuion
//given
D=101//mm
mr=2//kg
l=325//mm
sl=.15//m
```

```
Nmin=1500//rpm
Nmax=2500//rpm
r1=4//comp ratio
p=2.5//N/mm^2
r=sl/2//radius of crank
n=l/r
Fl=(%pi/4)*D^2*p//N
wmax=(2*%pi*Nmax)/60//rad/s
Fi=mr*(wmax)^2*r*[1+1/n]//N
Fc=Fl//N
//ref fig 16.11
//Ixx/Iyy=3.2
//kxx^2/kyy^2=3.2
Wcr=Fc*6//N
//A=2*(4*t*t)+ t*3*t=11t^2
//Ixx=[4t*5t^3/12-3t*3t^3/12]=419*t^4/12
//kxx=sqrt(Ixx/A)=1.78*t
L=l//mm
fc=320//N/mm^2
a=1/7500
//Wcr=(fc*A)/(1+a*(L/k)^2)
//on solving we egt
//t^2=44.55
t=sqrt(44.55)//mm
printf("the heigth and width is,%f mm\n,%f mm\n",5*t
    ,4*t)
printf("the thickness oflnage is,%f mm\n",t)
```

# Chapter 17

# Ch17

**Scilab code Exa 17.1** Machine design

```

clc
//solution
//given
d=50//mm
p=12.5//mm
W=10000//N
D=60//mm
R=30//mm
u=0.15//tan(q)=u
u1=0.18
P1=100//N
//tan(a)=p/(%pi/d)=b=0.08
b=0.08
//P=W*tan(u+a)
//P=W*[(tan(a)+tan(q))/(1-tan(a)*tan(q))]
P=W*[(b+u)/(1-(b*u))]//N
T=(P*d/2)+(u1*W*R)//N-mm
//let D1 be dia of wheel
P1=100
//T=2*P1*D1/2=100*D1
```

```
D1=T/100//mm

printf("the dia of wheel is ,%f mm\n",D1)
```

**Scilab code Exa 17.2** Machine design

```
//estimate Power
clc
//soltuion
//given
W=75000//N
v=300//mm/min
p=6//mm
do=40//mm
u=0.1//=tan(q)
d=do-(p/2)//mm
//tan(a)=p/(%pi/d)=b=0.0516
b=0.0516
//P=W*tan(u+a)
//P=W*[(tan(a)+tan(q))/(1-tan(a)*tan(q))]
P=W*[(b+u)/(1-(b*u))]//N
T=(P*d/2)/1000//N-m
N=v/p//rpm
w=2*%pi*N/60//rad/sec
P=T*w//W
printf("the power transmitted is ,%f W",P)
```

**Scilab code Exa 17.3** Machine design

```

clc
//soluiton
//given
```

```
do=55//mm
p=10//mm
W=400//N
D2=60//mm
D1=90//mm
R1=45//mm
R2=30//mm
u=0.15
u1=0.15//=//tan(q)
v=6//m/min
d=do-(p/2)//mm
//tan(a)=p/(%pi/d)=b=0.0637
b=0.0637
//P=W*tan(u+a)
//P=W*[(tan(a)+tan(q))/(1-tan(a)*tan(q))]
P=W*[(b+u)/(1-(b*u))]//N
R=(R1+R2)/2//mm
T=[(P*d/2)+(u1*W*R)]/1000//N-mm
N=v/0.01//rpm
w=2*%pi*N/60//rad/sec
P=T*w//W
printf("the power transmitted is,%f W\n",P)
//eff=To/T
eff=(W*b*(d/2))/(1000*T)
printf("the efficuency is,%f",eff)
```

**Scilab code Exa 17.4** Machine design

```

clc
//soltuion
//given
d=100//mm
p=20//mm
W=18000//N
```

```
D1=250//mm
R1=125//mm
D2=100//mm
R2=50//mm
l=400//mm
u=0.15//=tan(q)
u1=0.20
Lead=2*p
//tan(a)=Lead/(%pi/d)=b=0.127
b=0.127
//P=W*tan(u+a)
//P=W*[(tan(a)+tan(q))/(1-tan(a)*tan(q))]
P=W*[(b+u)/(1-(b*u))]//N
R=(R1+R2)/2//mm
T=[(P*d/2)+(u1*W*R)]//N-mm
//let P1 be req force
P1=T/l//N
printf("the req force is ,%f N\n",P1)
//P=W*tan(u-a)
//P=W*[(tan(a)-tan(q))/(1+tan(a)*tan(q))]
P2=W*[(u-b)/(1+(b*u))]//N
T2=[(P2*d/2)+(u1*W*R)]//N-mm
//let P3 be the force req
P3=T2/l//N
printf("the force req for lowering load is ,%f N",P3)
```

**Scilab code Exa 17.5** Machine design

```

clc
//soltuion
//given
p=10//mm
d=50//mm
W=20000//N
```

```
D1=60//mm
R1=30//mm
D2=10//mm
R2=5//mm
u=0.08//=tan(q)
u1=u
//tan(a)=p/(%pi/d)=b=0.0637
b=0.0637
//P=W*tan(u+a)
//P=W*[(tan(a)+tan(q))/(1-tan(a)*tan(q))]
P=W*[(b+u)/(1-(b*u))]//N
T=(P*d/2)/1000//N-m
N=170/10
Wd1=T*2*%pi*N//N-m
//wen load rotates with th screw
printf("the workdone in lifting is,%f N-m\n",Wd1)
//eff1=tan(a)/(tan(a+q))
eff1=b*(1-b*u)/(b+u)
printf("the eff is,%f \n",eff1)
//wen load doesn't trotate
R=(R1+R2)/2//mm
T2={(P*d/2)+(u1*W*R)}/1000//N-m
Wd2=T2*2*%pi*N//N-m
printf("the work done wen scre dosnt rotate is,%f N-m\n",Wd2)
//To=W*tan(a)*d/2
To=W*b*d/2/1000//N-m
eff2=To/T2
printf("the effi in this cse is,%f ",eff2)
```

**Scilab code Exa 17.6** Machine design

```

//soltuion
//given
```

```
do=50//mm
p=8//mm
W=2500//N
D1=110//mm
R1=55//mm
D2=55//mm
R2=27.5//mm
N=30//rpm
u=0.15//=tan(q)
u2=0.12
//tan(a)=p/(%pi/d)=b=0.055
b=0.055
//u1=u/cos(B)=0.15/cos(14.5)=0.155
u1=0.155
//P=W*tan(u+a)
//P=W*[(tan(a)+tan(q1))/(1-tan(a)*tan(q1))]
P=W*[(b+u1)/(1-(b*u1))]//N
T1=(P*d/2)//N-mm
R=(R1+R2)/2//mm
T2=u2*W*R//N-mm
T=(T1+T2)/1000//N-m
Power=T*2*%pi*N/60//W
printf("the power req is,%f W\n",Power)
To=W*b*d/2/1000//N-m
printf("the torque acting is,%f N-m\n",To)
eff=To/T
printf("the eff is,%f ",eff)
```

**Scilab code Exa 17.7** Machine design

```

clc
//soltuion
//given
do=25//mm
```

```
p=5//mm
W=10000//N
D1=50//mm
R1=25//mm
D2=20//mm
R2=10//mm
u=0.2//=tan(q)
u1=0.15
N=12//rpm
pb=5.8//N/mm^2
d=do-(p/2)//mm
Lead=2*p
//tan(a)=Lead/(%pi/d)=b=0.1414
b=0.1414
//P=W*tan(u+a)
//P=W*[(tan(a)+tan(q))/(1-tan(a)*tan(q))]
P=W*[(b+u)/(1-(b*u))]//N
R=(R1+R2)/2//mm
T=[(P*d/2)+(u1*W*R)]/1000//N-mm
printf("the torque acting is,%f N-m\n",T)
dc=do-p//mm
Ac=(%pi/4)*dc^2//mm^2
fc=W/Ac//N/mm^2
printf("the direct stress acting,%f N/mm^2\n",fc)
t=(16*T*1000)/(%pi*dc^3)//N/mm^2
printf("the shear stressa acting is,%f N/mm^2\n",t)
tmax=0.5*sqrt(fc^2 +4*t^2)//N/mm^2
printf("the stressa cting is ,%f N/mm^2\n",tmax)
//let n be number of threads
t1=p/2//mm//thickness of threads
n=W/(%pi*d*t1*5.8)
printf("the number of threads are,%f ",n)
```

**Scilab code Exa 17.9** Machine design

```

//soltuion
//given
W1=18000//N
F=4000//N
do=60//mm
p=10//mm
D1=150//mm
R1=75//mm
D2=50//mm
R2=25//mm
u=0.1//=tan(q)
u1=0.12
pb=7//N/mm^2
//let P1 be max force
dc=do-p//mm
d=(do+dc)/2//mm
//tan(a)=p/(%pi*d)=0.058
b=0.058
W=W1+F//N
T1=W*[(b+u)/(1-(b*u))]*d/2//N-mm//torque aacting
R=(R1+R2)/2//mm
T2=u1*W*R//N-mm
T=T1+T2//N-mm
//T=2*P1*1000
P1=T/(2*1000)//N
printf("the force acting at end of lever is,%f N\n",
   P1)
W2=W1-F//N
T3=W2*[(u-b)/(1+(b*u))]*d/2//N-mm
T4=u1*W2*R//N-mm
T5=T4+T3//N-mm
P2=T5/(2000)//N
printf("the force acting in lowering the agte is,%f
   N\n",P2)
To=W*b*d/2//N-mm
eff=To/T
printf("the eff is,%f \n",eff)
```

```
//let n be numbr of theads
t=p/2//mm//thikness
n=(W)/(7*%pi*d*t)
printf("the numbr of threads are ,%f",n)
```

**Scilab code Exa 17.10** Machine design

```
//find...
clc
//soltuion
//given
do=48//mm
p=8//mm
u=0.15//tan(q)
T=40000//N-mm
//let W be weigth
d=do-p/2//mm
Lead=3*p
//tan(a)=Lead/(%pi/d)=b=0.174
b=0.174
//u1=u/(cos(B))=u/(cos(15)=0.155
u1=0.155
//T1=W*[(b+u)/(1-(b*u))]*d/2//N-mm//torque aacting
//T=7.436*W
W=T/7.436//N
printf("the load acting is ,%f N\n",W)
h=50//mm//heigth of nut
n=h/p//numbr of thread
t=p/2//thikness of therrad
pb=W/(%pi*n*t*d)//N/mm^2
printf("the bearing pressure is ,%f N/mm^2",pb)
```

**Scilab code Exa 17.11** Machine design

```
//find...
clc
//soltuion
//given
//ref fig 17.10
do=12//mm
p=2//mm
u=0.12//tan(q)
u2=0.25
R=6//mm
P1=80//N
W=4000//N
d=do-p/2//mm
//tan(a)=p/(%pi*d)=0.058
b=0.058
//u1=u/(cos(B))=u/(cos(15)=0.124
u1=0.124
T1=W*[(b+u)/(1-(b*u))]*d/2//N-mm//torque acting
T2=u2*W*R//N-mm
T=T1+T2//N-mn
l=T/P1//mm
printf("the length of handle req is,%f mm\n",l)
dc=do-p//mm
//T=(%pi/16)*t*dc^2
t=16*T/(%pi*dc^3)//N/mm^2
M=P1*150//N-mm
fb=32*M/(%pi*dc^3)//N/mm^2
tmax=0.5*sqrt(fb^2 +4*t^2)//N/mm^2
printf("the max shear stressa cting is,%f N/mm^2\n",
   tmax)
h=25//mm
n=h/p
t1=p/2
pb=W/(%pi*n*t1*d)//N/mm^2
printf("the bearing pressure is,%f N/mm^2",pb)
```

**Scilab code Exa 17.12** Machine design

```
//find...
clc
//soltuion
//given
W=100*1000//n
N=60//rpm
u=0.12
fc=100//N/mm^2
//let Ac be core dia
Ac=W/fc//mm^2
//corr to Ac,we get'
do=50//mm
dc=41.5//mm
d=46//mm
p=8//mm
printf("the nominal,core ,mean dia and pitch of
    screw corresponding to Ac are,%f mm\n,%f mm\n,%f
    mm\n,%f mm\n",do,dc,d,p)
//tan(a)=p/(%pi*d)=0.055
b=0.055
//u1=u/(cos(B))=u/(cos(15)=0.124
u1=0.124
P=W*[(b+u)/(1-(b*u))]//N
T1=P*d/2//N-mm
T2=0.1*T1//N
T=T1+T2//N-mm
To=W*b*d/2//N
eff=To/T
Power=T*2*%pi*N/60000//W
printf("the effi and power tranmitted is,%f \n,%f W\
    n",eff,Power)
```

**Scilab code Exa 17.14** Machine design

```
//find ...
clc
//soltuion
//given
W=40000//N
L=400//mm
do=50//mm
p=10//mm
fcu=320//N/mm^2
fy=200//N/mm^2
ty=120//N/mm^2
tc=20//N/mm^2
pb=12//N/mm^2
E=210*1000//N/mm^2
u=0.13///=tan(q)
dc=do-p//mm
Ac=(%pi/4)*dc^2
fc=W/Ac//N/mm^2
d=(do+dc)/2//mm
//tan(a)=p/(%pi*d)=0.07
b=0.07
T=W*[(b+u)/(1-(b*u))]*d/2//N-mm//torque acting
//let t be stress
t=(T*16)/(%pi*dc^3)//N/mm^2
tmax=0.5*sqrt(fc^2 +4*t^2)//N/mm^2
printf("the max shear stressa cting is,%f N/mm^2\n",
    tmax)
Fs=ty/tmax
printf("factor of safety is,%f\n",Fs)
//let n be numbr of therads
//n=W/(12*%pi/4*(do^2-dc^2))
printf("the numbr of threads is,%f \n",W/(12*%pi/4*(
```

```
    do^2-dc^2)))
printf("the numbr of threads is n=5\n")
n=5
h=p*n//mm
printf("the heigth of nut is ,%f mm\n",h)
To=W*b*d/2//N-mm
eff=To/T
printf("the eff of arrngement is ,%f",eff)
```

**Scilab code Exa 17.15** Machine design

```
//find ...
clc
//soltuion
//given
W=80000//N
H1=400//mm
fet=200//N/mm^2
fec=200//N/mm^2
te=120//N/mm^2
fetn=100//N/mm^2
fecn=90//N/mm^2
te=80//N/mm^2
pb=18//N/mm^2
//let dc be core dia
Fs=2
//W=(%pi/4)*dc^2*fec/Fs=78.55*dc^2
//dc=sqrt(W/78.55)
printf("the core dia is ,%f mm\n",sqrt(W/78.55))
printf("the core dia is ,say 38mm selcted from table
    17.2\n")
dc=38//mm
do=46//mm
p=8//m
printf("the nomnal dia and pitch is ,%f mm\n,%f mm\n"
```

```
    ,do,p)
d=(do+dc)/2//mm
//tan(a)=p/(%pi*d)=0.0606
b=0.0606
u=0.14//=tan(q)
T1=W*[(b+u)/(1-(b*u))]*d/2//N-mm//torque acting
fc=W/(%pi*dc^2/4)//N/mm^@
t=(16*T1)/(%pi*dc^2)//N/mm^2
fcmax=0.5*[fc+sqrt(fc^2 +4*t^2)]//N/mm^2
printf("the max pric stress is,%f N/mm^2\n",fcmax)
tmax=0.5*sqrt(fc^2 +4*t^2)//N/mm^2
printf("the max shear stress is,%f N/mm^2\n",tmax)
//let n be numbr of therads
//n=W/(12*%pi/4*(do^2-dc^2))
printf("the numbr of threads is,%f \n",W/(12*%pi/4*(
    do^2-dc^2)))
printf("the numbr of threads is n=10\n")
n=10
h=p*n//mm
printf("the heigth of nut is,%f mm\n",h)
//let D1 be outer dia of nut
//W=(%pi/4)*[D1^2-do^2]*fetn/2=39.3*(D1^2-2116)
D1=sqrt(W/39.3 +2116)//mm
printf("the outer dia of nut is,%f mm\n",D1)
//let D2 be outer dia of nut collar
//W=(%pi/4)*[D2^2-D1^2]*fetn/2=35.3*(D2^2-4225)
D2=sqrt(W/35.3 + 4225)//mm
printf("the oter dia of collar nut is,%f mm\n",D2)
t1=W/(%pi*D1*40)//mm
printf("the thickness of nut is,%f mm\n",t1)
D3=1.75*do//mm
h3=50//mm
t3=10//mm
d3=160//mm
printf("the heigth ,thickness ,and dia of top of cup
     is,%f mm\n,%f mm\n,%f mm\n",h3,t3,d3)
u1=u//assume
//M=force applied * length of lever
```

```
M=300*2250//N-mm
//let D4 be dia of handle
fb=200/2
D4=(M/(%pi/32*fb))^(1/3)//mm
printf("the dia of ahndle is ,%f mm\n",D4)
H4=2*D4//mm
printf("the heigth of head is ,%f mm\n",H4)
//design of body
D5=1.5*D2//mm
t5=0.25*do//mm
D6=2.25*D2//mm
D7=1.75*D6//mm
t2=2*t1//mm
To=W*b*d/2//N-mm
printf("the dia of body at top is ,%fmm\n",D5)
printf("the thickness of boody is ,%f mm\n",t5)
printf("the inner dia is ,%f mm\n",D6)
printf("the outr dia is ,%f mm\n",D7)
printf("the thickness of base is ,%f mm\n",t2)
```

**Scilab code Exa 17.16** Machine design

```
//desing
clc
//soltuion
//given
//ref fig 17.12
W=4000//N
l=110//mm
ft=100//N/mm^2
t=50//N/mm^2
pb=20//N/mm^2
p=6
u=0.20
//design of square
```

```
//cos(q)=0.8112
q=(%pi/180)*35.1//rad
F=W/(2*tan(q))//N
W1=2*F//N
//let dc be core dia
//dc=sqrt(4*W1/(%pi*ft))
printf("the core dia is,%f mm\n",sqrt(4*W1/(%pi*ft))
    )
printf("the core dia is,say dc=14 mm\n")
dc=14//mm
do=dc+p
printf("the nominal dia is,%f mm\n",do)
d=do-p/2
//tan(a)=p/(%pi/d)=b=0.1123
b=0.1123
P=W*[(b+u)/(1-(b*u))]//N
T=(P*d/2)
t1=(16*T)/(%pi*dc^3)///N/mm^2
ft1=W1/(%pi/4*dc^2)//N/mm^2
ftmax=0.5*(ft1+ sqrt(ft1^2 +4*t1^2))//N/mm^2
tmax=0.5*(sqrt(ft1^2 + 4* t1^2))//N/mm^2
printf("the max prin stress and max shear stress is,
    %f N/mm^2\n,%f N/mm^2\n",ftmax,tmax)
printf("since max stresses are within safe limits,
    therefore design is safe\n")
//design of nut
//let n be numbr of threads
//n=W1/(%pi/4*20*(do^2-dc^2))
printf("the numbr of threads are ,%f \n",W1/(%pi
    /4*20*(do^2-dc^2)))
printf("since number of threads can not so less,so
    we take n=4\n")
n=4
t2=n*p//mm
printf("the number of therd and thickness of threads
     is,%f \n,%f mm\n",n,t2)
b1=1.5*do
printf("the width of nut is,%f mm\n",b1)
```

```
length =210+t2+(2*8)
printf("the length of screwd portion is ,%f mm\n",
   length)
//desig of pins in nuts
//let d1 be dia
d1=sqrt(F/(2*%pi/4*t))
printf("the dia of pins in nuts is ,%f mm\n",d1)
//design of links
F1=F/2//load on link
Wcr=1423*5//Fs=5
//let t3 be thickness and b3 be width of link
//Al=t3*3t3=3*t3^2//b3=3*t3
//I=(1/12)*t3*b3^2=2.25*t3^4
//k=sqrt(I/Al)=0.866*t3
L=110
a=1/7500
//acc tor ankine fornula
//Wcr=(ft*Al)/(1+a*(L/k)^2)=300*t3^2/(1+(2.15/t1^2))
//t3^4-23.7*t3^2-51=0
//t3=sqrt(25.7)//mm
printf("the thickness and width is ,%f mm\n,%f mm\n",
   sqrt(25.7),3*sqrt(25.7))
printf("the thickness is say 6mm\n")
t3=6//mm
b3=3*t3//mm
Al=3*t3^2
```

**Scilab code Exa 17.17** Machine design

