

Scilab Textbook Companion for
Theory Of Machines
by B. K. Sarkar¹

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Book Description

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

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Chapter 1

Basic kinematics

Scilab code Exa 1.1 Length of the stroke

```
1 //CHAPTER 1 ILLUSTRATION 1 PAGE NO 15
2 //TITLE: Basic kinematics
3 //Figure 1.14
4 clc
5 clear
6 pi=3.141
7 AO=200// distance between fixed
   centres in mm
8 OB1=100// length of driving crank in
   mm
9 AP=400// length of slotter bar in mm
10 //=====
11 OAB1=asind(OB1/AO)// inclination of
   slotted bar with vertical in degrees
12 beeta=(90-OAB1)*2// angle through
   which crank turns in return stroke in degrees
13 A=(360-beeta)/beeta// ratio of time of
   cutting stroke to the time of return stroke
14 L=2*AP*sind(90-(beeta)/2)// length of the
   stroke in mm
15 printf('Inclination of slotted bar with vertical= %
```

```
.3f degrees\n Length of the stroke= %.3f mm',OAB1  
,L)
```

Scilab code Exa 1.2 Ratio of time taken on the cutting to the return stroke

```
1 //CHAPTER 1 ILLUSRTATION 2 PAGE NO 16  
2 //TITLE:Basic kinematics  
3 //Figure 1.15  
4 clc  
5 clear  
6 OA=300// distance between the fixed  
   centres in mm  
7 OB=150// length of driving crank in  
   mm  
8 //=====  
9 OAB=asind(OB/OA)// inclination of  
   slotted bar with vertical in degrees  
10 beeta=(90-OAB)*2// angle through which  
   crank turns inreturn stroke in degrees  
11 A=(360-beeta)/beeta// ratio of time of  
   cutting stroke to the time of return stroke  
12 printf('Ratio of time taken on the cutting to the  
   return stroke= %.0f ',A)
```

Scilab code Exa 1.3 Ratio of time taken on the cutting to the return stroke

```
1 //CHAPTER 1 ILLUSRTATION 3 PAGE NO 16  
2 //TITLE:Basic kinematics  
3 //Figure 1.16  
4 clc  
5 clear  
6 OB=54.6// distance between the fixed  
   centres in mm
```

```

7 OA=85 //          length of driving crank in
  mm
8 OA2=OA
9 CA=160 //        length of slotted lever in
  mm
10 CD=144 //       length of connectin rod in
  mm
11 //=====
12 beeta=2*(acosd(OB/OA2)) //      angle through which
  crank turns inreturn stroke in degrees
13 A=(360-beeta)/beeta //          ratio of time of
  cutting stroke to the time of return stroke
14 printf('Ratio of time taken on the cutting to the
  return stroke= %.0f',A)

```

Scilab code Exa 1.4 Angular velocity of connecting rod

```

1 //CHAPTER 1 ILLUSRTATION 4 PAGE NO 17
2 //TITLE:Basic kinematics
3 //Figure 1.18,1.19
4 clc
5 clear
6 pi=3.141
7 Nao=180 //      speed of the crank in rpm
8 wA0=2*pi*Nao/60 // angular speed of the crank in rad
  /s
9 AO=.5 //        crank length in m
10 AE=.5
11 Vao=wA0*AO //   velocity of A in m/s
12 //=====
13 Vb1=8.15 //     velocity of piston B in m/s by
  measurment from figure 1.19
14 Vba=6.8 //     velocity of B with respect to A in m/s
15 AB=2 //         length of connecting rod in m
16 wBA=Vba/AB //   angular velocity of the connecting

```

```

    rod BA in rad/s
17 ae=AE*Vba/AB//      velocity of point e on the
    connecting rod
18 oe=8.5//           by measurement velocity of point
    E
19 Do=.05//           diameter of crank shaft in m
20 Da=.06//           diameter of crank pin in m
21 Db=.03//           diameter of cross head pin B m
22 V1=wA0*Do/2//      velocity of rubbing at the
    pin of the crankshaft in m/s
23 V2=wBA*Da/2//      velocity of rubbing at the
    pin of the crank in m/s
24 Vb=(wA0+wBA)*Db/2// velocity of rubbing at the
    pin of cross head in m/s
25 ag=5.1//           by measurement
26 AG=AB*ag/Vba//     position and linear velocity of
    point G on the connecting rod in m
27 //=====
28 printf('Velocity of piston B= %.3f m/s\n Angular
    velocity of connecting rod= %.3f rad/s\n velocity
    of point E=%.1f m/s\n velocity of rubbing at the
    pin of the crankshaft=%.3f m/s\n velocity of
    rubbing at the pin of the crank =%.3f m/s\n
    velocity of rubbing at the pin of cross head =%.3
    f m/s\n position and linear velocity of point G
    on the connecting rod=%.3f m', Vb1, wBA, oe, V1, V2, Vb
    , AG)

```

Scilab code Exa 1.5 Linear velocity of point P

```

1 //CHAPTER 1 ILLUSRTATION 5 PAGE NO 19
2 //TITLE:Basic kinematics
3 //Figure 1.20 ,1.21
4 clc
5 clear

```

```

6 pi=3.141
7 N=120//      speed of crank in rpm
8 OA=10//     length of crank in cm
9 BP=48//     from figure 1.20 in cm
10 BA=40//    from figure 1.20 in cm
11 //=====
12 w=2*pi*N/60//      angular velocity of the crank OA
      in rad/s
13 Vao=w*OA//        velocity of ao in cm/s
14 ba=4.5//          by measurement from 1.21 in cm
15 Bp=BP*ba/BA
16 op=6.8//          by measurement in cm from figure
      1.21
17 s=20//            scale of velocity diagram 1cm=20
      cm/s
18 Vp=op*s//         linear velocity of P in m/s
19 ob=5.1//          by measurement in cm from figure
      1.21
20 Vb=ob*s//         linear velocity of slider B
21 printf('Linear velocity of slider B= %.2f cm/s\n
      Linear velocity of point P= %.2f cm/s',Vb,Vp)

```

Scilab code Exa 1.6 velocity of point F

```

1
2 //CHAPTER 1 ILLUSRTATION 6 PAGE NO 20
3 //TITLE:Basic kinematics
4 //Figure 1.22,1.23
5 clc
6 clear
7 pi=3.141
8 AB=6.25//      length of link AB in cm
9 BC=17.5//      length of link BC in cm
10 CD=11.25//    length of link CD in cm
11 DA=20//       length of link DA in cm

```

```

12 CE=10
13 N=100//          speed of crank in rpm
14 //=====
15 wAB=2*pi*N/60//  angular velocity of AB in rad/s
16 Vb=wAB*AB//      linear velocity of B with
    respect to A
17 s=15//          scale for velocity diagram 1 cm= 15 cm/s
18 dc=3//          by measurement in cm
19 Vcd=dc*s
20 wCD=Vcd/CD//    angular velocity of link CD in
    rad/s
21 bc=2.5//        by measurement in cm
22 Vbc=bc*s
23 wBC=Vbc/BC//    angular velocity of link BC in rad/
    s
24 ce=bc*CE/BC
25 ae=3.66//       by measurement in cm
26 Ve=ae*s//       velocity of point E 10 from c on
    the link BC
27 af=2.94//       by measurement in cm
28 Vf=af*s//       velocity of point F
29 printf('The angular velocity of link CD= %.3f rad/s\
    n The angular velocity of link BC= %.3f rad/s\n
    velocity of point E 10 from c on the link BC= %.3
    f cm/s\n velocity of point F= %.3f cm/s',wCD,wBC,
    Ve,Vf)

```

Scilab code Exa 1.7 angular velocity of link BD

```

1 //CHAPTER 1 ILLUSRTATION 7 PAGE NO 21
2 //TITLE:Basic kinematics
3 //Figure 1.24,1.25
4 clc
5 clear
6 pi=3.141

```

```

7 Noa=600//      speed of the crank in rpm
8 OA=2.8//      length of link OA in cm
9 AB=4.4//      length of link AB in cm
10 BC=4.9//     length of link BC in cm
11 BD=4.6//     length of link BD in cm
12 //=====
13 wOA=2*pi*Noa/60//      angular velocity of crank
      in rad/s
14 Vao=wOA*OA//      The linear velocity of
      point A with respect to oin m/s
15 s=50//      scale of velocity diagram
      in cm
16 od=2.95//      by measurement in cm from
      figure
17 Vd=od*s/100//      linear velocity slider in
      m/s
18 bd=3.2//      by measurement in cm from
      figure
19 Vbd=bd*s
20 wBD=Vbd/BD//      angular velocity of link BD
21 printf('linear velocity slider D= %.3f m/s\n angular
      velocity of link BD= %.1f rad/s',Vd,wBD)

```

Scilab code Exa 1.8 Angular velocity of link CD

```

1 //CHAPTER 1 ILLUSRTATION 8 PAGE NO 22
2 //TITLE:Basic kinematics
3 //Figure 1.26,1.27
4 clc
5 clear
6 pi=3.141
7 Noa=60//      speed of crank in rpm
8 OA=30//      length of link OA in cm
9 AB=100//     length of link AB in cm
10 CD=80//     length of link CD in cm

```



```

11 //AC=CB
12 //=====
13 wOA=2*pi*Noa/60//      angular velocity of crank in
      rad/s
14 Vao=wOA*OA/100//      linear velocity of point A
      with respect to O
15 s=50//                scale for velocity diagram 1 cm= 50
      cm/s
16 ob=3.4//              by measurement in cm from figure
      1.27
17 od=.9//                by measurement in cm from figure
      1.27
18 Vcd=160//              by measurement in cm/s from figure
      1.27
19 wCD=Vcd/CD//          angular velocity of link in rad/s
20 printf('Angular velocity of link CD= %d rad/s',wCD)

```

Scilab code Exa 1.9 velocity of sliding of the block

```

1 //CHAPTER 1 ILLUSRTATION 9 PAGE NO 23
2 //TITLE: Basic kinematics
3 //Figure 1.28,1.29
4 clc
5 clear
6 pi=3.141
7 Nao=120//              speed of the crank in rpm
8 OQ=10//                length of link OQ in cm
9 OA=20//                length of link OA in cm
10 QC=15//               length of link QC in cm
11 CD=50//               length oflink CD in cm
12 //=====
13 wOA=2*pi*Nao/60//      angular speed of crank in rad
      /s
14 Vad=wOA*OA/100//      velocity of pin A in m/s
15 BQ=41//               from figure 1.29

```

```

16 BC=26//          from figure 1.29
17 bq=4.7//        from figure 1.29
18 bc=bq*BC/BQ//   from figure 1.29 in cm
19 s=50//          scale for velocity diagram in
    cm/s
20 od=1.525//      velocity vector od in cm from
    figure 1.29
21 Vd=od*s//       velocity of ram D in cm/s
22 dc=1.925//      velocity vector dc in cm from
    figure 1.29
23 Vdc=dc*s//      velocity of link CD in cm/s
24 wCD=Vdc/CD//    angular velocity of link CD
    in cm/s
25 ba=1.8//        velocity vector of sliding of
    the block in cm
26 Vab=ba*s//      velocity of sliding of the
    block in cm/s
27 printf('Velocity of RAM D= %.3f cm/s\n angular
    velocity of link CD= %.3f rad/s\n velocity of
    sliding of the block= %.3f cm/s',Vd,wCD,Vab)

```

Scilab code Exa 1.10 angular acceleration of connecting rod BA

```

1 //CHAPTER 1 ILLUSRTATION 10 PAGE NO 24
2 //TITLE:Basic kinematics
3 //Figure 1.30(a),1.30(b),1.30(c)
4 clc
5 clear
6 pi=3.141
7 Nao=300//        speed of crank in rpm
8 A0=.15//         length of crank in m
9 BA=.6//          length of connecting rod in m
10 //=====
11 wA0=2*pi*Nao/60// angular velocity of link in
    rad/s

```

```

12 Vao=wA0*A0//          linear velocity of A with
    respect to 'o'
13 ab=3.4//            length of vector ab by measurement
    in m/s
14 Vba=ab
15 ob=4//            length of vector ob by measurement in
    m/s
16 oc=4.1//          length of vector oc by measurement
    in m/s
17 fRao=Vao^2/A0//    radial component of acceleration
    of A with respect to O
18 fRba=Vba^2/BA//    radial component of acceleration
    of B with respect to A
19 wBA=Vba/BA//      angular velocity of connecting
    rod BA
20 fTba=103//        by measurement in m/s^2
21 alphaBA=fTba/BA// angular acceleration of
    connecting rod BA
22 printf('linear velocity of A with respect to O= %.3f
    m/s\n radial component of acceleration of A with
    respect to O= %.3f m/s^2\n radial component of
    acceleration of B with respect to A= %.3f m/s^2\n
    angular velocity of connecting rod B= %.3f rad/s
    \n angular acceleration of connecting rod BA= %.3
    f rad/s^2',Vao,fRao,fRba,wBA,alphaBA)

```

Scilab code Exa 1.11 angular acceleration of AB

```

1 //CHAPTER 1 ILLUSRTATION 11 PAGE NO 26
2 //TITLE:Basic kinematics
3 //Figure 1.31(a),1.31(b),1.31(c)
4 clc
5 clear
6 pi=3.141
7 wAP=10//          angular velocity of crank in rad

