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

Created by
Karan
B-tech
Mechanical Engineering
National institute of technology Karnataka
College Teacher
Dr Kumar G.N
Cross-Checked by

July 30, 2019

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

Book Description

Title: A Textbook Of Machine Design

Author: R. S. Khurmi And J. K. Gupta

Publisher: S. Chand & Co. Ltd., New Delhi

Edition: 14

Year: 2010

ISBN: 81-219-2537-1

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 soderbergs 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=0.5*sigmay//yield stress in shear loading is
    taken as one half of yield stress in reverse
    bending
FS=1/0.541
0==(taum/tauy)-((tauv*Kf)/(taue*Ksur*Ksz)-(1/FS))//
    according to Soderberg's relation

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 soderbergs 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(t2,"Minimum wall thickness in mm=")
//when circumferential stress does not exceed 42MPa
t1=(p*d)/(2*sigmat1)
disp(t1,"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
pi = %pi;
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
pi = %pi;
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
pi = %pi;
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)

//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=(l-l/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;
d=(Wcr/0.043)^(1/4)//mm;
//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

//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*do/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*do/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&gt;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 percentage 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 %i 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//mm^2
//conveting to N-m
dE=985*0.087//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=13668*t^2
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/m^3
//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)
tf=40;
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
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
p2=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*d^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)
d1=10
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=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;
N=1295//rpm;
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

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
pb = 0.5;
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
//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=14
//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")

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;
Tg = Tp*4;
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)<=""
div=""></fog*yg... therefore>
```

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,
```

```
    therfoeere 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&gt;Wt, design is safe\n")
WS=168*b*%pi*m*y1
printf("static loac is ,%f N\n",WS)
printf("since WS&gt;Wt, design is safe\n")
K=0.55
WW=Dg*b*K'
printf("wear laod is,%f N \n",WW)
printf("since WW&gt;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
pb=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)
```