```
//det ...
clc
//solution
//given
do=50//mm
u=0.15//tan(q)
```

```
p1=16//mm
p2=12//mm
tmax=28//N/mm^2
d1=do-p1/2
d2=do-p2/2
//tan(a1)=p/(%pi/d1)=b1=0.1212
b1=0.1212
//tan(a2)=p/(%pi/d2)=b2=0.0868
b2=0.0868
//let W be load
//T1=W*[(b1+u)/(1-(b1*u))]*d1/2=5.8*W//N-mm
//T2=W*[(u-b2)/(1+(b2*u))]*d2/2=-.37*W//N-mm
//T=T1-T2=7.17*W
//To=W*(p1-p2)/(2*%pi)=0.636*W
//eff=To/T
eff=0.636/7.17
printf("the eff is,%f \n",eff)
dc1=do-p1
//fc=W/Ac1=W/(%pi/4 * dc1^2)=W/908//N/mm^2
//t1=16T/(%pi*dc1^3)=W/1331//N/mm^2
//tmax=0.5*sqrt(fc^2 + 4*t1^2)=0.5*1.863*10^-3*W
W=tmax/(0.5*1.863*10^-3)//N
printf("the load acting is,%f N",W)
```

# Chapter 18

# Ch18

**Scilab code Exa 18.1** Machine design

```
//find ..
clc
//soltuion
//given
N1=150//rpm
d1=750//rpm
d2=450//mm
d3=900//mm
d4=150//mm
s1=0.02
s2=0.02
//ref fig 18.12
N4={(d1*d3)/(d2*d4)}*N1//rpm
printf("the value of N4 is ,%f rpm\n",N4)
//wen slip is there
N4s={(d1*d3)/(d2*d4)}*N1*(1-s1)*(1-s2)//rpm
printf("the value N4 when slip is there is ,%f rpm",
   N4s)
```

**Scilab code Exa 18.2** Machine design

```
//find ..
clc
//soltuion
//given
d1=0.450//rpm
r1=0.225//m
d2=0.2//m
r2=0.1//m
N1=200//rpm
x=1.95//m
T1=1000//N
u=0.25
//ref fig 18.17
L=%pi*(r1+r2)+2*x+(r1+r2)^2/x//m
printf("the length of belt is ,%f m\n",L)
//sin(a)=(r1+r2)/x=0.1667
//a=9.6//deg
a=(%pi/180)*9.6//rad
q=%pi+(2*a)//rad
printf("te angle of contact is ,%f rad\n",q)
//let T1 and  T2 be tneion on tight and slag side
//T1/T2=y
//log(T1/T2)=u*q=0.25*3.477=0.8693
T2=T1/2.387//N
v=%pi*N1*d1/60//m/s
P=(T1-T2)*v
printf("the power transmitted is ,%f W\n",P)
```

**Scilab code Exa 18.3** Machine design

```
//find ..
clc
//soltuion
```

```
//given
t=0.009//m
b=0.25//m
d=0.9//m
N=336//rpm
q=2.1//rad
f=2//N/mm^2
rho=980//kg/m^3
u=0.35
v=%pi*N*d/60//m/s
a=b*t//area
Tt1=f*a*1000*1000//N
T=Tt1
printf("the value of Tt1 is ,%f N\n",Tt1)
m=a*rho//mass/length
Tc=m*v^2//N
printf("the centrifugal tension is ,%f N\n",Tc)
T1=T-Tc//N
//let T1 and  T2 be tneion on tight and slag side
//T1/T2=y
//log(T1/T2)=u*q=0.25*3.477=0.735
T2=T1/2.085//N
printf("the value of T2 is ,%f N\n",T2)
P=(T1-T2)*v//W
printf("the poweer capacity is ,%f W\n",P)
Tt2=T2+Tc//N
P1=(Tt1-Tt2)*v//W
printf("the power capcity by taking centrifugal
    force is ,%f W\n",P1)
```

---

**Scilab code Exa 18.4** Machine design

```
//find..
clc
//soltuion
```

```
//given
P=30000//W
d=1.5//m
N=300//rpm
q=2.88//rad
u=0.3
t=0.0095//m
rho=1100//kg/m^3
f=2.5*10^6//N/m^2
//let T1 and  T2 be tneion on tight and slag side
v=%pi*N*d/60//m/s
printf("the vel of belt is,%f m/s\n",v)
//P=(T1-T2)*v//W
//T1-T2=P/v=1273//N
//log(T1/T2)=u*q=0.25*3.477=2.375
//T2=T1/2.375//N
T1=2199//N
T2=926//N
//let b is width
//m=A*rho=b*t*rho=10.45*b//kg/m
//Tc=m*v^2=5805*b
//T=T1+Tc=f*b*t
//23750*b=2199+5805*b
b=2199/(23750-5805)//m
printf("the widht of belt is,%f m\n",b)
```

**Scilab code Exa 18.5** Machine design

```
//find..
clc
//soltuion
//given
d1=400//mm
r1=200//mm
d2=1600//mm
```

```
r2=800//mm
q1=2.5//rad
q2=3.78//rad
u1=0.3
u2=0.25
N1=700//rpm
P=22.5*10^3//W
t=0.005//mm
f=2.3*10^6//N/m^2
//ref fig 18.19
v=%pi*N1*d1/60//m/s
//let T1 and  T2 be tneion on tight and slag side
printf("the vel of belt is,%f m/s\n",v)
//P=(T1-T2)*v//W
//T1-T2=P/v=1530//N
//log(T1/T2)=u*q=0.25*3.477=0.75
//T2=T1/2.21//N
T1=2896//N
T2=1366//N
//let b is width
//m=A*rho=b*t*rho=5*b//kg/m
//Tc=m*v^2=1080*b
//T=T1+Tc=f*b*t
//11500*b=2896+1080*b
b=2896/(11500-1080)//m
printf("the widht of belt is,%f m\n",b)
```

**Scilab code Exa 18.7** Machine design

```
//find..
clc
//soltuion
//given
P=110*1000//W
d1=0.9//m
```

```
r1=0.45//m
d2=1.2//m
r2=0.6//m
v=20//m/s
x=3.6//m
u=0.3
s1=0.012
s2=0.012
rho=100//kg/m^3
//v=%pi*N1*d1/60*(1-s1)//m/s
N1=20/0.0466//rpm
//v*(1-s2)=%pi*N2*d2/60//m/s
N2=19.76*60/(%pi*1.2)//rpm
T=P*60/(2*%pi*N2)
//since there is 5% friction
Tn=1.05*T//net torque
//since belt is to designed for 20% overload
TN=1.2*Tn//N-m
//let T1 and  T2 be tneion on tight and slag side
//TN=(T1-T2)*r2
//T1-T2=TN/r2=7000/N
//sin(a)=(r2-r1)/x=2.4 deg
a=(%pi/180)*2.4//rad
q1=%pi-a//rad
printf("the angle of contact is,%f rad \n",q1)
//log(T1/T2)=u*q1=0.3*q1=0.918
//T2=T1/2.51//N
T1=11636//N
T2=4636//N
//let b is width
//m=A*rho=b*t*rho=15*b//kg/m
//Tc=m*v^2=6000*b
//T=T1+Tc=f*b*t
//37500*b=11636+6000*b
b=11636/(37500-6000)//m
printf("the widht of belt is,%f m\n",b)
L=%pi*(r1+r2)+2*x+(r1+r2)^2/x//m
printf("the length of belt is,%f m",L)
```

**Scilab code Exa 18.8** Machine design

```
//find..
clc
//soltuion
//given
b=0.100//m
t=0.01//m
v=16.67//m/s
//T1-T2=1.8 *T2
f=1.6//N/mm^2
rho=1000//kg/m^3
//let T1 and  T2 be tneion on tight and slag side
T=f*b*t*10^6//N//max tension
m=0.1*0.01*1000//kg/m
Tc=m*v^2//N
T1=T-Tc//N
T2=T1/2.8//N
P=(T1-T2)*v
printf("the power transmitted is ,%f W\n",P)
vm=sqrt(T/(3*m))//m/s
Tc1=T/3//N
T11=T-Tc1
T21=T11/2.8
P1=(T11-T21)*vm
printf("the max power tans is ,%f W\n",P1)
```

**Scilab code Exa 18.9** Machine design

```
//find..
clc
```

```
//soltuion
//given
x=4.8//m
d1=1.5//m
d2=1//m
To=3000//N
m=1.5//kg/m
u=0.3
N2=400//rpm
v=%pi*N2*d2/60//m/s
Tc=m*v^2
//let T1 and  T2 be tneion on tight and slag side
//To=(T1+T2+2*Tc)/2
//T1+T2=4677
//sin(a)=(r1-r2)/x=0.0521
a=(%pi/180)*3//rad
q=%pi-2*a//rad
printf("the angle of contact is,% f rad\n",q)
//log(T1/T2)=u*q=0.3*q=0.3965
//T2=T1/2.5//N
T1=3341//N
T2=1336//N
P=(T1-T2)*v
printf("the power transmitted is,%f W\n",P)
```

**Scilab code Exa 18.10** Machine design

```
//find..
clc
//soltuion
//given
N2=600//rpm
P=15*1000//w
N1=1750//rpm
rho=1000//kg/m^3
```

```
f=4*10^6//N/m^2
u1=0.5
u2=0.4
v=20//m/s
//ref fig 18.21
d1=v*60/(%pi*N1)//m
d2=v*60/(%pi*N2)//m
printf("the dia of mottr and blower pulley are,%f m\n,%f m\n",d1,d2)
x=2*d2//m
L=(%pi/2)*(d1+d2)+(2*x)+(d1-d2)^2/(4*x)
printf("the length of belt is,%f m\n",L)
//sin(a)=(r1-r2)/x=0.1643
a=(%pi/180)*9.46//rad
q=%pi-2*a//rad
q2=%pi+2*a
//since u1*q1 >u2*q2,therfore design is blower based

//let T1 and  T2 be tneion on tight and slag side
//P=(T1-T2)*v
//T1-T2=750//N
//log(T1/T2)=u*q=0.4*q2=0.6035
//T2=T1/4//N
T1=1000//N
T2=250//N
//let a be the area
//m=a*rho=1500*a//mass/length
//Tc=m*v^2=0.6*10^6*a//N
//T=T1+Tc=1000+(0.6*10^6*a)...eq1
//T=f*a=4*10^6*a....eq2
//eq1=eq2
a=1000/(3.4*10^6)//m^2
printf("the area of belt is,%f m^2\n",a)
Tc=0.6*10^6*a//N
To=(T1+T2+2*Tc)/2//N
printf("min initial tension is,%f N\n",To)
Toi=To+(0.5)*To//N//increased initial tensaion
//Toi=(T1i+T2i+2*Tc)/2//N
```

```
//T1i+T2i=2051.2...eq3
//T1i/T2i=4...eq4
//from eq3 an eq4
T1i=1640.96//N
T2i=T1i/4
printf("the resultant force in plane of blower is,%f N",T1i-T2i)
```

**Scilab code Exa 18.11** Machine design

```
//find..
clc
//soltuion
//given
d1=0.3//m
d2=0.45//m
q1=2.8//rad
q2=3.66//rad
N1=200//rpm
u=0.25
P=3000//W
//let T1 and  T2 be tneion on tight and slag side
//since q2>q1,therfore design is smaller pulley based
v=%pi*N1*d1/60//m/s
//P=(T1-T2)*v
//T1-T2=955//N
//log(T1/T2)=u*q=0.25*q1=0.3043
//T2=T1/2.015//N
T1=1896//N
T2=941//N
To=(T1+T2)/2
Toi=To+(0.1)*To//N//incresed initial tension
//Toi=(T11+T22)/2//N
//T11+T22=2*Toi//N
```

```
//T11+T22=3120.7//N....eq1
//T12/T22=2.015...eq2
//from eq1 and eq2
T11=2085.7
T22=1035//N
P1=(T11-T22)*v
u1=u+(0.1)*u
//log(T111/T222)=u1*q1=0.3348
//T111/T222=2.16
//Toi=(T111+T222)/2.....eq3
//T111+T222=2837....eq4
//from eq3 and eq4
T111=1939//N
T222=898//N
P2=(T111-T222)*v//W
pi1=((P1-P)/P)*100
pi2=((P2-P)/P)*100
printf("the perctage inc in power wen initial
   tension is inc is,%f \n",pi1)
printf("the %age perct inc inpower wen coefficient
   of riction si,%f",pi2)
```

# Chapter 19

# Ch19

**Scilab code Exa 19.1** Machine design

```
// find..
clc
//solution
//given
P=20*1000//W
N=300//rpm
d=550//mm
n=4
fb=15//N/mm^2
//let b1 minor axis,a1 major axis
T=(P*60)/(2*%pi*N)//N-m
M=2*T/n*1000//N-mm
//a1=2b1
//Z=(%pi/32)*b1*a1^2=(%pi)/8*b1^3
//fb=M/Z
b1=(M/(%pi/8*fb))^(1/3)//mm
printf("the minor and moajor axis is,%f mm\n,%f mm",
   b1,2*b1)
```

**Scilab code Exa 19.2** Machine design

```
// find..
clc
//solution
//given
P=35000//W
N=240//rpm
L=0.350//mm
u=0.25
t=10//mm
n=6
q=%pi
fts=80//N/mm^2
ftk=80//N/mm^2
ts=50//N/mm^2
tk=50//N/mm^2
f=2.5//N/mm^2
ft=4.5//N/mm^2
fb=15//N/mm^2
rho=7200//kg/m^3
//fb*10^6=rho*v^2
v=sqrt(ft*10^6/rho)//m/s
printf("the speed is,%f m/s\n",v)
D=(v*60)/(%pi*N)//m
printf("the dia of pulley is,%f m\n",D)
//let b e width of belt
//let T1 and T2 be tension on tight and slag side
//P=(T1-T2)*v
//T1-T2=1400//N
//log(T1/T2)=u*q=0.25*3.14=0.3415
//T2=T1/2.195//N
T1=2572//N
T2=1172//N
rho1=1000//kg/m^3
//A=b*t=10*b/10^6//m^2
//let b is width
//m=A*rho1=b*t*rho=0.01*b//kg/m
```

```
//Tc=m*v^2=6.25*b
//T=f*b*t=25*b//N
//T1=T-Tc
//T1=25*b-6.25b
//b=T1/18.75//mm
printf("the width of belt si,%f mm\n",T1/18.75)
printf("the standard width of belt is b=140mm\n")
b=140//mm
Tc=6.25*b//N
//let d eb dia of shaft
T3=(P*60)/(2*%pi*N)//N-mm
M=(T1+T2+2*Tc)*L
Te=sqrt(M^2 + T3^2)
//d=((Te*16*1000)/(%pi*ts))^(1/3)//mm
printf("the dia of shaft is,%f mm\n",((Te*16*1000)/(
    %pi*ts))^(1/3))
printf("the standard dia of shaft is d=65mm\n")
d=65//mm
//corres to d=65mm,
width =20//mm
thickness =12//mm
printf("correponding to d=65mm,thickness and width
    is,%f mm\n,%f mm\n",thickness,width)
//let l be length of key
//T3*1000=l*20*tk*d/2
//l=T3/(32500)//mm
printf("the length of key is,%f mm\n",T3/(32500))
printf("length should be atleast l=102 mm\n")
printf("therfore length is 102 mm\n")
l=102//mm
//let b1 minor axis,a1 major axis
M=2*T3/n*1000//N-mm
//a1=2b1
//Z=(%pi/32)*b1*a1^2=(%pi)/8*b1^3=0.2=393*b1^3
//fb=M/Z
b1=(M/(0.393*fb))^(1/3)//mm
printf("the minor and moajor axis is,%f mm\n,%f mm",
    b1,2*b1)
```

**Scilab code Exa 19.3** Machine design

```
// find..
clc
//solution
//given
D=0.9//m
N=200//rpm
P=7500//W
T=145//n
//T1=2*T2
n=6
fb=15//N/mm^2
t=63//N/mm^2
v=%pi*N*D/60//m/s
//let T1 and  T2 be tneion on tight and slag side
//P=(T1-T2)*v...eq1
//T1=2T2...eq2
//from 1 and 2
T2=796//N
T1=1592//N
//b=T1/14.5//mm
printf("the widht is,%f mm\n",T1/14.5)
printf("the widht is,say 112mm\n")
b=112//mm
T=(P*60)/(2*%pi*N)*1000//N-mm
//((T*16)/(%pi*t))(1/3)=12.4*d^3
printf("the dia of shaft is,%f mm\n",(T/12.4)^(1/3))
printf("the dia of shaft is,say d=35mm\n")
d=35//mm
printf("width of pulley is B\n",112+13)
t1=D*1000/300 + 2//mm
printf("the thickness of pulley is,%f mm\n",t1)
//let b1 minor axis,a1 major axis
```

```
//a1=2*b1
M=2*T1/n*1000//N-mm
//Z=(%pi/32)*b1*a1^2=(%pi)/8*b1^3=0.393*b1^3
//fb=M/Z
b1=(M/(0.393*fb))^(1/3)//mm
printf("the minor and moajor axis is,%f mm\n,%f mm",
   b1,2*b1)
```

# Chapter 20

# Ch20

**Scilab code Exa 20.1** Machine design

```
//find ..
clc
//soltuion
//given
P=90000//W
N2=250//rpm
N1=750//rpm
d2=1//m
x=1.75//m
v=26.67//m/s
A=375*10^(-6)//m^2
rho=1000//kg/m^3
f=2.5//N/mm^2
B=17.5//deg
u=0.25
d1=N2*d2/N1//m
//sin(a)=(r2-r1)/x=0.1914
a=(%pi/180)*11.04
q=%pi-2*a//rad
printf("the angle of contact is,%f rad\n",q)
m=A*rho//kg/m
```

```
Tc=m*v^2//N
printf("the centrifugl tension is ,%f N\n",Tc)
T=f*A*10^6//N
printf("max tension is ,%f N\n",T)
T1=T-Tc//N
//log(T1/T2)=u*q*cosec(%pi/180*B)=0.9976
T2=T1/9.95//N
Ppb=(T1-T2)*v//W
printf("power tranmited per belt is ,%f W\n",Ppb)
//n=P/Ppb//
printf("the number of belts are ,%f \n",P/Ppb)
printf("number of belts are say 6\n")
n=6
r1=d1/2
r2=d2/2
L=%pi*(r2+r1)+2*x+(r2-r1)^2/x
printf("the length of belt is ,%f m",L)
```

**Scilab code Exa 20.2** Machine design

```
//find..
clc
//soltuion
//given
n=2
B=15//deg
A=750*10^-6
u=0.12
rho=1200//kg/m^3
f=7*10^6//N/m^2
d=0.300//m
N=1500//rpm
m=A*rho//kg/m
v=(%pi*N*d)/60//m/s
Tc=m*v^2//N
```

```
q=%pi
printf("the centrifugl tension is,%f N\n",Tc)
T=f*A//N
printf("max tension is,%f N\n",T)
T1=T-Tc//N
//log(T1/T2)=u*q*cosec(%pi/180*B)=0.6335
T2=T1/4.3//N
P=(T1-T2)*v*n//W
printf("the power trans is,%f W\n",P)
//for max power tranfer
//let N1 be speed
//Tc1=T/3
//Tc1=m*v1^2
v1=sqrt(T/(3*m))//m/s
N1=(v1*60/(%pi*d))
printf("rpm of shaft at max power trans,%f rpm",N1)
```

**Scilab code Exa 20.3** Machine design

```
//find..
clc
//soltuion
//given
x=1//m
P=95*1000//W
d1=0.3//m
N1=1000//rpm
N2=375//rpm
B=20//deg
A=400*10^-6//m^2
f=2.1//N/mm^2
rho=1100//kg/m^3
u=0.28
t=42//N/mm^2
d2=N1*d1/N2//m
```

```
//sin(a)=(r2-r1)/x=0.25
a=(%pi/180)*14.5
q=%pi-2*a//rad
printf("the angle of contact is,%f rad\n",q)
m=A*rho//kg/m
v=(%pi*N1*d1)/60//m/s
Tc=m*v^2//N
T=f*A*10^6//N
printf("max tension is,%f N\n",T)
T1=T-Tc//N
//log(T1/T2)=u*q*cosec(%pi/180*B)=0.9407
T2=T1/8.72//N
Ppb=(T1-T2)*v//W
printf("power tranmited per belt is,%f W\n",Ppb)
//n=P/Ppb//
printf("the number of belts are,%f \n",P/Ppb)
printf("number of belts are say 10\n")
n=10
//let D be dia of shaft
T3=(P*60)/(2*%pi*N2)*1000//N-mm
M=(T1+T2+2*Tc)*200*10//N-mm
Te=sqrt(T3^2 + M^2)
D=[(Te*16)/(%pi*t)]^(1/3)//m
printf("shaft dia is,%f mm\n",D)
```

**Scilab code Exa 20.5** Machine design