```

```

/s
8 P1A=30//          length of link P1A in cm
9 P2B=36//          length of link P2B in cm
10 AB=36//          length of link AB in cm
11 P1P2=60//         length of link P1P2 in cm
12 AP1P2=60//        crank inclination in degrees
13 alphaP1A=30//     angulare acceleration of crank
    P1A in rad/s^2
14 //=====
15 Vap1=wAP*P1A/100// linear velocity of A with
    respect to P1 in m/s
16 Vbp2=2.2//        velocity of B with respect to
    P2 in m/s(measured from figure )
17 Vba=2.06//        velocity of B with respect to
    A in m/s(measured from figure )
18 wBP2=Vbp2/(P2B*100)// angular velocity of P2B in
    rad/s
19 wAB=Vba/(AB*100)// angular velocity of AB in
    rad/s
20 fAB1=alphaP1A*P1A/100// tangential component of the
    acceleration of A with respect to P1 in m/s^2
21 frAB1=Vap1^2/(P1A/100)// radial component of the
    acceleration of A with respect to P1 in m/s^2
22 frBA=Vba^2/(AB/100)// radial component of the
    acceleration of B with respect to B in m/s^2
23 frBP2=Vbp2^2/(P2B/100)// radial component of the
    acceleration of B with respect to P2 in m/s^2
24 ftBA=13.62//      tangential component of B
    with respect to A in m/s^2(measured from figure)
25 ftBP2=26.62//     tangential component of B
    with respect to P2 in m/s^2(measured from figure)
26 alphaBP2=ftBP2/(P2B/100)// angular acceleration of
    P2B in m/s^2
27 alphaBA=ftBA/(AB/100)// angular acceleration of
    AB in m/s^2
28 //=====
29 printf('Angular acceleration of P2B=%0.3f rad/s^2\n
    angular acceleration of AB =%0.3f rad/s^2',

```

alphaBP2 , alphaBA)

Scilab code Exa 1.12 Acceleration of the slider

```
1 //CHAPTER 1 ILLUSRTATION 12 PAGE NO 28
2 //TITLE:Basic kinematics
3 //Figure 1.32(a) ,1.32(b) ,1.32(c)
4 clc
5 clear
6 PI=3.141
7 AB=12// length of link AB in cm
8 BC=48// length of link BC in cm
9 CD=18// length of link CD in cm
10 DE=36// length of link DE in cm
11 EF=12// length of link EF in cm
12 FP=36// length of link FP in cm
13 Nba=200// roating speed of link BA IN rpm
14 wBA=2*PI*200/60// Angular velocity of BA in rad/s
15 Vba=wBA*AB/100// linear velocity of B with
    respect to A in m/s
16 Vc=2.428// velocity of c in m/s from diagram 1.32(
    b)
17 Vd=2.36// velocity of D in m/s from diagram
    1.32(b)
18 Ve=1// velocity of e in m/s from diagram 1.32(b)
19 Vf=1.42// velocity of f in m/s from diagram 1.32(
    b)
20 Vcb=1.3// velocity of c with respect to b in m/s
    from figure
21 fBA=Vba^2*100/AB// radial component of
    acceleration of B with respect to A in m/s^2
22 fCB=Vcb^2*100/BC// radial component of
    acceleration of C with respect to B in m/s^2
23 fcb=3.52// radial component of acceleration
    of C with respect to B in m/s^2 from figure
```

```

24 fC=19//          acceleration of slider in m/s^2
    from figure
25 printf('velocity of c=%0.3f m/s\n velocity of d=%0.3f
    m/s\n velocity of e=%0.3f m/s\n velocity of f=%0.3f
    m/s\n Acceleration of slider=%0f m/s^2',Vc,Vd,Ve,
    Vf,fC)

```

Scilab code Exa 1.13 angular acceleration

```

1 //CHAPTER 1 ILLUSRTATION 13 PAGE NO 30
2 //TITLE:Basic kinematics
3 //Figure 1.33(a),1.33(b),1.33(c)
4 clc
5 clear
6 PI=3.141
7 N=120//          speed of the crank OC in rpm
8 OC=5//           length of link OC in cm
9 cp=20//          length of link CP in cm
10 qa=10//          length of link QA in cm
11 pa=5//           length of link PA in cm
12 CP=46.9//        velocity of link CP in cm/s
13 QA=58.3//        velocity of link QA in cm/s
14 Pa=18.3//        velocity of link PA in cm/s
15 Vc=2*PI*N*OC/60// velocity of C in m/s
16 Cco=Vc^2/OC//    centripetal acceleration of C
    relative to O in cm/s^2
17 Cpc=CP^2/cp//    centripetal acceleration of P
    relative to C in cm/s^2
18 Caq=QA^2/qa//    centripetal acceleration of A
    relative to Q in cm/s^2
19 Cap=Pa^2/pa//    centripetal acceleration of
    A relative to P in cm/s^2
20 pp1=530
21 a1a=323
22 a2a=207.5

```

```
23 ACP=pp1/cp//          angular acceleration of link CP
    in rad/s^2
24 APA=a1a/qa//          angular acceleration of link PA
    in rad/s^2
25 AAQ=a2a/pa//          angular acceleration of link AQ
    in rad/s^2
26 printf('angular acceleration of link CP =%.3f rad/s
    ^2\n angular acceleration of link CP=%.3f rad/s
    ^2\n angular acceleration of link CP=%.3f rad/s^2
    ',ACP,APA,AAQ)
```

Chapter 2

TRANSMISSION OF MOTION AND POWER BY BELTS AND PULLEYS

Scilab code Exa 2.1 finding the diameter of the belt

```
1 //CHAPTER 2 ILLUSRTATION 1 PAGE NO 57
2 //TITLE:TRANSMISSION OF MOTION AND POWER BY BELTS
  AND PULLEYS
3 clc
4 clear
5 //


---


6 //INPUT DATA
7 Na=300; //driving shaft running speed in rpm
8 Nb=400; //driven shaft running speed in rpm
9 Da=60; //diameter of driving shaft in mm
10 t=.8; //belt thickness in mm
11 s=.05; //slip in percentage(5%)
12 //
```

```

13 //calculation
14 Db=(Da*Na)/Nb;//finding out the diameter of driven
    shaft without considering the thickness of belt
15 Db1=((Da+t)*Na)/Nb)-t///considering the thickness
16 Db2=(1-s)*(Da+t)*(Na/Nb)-t//considering slip also
17 //

=====

18 //output
19 printf('the value of Db is %3.0f cm',Db)
20 printf('\nthe value of Db1 is %f cm',Db1)
21 printf('\nthe value of Db2 is %f cm',Db2)

```

Scilab code Exa 2.2 speed of shafts

```

1 //CHAPTER 2,ILLUSRTATION 2 PAGE NO 57
2 //TITLE:TRANSMISSION OF MOTION AND POWER BY BELTS
    AND PULLEYS
3 clc
4 clear
5 //

=====

6 //input
7 n1=1200//rpm of motor shaft
8 d1=40//diameter of motor pulley in cm
9 d2=70//diameter of 1st pulley on the shaft in cm
10 s=.03//percentage slip(3%)
11 d3=45//diameter of 2nd pulley
12 d4=65//diameter of the pulley on the counnter shaft
13 //

=====

14 //calculation
15 n2=n1*d1*(1-s)/d2//rpm of driven shaft

```

```

16 n3=n2//both the pulleys are mounted on the same
    shaft
17 n4=n3*(1-s)*d3/d4//rpm of counter shaft
18
19 //output
20 printf('the speed of driven shaft is %f rpm\nthe
    speed of counter shaft is %f rpm',n2,n4)

```

Scilab code Exa 2.3 length of belt

```

1 //CHAPTER 2 ILLUSTRATION 3 PAGE NO:58
2 //TITLE:TRANSMISSION OF MOTION AND POWER BY BELTS
    AND PULLEYS
3 clc
4 clear
5 //

```

```

6 //input
7 d1=30//diameter of 1st shaft in cm
8 d2=50//diameter 2nd shaft in cm
9 pi=3.141
10 c=500//centre distance between the shafts in cm
11 //

```

```

12 //calculation
13 L1=((d1+d2)*pi/2)+(2*c)+((d1+d2)^2)/(4*c)//lenth of
    cross belt
14 L2=((d1+d2)*pi/2)+(2*c)+((d1-d2)^2)/(4*c)//lenth of
    open belt
15 r=L1-L2//remedy
16 //

```

```

17 //OUTPUT
18 printf('length of cross belt is %3.3fcm \n length of
    open belt is %3.3f cm \n the length of the belt
    to be shortened is %3.0f cm',L1,L2,r)

```

Scilab code Exa 2.4 power required

```

1 //CHAPTER 2,ILLUSTRATION 4 PAGE 59
2 //TITLE:TRANSMISSION OF MOTION AND POWER BY BELTS
  AND PULLEYS
3 clc
4 clear
5 //

```

```

6 //INPUT
7 D1=.5//          DIAMETER OF 1ST SHAFT IN m
8 D2=.25//        DIAMETER OF 2nd SHAFT IN m
9 C=2//           CENTRE DISTANCE IN m
10 N1=220//       SPEED OF 1st SHAFT
11 T1=1250//      TENSION ON TIGHT SIDE IN N
12 U=.25//        COEFFICIENT OF FRICTION
13 PI=3.141
14 e=2.71
15 //

```

```

16 //CALCULATION
17 L=(D1+D2)*PI/2+((D1+D2)^2/(4*C))+2*C
18 F=(D1+D2)/(2*C)
19 ALPHA=asind(F)
20 THETA=(180+(2*ALPHA))*PI/180//    ANGLE OF CONTACT IN
    radians
21 T2=T1/(e^(U*THETA))//            TENSION ON SLACK
    SIDE IN N

```

```

22 V=PI*D1*N1/60 // VELOCITY IN m/s
23 P=(T1-T2)*V/1000 // POWER IN kW
24 //

```

```

25 //OUTPUT
26 printf('\nLENGTH OF BELT REQUIRED =%f m',L)
27 printf('\nANGLE OF CONTACT =%f radians',THETA)
28 printf('\nPOWER CAN BE TRANSMITTED=%f kW',P)

```

Scilab code Exa 2.5 tension in belt

```

1 //CHAPTER 2,ILLUSTRATION 5 PAGE 5
2 //TITLE:TRANSMISSION OF MOTION AND POWER BY BELTS
  AND PULLEYS
3 clc
4 clear
5 //

```

```

6 //input
7 n1=100 // of driving shaft
8 n2=240 //speed of driven shaft
9 p=11000 //power to be transmitted in watts
10 c=250 //centre distance in cm
11 d2=60 //diameter in cm
12 b=11.5*10^-2 //width of belt in metres
13 t=1.2*10^-2 //thickness in metres
14 u=.25 //co-efficient of friction
15 pi=3.141
16 e=2.71
17 //

```

```

18 //calculation for open bely drive

```

```

19 d1=n2*d2/n1
20 f=(d1-d2)/(2*c)//sin(alpha) for open bely drive
21 //angle of arc of contact for open belt drive is ,
    theta=180-2*alpha
22 alpha=asind(f)
23 teta=(180-(2*alpha))*3.147/180//pi/180 is used to
    convert into radians
24 x=(e^(u*teta))//finding out the value of t1/t2
25 v=pi*d2*10*n2/60//finding out the value of t1-t2
26 y=p*1000/(v)
27 t1=(y*x)/(x-1)
28 Fb=t1/(t*b)/1000
29 //

```

```

30 //calculation for cross belt drive bely drive
31 F=(d1+d2)/(2*c)//for cross belt drive bely drive
32 ALPHA=asind(F)
33 THETA=(180+(2*ALPHA))*pi/180//pi/180 is used to
    convert into radians
34 X=(e^(u*THETA))//finding out the value of t1/t2
35 V=pi*d2*10*n2/60//finding out the value of t1-t2
36 Y=p*1000/(V)
37 T1=(Y*X)/(X-1)
38 Fb2=T1/(t*b)/1000
39 //

```

```

40 //output
41 printf('for a open belt drive:\n')
42 printf('the tension in belt is %.3f N\nstress
    induced is %.3f kN/m^2\n',t1,Fb)
43 printf('for a cross belt drive:\n')
44 printf('the tension in belt is %.3f N\nstress
    induced is %.3f kN/m^2\n',T1,Fb2)

```

Scilab code Exa 2.6 width of belt required

```
1 //CHAPTER 2,ILLUSTRATION 6 PAGE 61
2 //TITLE:TRANSMISSION OF MOTION AND POWER BY BELTS
  AND PULLEYS
3 clc
4 clear
5 //


---


6 //INPUT
7 D1=80//DIAMETER OF SHAFT IN cm
8 N1=160//SPEED OF 1ST SHAFT IN rpm
9 N2=320//SPEED OF 2ND SHAFT IN rpm
10 C=250//CENTRE DISTANCE IN CM
11 U=.3//COEFFICIENT OF FRICTION
12 P=4//POWER IN KILO WATTS
13 e=2.71
14 PI=3.141
15 f=110//STRESS PER cm WIDTH OF BELT
16 //


---


17 //CALCULATION
18 V=PI*D1*10^-2*N1/60//VELOCITY IN m/s
19 Y=P*1000/V//Y=T1-T2
20 D2=D1*N1/N2//DIAMETER OF DRIVEN SHAFT
21 F=(D1-D2)/(2*C)
22 ALPHA=asind(F)
23 THETA=(180-(2*ALPHA))*PI/180//ANGLE OF CONTACT IN
  radians
24 X=e^(U*THETA)//VALUE OF T1/T2
25 T1=X*Y/(X-1)
26 b=T1/f//WIDTH OF THE BELT REQUIRED
```

```
27 //
```

```
28 //OUTPUT
```

```
29 printf('THE WIDTH OF THE BELT IS %f cm',b)
```

Scilab code Exa 2.7 power supplied by drum

```
1 //CHAPTER 2 ILLUSRTATION 7 PAGE NO 62
```

```
2 //TITLE:TRANSMISSION OF MOTION AND POWER BY BELTS  
  AND PULLEYS
```

```
3 clc
```

```
4 clear
```

```
5 //
```

```
6 //INPUT DATA
```

```
7 m=1000//           MASS OF THE  
  CASTING IN kg
```

```
8 PI=3.141
```

```
9 THETA=2.75*2*PI//  ANGLE OF  
  CONTACT IN radians
```

```
10 D=.26//           DIAMETER OF  
  DRUM IN m
```

```
11 N=24//            SPEED OF THE  
  DRUM IN rpm
```

```
12 U=.25//           COEFFICIENT OF  
  FRICTION
```

```
13 e=2.71
```

```
14 T1=9810//         TENSION ON  
  TIGHTSIDE IN N
```

```
15 //
```

```
16 //CALCULATION
```

```

17 T2=T1/(e^(U*THETA))//          tension on
    slack side of belt in N
18 W=m*9.81//                     WEIGHT OF
    CASTING IN N
19 R=D/2//                         RADIUS OF DRUM
    IN m
20 P=2*PI*N*W*R/60000//           POWER REQUIRED
    IN kW
21 P2=(T1-T2)*PI*D*N/60000//      POWER
    SUPPLIED BY DRUM IN kW
22 //

```

```

23 //OUTPUT
24 printf('FORCE REQUIRED BY MAN=%f N\n POWER REQUIRED
    TO RAISE CASTING=%f kW\n POWER SUPPLIED BY DRUM=
    %f kW\n',T2,P,P2)

```

Scilab code Exa 2.8 power capacity of belt

```

1 //CHAPTER 2,ILLUSTRATION 8 PAGE 62
2 //TITLE:TRANSMISSION OF MOTION AND POWER BY BELTS
    AND PULLEYS
3 clc
4 clear
5 //INPUT
6 t=9//THICKNESS IN mm
7 b=250//WIDTH IN mm
8 D=90//DIAMETER OF PULLEY IN cm
9 N=336//SPEED IN rpm
10 PI=3.141
11 U=.35//COEFFICIENT FRICTION
12 e=2.71
13 THETA=120*PI/180
14 Fb=2//STRESS IN MPa

```



```

15 d=1000 //DENSITY IN KG/M^3
16
17 //CALCULATION
18 M=b*10^-3*t*10^-3*d //MASS IN KG
19 V=PI*D*10^-2*N/60 //VELOCITY IN m/s
20 Tc=M*V^2 //CENTRIFUGAL TENSION
21 Tmax=b*t*Fb //MAX TENSION IN N
22 T1=Tmax-Tc
23 T2=T1/(e^(U*THETA))
24 P=(T1-T2)*V/1000
25
26 //OUTPUT
27 printf('THE TENSION ON TIGHT SIDE OF THE BELT IS %f
      N\n',T1)
28 printf('THE TENSION ON SLACK SIDE OF THE BELT IS %f
      N\n',T2)
29 printf('CENTRIFUGAL TENSION =%f N\n',Tc)
30 printf('THE POWER CAPACITY OF BELT IS %f KW\n',P)

```

Scilab code Exa 2.9 thickness of belt

```

1 //CHAPTER 2,ILLUSTRATION 9 PAGE 63
2 //TITLE:TRANSMISSION OF MOTION AND POWER BY BELTS
  AND PULLEYS
3 clc
4 clear
5 //INPUT
6 P=35000 //POWER TO BE TRANSMITTED IN WATTS
7 D=1.5 //EFFECTIVE DIAMETER OF PULLEY IN METRES
8 N=300 //SPEED IN rpm
9 e=2.71
10 U=.3 //COEFFICIENT OF FRICTION
11 PI=3.141
12 THETA=(11/24)*360*PI/180 //ANGLE OF CONTACT
13 density=1.1 //density of belt material in Mg/m^3

```

```

14 L=1//in metre
15 t=9.5//THICKNESS OF BELT IN mm
16 Fb=2.5//PERMISSIBLE WORK STRESS IN N/mm^2
17
18 //CALCULATION
19 V=PI*D*N/60//VELOCITY IN m/s
20 X=P/V//X=T1-T2
21 Y=e^(U*THETA)//Y=T1/T2
22 T1=X*Y/(Y-1)
23 Mb=t*density*L/10^3//value of m/b
24 Tc=Mb*V^2//centrifugal tension/b
25 Tmaxb=t*Fb//max tension/b
26 b=T1/(Tmaxb-Tc)//thickness in mm
27 //output
28 printf('\nTENSION IN TIGHT SIDE OF THE BELT =%f N',
        T1)
29 printf('\nTHICKNESS OF THE BELT IS =%f mm',b)

```

Scilab code Exa 2.10 stress developed on tight side of belt

```

1 //CHAPTER 2,ILLUSTRATION 10 PAGE 64
2 //TITLE:TRANSMISSION OF MOTION AND POWER BY BELTS
  AND PULLEYS
3 clc
4 clear
5 //INPUT
6 t=5//THICKNESS OF BELT IN m
7 PI=3.141
8 U=.3
9 e=2.71
10 THETA=155*PI/180//ANGLE OF CONTACT IN radians
11 V=30//VELOCITY IN m/s
12 density=1//in m/cm^3
13 L=1//LENGTH
14

```

```

15 // calculation
16 Xb=80// (T1-T2)=80b;so let (T1-T2)/b=Xb
17 Y=e^(U*THETA)// LET Y=T1/T2
18 Zb=80*Y/(Y-1)// LET T1/b=Zb;BY SOLVING THE ABOVE
    2 EQUATIONS WE WILL GET THIS EXPRESSION
19 Mb=t*L*density*10^-2// m/b in N
20 Tcb=Mb*V^2// centrifugal tension/b
21 Tmaxb=Zb+Tcb// MAX TENSION/b
22 Fb=Tmaxb/t//STRESS INDUCED IN TIGHT BELT
23
24 //OUTPUT
25 printf('THE STRESS DEVELOPED ON THE TIGHT SIDE OF
    BELT=%f N/cm^2 ',Fb)

```

Scilab code Exa 2.11 speed of the pulley

```

1 //CHAPTER 2,ILLUSTRATION 11 PAGE 65
2 //TITLE:TRANSMISSION OF MOTION AND POWER BY BELTS
    AND PULLEYS
3 clc
4 clear
5 //INPUT
6 C=4.5// CENTRE DISTANCE IN metres
7 D1=1.35// DIAMETER OF LARGER PULLEY IN metres
8 D2=.9// DIAMETER OF SMALLER PULLEY IN metres
9 To=2100// INITIAL TENSION IN newtons
10 b=12// WIDTH OF BELT IN cm
11 t=12// THICKNESS OF BELT IN mm
12 d=1// DENSITY IN gm/cm^3
13 U=.3// COEFFICIENT OF FRICTION
14 L=1// length in metres
15 PI=3.141
16 e=2.71
17
18 //CALCULATION

```

```

19 M=b*t*d*L*10^-2//          mass of belt per
    metre length in KG
20 V=(To/3/M)^.5//          VELOCITY OF FOR MAX
    POWER TO BE TRANSMITTED IN m/s
21 Tc=M*V^2//              CENTRIFUGAL TENSION
    IN newtons
22 //                      LET (T1+T2)=X
23 X=2*To-2*Tc //          THE VALUE OF (T1+T2)
24 F=(D1-D2)/(2*C)
25 ALPHA=asind(F)
26 THETA=(180-(2*ALPHA))*PI/180//  ANGLE OF CONTACT IN
    radians
27 //                      LET T1/T2=Y
28 Y=e^(U*THETA)//          THE VALUE OF T1/T2
29 T1=X*Y/(Y+1)//          BY SOLVING X AND Y
    WE WILL GET THIS EQN
30 T2=X-T1
31 P=(T1-T2)*V/1000//          MAX POWER
    TRANSMITTED IN kilowatts
32 N1=V*60/(PI*D1)//          SPEED OF LARGER
    PULLEY IN rpm
33 N2=V*60/(PI*D2)//          SPEED OF SMALLER
    PULLEY IN rpm
34 //OUTPUT
35 printf('\n MAX POWER TO BE TRANSMITTED =%f KW',P)
36 printf('\n SPEED OF THE LARGER PULLEY =%f rpm',N1)
37 printf('\n SPEED OF THE SMALLER PULLEY =%f rpm',N2)

```

Scilab code Exa 2.12 efficiency of drive

```

1 //CHAPTER 2,ILLUSTRATION 12 PAGE 66
2 //TITLE:TRANSMISSION OF MOTION AND POWER BY BELTS
  AND PULLEYS
3 clc
4 clear

```

```

5 //


---


6 //INPUT
7 PI=3.141
8 e=2.71
9 D1=1.20 // DIAMETER OF DRIVING SHAFT IN
   m
10 D2=.50 // DIAMETER OF DRIVEN SHAFT IN
   m
11 C=4 // CENTRE DISTANCE BETWEEN THE
   SHAFTS IN m
12 M=.9 // MASS OF BELT PER METRE
   LENGTH IN kg
13 Tmax=2000 // MAX TENSION IN N
14 U=.3 // COEFFICIENT OF FRICTION
15 N1=200 // SPEED OF DRIVING SHAFT IN
   rpm
16 N2=450 // SPEED OF DRIVEN SHAFT IN rpm
17 //


---


18 //CALCULATION
19 V=PI*D1*N1/60 // VELOCITY OF BELT IN m/s
20 Tc=M*V^2 // CENTRIFUGAL TENSION IN N
21 T1=Tmax-Tc // TENSION ON TIGHTSIDE IN N
22 F=(D1-D2)/(2*C)
23 ALPHA=asind(F)
24 THETA=(180-(2*ALPHA))*PI/180 // ANGLE OF CONTACT IN
   radians
25 T2=T1/(e^(U*THETA)) // TENSION ON SLACK
   SIDE IN N
26 TL=(T1-T2)*D1/2 // TORQUE ON THE SHAFT
   OF LARGER PULLEY IN N-m
27 TS=(T1-T2)*D2/2 // TORQUE ON THE SHAFT
   OF SMALLER PULLEY IN N-m
28 P=(T1-T2)*V/1000 // POWER TRANSMITTED
   IN kW

```

```

29 Pi=2*PI*N1*TL/60000 //          INPUT POWER
30 Po=2*PI*N2*TS/60000 //          OUTPUT POWER
31 P1=Pi-Po //                      POWER LOST DUE TO
    FRICTION IN kW
32 n=Po/Pi*100 //                   EFFICIENCY OF DRIVE
    IN %
33 //

```

```

34 //OUTPUT
35 printf( '\nTORQUE ON LARGER SHAFT =%f N-m', TL)
36 printf( '\nTORQUE ON SMALLER SHAFT =%f N-m', TS)
37 printf( '\nPOWER TRANSMITTED =%f kW', P)
38 printf( '\nPOWER LOST DUE TO FRICTION =%f kW', P1)
39 printf( '\nEFFICIENCY OF DRINE =%f percentage', n)

```

Scilab code Exa 2.13 no of belts required

```

1 //CHAPTER 2,ILLUSTRATION 13 PAGE 67
2 //TITLE:TRANSMISSION OF MOTION AND POWER BY BELTS
    AND PULLEYS
3 clc
4 clear
5 //

```

```

6 //INPUT
7 PI=3.141
8 e=2.71
9 P=90 //                          POWER OF A COMPRESSOR IN
    kW
10 N2=250 //                         SPEED OF DRIVEN SHAFT IN
    rpm
11 N1=750 //                         SPEED OF DRIVER SHAFT IN
    rpm

```

```

12 D2=1// DIAMETER OF DRIVEN SHAFT
    IN m
13 C=1.75// CENTRE DISTANCE IN m
14 V=1600/60// VELOCITY IN m/s
15 a=375// CROSECTIONAL AREA IN mm
    ^2
16 density=1000// BELT DENSITY IN kg/m^3
17 L=1// length to be considered
18 Fb=2.5// STRESSS INDUCED IN MPa
19 beeta=35/2// THE GROOVE ANGLE OF
    PULLEY
20 U=.25// COEFFICIENT OF FRICTION
21 //

```

```

22 //CALCULATION
23 D1=N2*D2/N1// DIAMETER OF DRIVING
    SHAFT IN m
24 m=a*density*10^-6*L// MASS OF THE BELT IN kg
25 Tmax=a*Fb// MAX TENSION IN N
26 Tc=m*V^2// CENTRIFUGAL TENSION IN N
27 T1=Tmax-Tc// TENSION ON TIGHTSIDE OF
    BELT IN N
28 F=(D2-D1)/(2*C)
29 ALPHA=asind(F)
30 THETA=(180-(2*ALPHA))*PI/180// ANGLE OF CONTACT IN
    radians
31 T2=T1/(e^(U*THETA/sind(beeta)))//TENSION ON
    SLACKSIDE IN N
32 P2=(T1-T2)*V/1000// POWER TRANSMITTED
    PER BELT kW
33 N=P/P2// NO OF V-BELTS
34 N3=N+1
35 //