```
//find..
clc
//soltuion
//given
P=20000//W
d1=0.25//m
N1=1800//rpm
d2=0.9//m
```

```
x=1//m
B=20//deg
u=0.2
rho=1110//kg/m^3
f=2.1//N/mm^2
A=230*10^-6//m^2
//sin(a)=(r2-r1)/x=0.325
a=(%pi/180)*18.96
q1=%pi-2*a//rad
q2=%pi+2*a
//since uq for flat pulley si smalll,therfore desing is flat pulley based
v=(%pi*N1*d1)/60//m/s
m=A*rho//kg/m
Tc=m*v^2//N
printf("the centrifugl tension is,%f N\n",Tc)
T=f*A*10^6//N
printf("max tension is,%f N\n",T)
T1=T-Tc//N
//log(T1/T2)=u*q2=0.3304
T2=T1/2.14//N
Ppb=(T1-T2)*v//W
printf("power tranmited per belt is,%f W\n",Ppb)
//n=P/Ppb//
printf("the number of belts are,%f \n",P/Ppb)
printf("number of belts are say 5\n")
n=5
```

**Scilab code Exa 20.6** Machine design

```
//find..
clc
//soltuion
//given
d=2.6//m
```

```
n=15
B=22.5
q=2.967//rad
u=0.28
T=960//N
m=1.5//kg/m
//let N be speed
v=sqrt(T/(3*m))//m/s
N=(v*60)/(%pi*d)//rpm
printf("rpm is ,%f rpm\n",N)
//for max power trans
Tc=T/3
T1=T-Tc
//log(T1/T2)=u*q*cosec(%pi/180*B)=0.9435
T2=T1/8.78//
P=(T1-T2)*v*n//W
printf("the power trans is ,%f W\n",P)
```

**Scilab code Exa 20.7** Machine design

```
//find..
clc
//soltuion
//given
n=10
v=25//m/s
P=115*1000//W
q=%pi
B=22.5//deg
u=0.2
m=0.6//kg/m
//let T1 and T2 be tension on tight and slag side
//P=(T1-T2)*v*n//W
//T1-T2=460...eq1
//log(T1/T2)=u*q*cosec(%pi/180*B)=0.714
```

```
T2=T1/5.18//....eq2
//from eq1 and eq2
T1=570//N
T2=110//N
Tc=m*v^2
Tt1=T1+Tc
Tt2=T2+Tc
printf("the value of Tt1 and Tt2 is ,%f N\n,%f N",Tt1,Tt2)
```

**Scilab code Exa 20.8** Machine design

```
//find..
clc
//soltuion
//given
P=600*1000//W
d=4//m
N=90//rpm
q=2.8//rad
B=22.5//deg
u=0.28
m=1.5//kg/m
T=2400//N
v=(%pi*N*d)/60//m/s
Tc=m*v^2//N
printf("the centrifugl tension is ,%f N\n",Tc)
T1=T-Tc//N
//log(T1/T2)=u*q*cosec(%pi/180*B)=0.8907
T2=T1/7.78//N
Ppb=(T1-T2)*v//W
printf("power tranmited per belt is ,%f W\n",Ppb)
//n=P/Ppb//
printf("the number of belts are ,%f \n",P/Ppb)
printf("number of belts are say 20\n")
```

**Scilab code Exa 20.9** Machine design

```
//design wire rope
clc
//soltuion
//given
W=55000//N
depth=300//m
v=500//m/min
t=10//s
//ref T20.6,we choose rope type 6*19
//,tab; 20.11,Fs =7,for depth 300 to 600m,design
   load is calculated by taking 2 to 2.5 times
   factor of safety fiven is table
//ref table 20.11
Designload=15*55*1000//N
//ref table 20.6,tesnile strength of 6*19 is=595*d^2
//595d^2=designload
//d=sqrt(Desingload/595)//mm
printf("the dia of rope is,%f mm\n",sqrt(Designload
   /595))
printf("the dia of rope is,say 38mm\n")
d=38//mm
dw=0.063*d//ref table 20.10,dw=dia of wire
A=0.38*d^2
//ref table 20.6
w=0.0363*d^2*depth//N
//ref table 20.12
D=100*d
fb=84000*dw/D
printf("bending stress acting is,%f N/mm^2\n",fb)
Wb=fb*A//N
printf("the bending load on rope is,%f N\n",Wb)
a=v/(60*t)//acceleration
```

```
g=9.81//m/s^2
Wa=(W+w)/g*a//additonal load
printf("additional load due to acc si,%f N\n",Wa)
Wst=2*(W+w)
printf("the starting load acting is,%f N\n",Wst)
We=W+w+Wb//N
printf("effctive load during uniform velocity is,%f
    N\n",We)
Fsa=Designload/We
printf("actual factor of safety is,%f \n",Fsa)
printf("since factor of safety caculated above are
    safe,therefore wire rope of dia 38mm and 6*19 is
    chosen")
```

---

**Scilab code Exa 20.10** Machine design

```
//design wire rope
clc
//soltuion
//given
W=55000//N
depth=300//m
v=500//m/min
t=10//s
//ref T20.6,we choose rope type 6*19
//,tab; 20.11,Fs =7,for depth 300 to 600m,design
    load is calculated by taking 2 to 2.5 times
    factor of safety fiven is table
//ref table 20.11
Designload=15*55*1000//N
//ref table 20.6,tesnile strength of 6*19 is=595*d^2
//595d^2=designload
//d=sqrt(Desingload/595)//mm
printf("the dia of rope is,%f mm\n",sqrt(Designload
    /595))
```

```
printf("the dia of rope is ,say 38mm\n")
d=38//mm
dw=0.063*d//ref table 20.10,dw=dia of wire
A=0.38*d^2
//ref table 20.6
w=0.0363*d^2*depth//N
//ref table 20.12
D=100*d
fb=84000*dw/D
printf("bending stress acting is ,%f N/mm^2\n",fb)
Wb=fb*A//N
printf("the bending load on rope is ,%f N\n",Wb)
a=v/(60*t)//acceleration
g=9.81//m/s^2
Wa=(W+w)/g*a//additonal load
printf("additional load due to acc si ,%f N\n",Wa)
Wst=2*(W+w)
printf("the starting load acting is ,%f N\n",Wst)
We=W+w+Wb//N
printf("effctive load during uniform velocity is ,%f
   N\n",We)
Fsa=Designload/We
printf("actual factor of safety is ,%f \n",Fsa)
printf("since factor of safety caculated above are
   safe ,therefore wire rope of dia 38mm and 6*19 is
   chosen")
```

**Scilab code Exa 20.11** Machine design

```
//finf Fs
clc
//soltuion
//given
d=38//mm
D=2000//mm
```

```
W=50000//N
depth=900//m
v=3//m/s
a=1.5//m/s^2
dw=0.05*d//mm
Bs=1880//N/mm^2//breaking strength
Er=84*1000//N/mm^2
w=47700//N
//rope is 8*19
n=8*19
A=(%pi/4)*dw^2*n//mm^2
mbs=Bs*A//min breaking strength
printf("min breaking stresngth is,%f N\n",mbs)
fb=84000*dw/D
printf("bending stress acting is,%f N/mm^2\n",fb)
Wb=fb*A//N
printf("the bending load on rope is,%f N\n",Wb)
g=9.81//m/s^2
Wa=(W+w)/g*a//additonal load
printf("additional load due to acc si,%f N\n",Wa)
Wst=2*(W+w)
printf("the starting load acting is,%f N\n",Wst)
Wen=W+w+Wb//N//during normal working
printf("effctive load during uniform velocity is,%f
   N\n",Wen)
Fs=mbs/Wen
printf("the factor of safety during normal working
   is,%f \n ",Fs)
Wea=W+w+Wb+Wa//N//during acc
Fsa=mbs/Wea
printf("the factor of safety during acc is,%f ",Fsa)
//during straing
Wes=Wst+Wb//N
Fss=mbs/Wes
printf("the factor of safety during startin is,%f ",
   Fss)
```

**Scilab code Exa 20.12** Machine design

```
//finf dia of wire
clc
//soltuion
//given
W=25000//N
w=15000//n
//D=30*d
a=1//m/s^2
er=80000//N/mm^2
fu=1800//N/mm^2
//A=0.38*d^2
//let d be dia of rope
Wd=W+w//N
//dw=0.063*d..
//Wb=Er*dw/D*A=63.84*d^2//N
g=9.81
Wa=(W+w)/g*a
//Wt=Wd+Wa+Wb=44080+63.84*d^2//N....eq1
//WT=A*stress=A*fu/Fs=114*d^2//assume Fs=6...eq2
//from eq1 and eq2
d=sqrt(44080/(114-63.84))//mm
printf("choosing value of d from table 20.6,we get
    32mm")
```

# Chapter 21

# Ch21

**Scilab code Exa 21.1** Machine design

```
clc
//soltuion
//given
RP=15000//W//rated power
N1=1000//rpm
N2=350//rpm
VR=N1/N2
//ref table 21.5,numbr of teeth on smaller sprocket
   is T1=25
T1=25
T2=T1*N1/N2
K1=1.5//load factor
K2=1//lubricaiton factor
K3=1.25//rating factor
Ks=K1*K2*K3//service factor
DP=Ks*RP//design power
//from table 21.4,corrs to N1=1000rpm,power
   transmittd for chain 12 is 15.65 kW per strand,
//therefore chain 12 with 2 strands is used tot
   ransmit power
```

```
//using table 21.1
p=19.05//pitch//mm
d=12.07//mm//roller dia
w=11.68//mm//min width of roller
Wb=59000//N
//d1=p*cosec(180/T1)=0.152//m
d1=0.152//m
//d2=p*cosec(180/T2)=0.436//m
d2=0.436//m
printf("the itch circle dia of smalla nd large sprocket is ,%f mm\n,%f mm\n",d1,d2)
v1=%pi*d1*N1/60//m/s
W=RP/v1//N
Fs=Wb/W
c=30*p//mm//min center dis
x=c-4//correct centre dis
K=(T1+T2)/2+(2*x/p)+[(T1-T2)/(2*%pi)]^2*p/x//mm
L=K*p
printf("the length of chian is ,%f mm\n",L)
```

# Chapter 22

# Ch22

**Scilab code Exa 22.1** Machine design

```

clc
//solution
//given
D=300//mm
R=0.150//mm
Cs=0.003
N=1800//rpm
w=188.5//rad/s
rho=7250//kg/m^3
//let m eb the mass of fly wheel
//ref fig 22.6
//total energy at E =total energy at A
//Eb=E+295
//Ec=E+295-685=E-390
//Ed=E-350
//Ee=E-690
//Ef=E+270
//Eg=E
//Ea=E
//max energy is at B and min is a E
```

```
//dE=Eb−Ee=985
//dE=985//mmˆ2
//conveting to N−m
dE=985*0.087//N−m
//dE=m*Rˆ2*wˆ2*Cs
m=dE/(R^2*w^2*Cs)//kg
printf("the mass of flywheel is,%f kg\n",m)
//let t be thickness and b be width of rim
//b=2t
//A=b*t=2*tˆ2
//m=A*2*%pi*R*rho=13668*tˆ2
t=sqrt(m/13668)//m
printf("the thicknes and width is,%f m\n,%f m\n",t
    ,2*t)
```

**Scilab code Exa 22.2** Machine design

```
//find...
clc
//solution
//given
N=900//rpm
w=94.26//rad/s
//(w1−w2)/w=0.02
Cs=0.02
D=650//mm
R=0.325//m
rho=7200//kg/mˆ3
//let m eb the mass of fly wheel
//ref fig 22.7
//total energy at E =total energy at A
//Eb=E−35
//Ec=E+375
//Ed=E+390
//Ee=E+415
```

```
//Ef=E+80
//Eg=E+340
//Eh=E-25
//Ek=E+360
//El=E
//Ea=E
//max energy is at B and min is a E
//dE=Eb-Ee=450
//dE=450//mm^2
//conveting to N-m
dE=450*5.5//N-m
//dE=m*R^2*w^2*Cs
m=dE/(R^2*w^2*Cs)//kg
printf("the mass of flywheel is,%f kg\n",m)
//let t be thickness and b be width of rim
//b=2t
//A=b*t=2*t^2
//m=A*2*%pi*R*rho=29409*t^2
t=sqrt(m/29409)//m
printf("the thicknes and width is,%f m\n,%f m\n",t,2*t)
```

**Scilab code Exa 22.3** Machine design

```

clc
//solution
//given
P=150*1000//W
N=80//rpm
Ce=0.1
//(w1-w2)=0.02
D=2//m
R=1//m
rho=7200//kg/m^3
```

```
w=2*%pi*N/60//rad/s
//Cs=(w1-w2)/w
Cs=0.04
Wdpc=P*60/N//N-m
dE=Ce*Wdpc//N-m
dEm=0.95*dE
//let m eb the mass of fly wheel
//dE=m*R^2*w^2*Cs
m=dEm/(R^2*w^2*Cs)//kg
printf("the mass of flywheel is,%f kg\n",m)
//let A be the area of rim
//m=A*2*%pi*R*rho
A=m/(2*%pi*R*rho)//m^2
printf("the area of rim is,%f m^2",A)
```

**Scilab code Exa 22.4** Machine design

```

clc
//solution
//given
P=20000//W
N=300//rpm
w=31.42//rad/s
//(w1-w2)/w=0.01*w
//ref fig 22.8
q=4*%pi
Tmean=(P*60)/(2*%pi*N)//N-m
printf("mean torque acting is,%f N-m\n",Tmean)
Wdpc=Tmean*q//N-m...eq1
//Wn=We-Wc=We-We/2.3=0.565*We...eq2
//from eq1 and eq2
We=14160//N-m
Tmax=We*2/(%pi)//N-m
//BG=BF-FG
```

```
BG=Tmax-Tmean//N-m
BF=Tmax
dE=We*(BG/BF)^2//N-m
printf("the ")
//Cs=(w1-w2)/w
Cs=0.02
//let I be moment of inertia
//dE=I*w^2*Cs
I=dE/(w^2*Cs)//kg-m^2
printf("the moment of inertia is,%f kg-m^2",I)
```

**Scilab code Exa 22.5** Machine design

```

clc
//solution
//given
N=600//rpm
w=62.84//rad/s
rho=7250//kg/m^3
ft=6*10^6//n/M^2
//REF fig 22.12
//let I be mont of inertia
//total energy at E =total energy at A
//Eb=E+160
//Ec=E-12
//Ed=E+156
//Ee=E-35
//Ef=E+162
//Eg=E
//Ea=E
//max energy is at F and min is a E
//dE=Ef-Ee=197
//dE=197//mm^2
//conveting to N-m
```

```
dE=197*13.1//N-m
//Cs=(w1-w2)/w
Cs=0.02
//let I be moment of inertia
//dE=I*w^2*Cs
I=dE/(w^2*Cs)//kg-m^2
printf("the moment of inertia is,%f kg-m^2\n",I)
//let t be thickness and b be width of rim
//b=2t
v=sqrt(ft/rho)//m/s
printf("the tangetntial velocity is,%f m/s\n",v)
//v=%pi*D*N/60=31.42*D
printf("dia of flywheel is,%d mm\n",v/31.42*1000)
//let E be total energy
E=dE/(2*Cs)//N-m
Emin=0.92*E//N-m
//let m eb bmass
m=Emin*2/(v^2)//kg
//let t be thickness and b be width of rim
//b=2t
//A=b*t=2*t^2
//m=A*2*%pi*R*rho=41686*t^2
t=sqrt(m/41686)//m
printf("the thickness and iwth of rim is,%f m\n,%f m\n",t,2*t)
```

**Scilab code Exa 22.6** Machine design

```

//solution
//given
N=300//rpm
w=31.42//rad/s
ft=5.6*10^6//N/m^2
rho=7200
```

```
//let D be dia
//v=(%pi*D*N)/60=15.71*D//m/s
//ft=rho*v^2=1.8*10^6*D^2
D=sqrt(ft/(1.8*10^6))//m
R=D/2//m
printf("the dia of flywheel is,%f m\n",D)
//ref fig 22.13
//total energy at E =total energy at A
//Eb=E-32
//Ec=E+376
//Ed=E+109
//Ee=E+442
//Ef=E+132
//Eg=E+358
//Eh=E-16
//Ei=E+244
//Ej=E
//Ea=E
//max energy is at E and min is a B
//dE=Eb-Ee=474
//dE=474//mm^2
//conveting to N-m
dE=474*27.3//N-m
//Cs=(w1-w2)/w
Cs=0.03
//dE=m*R^2*w^2*Cs
m=dE/(R^2*w^2*Cs)//kg
printf("the mass of flywheel is,%f kg\n",m)
//let t be thickness and b be width of rim
//b=4t
//A=b*t=4*t^2
//m=A*2*%pi*R*rho=159624*t^2
t=sqrt(m/159624)//m
printf("the thickness and iwth of rim is,%f m\n,%f m
    \n",t,4*t)
```

**Scilab code Exa 22.7** Machine design

```

//solution
//given
P=50000//W
N=150//rpm
n=75
ft=4*10^6//N/m^2
rho=7200
Tmean=(P*60)/(2*%pi*N)//N-m
printf("mean torque acig is,%f N-m\n",Tmean)
//ref fig 22.14
q=4*%pi
Wdpc=Tmean*q
Wp=1.4*Wdpc//work done in power stroke....eq1
//from dia
//Wp1=(0.5*%pi)*Tmax...eq2
Tmax=Wp/1.571//N-m
printf("max torque is,%f N-m\n",Tmax)
//BG=BF-FG
BG=Tmax-Tmean//N-m
BF=Tmax
dE=Wp*(BG/BF)^2//N-m
printf("dE is,%f N-m\n",dE)
//let D be mean dia
//let v be peripheral velo
v=sqrt(ft/rho)//m/s
D=(v*60)/(N*%pi)//m
printf("the dia of wheel is,%f m\n",D)
//let t be thickness and b be width of rim
//b=4t
//A=b*t=4*t^2
//N1-N2=0.01*N
```

```
Cs=0.01
//dE=E*2*Cs
E=dE/(2*Cs)//N-m
Erim=(15/16)*E//N-m
printf("Erim is ,%f N-m\n",Erim)
m=Erim*2/v^2//kg
t=sqrt(m/271468)
printf("the thickness and width si ,%f m\n,%f m\n",t
    ,4*t)
```

**Scilab code Exa 22.9** Machine design

```

//solution
//given
n=25
d1=25//mm
t1=18//mm
tu=300//N/mm^2
effm=0.95
Cs=0.1
ft=6//N/mm^2
rho=7250//kg/m^3
D=1.4//m
R=0.7//m
As=%pi*d1*t1//area of plate sheared
Fs=As*tu//N
Eps=0.5*Fs*t1//N-mm//energy req per stroke
Epm=Eps*n/1000//N-m
P=Epm/(60*effm)//W
printf("power req is ,%f W\n",P)
//let t be thickness and b be width of rim
//b=2t
//A=b*t=2*t^2
dE=(9/10)*Eps//N-m
```

```
//let m be mass of wheel
Erim=0.95*dE//N-m
N=9*25//rpm
w=2*%pi*N/60//rad/s
m=Erim/(R^2*w^2*Cs)//kg
//m=A*2*%pi*R*rho=63782*t^2
t=sqrt(m/63782)//m
printf("the thickness and width is ,%f m\n,%f m\n",t
    ,2*t)
```

---

**Scilab code Exa 22.10** Machine design

```
clc
//solution
//given
P=180*1000//W
N=240//rpm
ft=5.2*10^6//N/m^2
//N1-N2=0.03
rho=7220//kg/m^3
tf=40//N/mm^2
Tmean=(P*60)/(2*%pi*N)//N-m
printf("mean torque acig is ,%f N-m\n",Tmean)
//ref fig 22.18
q=4*%pi
Wdpc=Tmean*q
Wp=1.33*Wdpc//work done in power stroke....eq1
//Wp1=(0.5*%pi)*Tmax...eq2
Tmax=Wp/(%pi/2)//N-m
printf("max torque is ,%f N-m\n",Tmax)
//BG=BF-FG
BG=Tmax-Tmean//N-m
BF=Tmax
dE=Wp*(BG/BF)^2//N-m
printf("dE is ,%f N-m\n",dE)
```