```

```

36 //OUTPUT
37 printf('NO OF BELTS REQUIRED TO TRANSMIT POWER=%f

```

APPROXIMATELY= $\%d \setminus n$ ', N, N3)

Scilab code Exa 2.14 initial rope tension

```
1 //CHAPTER 2,ILLUSTRATION 14 PAGE 68
2 //TITLE:TRANSMISSION OF MOTION AND POWER BY BELTS
  AND PULLEYS
3
4 clc
5 clear
6 //

```

```
7 //INPUT
8 PI=3.141
9 e=2.71
10 P=75//          POWER IN kW
11 D=1.5//        DIAMETER OF PULLEY IN m
12 U=.3//         COEFFICIENT OF FRICTION
13 beeta=45/2//   GROOVE ANGLE
14 THETA=160*PI/180// ANGLE OF CONTACT IN radians
15 m=.6//        MASS OF BELT IN kg/m
16 Tmax=800//    MAX TENSION IN N
17 N=200//       SPEED OF SHAFT IN rpm
18 //

```

```
19 //calculation
20 V=PI*D*N/60//  VELOCITY OF ROPE IN m/s
21 Tc=m*V^2//    CENTRIFUGAL TENSION IN N
22 T1=Tmax-Tc//  TENSION ON TIGHT
  SIDE IN N
23 T2=T1/(e^(U*THETA/sind(beeta)))//TENSION ON
  SLACKSIDE IN N
24 P2=(T1-T2)*V/1000// POWER TRANSMITTED
```



```

    PER BELT kW
25 No=P/P2 //
26 N3=No+1 //
27 To=(T1+T2+Tc*2)/2 //
28 //

NO OF V-BELTS
ROUNDING OFF
INITIAL TENSION



---



29 //OUTPUT
30 printf('NO OF BELTS REQUIRED TO TRANSMIT POWER=%f
    APPROXIMATELY=%d\n',No,N3)
31 printf('INITIAL ROPE TENSION=%f N',To)

```

Chapter 3

FRICTION

Scilab code Exa 3.1 finding out the coefficient of friction

```
1 //CHAPTER 3 ILLUSRTATION 1 PAGE NO 102
2 //TITLE:FRICTION
3 //FIRURE 3.16(a) ,3.16(b)
4 clc
5 clear
6 //


---


7 //INPUT DATA
8 P1=180//          PULL APPLIED TO THE
   BODY IN NEWTONS
9 theta=30//       ANGLE AT WHICH P IS
   ACTING IN DEGREES
10 P2=220//        PUSH APPLIED TO THE
   BODY IN NEWTONS
11 //Rn=           NORMAL REACTION
12 //F=            FORCE OF FRICTION IN
   NEWTONS
13 //U=            COEFFICIENT OF
   FRICTION
14 //W=            WEIGHT OF THE BODY
```

```

15 //      IN NEWTON


---


16 //CALCULATION
17 F1=P1*cosd(theta) //      RESOLVING FORCES
      HORIZONTALLY FROM 3.16(a)
18 F2=P2*cosd(theta) //      RESOLVING FORCES
      HORIZONTALLY FROM 3.16(b)
19 //      RESOLVING FORCES
      VERTICALLY Rn1=W-P1*sind(theta) from 3.16(a)
20 //      RESOLVING FORCES
      VERTICALLY Rn2=W+P1*sind(theta) from 3.16(b)
21 //      USING THE RELATION
      F1=U*Rn1 & F2=U*Rn2 AND SOLVING FOR W BY
      DIVIDING THESE TWO EQUATIONS
22 X=F1/F2 //      THIS IS THE VALUE
      OF Rn1/Rn2
23 Y1=P1*sind(theta)
24 Y2=P2*sind(theta)
25 W=(Y2*X+Y1)/(1-X) //      BY SOLVING ABOVE
      3 EQUATIONS
26 U=F1/(W-P1*sind(theta)) //      COEFFICIENT OF
      FRICTION
27 //


---


28 //OUTPUT
29 printf('WEIGHT OF THE BODY =%.3 fN\nTHE COEFFICIENT
      OF FRICTION =%.3 f ',W,U)

```

Scilab code Exa 3.2 DISTANCE ALONG THE INCLINED PLANE

```

1 //CHAPTER 3 ILLUSTRATION 2 PAGE NO 103
2 //TITLE:FRICTION

```

```

3 //FIRURE 3.17
4 clc
5 clear
6 //

```

```

7 //INPUT DATA
8 THETA=45 //          ANGLE OF INCLINATION IN
   DEGREES
9 g=9.81 //          ACCELERATION DUE TO
   GRAVITY IN N/mm^2
10 U=.1 //          COEFFICIENT FRICTION
11 //Rn=NORMAL REACTION
12 //M=MASS IN NEWTONS
13 //f=ACCELERATION OF THE BODY
14 u=0 //          INITIAL VELOCITY
15 V=10 //          FINAL VELOCITY IN m/s^2
16 //

```

```

17 //CALCULATION
18 //CONSIDER THE EQUILIBRIUM OF FORCES PERPENDICULAR
   TO THE PLANE
19 //Rn=Mgcos(THETA)
20 //CONSIDER THE EQUILIBRIUM OF FORCES ALONG THE PLANE
21 //Mgsin(THETA)-U*Rn=M*f .....BY SOLVING THESE
   2 EQUATIONS
22 f=g*sind(THETA)-U*g*cosd(THETA)
23 s=(V^2-u^2)/(2*f) //          DISTANCE ALONG
   THE PLANE IN metres
24 //

```

```

25 //OUTPUT
26 printf('DISTANCE ALONG THE INCLINED PLANE=%3.3 f m',s
   )

```

Scilab code Exa 3.3 workdone

```
1 //CHAPTER 3 ILLUSRTATION 3 PAGE NO 104
2 //TITLE: FRICTION
3 //FIRURE 3.18
4 clc
5 clear
6 //


---


7 //INPUT DATA
8 W=500 // WEGHT IN NEWTONS
9 THETA=30 // ANGLE OF INCLINATION IN
    DEGRESS
10 U=0.2 // COEFFICIENT FRICTION
11 S=15 // DISTANCE IN metres
12 //


---


13 Rn=W*cosd(THETA) // NORMAL REACTION IN NEWTONS
14 P=W*sind(THETA)+U*Rn // PUSHING FORCE ALONG THE
    DIRECTION OF MOTION
15 w=P*S
16 //


---


17 //OUTPUT
18 printf('WORK DONE BY THE FORCE=%3.3 f N-m', w)
```

Scilab code Exa 3.4 FINDING OUT COEFFICIENT OF FRICTION

```
1 //CHAPTER 3 ILLUSRTATION 4 PAGE NO 104
```

```

2 //TITLE: FRICTION
3 //FIGURE 3.19(a) & 3.19(b)
4 clc
5 clear
6 //

```

```

7 //INPUT DATA
8 P1=2000//          FORCE ACTING UPWARDS WHEN ANGLE
   =15 degrees IN NEWTONS
9 P2=2300//          FORCE ACTING UPWARDS WHEN ANGLE
   =20 degrees IN NEWTONS
10 THETA1=15//       ANGLE OF INCLINATION IN 3.19(a)
11 THETA2=20//       ANGLE OF INCLINATION IN 3.19(b)
12 //F1=             FORCE OF FRICTION IN 3.19(a)
13 //Rn1=            NORMAL REACTION IN 3.19(a)
14 //F2=             FORCE OF FRICTION IN 3.19(b)
15 //Rn2=            NORMAL REACTION IN 3.19(b)
16 //U=              COEFFICIENT OF FRICTION
17 //

```

```

18 //CALCULATION
19 //P1=F1+Rn1        RESOLVING THE FORCES ALONG
   THE PLANE
20 //Rn1=W*cosd(THETA1) . . . .NORMAL REACTION IN 3.19(a)
21 //F1=U*Rn1
22 //BY SOLVING ABOVE EQUATIONS P1=W(U*cosd(THETA1)+
   sind(THETA1))-----1
23 //P2=F2+Rn2        RESOLVING THE FORCES
   PERPENDICULAR TO THE PLANE
24 //Rn2=W*cosd(THETA2) . . . .NORMAL REACTION IN 3.19(b)
25 //F2=U*Rn2
26 //BY SOLVING ABOVE EQUATIONS P2=W(U*cosd(THETA2)+
   sind(THETA2))-----2
27 //BY SOLVING EQUATIONS 1 AND 2
28 X=P2/P1
29 U=(sind(THETA2)-(X*sind(THETA1)))/((X*cosd(THETA1))-

```

```

        cosd(THETA2))) //          COEFFICIENT OF FRICTION
30 W=P1/(U*cosd(THETA1)+sind(THETA1))
31 //

```

```

32 //OUTPUT
33 // printf( '%f' ,X)
34 printf( 'COEFFICIENT OF FRICTION=%3.3 f\n WEIGHT OF
        THE BODY=%3.3 f N' ,U,W)

```

Scilab code Exa 3.5 EFFORT NEED TO APPLIED

```

1 //CHAPTER 3 ILLUSRTATION 5 PAGE NO 105
2 //TITLE: FRICTION
3 clc
4 clear
5 //

```

```

6 //INPUT DATA
7 d=5 //          DIAMETER OF SCREW JACK IN
        cm
8 p=1.25 //      PITCH IN cm
9 l=50 //        LENGTH IN cm
10 U=.1 //        COEFFICIENT OF FRICTION
11 W=20000 //     LOAD IN NEWTONS
12 PI=3.147
13 //

```

```

14 //CALCULATION
15 ALPHA=atand(p/(PI*d))
16 PY=atand(U)
17 P=W*tand(ALPHA+PY)
18 P1=P*d/(2*l)

```

```

19 //
20 //OUTPUT
21 printf('THE AMOUNT OF EFFORT NEED TO APPLY =%3.3 f N'
        ,P1)

```

Scilab code Exa 3.6 EFFICIENCY OF THE MACHINE

```

1 //CHAPTER 3 ILLUSRTATION 6 PAGE NO 106
2 //TITLE: FRICTION
3 clc
4 clear
5 //
6 //INPUT DATA
7 d=50// DIAMETER OF SCREW IN mm
8 p=12.5// PITCH IN mm
9 U=0.13// COEFFICIENT OF FRICTION
10 W=25000// LOAD IN mm
11 PI=3.147
12 //
13 //CALCULATION
14 ALPHA=atand(p/(PI*d))
15 PY=atand(U)
16 P=W*tand(ALPHA+PY)// FORCE REQUIRED TO RAISE
    THE LOAD IN N
17 T1=P*d/2// TORQUE REQUIRED IN Nm
18 P1=W*tand(PY-ALPHA)// FORCE REQUIRED TO LOWER
    THE SCREW IN N
19 T2=P1*d/2// TORQUE IN N
20 X=T1/T2// RATIOS REQUIRED

```

```

21 n=tand(ALPHA/(ALPHA+PY)) // EFFICIENCY
22 //

```

```

23 printf('RATIO OF THE TORQUE REQUIRED TO RAISE THE
LOAD, TO THE TORQUE REQUIRED TO LOWER THE LOAD =%
.3 f ', X)

```

Scilab code Exa 3.7 EFFICIENCY OF MACHINE

```

1 //CHAPTER 3 ILLUSRTATION 7 PAGE NO 107
2 //TITLE: FRICTION
3 clc
4 clear
5 //

```

```

6 //INPUT DATA
7 d=39 // DIAMETER OF THREAD IN mm
8 p=13 // PITCH IN mm
9 U=0.1 // COEFFICIENT OF FRICTION
10 W=2500 // LOAD IN mm
11 PI=3.147
12 //

```

```

13 //CALCULATION
14 ALPHA=atand(p/(PI*d))
15 PY=atand(U)
16 P=W*tand(ALPHA+PY) // FORCE IN N
17 T1=P*d/2 // TORQUE REQUIRED IN Nm
18 T=2*T1 // TORQUE REQUIRED ON THE
COUPLING ROD IN Nm
19 K=2*p // DISTANCE TRAVELLED FOR
ONE REVOLUTION

```

```

20 N=20.8/K//          NO OF REVOLUTIONS
    REQUIRED
21 w=2*PI*N*T/100//    WORKDONE BY TORQUE
22 w1=w*(7500-2500)/2500//    WORKDONE TO INCREASE
    THE LOAD FROM 2500N TO 7500N
23 n=tand(ALPHA)/tand(ALPHA+PY)//    EFFICIENCY
24 //

```

```

25 //OUTPUT
26 printf('workdone against a steady load of 2500N=%3.3
    f N\n workdone if the load is increased from 2500
    N to 7500N=%3.3f N\n efficiency=%0.3f ',w,w1,n)

```

Scilab code Exa 3.8 NO OF TEETH ON PINION

```

1 //CHAPTER 3 ILLUSRTATION 8 PAGE NO 107
2 //TITLE: FRICTION
3 clc
4 clear
5 //

```

```

6 //INPUT DATA
7 W=50000//          WEIGHT OF THE
    SLUICE GATE IN NEWTON
8 P=40000//          POWER IN WATIS
9 N=580//            MAX MOTOR RUNNING
    SPEEED IN rpm
10 d=12.5//          DIAMETER OF THE
    SCREW IN cm
11 p=2.5//           PITCH IN cm
12 PI=3.147
13 U1=.08//          COEFFICIENT OF
    FRICTION for SCREW

```

```

14 U2=.1 // C.O.F BETWEEN
    GATES AND SCREW
15 Np=2000000 // NORMAL PRESSURE IN
    NEWTON
16 F1=.15 // FRICTION LOSS
17 n=1-F1 // EFFICIENCY
18 ng=80 // NO OF TEETH ON GEAR
19 //

```

```

20 //CALCULATION
21 TV=W+U2*Np // TOTAL VERTICAL HEAD
    IN NEWTON
22 ALPHA=atand(p/(PI*d)) //
23 PY=atand(U1) //
24 P1=TV*tand(ALPHA+PY) // FORCE IN N
25 T=P1*d/2/100 // TORQUE IN N-m
26 Ng=60000*n*P*10^-3/(2*PI*T) // SPEED OF
    GEAR IN rpm
27 np=Ng*ng/N // NO OF TEETH ON
    PINION
28 //

```

```

29 //OUTPUT
30 printf('NO OF TEETH ON PINION =%.2f say %d',np,np+1)

```

Scilab code Exa 3.9 TO FIND THE DIAMETER OF HAND WHEEL

```

1 //CHAPTER 3 ILLUSRTATION 9 PAGE NO 108
2 //TITLE: FRICTION
3 clc
4 clear
5 //

```

```

6 //INPUT DATA
7 d=5// MEAN DIAMETER OF SCREW
   IN cm
8 p=1.25// PITCH IN cm
9 W=10000// LOAD AVAILABLE IN
   NEWTONS
10 dc=6// MEAN DIAMETER OF
   COLLAR IN cm
11 U=.15// COEFFICIENT OF
   FRICTION OF SCREW
12 Uc=.18// COEFFICIENT OF
   FRICTION OF COLLAR
13 P1=100// TANGENTIAL FORCE
   APPLIED IN NEWTON
14 PI=3.147
15 //

```

```

16 //CALCULATION
17 ALPHA=atand(p/(PI*d))//
18 PY=atand(U)//
19 T1=W*d/2*tand(ALPHA+PY)/100// TORQUE ON
   SCREW IN NEWTON
20 Tc=Uc*W*dc/2/100// TORQUE ON
   COLLAR IN NEWTON
21 T=T1+Tc// TOTAL TORQUE
22 D=2*T/P1/2*100// DIAMETER OF
   HAND WHEEL IN cm
23 //

```

```

24 //OUTPUT
25 printf('SUITABLE DIAMETER OF HAND WHEEL =%3.3 f cm',D
   )

```

Scilab code Exa 3.10 FORCE REQUIRED

```
1 //CHAPTER 3 ILLUSRTATION 10 PAGE NO 108
2 //TITLE: FRICTION
3 clc
4 clear
5 //

```

```
6 //INPUT DATA
7 PI=3.147
8 d=2.5 // MEAN DIA OF BOLT IN cm
9 p=.6 // PITCH IN cm
10 beeta=55/2 // VEE ANGLE
11 dc=4 // DIA OF COLLAR IN cm
12 U=.1 // COEFFICIENT OF FRICTION
    OF BOLT
13 Uc=.18 // COEFFICIENT OF
    FRICTION OF COLLAR
14 W=6500 // LOAD ON BOLT IN NEWTONS
15 L=38 // LENGTH OF SPANNER
16 //

```

```
17 //CALCULATION
18 //LET X=tan(py)/tan(beeta)
19 //y=tan(ALPHA)*X
20 PY=atand(U)
21 ALPHA=atand(p/(PI*d))
22 X=tand(PY)/cosd(beeta)
23 Y=tand(ALPHA)
24 T1=W*d/2*10^-2*(X+Y)/(1-(X*Y)) // TORQUE
    IN SCREW IN N-m
25 Tc=Uc*W*dc/2*10^-2 // TORQUE

```

```

    ON BEARING SERVICES IN N-m
26 T=T1+Tc//                                TOTAL
    TORQUE
27 P1=T/L*100//
    FORCE REQUIRED BY @ THE END OF SPANNER
28 //

```

```

29 //OUTPUT
30 printf('FORCE REQUIRED @ THE END OF SPANNER=%3.3 f N'
    ,P1)

```

Scilab code Exa 3.11 POWER LOST IN FRICTION

```

1 //CHAPTER 3 ILLUSRTATION 11 PAGE NO 109
2 //TITLE: FRICTION
3 clc
4 clear
5 //

```

```

6 //INPUT DATA
7 d1=15//                                DIAMETER OF
    VERTICAL SHAFT IN cm
8 N=100//                                SPEED OF THE
    MOTOR rpm
9 W=20000//                                LOAD
    AVILABLE IN N
10 U=.05//                                COEFFICIENT
    OF FRICTION
11 PI=3.147
12 //

```

```

13 T=2/3*U*W*d1/2//                                FRICTIONAL

```

```

    TORQUE IN N-m
14 PL=2*PI*N*T/100/60//          POWER
    LOST IN FRICTION IN WATTS
15 //

```

```

16 //OUTPUT
17 printf('POWER LOST IN FRICTION=%3.3 f watts ',PL)

```

Scilab code Exa 3.12 NO OF COLLARS REQUIRED

```

1 //CHAPTER 3 ILLUSRTATION 12 PAGE NO 109
2 //TITLE:FRICTION
3 clc
4 clear
5 //

```

```

6 //INPUT DATA
7 PI=3.147
8 d2=.30//          DIAMETER OF
    SHAFT IN m
9 W=200000//        LOAD AVAILABLE
    IN NEWTONS
10 N=75//           SPEED IN rpm
11 U=.05//          COEFFICIENT OF
    FRICTION
12 p=300000//        PRESSURE
    AVAILABLE IN N/m^2
13 P=16200//         POWER LOST DUE
    TO FRICTION IN WATTS
14 //

```

```

15 //CaLCULATION

```

```

16 T=P*60/2/PI/N//          TORQUE INDUCED
    IN THE SHFT IN N-m
17 //LET X=(r1^3-r2^3)/(r1^2-r2^2)
18 X=(3/2*T/U/W)
19 r2=.15//          SINCE d2=.30 m
20 c=r2^2-(X*r2)
21 b= r2-X
22 a= 1
23 r1=( -b+ sqrt (b^2 -4*a*c ))/(2* a);//          VALUE OF
    r1 IN m
24 d1=2*r1*100//          d1 IN cm
25 n=W/(PI*p*(r1^2-r2^2))
26 //

```

```

27 //OUTPUT
28 printf( '\nEXTERNAL DIAMETER OF SHAFT =%3.3 f cm\nNO
    OF COLLARS REQUIRED =%.3 f or %.0 f ', d1 ,n, n+1)

```

Scilab code Exa 3.13 POWER ABSORBED IN FRICTION

```

1 //CHAPTER 3 ILLUSRTATION 13 PAGE NO 111
2 //TITLE:FRICTION
3 clc
4 clear
5 //

```

```

6 //INPUT DATA
7 PI=3.147
8 W=20000//          LOAD IN
    NEWTONS
9 ALPHA=120/2//          CONE
    ANGLE IN DEGREES
10 p=350000//          INTENSITY

```



```

        OF PRESSURE
11 U=.06
12 N=120//                                SPEED OF
        THE SHAFT IN rpm
13 //d1=3d2
14 //r1=3r2
15 //

```

```

16 //CALCULATION
17 //LET K=d1/d2
18 k=3
19 Z=W/((k^2-1)*PI*p)
20 r2=Z^.5//                                INTERNAL
        RADIUS IN m
21 r1=3*r2
22 T=2*U*W*(r1^3-r2^3)/(3*sind(60)*(r1^2-r2^2))//
        total frictional torque in N
23 P=2*PI*N*T/60000//                        power
        absorbed in friction in kW
24 //

```

```

25 printf('\nTHE INTERNAL DIAMETER OF SHAFT =%3.3 f cm\
        nTHE EXTERNAL DIAMETER OF SHAFT =%3.3 f cm\nPOWER
        ABSORBED IN FRICTION =%.3 f kW',r2*100,r1*100,P)

```

Scilab code Exa 3.14 FINDING Radii

```

1 //CHAPTER 3 ILLUSRTATION 14 PAGE NO 111
2 //TITLE: FRICTION
3 clc
4 clear
5 //

```

```

6 //INPUT DATA
7 PI=3.147
8 P=10000// POWER
   TRRANSMITTED BY CLUTCH IN WATTS
9 N=3000// SPEED IN rpm
10 p=.09// AXIAL
   PRESSURE IN N/mm^2
11 //d1=1.4d2 RELATION
   BETWEEN DIAMETERS
12 K=1.4// D1/D2
13 n=2
14 U=.3// COEFFICIENT
   OF FRICTION
15 //

=====

16 T=P*60000/1000/(2*PI*N)//
   ASSUMING UNIFORM WEAR TORQUE IN N-m
17 r2=(T*2/(n*U*2*PI*p*10^6*(K-1)*(K+1)))^(1/3)//
   INTERNAL RADIUS
18
19 //

=====

20 printf('THE INTERNAL RADIUS =%f cm\n THE EXTERNAL
   RADIUS =%f cm',r2*100,K*r2*100)

```

Scilab code Exa 3.15 MAX AXIAL INTENSITY OF PRESSURE

```

1 //CHAPTER 3 ILLUSRTATION 14 PAGE NO 111
2 //TITLE: FRICTION
3 clc
4 //
5 clear

```

```

6 //


---


7 //INPUT DATA
8 PI=3.147
9 n1=3// NO OF DICS ON
    DRIVING SHAFTS
10 n2=2// NO OF DICS ON DRIVEN
    SHAFTS
11 d1=30// DIAMETER OF DRIVING
    SHAFT IN cm
12 d2=15// DIAMETER OF DRIVEN
    SHAFT IN cm
13 r1=d1/2
14 r2=d2/2
15 U=.3// COEFFICIENT FRICTION
16 P=30000// TRANSMITTING POWER IN
    WATTS
17 N=1800// SPEED IN rpm
18 //


---


19 //CALCULATION
20 n=n1+n2-1// NO OF PAIRS OF
    CONTACT SURFACES
21 T=P*60000/(2*PI*N)// TORQUE IN N-m
22 W=2*T/(n*U*(r1+r2)*10)// LOAD IN N
23 k=W/(2*PI*(r1-r2))
24 p=k/r2/100// MAX AXIAL
    INTENSITY OF PRESSURE IN N/mm^2
25 //


---


26 // OUTPUT
27 printf('MAX AXIAL INTENSITY OF PRESSURE =%f N/mm^2 ',
    p)

```

Chapter 4

Gears and Gear Drivers

Scilab code Exa 4.1 Length of arc of contact

```
1 //Chapter-4, Illustration 1, Page 133
2 //Title: Gears and Gear Drivers
3 //


---


4 clc
5 clear
6
7 //INPUT DATA
8 TA=48; //Wheel A teeth
9 TB=30; //Wheel B teeth
10 m=5; //Module pitch in mm
11 phi=20; //Pressure angle in degrees
12 add=m; //Addendum in mm
13
14 //CALCULATIONS
15 R=(m*TA)/2; //Pitch circle radius of wheel A in mm
16 RA=R+add; //Radius of addendum circle of wheel A in
    mm
17 r=(m*TB)/2; //Pitch circle radius of wheel B in mm
18 rA=r+add; //Radius of addendum circle of wheel B in
```

```

mm
19 lp=(sqrt((RA^2)-((R^2)*(cosd(phi)^2))))+(sqrt((rA^2)
    -((r^2)*(cosd(phi)^2))))-((R+r)*sind(phi));//
    Length of path of contact in mm
20 la=lp/cosd(phi);//Length of arc of contact in mm
21
22 //OUTPUT
23 mprintf('Length of arc of contact is %3.1f mm',la)
24
25
26
27
28
29
30
31
32 //=====END OF PROGRAM
    =====

```

Scilab code Exa 4.2 Addendum of wheel

```

1 //Chapter-4, Illustration 2, Page 133
2 //Title: Gears and Gear Drivers
3 //
    =====

4 clc
5 clear
6
7 //INPUT DATA
8 TA=40;//Wheel A teeth
9 TB=TA;//Wheel B teeth
10 m=6;//Module pitch in mm
11 phi=20;//Pressure angle in degrees
12 pi=3.141

```

```

13 x=1.75; //Ratio of length of arc of contact to
    circular pitch
14
15 //CALCULATIONS
16 Cp=m*pi; //Circular pitch in mm
17 R=(m*TA)/2; //Pitch circle radius of wheel A in mm
18 r=R; //Pitch circle radius of wheel B in mm
19 la=x*Cp; //Length of arc of contact in mm
20 lp=la*cosd(phi); //Length of path of contact in mm
21 RA=sqrt((((lp/2)+(R*sind(phi)))^2)+((R^2)*(cosd(phi)
    )^2)); //Radius of addendum circle of each wheel
    in mm
22 add=RA-R; //Addendum in mm
23
24 //OUTPUT
25 mprintf('Addendum of wheel is %3.3f mm',add)
26
27
28
29
30
31
32
33
34
35 //=====END OF PROGRAM
    =====

```

Scilab code Exa 4.3 Length of arc of contact

```

1 //Chapter-4, Illustration 3, Page 134
2 //Title: Gears and Gear Drivers
3 //