```
//let D be mean dia
//let v be peripheral velo
v=sqrt(ft/rho)//m/s
D=(v*60)/(N*%pi)//m
R=D/2
printf("the dia of wheel is,%f m\n",D)
//N1-N2=0.03*N
Cs=0.03
w=2*%pi*N/60//rad/s
//dE=E*2*Cs
m=dE/(R^2*w^2*Cs)
printf("mass of wheel is,%f kg\n",m)
//let t be thickness and b be width of rim
//b=2t
//A=b*t=2*t^2
t=sqrt(m/96730)//mm
printf("the thicknes and width is,%f m\n,%f m\n",t,2*t)
//let d be dia of hub ,d1 be dia of shaft,l be length of hub
//let Tmax1 be max torque on shaft
Tmax1=2*Tmean*1000//N-mm
//d1=(Tmax1*16/(%pi*tf))^(1/3)
printf("dia od shaft is,%f mm\n",(Tmax1*16/(%pi*tf))^(1/3))
printf("the dia of shaft is say 125mm\n")
d1=125//mm
d=2*d1//mm
l=2*t//mm
printf("the dia of hub and length of hub is,%f mm\n,%f m\n",d,l)
//let a1 be major and b1 be minor axis
//a1=2*b1
n=6
fb=15//N/mm^2
M=Tmax1*(D*1000-d)/(D*n*1000)//N-mm
printf("bending moment is,%f N-mm\n",M)
//Z=(%pi/32)*b1*a1^2=0.05*a1^3
```

```
//fb=M/Z
a1=(M/(fb*0.05))^(1/3)//mm
b1=0.5*a1
printf("major and minor axis is ,%f mm\n,%f mm\n",a1,
    b1)
printf("corrsponding to shaft of dia 125 mm, width is
     36 mm and thicknss ofkey is 20 mm\n")
//let L be length of key
L=Tmax1/(36*tf*d1/2)//mm
printf("length of key is ,%f mm\n",L)
```

**Scilab code Exa 22.11** Machine design

```

clc
//solution
//given
P=185*1000//W
N=100//rpm
//dE=0.15*E
D=2.4//m
R=1.2//m
//let m be mass
E=(P*60)/N//N-m
dE=0.15*E//N-m
rho=7200
Cs=0.02
v=(%pi*D*N)/60//m/s
m=dE/(v^2*Cs)//kg
printf("mass is ,%f kg\n",m)
//let t be thickness and b be width of rim
//b=2t
//m=A*%pi*D*rho
//A=b*t=2*t^2
t=sqrt(m/108588)//mm
```

```
printf("the thicknes and width is,%f m\n,%f m\n",t,2*t)
//let d be dia of hub ,d1 be dia of shaft,l be length of hub
Tmean=(P*60)/(2*%pi*N)//N-m
Tmax1=2*Tmean*1000//N-mm
//d1=(Tmax1*16/(%pi*tf))^(1/3)
printf("dia od shaft is,%f mm\n",(Tmax1*16/(%pi*tf))^(1/3))
printf("the dia of shaft is say 165mm\n")
d1=165//mm
d=2*d1//mm
l=2*t//mm
printf("the dia of hub and length of hub is,%f mm\n,%f m\n",d,l)
//let a1 be major and b1 be minor axis
//a1=2*b1
n=6
fb=14//N/mm^2
M=Tmax1*(D*1000-d)/(D*n*1000)//N-mm
printf("bending moment is,%f N-mm\n",M)
//Z=(%pi/32)*b1*a1^2=0.05*a1^3
//fb=M/Z
a1=(M/(fb*0.05))^(1/3)//mm
b1=0.5*a1
tf=40
printf("major and minor axis is,%f mm\n,%f mm\n",a1,b1)
printf("corrsponding to shaft of dia 165 mm, width is 45 mm and thicknss of key is 25 mm\n")
//let L be length of key
L=Tmax1/(45*tf*d1/2)//mm
printf("length of key is,%f mm\n",L)
```

**Scilab code Exa 22.13** Machine design

```
clc
//solution
//given
Do=1.8//m
Di=1.35//m
b=0.3//m
N=250//rpm
T=15000//N-m
ftb=35//n/mm^2
ftl=40//n/mm^2
//w=1.25*h
n=6
fta=15//N/mm^2
d1=150//mm
rho=7200//kg/m^3
D=(Do+Di)/2//m
t=(Do-Di)/2//m
v=(%pi*D*N)/60//m/s
ft=rho*v^2*10^6//N/mm^2
A=b*t//m^2
Ft=ft*A*10^6//N
//let dc be core dia
//Ft=(%pi/4)*dc^2*ftb*4=110*dc^2
//dc=sqrt(Ft/110)//mm
printf("the core dia is,%f mm\n",sqrt(Ft/110))
printf("the standard core dia is 48.65mm\n")
dc=48.65//mm
//let h be depth of link and w be width of link
//w=1.25*h
//Al=w*h=1.25*h^2
//let Fmax be max tensile force
Fmax=2*ft*A//N....eq1
//Fmax=4*ftl*Al=200*h^2...eq2
//from eq 1 and eq2
h=46//mm
w=1.25*h//mm
printf("the heigth and width of of link is,%f mm\n,
```

```
%f mm\n",h,w)
//let a1 be major and b1 be minor axis
//a1=2*b1
n=6
d=2*d1//m
M=T*(D*1000-d)/(D*n*1000)//N-mm
printf("bending moment is,%f N-mm\n",M*1000)
//Z=(%pi/32)*b1*a1^2=0.05*a1^3
//fb=M/Z
a1=(M*1000/(fta*0.05))^(1/3)//mm
b1=0.5*a1
tf=40
printf("major and minor axis is,%f mm\n,%f mm\n",a1,
   b1)
```

# Chapter 23

# Ch23

**Scilab code Exa 23.1** Machine design

```
//find
clc
//solution
//given
D=50//mm
d=5//mm
n=20//mm
W=500//N
C=D/d
Ks=1+(1/(2*C))
t=Ks*[8*W*D/(%pi*d^3)]//N/mm^2
printf("shear stress acting is ,%f N/mm^2",t)
```

**Scilab code Exa 23.2** Machine design

```
//find
clc
//solution
```

```
//given
d=6//mm
Do=75//mm
t=350//N/mm^2
G=84*1000//N/mm^2
D=Do-d//mm
C=D/d
//let W be axial load
//neglecting curvature
Ks=1+(1/(2*C))
//t=Ks*[8*W*D/(%pi*d^3)]//N/mm^2
W=(t*%pi*d^3)/(8*Ks*D)
printf("load acting is,%f N\n",W)
dpt=8*W*D^3/(G*d^4)//deflection per turn//mm
printf("defelection per turn is,%f mm",dpt)
//considering curvature
K=(4*C-1)/(4*C-4)+(0.615/C)
W=t*%pi*d^2/(K*8*C)//N
printf("load acting by takin curvature in
    consideration is,%f N\n",W)
```

**Scilab code Exa 23.3** Machine design

```
//find
clc
//solution
//given
W=1000//N
dx=80//mm
n=30
G=85*1000//N/mm^2
//let D be mean dia of spring coil ,d be dia of
    spring wire
//C =D/d
d=4//assume//mm
```

```
//dx=8*W*D^3*n/(G*d^4)
//dx=8*W*C^3*n/(G*d)
C=[dx*G*d/(8*W*n)]^(1/3)
D=C*d//mm
printf("dia of coil is,%f mm\n",D)
printf("outer dia is ,%f mm\n",D+d)
K=(4*C-1)/(4*C-4)+(0.615/C)
t=K*(8*W*C)/(%pi*d^2)
printf("max shear stress induced is,%f N/mm^2",t)
```

**Scilab code Exa 23.4** Machine design

```
//find
clc
//solution
//given
W=30//N
d=2//mm
n=18
C=6
D=12//mm
t=680//N/mm^2
G=80*1000//N/mm^2
K=(4*C-1)/(4*C-4)+(0.615/C)
t1=K*(8*W*C)/(%pi*d^2)
printf("tortional shear stress is,%f N/mm^2\n",t1)
k=G*d/(8*C^3*n)
printf("spring rate is,%f N/mm\n",k)
//let W1 force cause t shear
W1=t*%pi*d^2/(K*8*C)//N
printf("force to cause the body of spring to yield
    stregth is,%f N",W1)
```

**Scilab code Exa 23.5** Machine design

```
//find
clc
//solution
//given
W=30//N
d=2//mm
n=18
C=6
D=12//mm
t=680//N/mm^2
G=80*1000//N/mm^2
K=(4*C-1)/(4*C-4)+(0.615/C)
t1=K*(8*W*C)/(%pi*d^2)
printf("tortional shear stress is,%f N/mm^2\n",t1)
k=G*d/(8*C^3*n)
printf("spring rate is,%f N/mm\n",k)
//let W1 force cause t shear
W1=t*%pi*d^2/(K*8*C)//N
printf("force to cause the body of spring to yield
    stregth is,%f N",W1)
```

**Scilab code Exa 23.6** Machine design

```
//find
clc
//solution
//given
W1=2250//N
W2=2750//N
dx=6
C=5
t=420//N/mm^2
G=84*1000//N/mm^2
```

```
//T=W2*D/2=W*5d/2=6875*d
//T=(%pi/16)*t*d^3
d=sqrt(6875/82.48)//mm
printf("mean dia is,%f mm\n",5*d)
printf("outer dia is,%f \n",5*d+d)
printf("inner dia is,%f mm\n",5*d-d)
W=500//N
//n=dx*G*d/(8*W*C^3)
printf("numbr of tunrs are,%f \n",dx*G*d/(8*W*C^3))
printf("numbr of turns are say 10\n")
n=10
nb=n+2
dxmax=(6/500)*2750//mm
fL=nb*d + dxmax + 0.15*dxmax
printf("free length is ,%f mm\n",fL)
printf("pitch of coil is,%f mm",fL/(nb-1))
```

**Scilab code Exa 23.7** Machine design

```
//find
clc
//solution
//given
W1=400//N
W2=250//N
Di=25//mm
l1=40//mm
l2=50//mm
t=400//N/mm^2
//D=25+d
//T=W1*D/2=400*(25+d)/2=(5000+200*d)N-mm
//T=(%pi/16)*t*d^3
//78.55*d^3=5000+200*d
//by hit and trial,d=4.2//mm
d=4.47//mm(standard value od diameter from table
```

```
    23.2)
D=25+d
C=D/d
K=(4*C-1)/(4*C-4)+(0.615/C)
//d1=sqrt(K*8*W1*C/(t*%pi))
printf("value od d1 is ,%f mm\n",d)
printf("standard value corr to 4.54 is ,4.877 mm\n")
//taking d1=4.877 in to consideration
d1=4.877
D1=25+d1
Do=D1+d1
//let n be numbr of turns
dx=l2-l1//deflwection
//n=dx*G*d1^4/(8*D1^3*W)//
G=80000//N/mm^2
W=150
printf("numbr of turns are ,%f \n",dx*G*d1^4/(8*D1
    ^3*W))
printf("numbr of turns are say 15\n")
n=15
nb=n+2
dxmax=(dx/150)*W1
fL=nb*d1 + dxmax + 0.15*dxmax
printf("free length is ,%f mm\n",fL)
printf("pitch of coil is ,%f mm",fL/(nb-1))
```

**Scilab code Exa 23.8** Machine design

```
//find
clc
//solution
//given
D1=65//mm
p1=0.7//N/mm^2
p1=0.75//N/mm^2
```

```
dx=3.5//mm
t=550//N/mm^2
G=84000//N/mm^2
C=6
W1=(%pi/4)*D1^2*p1//N
W2=(%pi/4)*D1^2*p2//N
W=W1-W2//N
//T=W2*D/2=7467*d
//D=6d
//T=(%pi/16)*t*d^3=108*d^3
//d=sqrt(7467/108)//mm
printf("dia of spring wire is ,%f mm\n",sqrt
    (7467/108))
printf("standard dia is 8.839 mm from table 23.2\n")
d=8.839
D=6*d//mm
Do=D+d
Di=D-d
printf("mean dia,outer di and inner dia are,%f mm\n,
    %f mm\n,%f mm\n",D,Do,Di)
//let n be nubr of tunrs
printf("numbr of turns are ,%f \n",dx*G*d1^4/(8*D1
    ^3*W))
printf("numbr of turns are say 10\n")
n=10
nb=n+1
fL=n*d+ (n-1)*d
printf("free length is ,%f mm\n",fL)
printf("pitch of coil is,%f mm",fL/(nb-1))
```

**Scilab code Exa 23.9** Machine design

```
//find
clc
//solution
```

```
//given
vd=60//mm//valve dia
pb=1.2//N/mm^2
dx2=10//mm
C=5
dx1=35//mm
t=500//N/mm^2
G=80000//N/mm^2
W1=(%pi/4)*vd^2//N
dxmax=dx1+dx2
W=W1*dxmax/dx1//N
K=(4*C-1)/(4*C-4)+(0.615/C)
printf("dia of sprig wire is,%f vmm\n",sqrt((K*8*W*C)/(t*%pi)))
printf("dia is say 12.7 mm,taking standard conditions rfom table 23.2\n")
d=12.7
D=C*d
printf("mean dia is,%f mm\n",D)
printf("numbr of tunrs are,%f \n",dxmax*G*d/(8*W*C^3))
printf("numbr of turns are say 11\n")
n=11
nb=n+2
fL=nb*d + dxmax + 0.15*dxmax
printf("free length is ,%f mm\n",fL)
printf("pitch of coil is,%f mm",fL/(nb-1))
```

**Scilab code Exa 23.10** Machine design

```
//find
clc
//solution
//given
m=2.97//kg
```

```
x=0.15//m
y=0.1125//m
r2=0.1//m
r1=0.15//m
N2=240//rpm
t=420//N/mm^2
G=84*1000//N/mm^2
C=8
//ref fig 23.16
w2=2*%pi*N2/60//rad/s
w1=w2+(7.5*w2/100)//rad/s
//let Fc1 and Fc2 be centri fugal forces a w1 and w2
//S1=2*Fc1*x/y
S1=2*m*r1*w1^2*x/y//N
S2=2*m*r2*w2^2*x/y//N
dx=(r1-r2)*y/x*1000//mm
K=(4*C-1)/(4*C-4)+(0.615/C)
W=S1//max force
printf("dia of sprig wire is ,%f vmm\n",sqrt((K*8*W*C
    )/(t*%pi)))
printf("dia is say 7.62 mm,taking standard
    conditions rfom table 23.2\n")
d=7.62
D=C*d
W1=S1-S2
printf("mean dia is ,%f mm\n",D)
printf("numbr of tunrs are ,%f \n",dx*G*d/(8*W1*C^3))
printf("numbr of turns are say 16\n")
n=16
nb=n+2
dxmax=dx*W/(W1)
fL=nb*d + dxmax + 0.15*dxmax
printf("free length is ,%f mm\n",fL)
printf("pitch of coil is ,%f mm",fL/(nb-1))
```

**Scilab code Exa 23.11** Machine design

```
//find
clc
//solution
//given
P=30000//W
N=3000//rpm
pb=0.085//N/mm^2
v=2300//m/min
//d1=1.3d2
//r1=1.3r2
u=0.3
ns=6
D=25//mm
t=420//N/mm^2
G=84000//N/mm^2
Tmean=P*60/(2*%pi*N)//N-m
Tmax=1.2*Tmean*1000//N-mm
//C=pb*r2
//W=C*2*%pi*(r1-r2)
//Tmax=2*%pi*u*C[r1^2-r2^2]
//Tmax=0.11*r2^3
r2=(Tmax/0.11)^(1/3)//mm
r1=1.3*r2//mm
r=(r1+r2)/2000//m
v1=2*%pi*N*r//m/min
printf("speed obtained is,%f m/min\n",v1)
//since velocity ontaine di sless then v,hence design is safe
//W=C*2*%pi*(r1-r2)
W=pb*r2*2*%pi*(r1-r2)//N
W1=W/6//force on each spring
//let d1 eb dia
T=W1*D/2//N-mm
d1=(16*T/(%pi*t))^(1/3)//mm
C=D/d1
K=(4*C-1)/(4*C-4)+(0.615/C)
```

```
printf("dia of sprig wire is,%f vmm\n",((K*8*W1*D)/(
   t*%pi))^(1/3))
printf("taking standard dia 4.064 from table 23.2,we
    get d is 4.064\n")
d=4.064//mm
Do=D+d
Di=D-d
printf("mean dia,outer di and inner dia are,%f mm\n,
   %f mm\n,%f mm\n",D,Do,Di)
dx=8*W1*D^3*8/(G*d^4)//mm
nb=8+2
fL=nb*d + dx +0.15*d
printf("free length is ,%f mm\n",fL)
printf("pitch of coil is,%f mm",fL/(nb-1))
```

**Scilab code Exa 23.12** Machine design

```
//find
clc
//solution
//given
U=1000//N-m
D=0.100//m
d=0.02//m
n=30
G=85*10^9//N/m^2
C=D/d
K=(4*C-1)/(4*C-4)+(0.615/C)
V=(%pi*D*n)*[%pi/4*d^2]//volume//m^3
t=(U*4*K^2*G/V)^(0.5)//N/m^2
printf("max shear stress acting is,%f N/m^2\n",t)
dx=%pi*t*D^2*n/(K*d*G)
printf("deflection produced is,%f m",dx)
```

**Scilab code Exa 23.13** Machine design

```
//find
clc
//solution
//given
d=10//mm
D=120//mm
n=10
W=200//N
G=80*1000//N/mm^2
t=8*W*D/(%pi*d^3)*[1+(d/2*D)]//N/mm^2
dx=8*W*D^3*n/(G*d^4)//mm
printf("stress and eflection is ,%f N/mm^2\n,%f N/mm
    ^2\n",t,dx)
sf=W/dx
printf("stiffness is ,%f N/mm\n",sf)
U=0.5*W*dx
printf("enerrgy stored is ,%f N-mm\n",U)
```

---

**Scilab code Exa 23.15** Machine design

```
//find
clc
//solution
//given
m=20000//kg
v=2//m/s
D=300//mm
dx=250//mm
t=600//N/mm^2
E=0.5*m*v^2*10^3//N-mm
```

```
//let W be equivalent load
//Es=0.5*W*dx*2=250*W
W=E/250//N
T=W*D/2//N-mm
printf("torque acting is,%f N-mm\n",T)
//d=(T*16/(%pi*t))^(1/3)//mm
printf("dia is,%f mm\n",(T*16/(%pi*t))^(1/3))
printf("dia is say 60mm\n")
d=60//mm
G=84000//N/mm^2
//let be numbr of active tunrs
//n=dx*G*d^4/(D^3*8*W)
printf("numbr of turns are,%f \n",dx*G*d^4/(D^3*8*W)
    )
printf("numbr of turns are,say 8\n")
nb=8+2
fL=nb*d + dx +0.15*dx
printf("free length is ,%f mm\n",fL)
printf("pitch of coil is,%f mm",fL/(nb-1))
```

---

**Scilab code Exa 23.16** Machine design

```
//find
clc
//solution
//given
m=1800//kg
v=1.2//m/s
dx=200//m
t=365//N/mm^2
C=6
G=80*1000//N/mm2
E=0.5*m*v^2*10^3//N-mm
//let W be equivalent load
//Es=0.5*W*dx*2=200*W
```

```
W=E/200//N
//let b be suide of square and D be mean Dia\
//D=6b
K=(4*C-1)/(4*C-4)+(0.615/C)
//t=K*2.4*W*D/b^3=116870/b^2
//b=sqrt(116870/t)//mm
printf("sqrt(116870/t),%f mm\n",sqrt(116870/t))
printf("side of square is,say 18 mm\n")
b=18//mm
printf("dia of coil is,%f mm\n",6*b)
//let be numbr of acitve colild
n=dx*G*b/(5.568*W*C^3)
printf("acitve turns are ,%f \n",n)
```

**Scilab code Exa 23.18** Machine design

```
//find
clc
//solution
//given
n=12//...k constant
n1=5//....k1
n2=7//....k2
//X=G*d^4/(8*D^3)//constant
//X=k*n
//k1=X/n1
//k2=X/n2
printf("stifness of spring 1 is X/5,i.e 2.4k and
    stiffness of spring 2 is X/7,i.e 1.7k")
```

**Scilab code Exa 23.19** Machine design

```
//find
```

```
clc
//solution
//given
W=5000//N
dx=40//mm
t1=850//N/mm^2
t2=850//N/mm^2
C=6
G=80000//N/mm^2
//ref fig 23.22
//D1-D2=2*d1
//D1=C*d1
//D2=C*d2
//d1/d2=1.5
//W1/W2=2.25....eq1
//W1+W2=W....eq2
//from 1 and 2,we get
W1=3492//N
W2=1538//N
K1=(4*C-1)/(4*C-4)+(0.615/C)
K2=K1
//d1=(K1*8*W1*C/(%pi*t1))^(0.5)
printf("dia of spring wires is,%f mm\n",(K1*8*W1*C/(
    %pi*t1))^(0.5))
printf("dia is ,say 10mm\n")
printf("mean outer dia is,%f mm\n",6*d1)
d1=10
D1=6*d1
printf("dia of spring wires is,%f mm\n",(K2*8*W2*C/(
    %pi*t2))^(0.5))
printf("dia is ,say 6 mm\n")
d2=6
printf("mean outer dia is,%f mm\n",6*d2)
D2=6*d2
//n1=(8*W1*C^3)/(dx*G*d1)
printf("number of turns are in outer coil,%f \n"
    ,1/[(8*W1*C^3)/(dx*G*d1)])
printf("numbr of turns are say 6\n")
```