```

```

4  clc
5  clear
6
7  //INPUT DATA
8  TA=48; //Gear teeth
9  TB=24; //Pinion teeth
10 m=6; //Module in mm
11 phi=20; //Pressure angle in degrees
12
13 //CALCULATIONS
14 r=(m*TB)/2; //Pitch circle radius of pinion in mm
15 R=(m*TA)/2; //Pitch circle radius of gear in mm
16 RA=sqrt((((r*sind(phi))/2)+(R*sind(phi)))^2)+((R^2)
    *(cosd(phi))^2)); //Radius of addendum circle of
    gear in mm
17 rA=sqrt((((R*sind(phi))/2)+(r*sind(phi)))^2)+((r^2)
    *(cosd(phi))^2)); //Radius of addendum circle of
    pinion in mm
18 addp=rA-r; //Addendum for pinion in mm
19 addg=RA-R; //Addendum for gear in mm
20 lp=((R+r)*sind(phi))/2; //Length of path of contact
    in mm
21 la=lp/cosd(phi); //Length of arc of contact in mm
22
23 //OUTPUT
24 mprintf('Addendum for pinion is %3.3f mm \n Addendum
    for gear is %3.2f mm \n Length of arc of contact
    is %3.3f mm',addp,addg,la)
25
26
27
28
29
30
31
32
33
34

```

```
35 //=====END OF PROGRAM
```

Scilab code Exa 4.4 Velocity ratio

```
1 //Chapter-4, Illustration 4, Page 135
2 //Title: Gears and Gear Drivers
3 //
4 clc
5 clear
6
7 //INPUT DATA
8 x=3.5; //Ratio of teeth of wheels
9 C=1.2; //Centre distance between axes in m
10 DP=4.4; //Diametrical pitch in cm
11
12 //CALCULATIONS
13 D=2*C*100; //Sum of diameters of wheels in cm
14 T=D*DP; //Sum of teeth of wheels
15 TB1=T/(x+1); //Teeth of wheel B
16 TB=floor(TB1); //Teeth of whhel B
17 TA=x*TB; //Teeth of wheel A
18 DA=TA/DP; //Diametral pitch of gear A in cm
19 DB=TB/DP; //Diametral pitch of gear B in cm
20 Ce=(DA+DB)/2; //Exact centre distance between shafts
    in cm
21 TB2=ceil(TB1); //Teeth of wheel B
22 TA2=T-TB2; //Teeth of wheel A
23 VR=TA2/TB2; //Velocity ratio
24
25 //OUTPUT
26 mprintf('Number of teeth on wheel A is %3.0f \n
    Number of teeth on wheel B is %3.0f \n Exact
```



```

    centre distance is %3.3f cm \n If centre distance
    is %3.1f m then \n Velocity ratio is %3.4f',TA,
    TB,Ce,C,VR)
27
28
29
30
31
32
33
34
35 //=====END OF PROGRAM
    =====

```

Scilab code Exa 4.5 Power transmitted

```

1 //Chapter-4, Illustration 5, Page 136
2 //Title: Gears and Gear Drivers
3 //
    =====

4 clc
5 clear
6
7 //INPUT DATA
8 C=600;//Distance between shafts in mm
9 Cp=30;//Circular pitch in mm
10 NA=200;//Speed of wheel A in rpm
11 NB=600;//Speed of wheel B in rpm
12 F=18;//Tangential pressure in kN
13 pi=3.141
14
15 //CALCULATIONS
16 a=Cp/(pi*10);//Ratio of pitch diameter of wheel A to
    teeth of wheel A in cm

```

```

17 b=Cp/(pi*10); //Ratio of pitch diameter of wheel B to
    teeth of wheel B in cm
18 T=(2*C)/(a*10); //Sum of teeth of wheels
19 r=NB/NA; //Ratio of teeth of wheels
20 TB=T/(r+1); //Teeth of wheel B
21 TB1=ceil(TB); //Teeth of wheel B
22 TA=TB1*r; //Teeth of wheel A
23 DA=a*TA; //Pitch diameter of wheel A in cm
24 DB=b*TB1; //Pitch diameter of wheel B in cm
25 CPA=(pi*DA)/TA; //Circular pitch of gear A in cm
26 CPB=(pi*DB)/TB1; //Circular pitch of gear B in cm
27 C1=(DA+DB)*10/2; //Exact centre distance in mm
28 P=(F*1000*pi*DA*NA)/(60*1000*100); //Power
    transmitted in kW
29
30 //OUTPUT
31 fprintf('Number of teeth on wheel A is %3.0f \n
    Number of teeth on wheel B is %3.0f \n Pitch
    diameter of wheel A is %3.2f cm \n Pitch diameter
    of wheel B is %3.3f cm \n Circular pitch of
    wheel A is %3.4f cm \n Circular pitch of wheel B
    is %3.4f cm \n Exact centre distance between
    shafts is %3.2f mm \n Power transmitted is %3.3f
    kW', TA, TB1, DA, DB, CPA, CPB, C1, P)
32
33
34
35
36
37
38
39
40 //=====END OF PROGRAM
    =====

```

Scilab code Exa 4.6 Number of teeth on gear

```
1 //Chapter-4, Illustration 6, Page 137
2 //Title: Gears and Gear Drivers
3 //


---


4 clc
5 clear
6
7 //INPUT DATA
8 r=16; //Speed ratio
9 mA=4; //Module of gear A in mm
10 mB=mA; //Module of gear B in mm
11 mC=2.5; //Module of gear C in mm
12 mD=mC; //Module of gear D in mm
13 C=150; //Distance between shafts in mm
14
15 //CALCULATIONS
16 t=sqrt(r); //Ratio of teeth
17 T1=(C*2)/mA; //Sum of teeth of wheels A and B
18 T2=(C*2)/mC; //Sum of teeth of wheels C and D
19 TA=T1/(t+1); //Teeth of gear A
20 TB=T1-TA; //Teeth of gear B
21 TC=T2/(t+1); //Teeth of gear C
22 TD=T2-TC; //Teeth of gear D
23
24 //OUTPUT
25 mprintf('Number of teeth on gear A is %3.0f \n
    Number of teeth on gear B is %3.0f \n Number of
    teeth on gear C is %3.0f \n Number of teeth on
    gear D is %3.0f',TA,TB,TC,TD)
26
27
28
29
30
31
```

```

32
33
34
35 //=====END OF PROGRAM
=====

```

Scilab code Exa 4.7 noof teeth on gears

```

1 //Chapter-4, Illustration 7, Page 138
2 //Title: Gears and Gear Drivers
3 //
=====

4 clc
5 clear
6
7 //INPUT DATA
8 N=4.5; //No. of turns
9
10 //CALCULATIONS
11 Vh=N/2; //Velocity ratio of main spring spindle to
    hour hand spindle
12 Vm=12; //Velocity ratio of minute hand spindle to
    hour hand spindle
13 T1=8// assumed no of teeth on gear 1
14 T2=32// assumed no of teeth on gear 2
15 T3=(T1+T2)/4// no of teeth on gear 3
16 T4=(T1+T2)-T3// no of teeth on gear 4
17 printf('no of teeth on gear 1=%d\n no of teeth on
    gear 2=%d\n no of teeth on gear 3=%d\n no of
    teeth on gear 4=%d',T1,T2,T3,T4)

```

Scilab code Exa 4.8 Speed of wheel

```

1 //Chapter-4, Illustration 8, Page 139
2 //Title: Gears and Gear Drivers
3 //

```

```

4 clc
5 clear
6
7 //Input data
8 Tb=70; //Teeth of wheel B
9 Tc=25; //Teeth of wheel C
10 Td=80; //Teeth of wheel D
11 Na=-100; //Speed of arm A in clockwise in rpm
12 y=-100 //Arm A rotates at 100 rpm clockwise
13
14 //Calculations
15 Te=(Tc+Td-Tb); //Teeth of wheel E
16 x=(y/0.5)
17 Nc=(y-(Td*x)/Tc); //Speed of wheel C in rpm
18
19 //Output
20 mprintf('Speed of wheel C is %3.0f rpm \n Direction
    of wheel C is anti-clockwise ',Nc)
21
22
23
24
25
26
27
28
29
30 //=====END OF PROGRAM

```

Scilab code Exa 4.9 Speed of wheels

```
1 //Chapter-4, Illustration 9, Page 140
2 //Title: Gears and Gear Drivers
3 //


---


4 clc
5 clear
6
7 //Input data
8 Tb=25; //Teeth of wheel B
9 Tc=40; //Teeth of wheel C
10 Td=10; //Teeth of wheel D
11 Te=25; //Teeth of wheel E
12 Tf=30; //Teeth of wheel F
13 y=-120; //Speed of arm A in clockwise in rpm
14
15 //Calculations
16 x=(-y/4)
17 Nb=x+y; //Speed of wheel B in rpm
18 Nf=(-10/3)*x+y; //Speed of wheel F in rpm
19
20 //Output
21 mprintf('Speed of wheel B is %3.0f rpm \n Direction
    of wheel B is clockwise \n Speed of wheel F is %3
    .0f rpm \n Direction of wheel F is clockwise ',Nb,
    Nf)
22
23
24
25
26
27
28
29
30 //=====END OF PROGRAM


---


```

Scilab code Exa 4.10 Speed of wheels

```
1 //Chapter-4, Illustration 10, Page 141
2 //Title: Gears and Gear Drivers
3 //


---


4 clc
5 clear
6
7 //Input data
8 Ta=96; //Teeth of wheel A
9 Tc=48; //Teeth of wheel C
10 y=-20; //Speed of arm C in rpm in clockwise
11
12 //Calculations
13 x=(y*Ta)/Tc
14 Tb=(Ta-Tc)/2; //Teeth of wheel B
15 Nb=(-Tc/Tb)*x+y; //Speed of wheel B in rpm
16 Nc=x+y; //Speed of wheel C in rpm
17
18 //Output
19 mprintf('Speed of wheel B is %3.0f rpm \n Speed of
    wheel C is %3.0f rpm',Nb,Nc)
20
21
22
23
24
25
26
27
28
29 //=====END OF PROGRAM
```

Scilab code Exa 4.11 speed of the arm

```
1 //Chapter-4, Illustration 11, Page 142
2 //Title: Gears and Gear Drivers
3 //
4 clc
5 clear
6 //Input data
7 Ta=40//          no of teeth on gear A
8 Td=90//          no of teeth on gear D
9
10 //Calculations
11 Tb=(Td-Ta)/2//   no of teeth on gear B
12 Tc=Tb//          no of teeth on gear C
13 //
14 //x+y=-1
15 //-40x+90y=45
16 A=[1 1
17     -Ta Td]//Coefficient matrix
18 B=[-1
19     (Td/2)]//Constant matrix
20 X=inv(A)*B//Variable matrix
21 //
22 //x+y=-1
23 //-40x+90y=0
24 A1=[1 1
25     -Ta Td]//Coefficient matrix
26 B1=[-1
27     0]//Constant matrix
28 X1=inv(A1)*B1//Variable matrix
29
```



```

30 disp(X(2))
31 printf('speed of the arm = %.3f revolution clockwise
        ',X1(2))

```

Scilab code Exa 4.12 Speed of wheel

```

1 //Chapter-4, Illustration 12, Page 144
2 //Title: Gears and Gear Drivers
3 //

```

```

4 clc
5 clear
6
7 //Input data
8 Te=30; //Teeth of wheel E
9 Tb=24; //Teeth of wheel B
10 Tc=22; //Teeth of wheel C
11 Td=70; //Teeth of wheel D
12 Th=15; //Teeth of wheel H
13 Nv=100; //Speed of shaft V in rpm
14 Nx=300; //Speed of spindle X in rpm
15
16 //Calculations
17 Nh=Nv; //Speed of wheel H in rpm
18 Ne=(-Th/Te)*Nv; //Speed of wheel E in rpm
19 Ta=(Tc+Td-Tb); //Teeth of wheel A
20 //x+y=-50
21 //y=300
22 x=(Ne-Nx)
23 Nz=(187/210)*x+Nx; //; //Speed of wheel Z in rpm
24
25 //Output
26 mprintf('Speed of wheel Z is %.3f rpm \n Direction
        of wheel Z is opposite to that of X',Nz)

```

Scilab code Exa 4.13 Speed of driven shaft

```
1 //Chapter-4, Illustration 13, Page 145
2 //Title: Gears and Gear Drivers
3 //


---


4 clc
5 clear
6
7 //Input data
8 Tp=20; //Teeth of wheel P
9 Tq=30; //Teeth of wheel Q
10 Tr=10; //Teeth of wheel R
11 Nx=50; //Speed of shaft X in rpm
12 Na=100; //Speed of arm A in rpm
13
14 // Calculations
15 //x+y=-50
16 //y=100
17 x=(-Nx-Na)
18 y=(-2*x+Na); //Speed of Y in rpm
19
20 //Output
21 mprintf('Speed of driven shaft Y is %3.0f rpm \n
    Direction of driven shaft Y is anti-clockwise',y)
```

Scilab code Exa 4.14 pitch circle diameter

```
1 //Chapter-4, Illustration 14, Page 146
2 //Title: Gears and Gear Drivers
```

```

3 //


---


4 clc
5 clear
6
7 //Input data
8 d=216; //Ring diameter in mm
9 m=4; //Module in mm
10
11 //Calculations
12 Td=(d/m); //Teeth of wheel D
13 Tb=Td/4; //Teeth of wheel B
14 Tb1=ceil(Tb); //Teeth of wheel B
15 Td1=4*Tb1; //Teeth of wheel D
16 Tc1=(Td1-Tb1)/2; //Teeth of wheel C
17 d1=m*Td1; //Pitch circle diameter in mm
18
19 //Output
20 mprintf('Teeth of wheel B is %3.0f \n Teeth of wheel
    C is %3.0f \n Teeth of wheel D is %3.0f \n Exact
    pitch circle diameter is %3.0f mm',Tb1,Tc1,Td1,
    d1)