```
n1=6
n1b=n1+2
Ls1=n1b*d1
n2b=n1b*d1/d2
n2=n2b-2
printf("numbr of tuns in inner coil is,%f \n",n2)
fL=Ls1+dx+0.15*dx
printf("free length is,%f mm\n",fL)
printf("outr dia of outr spring is,%f mm\n",D1+d1)
printf("innr dia of outr spring is,%f mm\n",D1-d1)
printf("outer dia of innr spring is,%f mm\n",D2+d2)
printf("innr dia of innr spring is,%f mm\n",D2-d2)
```

**Scilab code Exa 23.20** Machine design

```
//find
clc
//solution
//given
dx1=15//mm
n1=10
D1=40//mm
d1=5//mm
n2=8
D2=30//mm
d2=4//mm
W=400//N
G=84000//N/mm^2
//comprssion of each spring
P1=dx1*G*d1^4/(8*D1^3*n1)//N
R=W-P1//remaining load istaken by both spring
//P2=P1*dx2/dx1=10.27*dx2
//dx2=8*W2*D2^3/(G*d2^4)=0.08*W2
//W2=12.5*dx2
//P2+W2=W-P1
```

```
dx2=(W-P1)/(22.77)//mm
P2=10.27*dx2
printf("total deflection is,%f mm\n",dx1+dx2)
W1=P1+P2
printf("load on outr spring is,%f N\n",W1)
W2=12.5*dx2
printf("load shared by innr spring is,%f N\n",W2)
C1=D1/d1
C2=D2/d2
K1=(4*C1-1)/(4*C1-4)+(0.615/C1)
K2=(4*C2-1)/(4*C2-4)+(0.615/C2)
t1=K1*8*W1*D1/(%pi*d1^3)//N/mm^2
t2=K2*8*W2*D2/(%pi*d2^3)//N/mm^2
printf("stress induced in outr spring is,%f N/mm^2\n
    ",t1)
printf("strss induce in iner spring is,%f N/mm^2\n",
    t2)
```

**Scilab code Exa 23.21** Machine design

```
//find
clc
//solution
//given
D=60//mm
d=6//mm
M=6000//N-mm
C=10
E=200000//N/mm^2
n=5.5
K=(4*C^2-C-1)/(4*C^2-4*C)
fb=K*(32*M/(%pi*d^3))//N/mm^2
printf("bending stressa acting is,%f N/mm^2\n",fb)
q=64*M*D*n/(E*d^4)//rad
printf("angular deflection is,%f rad",q)
```

**Scilab code Exa 23.22** Machine design

```
//find
clc
//solution
//given
b=6//mm
t1=0.25//mm
l=2500//mm
t=800//N/mm^2
E=200*1000//N/mm^2
M=t*b*t1^2/(12)//N-mm
printf("bending moment is,%f N-mm\n",M)
q=12*M*l/(E*b*t1^2)//rad
printf("angular def is,%f rad\n",q)
U=0.5*M*q
printf("energy stored is,%f N-mm",U)
```

**Scilab code Exa 23.23** Machine design

```
//find
clc
//solution
//given
tL=140000//N
ns=4
n=10
L=500//mm
dx=80//mm
E=200000//N/mm^2
f=600//N/mm^2
```

```
W=tL/8//N
//let t be thickness and b be th width
//f=6WL/(nbt^2)
//nbt^2=87.5*1000...eq1
//dx=6WL^3/(nEbt^3)
//nbt^3=0.82*10^6....eq2
//from eq1 and eq2 ,we get
t=10//mm
b1=87.5*1000/(n*t^2)
printf("width using bending stress is,%f mm\n",b1)
b2=0.82*10^6/(n*t^3)
printf("width using deflection is,%f mm\n",b2)'
printf("taking larger value 87.5 mm into account..."
  )
```

**Scilab code Exa 23.24** Machine design

```
//find
clc
//solution
//given
n=12
nf=2
L1=525//mm
l=85//mm
W=2700//N
ff=280//N/mm^2
E=210*1000//N/mm^2
//let t be thickness and b be th width
//nt/b=3
//b=4t
n=12
L=(2*L1-l)/2//mm
ng=n-nf
//ff=18WL/(bt^2(2ng+3nf))
```

```
//ff=225476/t^3
t=(225476/ff)^(1/3)//mm
printf("thickness and width is,%f mm\n,%f mm\n",t,4*
   t)
b=4*t//taking t=9.3 not 10
dx=12*W*L^3/(E*b*t^3*(2*ng+3*nf))
printf("deflection is,%f mm\n",dx)//
```

**Scilab code Exa 23.26** Machine design

```
//find
clc
//solution
//given
W=3000//N
n=7
b=65//mm
nf=2
L1=550//mm
l=80//mm
f=350//N/mm^2
fb=80//N/mm^2
E=210000//N/mm^2
//let t be thickness
L=(2*L1-l)/2//mm
ng=n-nf
//f=18WL/(bt^2(2ng+3nf))=26480/t^2
//t=sqrt(26480/350)//mm
printf("thickness is,%f mm\n",sqrt(26480/350))
printf("thickness is, say 9mm\n")
t=9//mm
dx=12*W*L^3/(E*b*t^3*(2*ng+3*nf))
printf("deflection is,%f mm\n",dx)//
l1=b//length of pin
pb=8//N/mm^2
```

```
//let d be dia of pin
d=W/(l1*pb)//mm
//ref fig 23.33
l2=l1+4//mm
M=W*l2/4//N-mm
//Z=(%pi/32)*d1^3=0.0982*d1^3
d1=(M/(fb*0.0982))^(1/3)
printf("inner dia of pin is,%f mm\n",d1)
ls=1020/(7-1)+l//mm
printf("lnegth of smallest leaf is,%f mm\n",ls)
l2nd=1020/(7-1)*2+l//mm
printf("length of 2nd leaf is,%f mm\n",l2nd)
l3rd=1020/(7-1)*3+l//mm
printf("length of third leaf is,%f mm\n",l3rd)
l4th=1020/(7-1)*4+l//mm
printf("length of 4th leaf is,%f mm\n",l4th)
l5th=1020/(7-1)*5+l//mm
printf("length of 5th leaf is,%f mm\n",l5th)
l6th =1020/(7-1)*6+l//mm
printf("length of 6ht leaf is,%f mm\n",l6th)
mL=2*L1+%pi*(d+t)*2
```

# Chapter 24

# Ch24

**Scilab code Exa 24.1** Machine design

```
//find..
clc
//solution
//given
W=4000//N
r2=50//mm
r1=100//mm
//let pmax be max pressure
//C2=pmax*r2=50pmax
//W=2*%pi*C(r1-r2)=16710*pmax
pmax=W/15170//N/mm^2
printf("max pressure is,%f N/mm^2\n",pmax)
//let pmin be min pressure
//C1=r1*pmin=100*pmin
//W=2*%pi*C(r1-r2)=31420*pmin
pmin=W/31420//N/mm^2
printf("min pressure is,%f N/mm^2\n",pmin)
pav=W/(%pi*(r1^2-r2^2))//N/mm^2)
printf("avrage pressure is,%f N/mm^2\n",pav)
```

**Scilab code Exa 24.2** Machine design

```
//find..
clc
//solution
//given
P=110*1000//W
N=1250//rpm
d1=300//mm
r1=150//mm
u=0.4
n=2
p=0.14//N/mm^2
//let d2 b einner dia
//r2 be inner radius
T=P*60/(2*%pi*N)*1000//N-mm
//W=p*(%pi)*(r1^2-r2^2)=0.534*(150^2-r2^2)
//R=(2/3)*[(r1^3-r2^3)/(r1^2-r2^2)]
//T=n*u*W*R
//T=0.285*[150^3-r2^3]
r2=(150^3-2.95*10^6)^(1/3)//mm
d2=2*r2//mm
printf("inner dia is,%f mm\n",d2)
W=0.534*[r1^2-r2^2]//N
printf("axial thrust is,%f N\n",W)
R=(r1+r2)/2//mm
Tmax=n*u*W*R//N-mm
printf("max torque is,%f N-mm\n",Tmax)
pmax=W/(2*%pi*r2*(r1-r2))//N/mm^2
printf("max pressure acitngis,%f N/mm^2\n",pmax)
```

**Scilab code Exa 24.3** Machine design

```
//find..
clc
//solution
//given
n=2
P=25000//W
N=3000//rpm
u=0.255
//d1/d2=1.25
pmax=0.1//N/mm^2
T=P*60/(2*%pi*N)*1000//N-mm
//C=pmax*r2
//W=2*%pi*pmax*r2*(r1-r2)=0.157*r2//r1/r2=1.25
//R=(r1+r2)/2=1.125*r2
///T=n*u*W*R=0.09*r2^3//N-mm
r2=(T/0.09)^(1/3)//mm
r1=1.25*r2
d1=2*r1//mm
d2=2*r2//mm
W=2*%pi*0.1*r2*(r1-r2)//N
printf("outr dia is,%f mm\n",d1)
printf("nner dia is,%f mm\n",d2)
printf("axial thrust is,%f N\n",W)
```

**Scilab code Exa 24.4** Machine design

```
//find..
clc
//solution
//given
P=100*1000//W
N=2400//rpm
T=500*1000//N-mm
pb=0.07//N/mm^2
u=0.3
```

```
ns=8
Ss=40//N/mm
//let r1 be outr and r2 be inner rad
//r1=1.25*r2
//C=0.07*r2
//W=2*%pi*0.07*r2(r1-r2)=0.11*r2^2//N
//R=(r1+r2)/2=1.125*r2
///T=n*u*W*R=0.074*r2^3//N-mm
r2=(T/0.074)^(1/3)//mm
r1=1.25*r2//mm
printf("inner and outr radii is,%f mm\,%f mm\n",r2,
   r1)
s=Ss*ns//N/mm
W=0.11*r2^2//N
printf("axial force is,%f N\n",W)
dx=W/s
printf("intial compresion is,%f mm\n",dx)
```

**Scilab code Exa 24.6** Machine design

```
//find..
clc
//solution
//given
T=250*1000//N-mm
N=2000//rpm
d1=250//mm
r1=125//mm
v=15.3//m/s
Te=100//N-m
m=1500//kg
Dw=0.7//m
Rw=0.35//m
I=1//kg-m^2
Ta=175//N-m
```

```
gr=5//gear ratio
u=0.3
pb=0.13//N/mm^2
n=2
//R=(r1+r2)/2=62.5+0.5r2
//W=p*%pi*[r1^2-r2^2]//N
///T=n*u*W*R
//T=0.245*[976.56*1000+7812.5*r2-62.5*r2^2-0.5*r2^3]
//using hit and trial
r2=70//mm
we=2*%pi*N/60//rad/s
ww=v/Rw//rad/s
wo=ww*5//rad/s
ae=(Te-T)/I//rad/s^2
Fa=Ta/Rw//N
a=Fa/m//m/s^2
ao=a*gr/Rw//rad/s^2
dt=(wo-we)/(ao-ae)//s
qe=we*dt +0.5*ae*dt^2//rad
qo=wo*dt+0.5*ao*dt^2//rad
q=qo-qe//rad
x=q/(2*%pi)//numbr of revoltuion
printf("numbr of revolution are,%f revolution\n",x)
Q=T*q//heat
printf("heat generated is,%f J\n",Q)
```

**Scilab code Exa 24.7** Machine design

```
//find..
clc
//solution
//given
n=4
//n1+n2=5
pb=0.127//N/mm^2
```

```
N=500//rpm
r1=125//mm
r2=75//mm
u=0.3
C=pb*r2//N/mm
W=2*%pi*C*(r1-r2)//N
R=(r1+r2)/2/1000//m
T=n*u*W*R//N-m
P=T*2*%pi*N/60
printf("power trans is ,%f W\n",P)
```

**Scilab code Exa 24.8** Machine design

```
//find ..
clc
//solution
//given
n1=3
n2=2
d2=120//mm
r2=60//mm
pmax=0.1//N/mm^2
P=25000//W
N=1575//rpm
u=0.3
T=P*60/(2*%pi*N)*1000//N-mm
C=pmax*r2//N/mm
//W=2*%pi*C(r1-r2)=37.7(r1-60)//N
//R=(r1+r2)/2=0.5*r1 +30
n=n1+n2-1
//T=n*u*R*W=22.62*r1^2-81432
r1=sqrt((T+81432)/22.62)
printf("outr dia is ,%f mm\n",r1)
```

**Scilab code Exa 24.9** Machine design

```
//find..
clc
//solution
//given
n1=3
n2=2
n=4
d1=240//mm
r1=120//mm
d2=120//mm
r2=60//mm
u=0.3
P=25000//W
N=1575//rpm
T=P*60/(2*%pi*N)*1000//N-mm
R=(2/3)*[(r1^3-r2^3)/(r1^2-r2^2)]//mm
//T=u*n*W*R=112*W
W=T/112//N
printf("load acting is,%f N\n",W)
ns=6//numbr of springs
csos=8//contact surface of spring
we=1.25//wear on each spring
Twe=we*csos/1000//total wear
Ss=13000//N/m//stiffness of spring
Rsf=Twe*Ss*ns//reduction
W1=W-Rsf
R1=(r1+r2)/2000
T=n*u*W1*R1//N-m
P=T*2*%pi*N/60//W
printf("power trans is,%f W\n",P)
```

**Scilab code Exa 24.10** Machine design

```
//find..
clc
//solution
//given
n1=3
n2=2
n=4
d1=240//mm
r1=120//mm
d2=120//mm
r2=60//mm
u=0.3
P=25000//W
N=1575//rpm
T=P*60/(2*%pi*N)*1000//N-mm
R=(2/3)*[(r1^3-r2^3)/(r1^2-r2^2)]//mm
//T=u*n*W*R=112*W
W=T/112//N
printf("load acting is,%f N\n",W)
ns=6//numbr of springs
csos=8//contact surface of spring
we=1.25//wear on each spring
Twe=we*csos/1000//total wear
Ss=13000//N/m//stiffness of spring
Rsf=Twe*Ss*ns//reduction
W1=W-Rsf
R1=(r1+r2)/2000
T=n*u*W1*R1//N-m
P=T*2*%pi*N/60//W
printf("power trans is,%f W\n",P)
```

**Scilab code Exa 24.11** Machine design

```
//find..
clc
//solution
//given
D=80//mm
R=40//mm
a=(%pi/180)*15//deg
u=0.3
W=200//N
N=900//rpm
w=94.26//rad/s
m=14//kg
k=0.16//
//T=u*W*R*cosec(a)=9273//N-mm
T=9273//N-mm
printf("torque acting is,%f N-mm\n",T)
I=m*k^2//kg-m^2
alpha=T/(1000*I)//angular acc//rad/s^2
//w=0+alpha*t
t=w/alpha///sec
q=(w+0)/2*t//rad
E=T*q//energy lost in slipping
printf("energy lost is,%f N-mm\n",E)
```

**Scilab code Exa 24.12** Machine design

```
//find..
clc
//solution
//given
```

```
P=45*1000//W
N=1000//rpm
a=(%pi/180)*12.5
D=500//mm
R=250//mm
u=0.2
pn=0.1//N/mm^2
T=P*60/(2*%pi*N)*1000//N-mm
//let b be face width
//T=2*%pi*u*R^2*b
b=T/(2*%pi*pn*u*R^2)//mm
printf("face width is,%f mm\n",b)
Wn=pn*2*%pi*R*b//N
We=Wn*(sin(a)+0.25*u*cos(a))
printf("axial force applied is,%f N\n",We)
```

**Scilab code Exa 24.13** Machine design

```
//find..
clc
//solution
//given
P=30000//W
N=750//rpm
a=(%pi/180)*12.5
pn=0.1//N/mm62
Kl=1.75
t=42//N/mm^2
//D=6*b
T=60*P/(2*%pi*N)*Kl*1000//N-mm
//d=(T*16/(%pi*t))^(1/3)//mm
printf("dia of shaft is,%f mm\n",(T*16/(%pi*t))
    ^(1/3))
printf("dia of shaft is say,50 mm\n")
d=50//mm
```

```
//T=2*%pi*u*pn*R^2*b
//b=R/3
//T=0.042*R^3
R=(T/0.042)^(1/3)//mm
printf("mean dia of shaft is,%f mm\n",2*R)
D=2*R
b=D/6
printf("face width is,%f mm\n",b)
//ref fig 24.9
r1=R+ (b/2)*sin(a)//mm
printf("radius of outr clutch is,%f mm\n",r1)
r2=R-(b/2)*sin(a)//mm
printf("radius of inner clutch is,%f mm\n",r2)
```

**Scilab code Exa 24.14** Machine design

```
//find..
clc
//solution
//given
P=15000//W
N=900//rpm
n=4
R=0.15//m
u=0.25
//let m be the mass
w=2*%pi*N/60//rad/s
w1=(3/4)*w//rad/s
r=0.12//m
//Pc=m*w^2*r=1066*m//N
//Ps=m*w1^2*r=600m//N
T=P*60/(2*%pi*N)//N-m
//T=u*(Pc-Ps)*R*n=70m
m=T/70//kg
printf("mass of shoes is,%f kg\n",m)
```

```
a=%pi/3
l=R*a*1000//mm
//A=l*n=157*b//mm^2
//F=A*p=15.7*b//N
//15.7*b=Pc-Ps=466m
b=466*m/(15.7)//mm
printf("face width is,%f mm\n",b)
```

# Chapter 25

# Ch25

**Scilab code Exa 25.1** Machine design

```
//find..
clc
//solution
//given
m=1200//kg
s=1/5
v=20//m/s
h=50//m
d=600//mm
r=0.300//m
mb=20//kg
c=520//J/kg/dec C
Ek=(0.5)*m*v^2//N-m
g=9.81//m/s^2
Ep=m*g*h*s//N-m
E=Ep+Ek
Ft=E/50//N
Tb=Ft*r//N-m
printf("torque applied is,%f N-m\n",Tb)
//let dt be average temp rise
Hg=E
```

```
dt=Hg/(mb*c)//deg celcius
printf("average temperature rise is,%f deg celcius\n",dt)
//et u be coefficient of friction
Rn=m*g
u=Ft/(Rn)//
printf("min coefficient of friction is,%f ",u)
```

**Scilab code Exa 25.2** Machine design

```
//find..
clc
//solution
//given
d=250//mm
r=125//mm
q=%pi/4
P=700//N
u=0.35
ub=(4*u*sin(q))/(2*q+sin(2*q))//eqivalent coffint of friction
//Ft=ub*Rn
//taking moment abt O
//700*(250+200)+Ft*50=Rn*200=Ft/ub*200=520*Ft
Ft=700*(250+200)/470//N
Tb=Ft*r
printf("torque applied is,%f N-mm\n",Tb)
```

**Scilab code Exa 25.3** Machine design

```
//find..
clc
//solution
```

```
//given
r=0.16//m
u=0.3
P=600//N
//taking moment abt point A
//Rn=Ft/u
//Rn*350+Ft*(200-160)=600*(400+350)
Ft=600*750/1207//N
Tb=Ft*r//N-m
printf("torque acting is,%f N-m\n",Tb)
```

**Scilab code Exa 25.4** Machine design

```
//find..
clc
//solution
//given
Tb=360*1000//N-mm
d=300//mm
r=0.15//m
u=0.3
//ref fig 25.8 and 25.9
Ft=Tb/0.15/1000//N
Rn=Ft/u
//P*(600+200)+Ft*50=Rn*200
P=(Rn*200-Ft*50)/800
printf("force req in fig25.8 is,%f N\n",P)
//P1*800=Rn*200+Ft*50
P1=(Rn*200+Ft*50)/800
printf("force req in fig 25.9 is,%f N\n",P1)
//P*(600+200)+Ft*x-Rn*200=0
//if P=0
x=Rn*200/Ft//mm
printf("location of fulcrum is,%f mm\n",x)
```

**Scilab code Exa 25.5** Machine design

```
//find..
clc
//solution
//given
de=650//mm
re=0.325//m
d=1//m
r=0.500//mm
n=4
q=(%pi/180)*22.5
m=2000//kg
v=2.5//m/s
h=2.75//m
u=0.2
g=9.81//m/s^2
pb=0.3//N/mm^2
acc=v^2/(2*h)//m/s^2
fc=m*acc//N
W=(2000*9.81)+fc//N
T=W*re//N-m
Ftt=T/r//N
Ft=Ftt/4//N
Rn=Ft/0.2//N
//Ab=w*(2*r*sin(q))=382.7*w//mm^2
//pb=W/Ab
w=Rn/(0.3*382.7)//mm
printf("width of side is ,%f mm\n",w)
TE=(0.5*m*v^2)+(m*g*h)
printf("heat generated is,%f N-m\n",TE)
```

**Scilab code Exa 26.5** Machine design

```
//find
clc
//solution
//given
l=80//mm
W=2800//N
d=0.05//m
c=2*0.05//mm
Z=0.021
Qd=80//J/s
p=W/(l*d*1000)//N/mm^2
//u=(33/10^8)*(Z*N/p)*(d*1000/c)+0.002
//u=(495*N/10^8)+0.002
//Qg=u*W*V
V=%pi*d*N/60//m/s
//Qg=((495*N/10^8)+0.002)*2800*[%pi*d*N/60]
//N^2 +404 N-2.2*10^6=0
//solving quadratic equation
N=1295//rpm
printf("rpm is , %f rpm\n ",N)
```

---

**Scilab code Exa 25.6** Machine design

```
//find..
clc
//solution
//given
Tb=1400*1000//N-mm
d=350//mm
r=175//mm
q=(1.75)/2//rad
u=0.4
pb=0.3//N/mm^2
```

```
//ref fig 25.11
ub=(4*u*sin(q))/(2*q+sin(2*q))//eqivalent coffint of
    friction
//let S be spring force
//taking moment abt fulcrum O1
//Rn1=Ft1/u
//S*450=Rn1*200 + Ft1*(175-40)
//put Rn1=Ft1/ub...
//S*450=579.4*Ft1
//Ft1=S*450/579.4
//taking moment abt O2
//S*450+Ft2(175-40)=Rn2*200
//Rn2=Ft2/ub
//S*450+Ft2(175-40)=444.4Ft2
//Ft2=S*450/309.4
//Tb=(Ft1+Ft2)*r=390.25*S
S=Tb/390.25//N
printf("spring force is,%f N\n",S)
//let b be width of brakes shoes
//Ab=b*(2*r*sin(q))//mm
Ft1=S*450/579.4
Rn1=Ft1/ub
Ft2=S*450/309.4
Rn2=Ft2/ub
//pb=Rn2/Ab
b=Rn2/(pb*2*r*sin(q))
printf("width of brake is,%f mm\n",b)
```

**Scilab code Exa 25.7** Machine design

```
//find..
clc
//solution
//given
Tb=3*10^6//N-mm
```

```
d=1//m
r=500//mm
u=0.3
q=0.61//rad
ub=(4*u*sin(q))/(2*q+sin(2*q))//eqivalent coffint of friction
//ref fig 25.12
//let S be spring force
//taking moment abt fulcrum O1
//S*1250=Rn1*600 + Ft1*(500-250)
//put Rn1=Ft1/ub...
//S*1250=2125*Ft1
//Ft1=S*1250/2125
//taking moment abt O2
//S*1250+Ft2(500-250)=Rn2*600
//Rn2=Ft2/ub
//S*1250+Ft2(500-250)=1625Ft2
//Ft2=S*1250/1625
//Tb=(Ft1+Ft2)*r=680*S
S=Tb/680
printf("spring force is,%f N\n",S)
//let b be width of brakes shoes
//Ab=b*(2*r*sin(q))//mm
Ft1=S*1250/2125
Rn1=Ft1/ub
Ft2=S*1250/1625
Rn2=Ft2/ub
//pb=Rn2/Ab
b=Rn2/(pb*2*r*sin(q))
printf("width of brake is,%f mm\n",b)
//dimension of coil
//let D be mean dia and d be spring wire dia
C=6
t=500//N/mm^2
n=8
G=80000//N/mm^2
K=(4*C-1)/(4*C-4)+(0.615/C)
Ws=1.3*S
```

```
d=((K*8*Ws*C)/(t*%pi))^(0.5)//mm
D=6*d//mm
printf("meand and spring wire dia is ,%f mm\n,%f mm\n
   ",D,d)
dx=8*Ws*C^3*n/(G*d)//mm
nb=n+2
fL=nb*d + dx+0.15*dx
printf("free length of spring is ,%f mm\n",fL)
```

**Scilab code Exa 25.8** Machine design

```
//find ..
clc
//solution
//given
d=600//mm
r=300//mm
N=200//rpm
u=0.25
q=4.713//rad
P=35000//W
t=2.5//mm
ft=50//N/mm^2
//let P1 be pull
//log(T1/T2)=u*q
//T1/T2=3.25...eq1
//let Tb be breaking torque
//ref fig 25.16
Tb=P*60/(2*%pi*N)*1000//N-mm
//Tb=(T1-T2)*r=300(T1-T2)
//T1-T2=5557//N.....eq2
//from eq1 and eq2,we get
T1=8027//N
T2=2470//N
//taking moment abt O
```

```
//P1*750=T*OD=T2*62.5*1.414
P1=T2*62.5*1.414/750//N
printf("pull req is ,%f N\n",P1)
//let w be width
w=T1/(ft*t)
printf("width is ,%f mm\n",w)
```

**Scilab code Exa 25.9** Machine design

```
//find..
clc
//solution
//given
d=450//mm
r=225//mm
Tb=225*1000//N-mm
OB=100//mm
u=0.25
ft=70//N/mm^2
fc=70//N/mm^2
t=56//N/mm^2
pb=8//N/mm^2
//let P be operating force
//ref fig 25.17
q=4.713//rad
//log(T1/T2)=u*q
//T1/T2=3.25 ...eq1
//let Tb be breaking torque
//ref fig 25.17
//(T1-T2)*r=Tb//N-mm
//T1-T2=1000//N.....eq2
//r=from eq1 and eq2
T1=1444//N
T2=444//N
//taking moment abt O
```

```
//P*500=T2*100
P=T2*100/500
//let ds be dia of shaft
//ds=[Tb*16/(%pi*t)]^(1/3)
printf("dia fo shaft is ,%f mm\n",[Tb*16/(%pi*t)
   ]^(1/3))
printf("dia of shaft is ,say 30mm\n")
ds=30//mm
printf("corrsponding to dia 30mm ,we get width(w) is
    equal to 10 mm,and thickness 8mm\n")
//let l be length of key
w=10//mm
t1=8//mm
l1=Tb/(w*t*ds/2)//mm
printf("length on basis of shearing is ,%f mm\n",l1)
l2=Tb/(t1/2*fc*ds/2)//mm
printf("length using crushing stress is ,%f mm\n",l2)
printf("taking larger of two l2 ,in to consideration\
   n")
l=l2//mm
//let t2 be thickness of lever
//B be width ,B=2t2
//Z=(1/6)*t2*B^2=0.67*t2^3//mm^3
M=P*500//N-mm
//fc=M/Z
//t2=(M/(fc*0.67))^(1/3)
printf("thickness of lever is ,%f mm\n",(M/(fc*0.67))
   ^(1/3))
printf("thicnkness is say 10mm\n")
t2=10//mm
printf("width of lever is ,%f mm\n",2*t2)
//design of pins
//let d3 be dia and l3 be length of pins at O and B
//d3=1.25*d3
//T1=d3**l3*pb=10*d3^2
d3=sqrt(T1/10)//mm
printf("length and dia of pins is ,%f mm\n,%f mm\n"
   ,1.25*d3,d3)
```

```
ti=T1*4/(2*%pi*d3^2)//N/mm62
printf("induced stress is ,%f N/mm^2\n",ti)
printf("since induced stress is within permissible
   limit ,hence design is safe\n")
```

**Scilab code Exa 25.10** Machine design

```
//find ..
clc
//solution
//given
//ref fig 25.21 and 25.22
q=3.93//rad
d=350//mm
r=175//mm
Tb=350*1000//N-mm
u=0.3
//let P1 be pull ,cloackwise roration
//log(T1/T2)=u*q
//T1/T2=3.256   ...eq1
//Tb=(T1-T2)*r=175(T1-T2)
//T1-T2=2000//N.....eq2
//from eq1 and eq2 ,we get
T1=2886.5//N
T2=886.5//N
//taking moment abt O
P1=(T2*150-T1*35)/500
printf("pull req clockwise is ,%f N\n",P1)
//P2 ,anticlockwise
P2=(T1*150-T2*35)/500//N
printf("pull req in anticlockwise is ,%f N\n",P2)
//ref fig 25.23
//find OA
OB=35
//self locking considered
```

```
OA=T1*OB/T2//mm
printf("value of OA is ,%f mm\n",OA)
```

**Scilab code Exa 25.11** Machine design

```
//find..
clc
//solution
//given
d=600//mm
r=0.300//mm
q=4.2//rad
t=5//mm
w=100//mm
u=0.3
ft=50//N/mm^2
//let P be least force req
//log(T1/T2)=u*q
//T1/T2=3.53    ...eq1
T1=ft*t*w
T2=T1/3.53
P=(T2*150-T1*75)/(600)//N
printf("force req is  ,%f N\n ",P)
Tb=(T1-T2)*r//N-m
printf("torque applied is ,%f N-m\n",Tb)
```

**Scilab code Exa 25.12** Machine design

```
//find..
clc
//solution
//given
P=220//N
```

```
u=0.4
q=%pi
d=150//mm
r=0.075//m
//let T1 be max force
//T2 be min force
Tb=450//N-m
//Tb=(T1-T2)*r
T1=(T2+6000)//N
//taking mont abt O
//220*200+T1*50=T2*100
T2=[(220*200)+(300000)]/50//N
T1=6000+T2//N
printf("max and min force is,%f N\n,%f N\n",T1,T2)
//ref fig 25.25,26,27
//log(T11/T22)=u*q
//T11/T22=3.52   ...eq1
//taking moment ABT O
//220*200+T22*50=T11*100....eq2
//from eq1 and eq 2,we egt
T11=146//N
T22=514//N
Tb=(T11-T22)*r//N-m
printf("max torque acting is %f N-m\n",Tb)
```

**Scilab code Exa 25.14** Machine design

```
//find..
clc
//solution
//given
n=12
q=(%pi/180)*7.5//rad
t=0.075//m
d=0.85//m
```

```
P=225*1000//W
N=240//rpm
u=0.4
//ref fig 25.35
//(T1+T1b)*sin(q)=Rn....eq1
//(T1-T1b)*cos(q)=uRn....eq2
//(T1/T1b)=(1+utan(q))/(1-utan(q))//constant
//similarly for other blocks
//T1b/T2b=T2b/T3b..etc remain constant
//T1/T2={(1+utan(q))/(1-utan(q))}^12=3.55//....eq1
//let P1 be least force req at C
D=d+2*t//m
//(T1-T2)=P*60/(%pi*D*N)=17900//N....eq2
//from eq1 and eq2
T1=24920//N
T2=7020//N
P1=(T2*150-T1*30)/500//N
printf("least force req is,%f N\n",P1)
```

**Scilab code Exa 25.15** Machine design

```
//find..
clc
//solution
//given
//ref fig 25.37,25,38,39
b=35//mm
u=0.4
r=150//mm
l=200//mm
q1=(%pi/180)*25//rad
q2=(%pi/180)*125//rad
p1=0.4//N/mm^2
Tbi=u*p1*b*r^2*(cos(q1)-cos(q2))//braking torque
Tb=2*Tbi//total braking torque
```

```
O1B=100
OO1=O1B/cos(q1)//mm
printf("OO1 is ,%f mm\n",OO1)
Mn=0.5*p1*b*r*OO1*[(q2-q1)+0.5*(sin(2*q1)-sin(2*q2))
   ]
printf("moment due to normal force is ,%f N-mm\n",Mn)
Mf=u*p1*b*r*[r*(cos(q1)-cos(q2))+((OO1/4)*(cos(2*q2)
   -cos(2*q1)))]
printf("moment due to friction force is ,%f N-mm\n",
   Mf)
F1=(Mn-Mf)/l//N
printf("F1 is ,%f N\n",F1)
F2=(Mn+Mf)/l//N
printf("F2 is  ,%f N\n",F2)
```

# Chapter 26

# Ch26

**Scilab code Exa 26.1** Machine design

```
//find
clc
//solution
//given
W=20000//N
N=900//rpm
to=55//deg celcius
Z=0.017//kg/m/s
ta=15.5//deg celciusp=1.5//N/mm^2
t=10//deg celcius
C=1232//W/m^2/deg celcius
//from table 26.3
d=0.100//m//assume
p=1.5//N/mm^2
l=1.6*d*1000//mm
printf("length of journal is,%f mm\n",l)
pb=W/(l*d*1000)//bearig preassure
printf("bearing pressure actin is,%f N/mm^2\n",pb)
printf("since given bearing pressure is 1.5 ,hence
    dimension of l and d is safe\n")
//x1=Z*N/pb
```

```
//from table 26.3,operqating value of =ZN/pb=28
x1=28
//the minimum value of bearign modulus at which the
   oil film will break is given by
K1=x1/3
cr=0.0013//clearance ratio
//since calculated value of bearing characteristic
   numbr is is more then 9.33,hterfore
   bearignoperates in hydrodynamic conditions
K2=12.24
k=0.002
u=(33/10^8)*K2*(1/cr)+0.002
printf("coefficient of riction is,%f \n",u)
Qg=u*W*[%pi*d*N]/60//W
printf("heat generate is,%f W\n",Qg)
//Qd=C*A*(tb-ta)
//tb-ta=0.5(to-ta)=19.75
Qd=C*l*d*19.75/1000//W
printf("heat dessipated is,%f W\n",Qd)
Qa=Qg-Qd//artificial cooling req
//let m be mass of liq req
//Qt=m*S*t=m*1900*10=19000m//assume S=1900 J/kg/C
m=Qa/19000//kg/s
printf("mass of cooling liq req per sec is,%f kg/s",
   m)
```

**Scilab code Exa 26.2** Machine design

```
//find
clc
//solution
//given
W=150000//N
d=0.3//m
N=1800//rpm
```

```
p=1.6//N/mm^2
Z=0.02//kg/m/s
c=0.25//mm
//let l be the length of bearing in mm
//A=l*d=300*l//mm^2
//pb=W/A
l=W/(300*p)//mm
printf("length of bearing is,%f mm\n",l)
u=(33/10^8)*(Z*N/p)*(d*1000/c)+0.002
printf("coeeficient of friction is,%f \n",u)
V=%pi*d*N/60//m/s
Qg=u*W*V
printf("heat gen is,%f W\n",Qg)
```

**Scilab code Exa 26.3** Machine design

```
//find
clc
//solution
//given
d=0.05//m
l=0.1//m
p=1.4//N/mm^2
N=900//rpm
//d/c=1000
Z=0.011
to=75//deg C
ta=35//deg C
t=10//deg C
S=1850
u=(33/10^8)*(Z*N/p)*1000+0.002
W=p*d*l*10^6//N
V=%pi*d*N/60//m/s
Qg=u*W*V///W
//(tb-ta)=0.5(75-35)=20//deg C
```

```
C=280//W/m^2/C
Qd=C*l*d*20//J/s
printf("headt dessipated is,%f W\n",Qd)
Qa=Qg-Qd//W
//let m be mass
//Qt=m*S*t=18500*t
m=Qa/18500//kg/s
printf("artificial heat is,%f W\n",Qa)
printf("mass of lubricant ewq is,%f kg/s\n",m)
```

**Scilab code Exa 26.4** Machine design

```
//find
clc
//solution
//given
d=0.15//m
W=10000//N
N=1500//rpm
//l=1.5*d
c=0.15//mm
Z=0.011
l=1.5*d*1000//mm
p=W/(l*d*1000)//N/mm^2
u=(33/10^8)*(Z*N/p)*(d*1000/c)+0.002
printf("coefficient of friction is,%f\n",u)
V=%pi*d*N/60//m/s
Qg=u*W*V//W
printf("power wasted in friction is,%f W\n",Qg)
```

**Scilab code Exa 26.6** Machine design

```
//find
```

```
clc
//solution
//given
d=0.06//m
l=0.09//m
N=450//rpm
Z=0.06//kg/m/s
c=0.1
S=14.3*10^6
p=(Z*N)*(d*1000/c)^2/S//N/mm^2
printf("bearing pressure is ,%f N/mm^2",p)
W=p*l*d*10^6//N
printf("safe load is ,%f N\n",W)
```

**Scilab code Exa 26.7** Machine design

```
//find
clc
//solution
//given
d=80//mm
l=120//mm
n=4
W=16.5*1000//N
a=150//mm
fb=15//N/mm^2
ft=35//N/mm^2
E=110*1000//N/mm^2
t=sqrt(3*W*a/(2*fb*l))//mm
printf("thickness of bearing cap,%f mm\n",t)
//let dc be core dia
dc=[(4/3)*(W/n)*(4/%pi)*(1/ft)]^(0.5)//mm
printf("dia of bolts is,%f mm\n",dc)
//let dx be deflction
dx=W*a^3/(4*E*l*t^3)//mm
```

```
printf("deflction of cap is,%f mm\n",dx)
```

**Scilab code Exa 26.8** Machine design

```
//find
clc
//solution
//given
D=150//mm
R=75//mm
d=50//mm
r=25//mm
p=0.8//N/mm^2
N=100//rpm
u=0.015
W=p*%pi*[R^2-r^2]//N
printf("load to be supported is,%f N\n",W)
T=(2/3)*u*W*[(R^3-r^3)/(R^2-r^2)]//N-mm
P=2*%pi*N*T/60000
printf("power loast in friction is,%f W\n",P)
```

**Scilab code Exa 26.9** Machine design

```
//find
clc
//solution
//given
n=6
D=300//mm
R=150//mm
d=200//mm
r=100//mm
N=120//rpm
```

```
p=0.4//N/mm^2
u=0.05
W=p*%pi*n*[R^2-r^2]//N
printf("load to be supported is,%f N\n",W)
T=(2/3)*u*W*[(R^3-r^3)/(R^2-r^2)]//N-mm
P=2*%pi*N*T/60000
printf("power loast in friction is,%f W\n",P)
```

**Scilab code Exa 26.10** Machine design

```
//find
clc
//solution
//given
d=300//rpm
r=150//rpm
W=200*1000//N
N=75//rpm
u=0.05
p=0.3//N/mm^2
D=1.4*d//mm
R=D/2
n=W/(p*%pi*(R^2-r^2))
printf("numbr of collar is,%f ",n)
T=(2/3)*u*W*[(R^3-r^3)/(R^2-r^2)]//N-mm
P=2*%pi*N*T/60000
printf("power loast in friction is,%f W\n",P)
printf("heat generated at ba=earing is,%f W\n",P)
```

**Scilab code Exa 29.10** Machine design

```
//find
clc
```

```
//solution
//given
d=300//rpm
r=150//rpm
W=200*1000//N
N=75//rpm
u=0.05
p=0.3//N/mm^2
D=1.4*d//mm
R=D/2
n=W/(p*%pi*(R^2-r^2))
printf("numbr of collar is,%f ",n)
T=(2/3)*u*W*[(R^3-r^3)/(R^2-r^2)]//N-mm
P=2*%pi*N*T/60000
printf("power loast in friction is,%f W\n",P)
printf("heat generated at ba=earing is,%f W\n",P)
```

# Chapter 27

# Ch27

**Scilab code Exa 27.1** Machine design

```
//find
clc
//solution
//given
W1=3//kN
//n1=0.1*n
W2=2//kN
//n2=0.2*n
W3=1//kN
//n3=0.3n
W4=0
//n4=0.4n
L95=20*10^6//rev
b=1.17
//x=L95/L90
x=[log(1/0.95)/log(1/0.90)]^(1/1.17)
L90=L95/x//rev
W={[(0.1*W1^3)+(0.2*W2^3)+(0.3*W3^3)
    +0]/[0.1+0.2+0.3+0.4]}^(1/3)
C=W*(L90/10^6)^(1/3)
printf("dynamic load rating is,%f kN",C)
```

**Scilab code Exa 27.2** Machine design

```
//find
clc
//solution
//given
N=720//rpm
Lh=24000//hours
W=1//N
L99=60*N*Lh//rev
//x=L99/L90
x=0.85*0.9*[log(1/0.99)/log(1/0.90)]^(1/1.17)
L90=L99/x//rev
C=W*(L90/10^6)^(1/3)
printf("dynamic load rating is ,%f kN",C)
```

**Scilab code Exa 27.3** Machine design

```
//find
clc
//solution
//given
Wr=4000//N
Wa=5000//N
N=1600//rpm
Lh=5*300*10//hrs//bearing life in hours
L=60*N*Lh//rev
//W=XVWr + YWa
//from tale 27.4,..we get
X=0.56
Y=1
```