```

Scilab code Exa 4.15 Revolution of gears

```

1 //Chapter-4, Illustration 15, Page 147
2 //Title: Gears and Gear Drivers
3 //


---


4 clc
5 clear
6
7 //Input data

```

```

8 Ta=100//          no of teeth on gear A
9 Tc=101//          no of teeth on gear C
10 Td=99//          no of teeth on gear D
11 Tp=20//          no of teeth on planet gear
12 y=1//            from table 4.9(arm B makes one
    revolution)
13 x=-y//           as gear is fixed
14
15 //Calculations
16 Nc=(Ta*x)/Tc+y//          Revolution of gear C
17 Nd=(Ta*x)/Td+y//          Revolution of gear D
18
19 //Output
20 printf('Revolution of gear C = %f\n Revolution of
    gear D = %f',Nc,Nd)

```

Scilab code Exa 4.16 speed of road wheel

```

1 //Chapter-4, Illustration 16, Page 148
2 //Title: Gears and Gear Drivers
3 //


---


4 clc
5 clear
6
7 //Input data
8 Ta=12//          no of teeth on gear A
9 Tb=60//          no of teeth on gear B
10 N=1000//         speed of propeller shaft in rpm
11 Nc=210//         speed of gear C in rpm
12
13 //Calculations
14 Nb=(Ta*N)/Tb//   speed of gear B in rpm
15 x=(Nb-Nc)

```

```

16 Nd=Nb+x//          speed of road wheel driven by D
17
18 //Output
19 printf('speed of road wheel driven by D= %d rpm',Nd)

```

Scilab code Exa 4.17 ratio of torques

```

1 //Chapter-4, Illustration 17, Page 148
2 //Title: Gears and Gear Drivers
3 //

```

```

4 clc
5 clear
6 //Input data
7 Ta=20//    no of teeth on pinion A
8 Tb=25//    no of teeth on wheel B
9 Tc=50//    no of teeth on gear C
10 Td=60//    no of teeth on gear D
11 Te=60//    no of teeth on gear E
12 Na=200//   SPEED of the gear A
13 Nd=100//   speed of the gear D
14
15 //calculations
16 //(i)
17 //(5/6)x+y=0
18 //(5/4)x+y=200
19 A1=[(Tc/Td) 1
20      (Tb/Ta) 1]//Coefficient matrix
21 B1=[0
22      Na]//Constant matrix
23 X1=inv(A1)*B1//Variable matrix
24 Ne1=X1(2)-(Tc/Td)*X1(1)//
25 T1=(-Ne1/Na)//    ratio of torques when D is fixed
26 //(ii)

```

```

27 // (5/4)x+y=200
28 // (5/6)x+y=100
29 A2=[(Tc/Td) 1
30      (Tb/Ta) 1]//Coefficient matrix
31 B2=[Nd
32      Na]//Constant matrix
33 X2=inv(A2)*B2//Variable matrix
34 Ne2=X2(2)-(Tc/Td)*X2(1)
35 T2=(-Ne2/Na)//      ratio of torques when D ratates
      at 100 rpm
36
37 //Output
38 printf('speed of E= %.2f rpm in clockwise direction\
n speed of E in 2nd case(when D rotates at 100
rpm)= %d rpm in clockwise direction\n ratio of
torques when D is fixed= %d \n ratio of torques
when D ratates at 100 rpm= %d',Ne1,Ne2,T1,T2)

```

Chapter 5

Inertia Force Analysis in Machines

Scilab code Exa 5.1 Maximum velocity of the piston

```
1 //CHAPTER 5 ILLUSRTATION 1 PAGE NO 160
2 //TITLE:Inertia Force Analysis in Machines
3 clc
4 clear
5 pi=3.141
6 r=.3//          radius of crank in m
7 l=1//          length of connecting rod in m
8 N=200//        speed of the engine in rpm
9 n=l/r
10 //=====
11 w=2*pi*N/60//  angular speed in rad/s
12 teeta=acosd((-n+((n^2)+4*2*1)^.5)/(2*2))//
    angle of inclination of crank in degrees
13 Vp=w*r*(sind(teeta)+(sind(2*teeta))/n)//
    maximum velocity of the piston in m/s
14 printf('Maximum velocity of the piston = %.3f m/s',
    Vp)
```

Scilab code Exa 5.2 position of crank from inner dead centre position for zero acc

```
1 //CHAPTER 5 ILLUSRTATION 2 PAGE NO 161
2 //TITLE:Inertia Force Analysis in Machines
3 clc
4 clear
5 PI=3.141
6 r=.3//          length of crank in metres
7 l=1.5//        length of connecting rod in
      metres
8 N=180//        speed of rotation in rpm
9 teeta=40//     angle of inclination of crank
      in degrees
10 //=====
11 n=l/r
12 w=2*PI*N/60//  angular speed in rad/s
13 Vp=w*r*(sind(teeta)+sind(2*teeta)/(2*n))//
      velocity of piston in m/s
14 fp=w^2*r*(cosd(teeta)+cosd(2*teeta)/(2*n))//
      acceleration of piston in m/s^2
15 costeeta1=(-n+(n^2+4*2*1)^.5)/(2*2)
16 teeta1=acosd(costeeta1)//
      position of crank from inner dead centre position
      for zero acceleration of piston
17 //=====
18 printf('Velocity of Piston = %.3f m/s\n Acceleration
      of piston = %.3f m/s^2\n position of crank from
      inner dead centre position for zero acceleration
      of piston= %.3f degrees ',Vp,fp,teeta1)
```

Scilab code Exa 5.3 Turning moment on the crank shaft


```

1 //CHAPTER 5 ILLUSRTATION 3 PAGE NO 161
2 //TITLE:Inertia Force Analysis in Machines
3 clc
4 clear
5 pi=3.141
6 D=.3//          Diameter of steam engine in m
7 L=.5//          length of stroke in m
8 r=L/2
9 mR=100//        equivalent of mass of reciprocating
   parts in kg
10 N=200//        speed of engine in rpm
11 teeta=45//     angle of inclination of crank in
   degrees
12 p1=1*10^6//    gas pressure in N/m^2
13 p2=35*10^3//  back pressure in N/m^2
14 n=4//          ratio of crank radius to the
   length of stroke
15 //=====
16 w=2*pi*N/60//  angular speed in rad/s
17 F1=pi/4*D^2*(p1-p2)// Net load on piston in N
18 Fi=mR*w^2*r*(cosd(teeta)+cosd(2*teeta))/(2*n)//
   inertia force due to reciprocating parts
19 Fp=F1-Fi//     Piston effort
20 T=Fp*r*(sind(teeta)+(sind(2*teeta))/(2*(n^2-(sind(
   teeta))^2)^.5))
21 printf('Piston effort = %.3f N\n Turning moment on
   the crank shaft = %.3f N-m',Fp,T)

```

Scilab code Exa 5.4 net force on piston

```

1 //CHAPTER 5 ILLUSRTATION 4 PAGE NO 162
2 //TITLE:Inertia Force Analysis in Machines
3 clc
4 clear
5 pi=3.141

```

```

6 D=.10//          Diameter of petrol engine in m
7 L=.12//          Stroke length in m
8 l=.25//          length of connecting in m
9 r=L/2
10 mR=1.2//        mass of piston in kg
11 N=1800//        speed in rpm
12 teeta=25//      angle of inclination of crank
    in degrees
13 p=680*10^3//    gas pressure in N/m^2
14 n=1/r
15 g=9.81//        acceleration due to gravity
16 //=====
17 w=2*pi*N/60//   angular speed in
    rpm
18 F1=pi/4*D^2*p// force due to gas pressure
    in N
19 Fi=mR*w^2*r*(cosd(teeta)+cosd(2*teeta)/(n))//
    inertia force due to reciprocating parts in N
20 Fp=F1-Fi+mR*g// net force on piston in N
21 Fq=n*Fp/((n^2-(sind(teeta))^2)^.5)// resultant
    load on gudgeon pin in N
22 Fn=Fp*sind(teeta)/((n^2-(sind(teeta))^2)^.5)//
    thrust on cylinder walls in N
23 fi=F1+mR*g//    inertia force of the
    reciprocating parts before the gudgeon pin load
    is reversed in N
24 w1=(fi/mR/r/(cosd(teeta)+cosd(2*teeta)/(n)))^.5
25 N1=60*w1/(2*pi)
26 printf('Net force on piston = %.3f N\n Resultant
    load on gudgeon pin = %.3f N\n Thrust on cylinder
    walls = %.3f N\n speed at which other things
    remining same,the gudgeon pin load would be
    reversed in directionm= %.3f rpm ',Fp,Fq,Fn,N1)

```

Scilab code Exa 5.5 Net load on the gudgeon pin

```

1 //CHAPTER 5 ILLUSTRATION 5 PAGE NO 163
2 //TITLE:Inertia Force Analysis in Machines
3 //Figure 5.3
4 clc
5 clear
6 pi=3.141
7 N=1800//          speed of the petrol engine in rpm
8 r=.06//          radius of crank in m
9 l=.240//         length of connecting rod in m
10 D=.1//          diameter of the piston in m
11 mR=1//          mass of piston in kg
12 p=.8*10^6//     gas pressure in N/m^2
13 x=.012//        distance moved by piston in m
14 //=====
15 w=2*pi*N/60//   angular velocity of the
    engine in rad/s
16 n=l/r
17 F1=pi/4*D^2*p// load on the piston in N
18 teeta=32//     by measurement from the
    figure 5.3
19 Fi=mR*w^2*r*(cosd(teeta)+cosd(2*teeta)/(n))//
    inertia force due to reciprocating parts in N
20 Fp=F1-Fi//     net load on the gudgeon pin in
    N
21 Fq=n*Fp/((n^2-(sind(teeta))^2)^.5)//   thrust in
    the connecting rod in N
22 Fn=Fp*sind(teeta)/((n^2-(sind(teeta))^2)^.5)//
    reaction between the piston and cylinder in N
23 w1=(F1/mR/r/(cosd(teeta)+cosd(2*teeta)/(n)))^.5
24 N1=60*w1/(2*pi)//
25 printf('Net load on the gudgeon pin= %.3f N\n Thrust
    in the connecting rod= %.3f N\n Reaction between
    the cylinder and piston= %.3f N\n The engine
    speed at which the above values become zero= %.3f
    rpm ',Fp,Fq,Fn,N1)

```

Scilab code Exa 5.6 Torque exerted on the crank shaft

```
1 //CHAPTER 5 ILLUSRTATION 6 PAGE NO 165
2 //TITLE:Inertia Force Analysis in Machines
3 clc
4 clear
5 pi=3.141
6 D=.25//          diameter of horizontal steam
   engine in m
7 N=180//          speed of the engine in rpm
8 d=.05//          diameter of piston in m
9 P=36000//        power of the engine in watts
10 n=3//           ration of length of connecting
   rod to the crank radius
11 p1=5.8*10^5//   pressure on cover end side in
   N/m^2
12 p2=0.5*10^5//   pressure on crank end side in
   N/m^2
13 teeta=40//      angle of inclination of crank
   in degrees
14 m=45//          mass of flywheel in kg
15 k=.65//         radius of gyration in m
16 //=====
17 F1=(pi/4*D^2*p1)-(pi/4*(D^2-d^2)*p2)//          load
   on the piston in N
18 phi=asind(sind(teeta)/n)//
   angle of inclination of the connecting rod to the
   line of stroke in degrees
19 r=1.6*D/2
20 T=F1*sind(teeta+phi)/cosd(phi)*r//
   torque exerted on crank shaft in N-m
21 Fb=F1*cosd(teeta+phi)/cosd(phi)//
   thrust on the crank shaft bearing in N
22 TR=P*60/(2*pi*N)//
```

```

    steady resisting torque in N-m
23 Ts=T-TR//
    surplus torque available in N-m
24 a=Ts/(m*k^2)//
    acceleration of the flywheel in rad/s^2
25 printf('Torque exerted on the crank shaft= %.3f N-m\
n Thrust on the crank shaft bearing= %.3f N\n
Acceleration of the flywheel= %.3f rad/s^2',T,Fb,
a)

```

Scilab code Exa 5.7 Effective turning moment on the crank shaft

```

1 //CHAPTER 5 ILLUSRTATION 7 PAGE NO 166
2 //TITLE: Inertia Force Analysis in Machines
3 clc
4 clear
5 pi=3.141
6 D=.25//          diameter of vertical cylinder
    of steam engine in m
7 L=.45//          stroke length in m
8 r=L/2
9 n=4
10 N=360//          speed of the engine in rpm
11 teeta=45//       angle of inclination of crank
    in degrees
12 p=1050000//      net pressure in N/m^2
13 mR=180//         mass of reciprocating parts
    in kg
14 g=9.81//        acceleration due to gravity
15 //=====
16 F1=p*pi*D^2/4//  force on piston due to
    steam pressure in N
17 w=2*pi*N/60//    angular speed in rad/s
18 Fi=mR*w^2*r*(cosd(teeta)+cosd(2*teeta)/(n))//
    inertia force due to reciprocating parts in N