```
V=1
W=0.56*1*Wr +1*Wa//N
C=W*(L/10^6)^(1/3)
printf("dynamic load rating is ,%f kN\n",C)
//from table 27.6, bearing numbr 315.
Co=72000//N
C1=90000//N
//Wa/Co=0.07,..
//from table 27.4
X1=0.56
Y1=1.6
W=0.56*1*Wr + 1.6*Wa//N
Cb=W*(L/10^6)^(1/3)
printf("basic dynamic load rating is ,%f kN\n",Cb)
```

**Scilab code Exa 27.4** Machine design

```
//find
clc
//solution
//given
Wr=2500//N
Wa=1500//N
//Wa/Wr=0.6
//refer table 27.4
X=1
V=1
Y=0
W=X*V*Wr + Y*Wa//N
//from table 27.5,Ks=1.5...
Ks=1.5
W1=W*Ks//N
//ref table 27.6
C=53000//N
L=(C/W)^(3)*10^6
```

```
printf("rating life is,%f rev\n",L)
```

**Scilab code Exa 27.5** Machine design

```
//find
clc
//solution
//given
Wr=7000//N
Wa=2100//N
L=160*10^6//rev
N=300//rpm
//ref table 27.4,Wa/Wr=0.3..
X=0.65
Y=3.5
V=1
W=X*V*Wr + Y*Wa//N
C=W*(L/10^6)^(1/3)//N
printf("baisc dynamin load rating is,%f N\n",C)
```

**Scilab code Exa 27.6** Machine design

```
//find
clc
//solution
//given
Lh=15000//hrs
Wr1=2000//N
Wa1=1200//N
N1=400//rpm
Ks1=3
Wr2=1500//N
Wa2=1000//N
```

```
N2=500//rpm
Ks2=1.5
Wr3=1000//N
Wa3=1500//N
N3=600//rpm
Ks3=2
Wr4=1200//N
Wa4=2000//N
N4=800//rpm
Ks4=1
X=1
Y=1.5
V=1
W1=(Wr1 + Y*Wa1)*3//N
W2=(Wr2 + Y*Wa2)*1.5//N
W3=(Wr3 + Y*Wa3)*2//N
W4=(Wr4 + Y*Wa4)*1//N
printf("value of W1,W2,W3,W4 is ,%f N\n,%f N\n,%f N\n
    ,%f N\n",W1,W2,W3,W4)
//L=60*N*Lh=0.9*10^6*N
L1=(1/10)*0.9*10^6*N1
L2=(1/10)*0.9*10^6*N2
L3=(1/5)*0.9*10^6*N3
L4=(3/5)*0.9*10^6*N4
printf("life of bearing is ,%f rev\n,%f rev\n,%f rev\
    n,%f rev\n",L1,L2,L3,L4)
W=[(L1* W1^3 + L2* W2^3 + L3* W3^3 + L4* W4^3)/(L1+
    L2+L3+L4)]^(1/3)
L=L1+L2+L3+L4//rev
C=W*(L/10^6)^(1/3)//N
printf("dynamic load rating is ,%f kN",C)
```

# Chapter 28

# ch28

**Scilab code Exa 28.1** Machine design

```
//find
clc
//solution
//given
G=10
//Tg/Tp=10
//Dg/Dp=10
L=660//mm
P=500*1000//W
Np=1800//rpm
q=(%pi/180)*22.5
Wn=175//N/mm
Aw=1
//Tp=(2*Aw)/[G*{sqrt(1+1/G*(1/G +2)*(sin(q))^2)-1}]
//x=G*{sqrt(1+1/G*(1/G +2)*(sin(q))^2)-1}
printf("numbr of teeth on pinion is,%f\n",Tp)
printf("numbr of teeth on pinion is,say 14\n")
Tp=14
Tg=G*Tp
//L=Dg/2+Dp/2=5.5*Dp///Dg/Dp=10
Dp=L/5.5
```

```
Dg=10*Dp
m=Dp/Tp
printf("modulde is ,%f \n",m)
Tp1=Dp/m
Tg1=G*Tp1
printf("numbr of teeth on pinion and gear is ,%f \n,
   %f \n",Tp1,Tg1)
T=P*60/(2*%pi*Np)//N-m
Wt=T/(Dp/2)
Wn=Wt/cos(q)
b=Wn/175*1000//mm
printf("width is ,%f mm\n",b)
```

**Scilab code Exa 28.2** Machine design

```
//find
clc
//solution
//given
Np=600//rpm
vr=4//Tg/Tp=4
fop=84//N/mm^2
fog=105//N/mm^2
Tp=16
m=8//mm
b=90//mm
Dp=m*Tp/1000//m
v=%pi*Dp*Np/60//m/s
Cv=3/(3+v)
yp=0.154-(0.912/Tp)
yg=0.154-(0.912/Tg)
//fop*yp<fog*yg...therefore diseign is pinion based
Wt=fop*Cv*b*%pi*m*yp//N
P=Wt*v
printf("power trans is ,%f W\n",P)
```

**Scilab code Exa 28.3** Machine design

```
//find
clc
//solution
//given
P=20000//W
Np=300//rpm
vr=3//Tg/Tp=3
fop=120//N/mm^2
fog=100
Tp=15
//b=14*m
//v=%pi*Dp*Np/60=%pi*m*Tp*Np/60=0.236*m//m/s
Cs=1
//Wt=(P/v)*Cs=84746/m//N
//Cv=3/(3+v)=3/(3+0.236*m)
yp=0.154-(0.912/Tp)
Tg=3*Tp
yg=0.154-(0.912/Tg)
//fop*yp<fog*yg....desing is pinion based
//Wt=fop*Cv*b*%pi*m*yp//N=1476*m^2/(3+0.236m)
//using hit and trial ,m=6.4
//taking m=8 standard value
m=8
printf("module is ,%f mm\n",m)
b=14*m
printf("face width is ,%f mm\n",b)
Dp=m*Tp
Dg=m*Tg
printf("pitch dia of pinion and gear is ,%f \n,%f \n"
    ,Dp,Dg)
```

**Scilab code Exa 28.4** Machine design

```
//find
clc
//solution
//given
P=22500//W
vr=2//Dg/Dp=2
Np=200//rpm
L=600//mm
fop=60
fog=60
//b=10m
C=80
K=1.4
//L=Dg/2+Dp/2=1.5*Dp
Dp=L/1.5
Dg=2*Dp
v=%pi*Dp*Np/60//m/s
Cv=3/(3+v)
//Tp=Dp/m
//yp=0.175-(0.841/Tp)
//yp=0.175-0.0021*m
Cs=1//assume
Wt=P*Cs/v//N
//Wt=fop*Cv*b*%pi*m*yp//N=137.6m^2-1.65m^3
//using hit and trial ,m=0.65
//taking m=8 standard value
m=8
printf("module is ,%f mm\n",m)
b=14*m
printf("face width is ,%f mm\n",b)
Tp=Dp/m
Tg=Dg/m
```

```
printf("numbr of teeth on pinion and gear is,%f \n,
   %f \n",Tp,Tg)
```

**Scilab code Exa 28.5** Machine design

```
//find
clc
//solution
//given
L=500//mm
Nm=900//rpm
Nc=200//rpm
T=5000//N-m
Tmax=1.25*T
vr=Nm/Nc
//Dp+Dg=(L*2)...eq1
//Dg=vr*Dp....eq2
//usieng eq1 and eq2
Dp=182//mm
Dg=4.5*Dp/1000//m
v=%pi*Dg*Nc/60//m/s
Cv=3/(3+v)
fog=140
//yg=.175-(0.841/Tg)=0.175-0.841*m/Dg...Tg=Dg/m
//yg=0.175-0.001m
Wt=2*Tmax/Dg//N
//Wt=fog*Cv*b*%pi*m*yg=200*m^2-1.144m^3....
//using hit anf trial m=8.95,say 10
m=10//mm
b=10*m
printf("module is,%f mm\n",m)
printf("face width is,%f mm\n",b)
Tp=Dp/m
Tg=Dg/m
Dp=m*Tp
```

```
Dg=m*Tg
printf("pitch dia of pinion and gear si ,%f mm\n,%f
   mm\n",Dp,Dg*1000)
```

**Scilab code Exa 28.6** Machine design

```
//find
clc
//solution
//given
L=500//mm
Nm=900//rpm
Nc=200//rpm
T=5000//N-m
Tmax=1.25*T
vr=Nm/Nc
//Dp+Dg=(L*2)...eq1
//Dg=vr*Dp....eq2
//usieng eq1 and eq2
Dp=182//mm
Dg=4.5*Dp/1000//m
v=%pi*Dg*Nc/60//m/s
Cv=3/(3+v)
fog=140
//yg=.175-(0.841/Tg)=0.175-0.841*m/Dg...Tg=Dg/m
//yg=0.175-0.001m
Wt=2*Tmax/Dg//N
//Wt=fog*Cv*b*%pi*m*yg=200*m^2-1.144m^3....
//using hit anf trial m=8.95,say 10
m=10//mm
b=10*m
printf("module is ,%f mm\n",m)
printf("face width is ,%f mm\n",b)
Tp=Dp/m
Tg=Dg/m
```

```
Dp=m*Tp
Dg=m*Tg
printf("pitch dia of pinion and gear si ,%f mm\n,%f
   mm\n",Dp,Dg*1000)
```

**Scilab code Exa 28.7** Machine design

```
//find
clc
//solution
//given
Np=1500//rpm
P=15000//W
vr=3
q=(%pi/180)*14.5
Tp=25
fop=200
fog=200
t=40
P1=1.25*P
Tg=3*Tp
m=6//mm.. assume
Dp=m*Tp/1000
Dg=m*Tg
v=%pi*Dp*Np/60//m/s
Cs=1
Wt=(P1/v)*Cs//N
Cv=3/(3+v)
yp=0.124-(0.684/Tp)
//let b be face width
b1=Wt/(fop*Cv*%pi*m*yp)//mm
printf("face width is ,%f mm\n",b1)
//in practical situation b is btw 9.5m to 12.5m..
   sometime it is also taken as 6m
b=6*m
```

```
printf("face width actual is,%f mm\n",b)
printf("addndum,dedendum,working depth,min total
    depth,tooth thickness,min clearance is,%fmm \n,
    %fmm \n,%fmm \n,%fmm \n,%fmm \n,%fmm \n",m,1.25*m
    ,2*m,2.25*m,1.5708*m,0.25*m)
Wn=Wt/sin(q)
Wp=0.00118*Tp*b*m^2//N
Wr=sqrt(Wn^2 + Wp^2 +2*Wn*Wp*cos(q))
M=Wr*100//N-mm
T=Wt*(Dp/2)*1000//N-mm
Te=sqrt(T^2 +M^2)
//let dp be pinion hub dia
dp=(Te/7.855)^(1/3)
printf("pinion hub dia is,%f mm\n",dp)
```

# Chapter 29

# Ch29

**Scilab code Exa 29.1** Machine design

```
//find
clc
//solution
//given
P=15000//W
q=(%pi/180)*20
a=(%pi/180)*45
Np=10000//rpm
Dp=0.08//m
Dg=0.32//m
fop=100
fog=100
fes=618
//let m is module
T=P*60/(2*%pi*Np)//N-m
Wt=T/(Dp/2)//N
//Tp=Dp/m
//Te=Tp/(cos(a))^3=226.4/m
//ypb=0.175-(0.841/Te)=0.175-0.0037m
v=%pi*Dp*Np/60//m/s
Cv=0.75/(0.75+sqrt(v))
```

```
//b=12.5m... assume
//Wt=fop*Cv*b*%pi*m*ypb=72m^2-1.5m^3
//using hit and trial m=2.3..say 2.5
m=2.5
b=12.5*m
printf("module and face width is ,%f mm\n,%f mm\n",m,
   b)
vr=Dg/Dp
Q=2*vr/(vr+1)
//x=tan(qn)
x=tan(q)*tan(a)
qn=(%pi/180)*14.4
Ep=200*1000
Eg=200*1000
K=(fes)^2*sin(qn)*(1/1.4)*(1/Ep +1/Eg)//N/mm^2
Ww=Dp*b*Q*K*1000/(cos(a))^2//N
printf("load stress factor is ,%f N/mm^2\n",K)
printf("wear load acting is ,%f N\n",Ww)
printf("since wear load acting is more then
   tangentia tooth load ,hence design is safe")
```

**Scilab code Exa 29.2** Machine design

```
//find
clc
//solution
//given
a=(%pi/180)*30
P=35000//W
N=1500//rpm
Tg=24
q=(%pi/180)*20
fo=56
//b=3*pn...pn=pc*cos(a)...pc=%pi*m..put in eq2
T=P*60/(2*%pi*N)//N-mm
```

```
Te=T/(cos(a))^3//N
yb=0.154-(0.912/Te)
//Wt=T/(Dg/2)=(2T/m/Tg)....Dg=m*Tg
//Wt=18600/m....eq1
//v=%pi*N*Dg/60=%pi*m*Tg*N/60
//v=1.885 m//m/s
//Cv=15/(1+v)=15/(15+1.885m)
//Wt=fo*Cv*b*%pi*m*yp//N...eq2
//Wt=(fo*Cv)*3*%pi*m*cos(a)*%pi*m*yb
//Wt=2780m^2/(15+1.885*m)....eq3
//using hit an trial and eq 1 and 3,we get m=5.5,say
    6
m=6
Dg=m*Tg
printf("module and pitch dia of gear is ,%f mm\n,%f
   mm\n",m,Dg)
b=3*%pi*m*cos(a)
printf("face width is ,%f mm\n",b)
Wt=18600/m
Wa=Wt*tan(a)//N
printf("axial tooth is ,%f N\n",Wa)
```

**Scilab code Exa 29.3** Machine design

```
//find
clc
//solution
//given
P=22000//W
Np=1800//rpm
Ng=600//rpm
a=(%pi/180)*30
q=(%pi/180)*20
Tp=24
vr=3
```

```
fo=50//N/mm^2
//b=4*pc
oh=150//mm..overhang
t=50//N/mm^2
T=P*60*1000/(2*%pi*Np)//N-mm
printf("torque acting is ,%f N-mm\n",T)
Te=T/(cos(a))^3//N
yb=0.154-(0.912/Te)
//Wt=T/(Dp/2)=(2T/m/Tp)....Dp=m*Tp
//Wt=9725/m....eq1
//v=%pi*m*Tp*Np=135.735*m//m/min
//Cv=350/(350+v)
//Wt=fo*Cv*b*%pi*m*yp//N...eq2
//Wt=(fo*Cv)*4*%pi*m*%pi*m*yb...eq3
//using hit and trial in eq2 and eq3,we egt m=4.75..
   say 6
m=6
b=4*%pi*m
printf("module and face width is ,%f mm\n,%f mm\n",m,
   b)
Dp=m*Tp
Tg=3*Tp
printf("numbr of teeeth on gear is ,%f \n",Tg)
Dg=m*Tg
printf("pitch circle dia of pinion and gear is is ,%f
    mm\n,%f mm\n",Dp,Dg)
Tg=3*Tp
printf("numbr of teeeth on gear is ,%f \n",Tg)
//let dp be dia of pinion shaft
Wt=9725/m
printf("Wt is ,%f N\n",Wt)
Wa=Wt*tan(a)
printf("Wa is ,%f N\n",Wa)
M1=Wt*oh//N-mm
M2=Wa*Dp/2//N-mm
M=sqrt(M1^2 +M2^2)
printf("equivalnet bendng moment is ,%f N-mm\n",M)
Te=sqrt(T^2 +M^2)
```

```
//dp=(Te*16/(%pi*t))^(1/3)//mm
printf("dia of pinion shaft is,%f mm\n",(Te*16/(%pi*
    t))^(1/3))
printf("dia of pinion shaft is,say 35mm\n")
dp=35//mm
printf("dia of pinion hub is,%f mm\n",1.8*dp)
printf("length of hub is,%f mm\n",1.25*dp)
T1=T*vr//torque on gear shaft
M22=Wa*Dg/2
Mr=sqrt(M1^2 +M22^2)
Te1=sqrt(Mr^2 + T1^2)
//let dg be dia of gear shfat
//dg=(Te1*16/(%pi*t))^(1/3)//mm
printf("dia of gear shaft is,%f mm\n",(Te1*16/(%pi*t
    ))^(1/3))
printf("dia of gear shaft is,say 40 mm\n")
dg=40//mm
printf("dia of gear hub is,%f mm\n",1.8*dg)
printf("length of hub is,%f mm\n",1.25*dg)
//let a1 be major axis and b1 minor axis
//b1=a1/2
//Z=%pi*b1*a1^2/32=0.05*a1^3
v=135.735*m
Cv=350/(350+v)
Ws=Wt/Cv//N
Mb=Ws/4*Dg/2//N-mm
printf("max bending moment acting is,%f N-mm\n",Mb)
fb=42//N/mm^2
//fb=M/Z
a1=(Mb/(0.05*fb))^(1/3)//mm
printf("major and minor axis of section is,%f mm\n,
    %f mm\n",a1,a1/2)
```

# Chapter 30

# ch30

**Scilab code Exa 30.1** Machine design

```
//find
clc
//solution
//given
P=35000//W
Np=1200//rpm
Ng=780//rpm
qs=%pi/2
Tp=30
q=(%pi/180)*14.5
//b=L/4
vr=Np/Ng
Tg=vr*Tp
//tan(qp1)=1/vr
qp1=(%pi/180)*33
qp2=(%pi/2)-qp1
Tep=Tp/cos(qp1)
Teg=Tg/cos(qp2)
ypb=0.124-0.686/Tep
ygb=0.124-0.686/Teg
//since theyr are made of sme material,ypb <ypg,
```

```
    therfoere desing is pinion based
T=P*60*1000/(2*%pi*Np)//N-mm
//Wt=2*T/Dp=2T/(m*Tp)=18567/m//N
//v=%pi*Dp*Np/1000=%pi*m*Tp*Np/1000
//v=113.1*m m/min
//fw=140*(280/(280+v)//N/mm^2)
//L=Dp/(2*sin(qpi))=27.54*m//mm
//b=L/4=6.885*m
//Wt=fw*b*%pi*m*ypb*((L-b)/L)
//Wt=140*(280/(280+113.1m))*6.6685m*%pi*m*ypb
    *((27.54m-6.885m)/27.54m)
//using hit and trial,we get m=6.6,say 8
m=8
printf("module,face width,addendum,dedundum,dia of
    pinion,slant height are,%f mm\n,%f mm\n,%f mm\n,
    %f mm\n,%f mm\n %f mm\n",m,6.885*m,m,1.2*m,(m*Tp
    +2*8*cos(qp1)),27.54*m)
```

**Scilab code Exa 30.2** Machine design

```
//find
clc
//solution
//given
qs=(%pi/2)
Dp=0.08//m
Dg=0.1//m
q=(%pi/180)*14.5
fop=55
fog=55
P=2750//W
Np=1100
//rpm
fes=630
Ep=84000//N/mm^2
```

```
Eg=Ep
vr=Dg/Dp
//tan(qp1)=1/vr
qp1=(%pi/180)*38.66
qp2=(%pi/2)-qp1
//Tp=Dp*1000/m
//Tg=Dg*1000/m
//Tep=Tp/cos(qp1)
//Teg=Tg/cos(qp2)
//ypb=0.124-0.686/Tep=0.124-0.00668*m
//ygb=0.124-0.686/Teg
v=%pi*Dp*Np/60//m/s
Cv=6/(6+v)
L=sqrt((Dg/2)^2 +(Dp/2)^2)*1000//mm
b=L/3
T=P*60*1000/(2*%pi*Np)//N-mm
Wt=T/(Dp*1000/2)//N
//Wt=fop*Cv*b*%pi*m*(0.124-0.00668*m)((L-b)/L)
//Wt=175m-9.43m^2
//using hit and trial ,we get m=4.5,ssay
m=5
Tp=Dp*1000/m
Tg=Dg*1000/m
printf("module is ,%f mm\n",m)
printf("numbr of teeth on pinion and gear  is ,%f \n,
   %f \n",Tp,Tg)
```

**Scilab code Exa 30.3** Machine design

```
//find
clc
//solution
//given
qs=%pi/2
P=9000//W
```

```
Tp=21
Tg=60
fop=85
fog=55
Np=1200//rpm
Ng=420//rpm
q=(%pi/180)*14.5
vr=Tg/Tp
//tan(qp1)=1/vr
qp1=(%pi/180)*19.3
qp2=(%pi/2)-qp1
Tep=Tp/cos(qp1)
Teg=Tg/cos(qp2)
ypb=0.124-0.686/Tep
ygb=0.124-0.686/Teg
//since theyr are made of sme material,ygb <ypb, therfoere desing is gear based
T=P*60*1000/(2*%pi*Ng)//N-mm
//Wt=T/(Dg/2)=2*T/(m*Tg)=6820/m//N
//v=%pi*Dg*Ng/60=1320*m//mm/s
//Cv=6/(6+v)
//L=Dg/(2*sin(qp2))=Tg*m/(2*sin(qp2))=32*m
//b=L/3=10.67*m//mm
//Wt=fog*Cv8b*%pi*m*ygb*((L-b)/L)
//Wt=885m^2/(6+1.32*m)
//885*m^3 -9002*m-40920
//using hit and trial method,we get m=4.52,say m=5
m=5//mm
b=10.67*m
printf("module is,%f mm\n",m)
printf("face width is,%f mm\n",b)
Dp=m*Tp
Dg=m*Tg
printf("pitch dia of pinion and gear is,%f mm\n,%f mm\n",Dp,Dg)
v=1.32*m
Wt=6820/m
//table 28.7,
```

```
e=0.055//mm//error
//taking
K=0.107//14.5 composite teeth
Ep=210*1000//N/mm^2
Eg=84*1000//N/mm^2
C=K*e/(1/Ep + 1/Eg)//N/mm
Wd=Wt+[(21*v*(b*C + Wt))/(21*v + sqrt(b*C + Wt))]
printf("dynamic load acting is,%f N\n",Wd)
fe=84
Ws=fe*b*%pi*m*ygb
printf("static load acting is,%f N\n",Ws)
printf("since Ws<Wd,therefore desing is not perfect\n")
C1=0.107*0.015/(1/Ep +1/Eg)//N-mm
Wd1=Wt+[(21*v*(b*C1+ Wt))/(21*v + sqrt(b*C1 + Wt))]
printf("new dynamic load acting is,%f N\n",Wd1)
printf("now by changind dynamic factor (C),we get Ws>Wd,hence desing is,safe\n")
fes=630//N/mm^2
K1=(fes)^2*sin(q)*(1/1.4)*(1/Eg +1/Ep)//N/mm^2
Q=2*Teg/(Teg+Tep)
Ww=Dp*b*Q*K1
printf("wear load acting is,%f N\n",Ww)
printf("since Ww>Wd1.,hence desing is safe")
```

**Scilab code Exa 30.4** Machine design

```
//find
clc
//solution
//given
q=(%pi/180)*20
qs=%pi/2
vr=3
fog=70
```

```
fop=100
P=37500//W
Np=750//rpm
//b=L/3
oh=150//mm
//tan(qp1)=1/vr
qp1=(%pi/180)*18.43
qp2=(%pi/2)-qp1
Tp=20//assume
Tg=vr*Tp
Tep=Tp/cos(qp1)
Teg=Tg/cos(qp2)
ypb=0.124-0.686/Tep
ygb=0.124-0.686/Teg
Ng=Np/3
//since theyr are made of sme material,ygb <ypb,
    therfoere desing is gear based
T=P*60*1000/(2*%pi*Ng)//N-mm
//Wt=T/(Dg/2)=2*T/(m*Tg)=47.7*1000/m//N
//v=%pi*Dg*Ng/60=0.7855*m//m/s
//Cv=3/(3+v)
//L=Dg/(2*sin(qp2))=Tg*m/(2*sin(qp2))=32*m
//b=L/3=10.67*m//mm
//Wt=fog*Cv8b*%pi*m*ygb*((L-b)/L)
//Wt=691*m^2/(3+0.7855*m)
//using hit and trial,we get m=8.8,say 10
m=10
b=10.54*m
printf("module is,%f mm\n",m)
printf("face width is,%f mm\n",b)
Dp=m*Tp
Dg=m*Tg
printf("pitch dia of pinion and gear is,%f mm\n,%f
    mm\n",Dp,Dg)
//let dp be dia pf pinion shaft
T1=P*60*1000/(2*%pi*Np)
L=31.62*m
Rm=(L-b/2)*Dp/(2*L)//mm
```

```
WT=T1/Rm
WRH=WT*tan(q)*sin(qp1)//N
WRV=WT*tan(q)*cos(qp1)//N
printf("axiala nd radial force actin on piston shaft
    is,%f N\n,%f N\n",WRH,WRV)
M1=WRV*oh-WRH*Rm
printf("moment due to Wrh and Wrv is,%f  N-mm\n",M1)
M2=WT*oh
M3=sqrt(M1^2 +M2^2)
Te=sqrt(T1^2 + M3^2)
t=45
printf("net moment acting is,%f N-mm\n",M3)
dp=(16*Te/(%pi*t))^(1/3)
printf("dia of pinion shaft is,%f mm\n",dp)
```

# Chapter 31

# Ch31

**Scilab code Exa 31.1** Machine design

```
//find
clc
//solution
//given
n=3
m=6
Dw=50//mm
Tg=30
q=(%pi/180)*14.5
u=0.05
//tan(y)=m*n/Dw
y=(%pi/180)*19.8 //rad
printf("lead angle is,%f deg\n",y)
vr=Tg/n
printf("velocity ratio is,%f \n",vr)
Dg=m*Tg
x=(Dw+Dg)/2
printf("centre diat is,%f mm\n",x)
eff=tan(y)*(cos(q)-u*tan(y))/(cos(q)*tan(y)+u)
printf("effi is,%f \n",eff)
```

**Scilab code Exa 31.2** Machine design

```
//find
clc
//solution
//given
P=15000//W
Nw=2000//rpm
Ng=75//rpm
n=3
Dw=65//mm
Tg=90
m=6//mm
q=(%pi/180)*20
u=0.1
T=P*60000/(2*%pi*Nw)//N-mm
Wt=T/(Dw/2)//N
printf("tangential force acting is,%f N\n",Wt)
//let y be lead angle
//tan(y)=m*n/Dw
y=(%pi/180)*15.5 //rad
Wa=Wt/tan(y)
Wr=Wa*tan(q)
printf("axial force and separating force acting is%f
    N\n,%f N\n",Wa,Wr)
eff=tan(y)*(cos(q)-u*tan(y))/(cos(q)*tan(y)+u)
printf("effi is,%f \n",eff)
```

**Scilab code Exa 31.3** Machine design

```
//find
clc
```

```
//solution
//given
q=(%pi/180)*20
P=10000//W
NW=1400//rpm
vr=12
x=225//mm
//1/(tan(y))^3=vr
y=(%pi/180)*23.6
printf("lead angle is ,%f  rad\n",y)
//let x/ln=u
u=(1/2/%pi)*(1/sin(y)+vr/(cos(y)))
ln=x/u
//printf("normal lead is,%f mm\n",ln)
l=ln/cos(y)
//printf("axial lead is,%f mm\n",l)
n=4
Tw=n
//pa=l/4//axial pitch
m=8//assume
pa=%pi*m
printf("axial pitch is,%f mm\n",pa)
l1=pa*n
printf("axial lead is,%f mm\n",l1)
ln1=l1*cos(y)
printf("normal lead is,%f mm\n",ln1)
x1=(ln1/2/%pi)*(1/sin(y)+vr/(cos(y)))
printf("cenetre diatance is,%f mm\n",x1)
Dw=l1/(%pi*tan(y))//mm
printf("pitch circle dia is,%f mm\n",Dw)
Lw1=pa*(4.5 + 0.02 *Tw)//using table 31.3
//this length is to be inc by 25 to 30 mm for feed
   marks,therefore
Lw=Lw1+25//mm
printf("length of threaded portion is,%f mm\n",Lw)
h=0.623*pa
printf("depth of tooth is,%f mm\n",h)
a=0.286*pa
```

```
printf("addendum is,%f mm\n",a)
Dow=Dw+2*a
printf("outside dia of worm is,%f mm\n",Dow)
Tg=n*vr
Dg=m*Tg
printf("pitc circle dia of worm gear si,%f mm\n",Dg)
Dog=Dg+0.8903*pa
printf("outside dia of worm gear is,%f mm\n",Dog)
Dt=Dg +0.572*pa
printf("throat dia is,%f mm\n",Dt)
b=2.15*pa + 5
printf("face width is,%f mm\n",b)
NG=NW/vr
T=P*60/(2*%pi*NG)//N-m
WT=2*T*1000/Dg//N
v=%pi*0.384*Ng/60//m/s
Cv=6/(6+v)
y1=0.154-(0.912/Tg)
fo=84
//Wt=fo*Cv*b*%pi*m*y1=84*0.72*b*m*0.135
Wt=84*0.72*59*%pi*m*0.135
printf("tangtial load actingi is %f N\n",Wt)
printf("since it is more than load acting on gear ,
   so desing is safe\n")
WD=Wt/Cv
printf("dynamic load is,%f N\n",WD)
printf("since WD>Wt,design is safe\n")
WS=168*b*%pi*m*y1
printf("static loac is ,%f N\n",WS)
printf("since WS>Wt,design is safe\n")
K=0.55
WW=Dg*b*K'
printf("wear laod is,%f N \n",WW)
printf("since WW>Wt,design is safe\n")
rv=%pi*Dw*NW/cos(y)/1000
u2=0.025+rv/18000
//tan(q2)=u2
q2=(%pi/180)*2.548
```

```
eff2=tan(y)/(tan(q2+y))
Qg=1.25*P*(1-eff2)
Aw=(%pi/4)*Dw^2//mm^2
Ag=(%pi/4)*Dg^2
A=Aw+Ag//mm^2
//Qd=A*(t2-t1)*378
Qd=Qg
//t2-t1=G
G=Qg/45.4
printf("temp diff is ,%f degree C\n",G)
```

**Scilab code Exa 31.4** Machine design

```
//find
clc
//solution
//given
P=1100//W
vr=27
Nw=1440//rpm
q=(%pi/180)*20
x=100//mm
//Dw=(x)^(0.875)/(1.416)//
printf("pitch circle dia is,%f mm\n",(x)^(0.875)
    /(1.416))
printf("pitch cirlce dia is,say 40mm\n")
Dw=40//mm
Dg=2*x-Dw//mm
Tg=2*27//27 is transmission ratio,,from table 31.2
pa=%pi*Dg/Tg//mm
pc=pa
m=pc/%pi//mm//module
DG=pc*Tg/%pi
printf("actual pitch is%f mm\n",DG)
DW=2*x-DG
```

```
printf(" actual dia is ,%f mm\n",DW)
b=0.73*DW
printf(" face width is ,%f mm\n",b)
Ng=Nw/vr//rpm
v=%pi*Dg*Ng/60//m/s'
Cv=6/(6+v)
y=0.154-(0.912/Tg)
fo=84
Wt=fo*Cv*b*%pi*m*y//N
P1=Wt*v
printf(" power tran due to tangential load is ,%f W\n"
    ,P1)
printf(" since power tran is more then given power ,
    hence design is safe\n")
WD=Wt/Cv//N
P2=WD*v
printf(" powr due to dynamic load is ,%f W\n",P2)
printf(" since power tran is more then given power ,
    hence design is safe\n")
fe=168
Ws=fe*b*%pi*m*y//N
P3=Ws*v
printf(" powr due to static load is ,%f W\n",P3)
P4=3650*(x)^(1.7)/(vr+ 5)
printf(" power due to heat des is ,%f W",P4)
printf(" since power tran is more then given power ,
    hence design is safe\n")
```

# Chapter 32

# Ch32

**Scilab code Exa 32.1** Machine design

```
//find
clc
//solution
//given
BP=5000//W
N=1200//rpm
n=N/2
pm=0.35//N/mm^2
effm=0.8
//let D bebore dia
IP=BP/effm//W
//IP=pm*l*A*n/60
//A=%pi*D^2/4,l=1.5D
//IP=4.12*10^-3 *D^3
D=(IP*1000/4.12)^(1/3)//mm
printf("dia of bore dis,%f mm\n",D)
l=1.5*D
L=1.15*l
ft=42
printf("stroke length is,%f mm\n",L)
p=9*pm
```

```
C=0.1
th=D*sqrt(C*p/ft)
printf("thickness of head is ,%f mm\n",th)
Fc=(%pi/4)*D^2*p//N//force on cylinder ...eq1
//let ns be nu,mbr of studs
ns=6//...assume
///let dc be core dia
ft1=65//N/mm^2
//d be nominal  dia
//Fs=ns*(%pi/4)*dc^2*ft1=216*d^2....eq2...//dc=0.84*d
//using eq1 and eq2
//we get
//d=sqrt(Fc/216)
printf("nominal  dia is  ,%f mm\n",sqrt(Fc/216))
printf("nominal dia is ,say 14 mm\n")
d=14//mm
```

**Scilab code Exa 32.2** Machine design

```
//find
clc
//solution
//given
D=100//mm
L=0.125//m
p=5//N/mm^2
pm=0.75//N/mm^2
effm=0.8
m=41.7*10^-6//kg/BP/s
HCV=42*1000//kJ/kg
N=2000//rpm
ft=38
th1=sqrt((3*p*D^2)/(16*ft))
printf("thickness of head on basis of strength is ,%f
```

```
    mm\n",th1)
n=N/2
A=%pi*D^2/4//mm^2
IP=pm*L*A*n/60
BP=effm*IP
printf("brake power is,%f W\n",BP)
C=0.05
H=C*HCV*m*BP//heat flowing piston head
k=46.6//W/m/C
//TC-TE=w
w=220
th2=H*1000/(12.56*k*w)
printf("thickness of head on basis of heat
    dessiapation is,%f mm\n",th2)
printf("taking large r value into consideration \n")
th=th1
printf("thickness of head is,%f mm\n",th)
tr=7
printf("thickness of ribs is,%f m\n",tr)
pw=0.035
ft1=90
t1=D*sqrt(3*pw/ft1)
//t2 lies btw 0.7 t1  to t1
t2=3//mm
//b1 lies btw th to 1.2th=16 to 19.2
b1=18//mm
//b2 lies btw 0.75t2 to t2
b2=2.5
printf("with of top land and othe ring land is,%f mm
    \n,%f mm\n",b1,b2)
//G1 lie sbtw 3.5t1 to 4t1
G1=12.8//mm
//G2 lies btw 0.002D to 0.004 D
G2=0.3//mm
printf("gap btw free ends of ring and btw ring and
    cylindr is,%f mm\n,%f mm\n",G1,G2)
u=0.1
R1=u*%pi*D^2*p/4//...eq3
```

```
//R2=pb*D*l=45*l ... eq4
//from eq3 and eq4.
//l=R1/45
printf("length of skirt is,%f mm\n",R1/45)
printf("length of skirt is ,say 90mm\n")
l=90
Lp=l+(4*t2 + 3*3)+b1
printf("length of piston is,%f mm\n",Lp)
//let do be outside dia
//l1 be lenngth of pin
pb1=25//N/mm^2
l1=0.45*D
//Load1=pb1*do*l1=1125*do
lo2=%pi*D^2*p/4
do=lo2/1125//mm
di=0.6*do
printf("inside and outside dia is,%f mm\n,%f mm\n",
   di,do)
```

**Scilab code Exa 32.3** Machine design

```
//find
clc
//solution
//given
D=400//mm
L=600//mm
r=300//mm
pm=0.3//N/mm^2
p=2.5//N/mm^2
W=50//kN
//T1+T2=6.5//kN=P
P=6.5
q=(%pi/180)*pb
//l/r=5
```

```
Fp=(%pi/4)*D^2*p//N
b=2*D
b1=b/2
b2=b/2
H1=Fp*b1/b/1000//kN
H2=Fp*b2/b/1000//kN
//V2=W*c1/c
//c1=c2=c/2
V2=W/2
V2=W/2
H2b=P/2
H3b=P/2
//let dc be crankpin dia,lc be length
fb=75//N/mm^2
//Mc=(%pi/32)*dc^3*fb=7.364*10^-3*dc^3
Mc1=H1*b2
dc=(Mc1/(7.364*10^-3))^(1/3)
printf("dia of crankpin is,%f mm\n",dc)
```

**Scilab code Exa 32.4** Machine design

```
//find
clc
//solution
//given
D=400//mm
L=600//mm
r=300//mm
pm=0.3//N/mm^2
p=2.5//N/mm^2
W=50//kN
//T1+T2=6.5//kN=P
P=6.5
q=(%pi/180)*35
//l/r=5
```

```
Fp=(%pi/4)*D^2*p//N
b=2*D
b1=b/2
b2=b/2
H1=Fp*b1/b/1000//kN
H2=Fp*b2/b/1000//kN
//V2=W*c1/c
//c1=c2=c/2
V2=W/2
V3=W/2
H2b=P/2
H3b=P/2
//Desing of crankshaft wen crank is at dead centre
//let dc be crankpin dia,lc be length
fb=75//N/mm^2
//Mc=(%pi/32)*dc^3*fb=7.364*10^-3*dc^3
Mc1=H1*b2
dc=(Mc1/(7.364*10^-3))^(1/3)
printf("dia of crankpin is,%f mm\n",dc)
pb=10
lc=Fp/(dc*pb)//mm
printf("lengthb of crankipin is,%f mm\n",lc)
t=0.65*dc + 6.35
printf("thickness of crank web is,%f mm\n",t)
w=1.125*dc+12.7
printf("width of crank pin is,%f mm\n",w)
//let ds be dia of shaft
l1=2*(b/2-lc/2-t)
printf("l1 is,%f mm\n",l1)
//c=l1+300=667,take c=800
c=800
l2=l1
l3=l1
c1=c/2
c2=c/2
Mw=V3*c1*1000//N-mm
printf("bendin moment due to flywheel is,%f N-mm\n",Mw)
```

```
Mt=H3b*c1*1000//N-mm
Ms=sqrt(Mw^2 + Mt^2)//N-mm
fb1=42
printf("resultant bending moment is,%f N-mm\n",Ms)
ds=((Ms*32)/(%pi*fb1))^(1/3)
printf("dia of shaft is,%f mm\n",ds)
//Desing of crankshaftt wen crank is at an angle of
   max twisting moment
p1=1
Fp1=(%pi/4)*D^2*p1/1000//kN
q1=(%pi/180)*6.58
Fq1=Fp1/cos(q1)
FT1=Fq1*sin(q1+q)//kN
FR=Fq1*sin(q1+q)//kN
HT1=FT1*b1/b//kN
HT2=FT1*b2/b
HR1=FR*b1/b
HR2=FR*b2/b
//let dc1 be crankpin dia
MC1=HR1*b2//kN-mm
TC1=HT1*r//kN-mm
TE1=sqrt(MC1^2 + TC1^2)*1000//N-mm
t11=35//N/mm^2
dc1=((TE1*16)/(%pi*t11))^(1/3)
printf("dia of crankpin is,%f mm\n",dc1)
printf("take larger value dc equal to 205 into
   consideration\n")
//let ds1 be dai of shaft
TS1=FT1*r*1000//N-mm
TE2=sqrt(Ms^2 + TS1^2)
t22=35
ds22=(TE2*16/(%pi*t22))^(1/3)//mm
printf("shaft dia is,%f mm\n",ds22)
```

**Scilab code Exa 32.5** Machine design

```
//find
clc
//solution
//given
BP=5000//W
N=1200//rpm
n=N/2
pm=0.35//N/mm^2
effm=0.8
//let D bebore dia
IP=BP/effm//W
//IP=pm*l*A*n/60
//A=%pi*D^2/4,l=1.5D
//IP=4.12*10^-3 *D^3
D=(IP*1000/4.12)^(1/3)//mm
printf("dia of bore dis,%f mm\n",D)
l=1.5*D
L=1.15*l
ft=42
printf("stroke length is,%f mm\n",L)
p=9*pm
C==0.1
th=D*sqrt(C*p/ft)
printf("thickness of head is,%f mm\n",th)
Fc=(%pi/4)*D^2*p//N//force on cylinder...eq1
//let ns be nu,mbr of studs
ns=6//...assume
///let dc be core dia
ft1=65//N/mm^2
//d be nominal  dia
//Fs=ns*(%pi/4)*dc^2*ft1=216*d^2....eq2...//dc=0.84*d
//using eq1 and eq2
//we get
//d=sqrt(Fc/216)
printf("nominal  dia is ,%f mm\n",sqrt(Fc/216))
printf("nominal dia is,say 14 mm\n")
d=14//mm
```

**Scilab code Exa 32.6** Machine design

```
//find
clc
//solution
//given
dp=60//mm
p=4//N/mm^2
fb=46//N/mm^2
k=0.42
a=%pi/6
t=k*dp*sqrt(p/fb)//mm
printf("thickness of valve head is,%f mm\n",t)
ds=dp/8 + 6.35//mm
printf("stem dia is,%f mm\n",ds)
h=dp/(4*cos(a))
printf("max lift of valve is,%f mm\n",h)
```