```

```

19 Fp=F1-Fi+mR*g//          piston effort in N
20 phi=asind(sind(teeta)/n)//  angle of inclination
    of the connecting rod to the line of stroke in
    degrees
21 T=Fp*sind(teeta+phi)/cosd(phi)*r//
    torque exerted on crank shaft in N-m
22 printf('Effective turning moment on the crank shaft=
    %.3f N-m',T)

```

Scilab code Exa 5.8 Effective turning moment on the crank shaft

```

1 //CHAPTER 5 ILLUSTRATION 8 PAGE NO 166
2 //TITLE:Inertia Force Analysis in Machines
3 //figure 5.4
4 clc
5 clear
6 pi=3.141
7 D=.25//          diameter of vertical cylinder
    of diesel engine in m
8 L=.40//          stroke length in m
9 r=L/2
10 n=4
11 N=300//          speed of the engine in rpm
12 teeta=60//       angle of inclination of crank
    in degrees
13 mR=200//         mass of reciprocating parts
    in kg
14 g=9.81//         acceleration due to gravity
15 l=.8//           length of connecting rod in m
16 c=14//           compression ratio=v1/v2
17 p1=.1*10^6//     suction pressure in n/m^2
18 i=1.35//         index of the law of expansion
    and compression
19 //

```

```

20 Vs=pi/4*D^2*L//          swept volume in m^3
21 w=2*pi*N/60//          angular speed in rad/s
22 Vc=Vs/(c-1)
23 V3=Vc+Vs/10//          volume at the end of
    injection of fuel in m^3
24 p2=p1*c^i//          final pressure in N/m^2
25 p3=p2//          from figure
26 x=r*((1-cosd(teeta)+(sind(teeta))^2/(2*n)))//
    the displacement of the piston when the
    crank makes an angle 60 degrees with T.D.C
27 Va=Vc+pi*D^2*x/4
28 pa=p3*(V3/Va)^i
29 p=pa-p1//          difference of pressures on 2 sides
    of piston in N/m^2
30 Fl=p*pi*D^2/4//          net load on piston in N
31 Fi=mR*w^2*r*(cosd(teeta)+cosd(2*teeta)/(n))//
    inertia force due to reciprocating parts in N
32 Fp=Fl-Fi+mR*g//          piston effort in N
33 phi=asind(sind(teeta)/n)//          angle of inclination
    of the connecting rod to the line of stroke in
    degrees
34 T=Fp*sind(teeta+phi)/cosd(phi)*r//
    torque exerted on crank shaft in N-m
35 printf('Effective turning moment on the crank shaft=
    %.3f N-m',T)

```

Chapter 6

Turning Moment Diagram and Flywheel

Scilab code Exa 6.1 Kinetic energy of flywheel

```
1 //CHAPTER 6 ILLUSRTATION 1 PAGE NO 175
2 //TITLE:Turning Moment Diagram and Flywheel
3 clc
4 clear
5 k=1//          radius of gyration of flywheel in m
6 m=2000//      mass of the flywheel in kg
7 T=1000//      torque of the engine in Nm
8 w1=0//        speedin the begining
9 t=10//        time duration
10 //=====
11 I=m*k^2//     mass moment of inertia in kg-m^2
12 a=T/I//       angular acceleration of flywheel
    in rad/s^2
13 w2=w1+a*t//   angular speed after time t in rad/
    s
14 K=I*w2^2/2//  kinetic energy of flywheel in Nm
15 //=====
16 printf('Angular acceleration of the flywheel= %.3f
    rad/s^2\n Kinetic energy of flywheel= %.3f N-m',a
```


,K)

Scilab code Exa 6.2 Mass of the flywheel required

```
1 //CHAPTER 6 ILLUSTRATION 2 PAGE NO 176
2 //TITLE:Turning Moment Diagram and Flywheel
3 clc
4 clear
5 pi=3.141
6 N1=225//          maximum speed of flywheel in
   rpm
7 k=.5//          radius of gyration of flywheel
   in m
8 n=720//          no of holes punched per hour
9 E1=15000//       energy required by flywheel in
   Nm
10 N2=200//        minimum speed of flywheel in
   rpm
11 t=2//           time taking for punching a
   hole
12 //=====
13 P=E1*n/3600//    power required by motor
   per sec in watts
14 E2=P*t//        energy supplied by motor
   to punch a hole in N-m
15 E=E1-E2//       maximum fluctuation of
   energy in N-m
16 N=(N1+N2)/2//   mean speed of the
   flywheel in rpm
17 m=E/(pi^2/900*k^2*N*(N1-N2))
18 printf('Power of the motor= %.3f watts\n Mass of the
   flywheel required= %.3f kg',P,m)
```

Scilab code Exa 6.3 Mass of the flywheel required

```
1 //CHAPTER 6 ILLUSTRATION 3 PAGE NO 176
2 //TITLE:Turning Moment Diagram and Flywheel
3 clc
4 clear
5 pi=3.141
6 d=38// diameter of hole in cm
7 t=32// thickness of hole in cm
8 e1=7// energy required to punch one
   square mm
9 V=25// mean speed of the flywheel in
   m/s
10 S=100// stroke of the punch in cm
11 T=10// time required to punch a hole
   in s
12 Cs=.03// coefficient of fluctuation
   of speed
13 //=====
14 A=pi*d*t// sheared area in mm^2
15 E1=e1*A// energy required to punch
   entire area in Nm
16 P=E1/T// power of motor required in
   watts
17 T1=T/(2*S)*t// time required to punch a
   hole in 32 mm thick plate
18 E2=P*T1// energy supplied by motor in
   T1 seconds
19 E=E1-E2// maximum fluctuation of
   energy in Nm
20 m=E/(V^2*Cs)// mass of the flywheel
   required
21 printf('Mass of the flywheel required= %.0f kg',m)
```

Scilab code Exa 6.4 Mass of the flywheel

```

1 //CHAPTER 6 ILLUSTRATION 4 PAGE NO 177
2 //TITLE:Turning Moment Diagram and Flywheel
3 //figure 6.4
4 clc
5 clear
6 //=====
7 pi=3.141
8 N=480//          speed of the engine in rpm
9 k=.6//          radius of gyration in m
10 Cs=.03//       coefficient of fluctuation of
    speed
11 Ts=6000//      turning moment scale in Nm per
    one cm
12 C=30//         crank angle scale in degrees per
    cm
13 a=[0.5,-1.22,.9,-1.38,.83,-.7,1.07]//      areas
    between the output torque and mean resistance
    line in sq.cm
14 //=====
15 w=2*pi*N/60//   angular speed in rad/s
16 A=Ts*C*pi/180// 1 cm^2 of turning moment
    diagram in Nm
17 E1=a(1)//      max energy at B refer
    figure
18 E2=a(1)+a(2)+a(3)+a(4)
19 E=(E1-E2)*A//   fluctuation of energy in Nm
20 m=E/(k^2*w^2*Cs)// mass of the flywheel in kg
21 printf('Mass of the flywheel= %.3f kg',m)

```

Scilab code Exa 6.5 Mass of the flywheel

```

1 //CHAPTER 6 ILLUSTRATION 5 PAGE NO 178
2 //TITLE:Turning Moment Diagram and Flywheel
3 clc
4 clear

```

```

5 //=====
6 pi=3.141
7 P=500*10^3//      power of the motor in N
8 k=.6//           radius of gyration in m
9 Cs=.03//         coefficient of fluctuation of
    speed
10 OA=750//        REFER FIGURE
11 OF=6*pi//       REFER FIGURE
12 AG=pi// REFER FIGURE
13 BG=3000-750// REFER FIGURE
14 GH=2*pi// REFER FIGURE
15 CH=3000-750// REFER FIGURE
16 HD=pi// REFER FIGURE
17 LM=2*pi// REFER FIGURE
18 T=OA*OF+1/2*AG*BG+BG*GH+1/2*CH*HD//      Torque
    required for one complete cycle in Nm
19 Tmean=T/(6*pi)//      mean torque in Nm
20 w=P/Tmean//          angular velocity
    required in rad/s
21 BL=3000-1875// refer figure
22 KL=BL*AG/BG// From similar triangles
23 CM=3000-1875// refer figure
24 MN=CM*HD/CH//from similar triangles
25 E=1/2*KL*BL+BL*LM+1/2*CM*MN//      Maximum
    fluctuaion of energy in Nm
26 m=E*100/(k^2*w^2*Cs)//      mass of flywheel in kg
27 printf('Mass of the flywheel= %.3f kg',m)

```

Scilab code Exa 6.6 Angular acceleration

```

1 //CHAPTER 6 ILLUSRTATION 6 PAGE NO 179
2 //TITLE:Turning Moment Diagram and Flywheel
3 clc
4 clear
5 pi=3.141

```

```

6 PI=180//in degrees
7 theta1=0
8 theta2=PI
9 m=400//      mass of the flywheel in kg
10 N=250//     speed in rpm
11 k=.4//     radius of gyration in m
12 n=2*250/60000//      no of working strokes per
    minute
13 W=1000*pi-150*cosd(2*theta2)-250*sind(2*theta2)
    -(1000*theta1-150*cosd(2*theta1)-250*sind(2*
    theta1))//      workdone per stroke in Nm
14 P=W*n//     power in KW
15 Tmean=W/pi//      mean torque in Nm
16 twotheta=atand(500/300)//      angle at which T-
    Tmean becomes zero
17 THETA1=twotheta/2
18 THETA2=(180+twotheta)/2
19 E=-150*cosd(2*THETA2)-250*sind(2*THETA2)-(-150*cosd
    (2*THETA1)-250*sind(2*THETA1))//      FLUCTUATION
    OF ENERGY IN Nm
20 w=2*pi*N/60//      angular speed in rad/s
21 Cs1=E*100/(k^2*w^2*m)//      fluctuation range
22 Cs=Cs1/2//      total percentage of fluctuation
    of speed
23 Theta=60
24 T1=300*sind(2*Theta)-500*cosd(2*Theta)//
    Accelerating torque in Nm(T-Tmean)
25 alpha=T1/(m*k^2)//
    angular acceleration in rad/s^2
26 printf('Power delivered=%.3f kw\nTotal percentage of
    fluctuation speed= %.3f\nAngular acceleration= %
    .3f rad/s^2',P,Cs,alpha)

```

Scilab code Exa 6.7 Energy expended in performing each operation

```

1 //CHAPTER 6 ILLUSTRATION 7 PAGE NO 181
2 //TITLE:Turning Moment Diagram and Flywheel
3 clc
4 clear
5 pi=3.141
6 m=200//      mass of the flywheel in kg
7 k=.5//      radius of gyration in m
8 N1=360//    upper limit of speed in rpm
9 N2=240//    lower limit of speed in rpm
10 //=====
11 I=m*k^2//   mass moment of inertia in kg m^2
12 w1=2*pi*N1/60
13 w2=2*pi*N2/60
14 E=1/2*I*(w1^2-w2^2)// fluctuation of energy in Nm
15 Pmin=E/(4*1000)//    power in kw
16 Eex=Pmin*12*1000//  Energy expended in performing
    each operation in N-m
17 printf('Minimum power required= %.3f kw\n Energy
    expended in performing each operation= %.3f N-m',
    Pmin,Eex)

```

Scilab code Exa 6.8 Amount of Torque required

```

1 //CHAPTER 6 ILLUSTRATION 8 PAGE NO 182
2 //TITLE:Turning Moment Diagram and Flywheel
3 clc
4 clear
5 pi=3.141
6 b=8//      width of the strip in cm
7 t=2//      thickness of the strip in cm
8 w=1.2*10^3// work required per square cm
    cut
9 N1=200//    maximum speed of the
    flywheel in rpm
10 k=.80//    radius of gyration in m

```

```

11 N2=(1-.15)*N1//           minimum speed of the
    flywheel in rpm
12 T=3//                     time required to punch a
    hole
13 //=====
14 A=b*t//                   area cut of each stroke in cm^2
15 W=w*A//                   work required to cut a strip in
    Nm
16 w1=2*pi*N1/60//          speed before cut in rpm
17 w2=2*pi*N2/60//          speed after cut in rpm
18 m=2*W/(k^2*(w1^2-w2^2))// mass of the flywheel
    required in kg
19 a=(w1-w2)/T//            angular acceleration in rad/
    s^2
20 Ta=m*k^2*a//             torque required in Nm
21 printf('Mass of the flywheel= %.3f kg\n Amount of
    Torque required= %.3f Nm',m,Ta)

```

Scilab code Exa 6.9 Reduction in speed after the pressing is over

```

1 //CHAPTER 6 ILLUSRTATION 9 PAGE NO 182
2 //TITLE:Turning Moment Diagram and Flywheel
3 clc
4 clear
5 pi=3.141
6 P=5*10^3//                power delivered by motor in
    watts
7 N1=360//                  speed of the flywheel in rpm
8 I=60//                    mass moment of inertia in kg m
    ^2
9 E1=7500//                 energy required by pressing
    machine for 1 second in Nm
10 //=====
11 Ehr=P*60*60//            energy supplied per hour in Nm
12 n=Ehr/E1

```

```

13 E=E1-P//          total fluctuation of energy in Nm
14 w1=2*pi*N1/60//   angular speed before pressing in
    rpm
15 w2=((2*pi*N1/60)^2-(2*E/I))^0.5//   angular speed
    after pressing in rpm
16 N2=w2*60/(2*pi)
17 R=N1-N2//         reduction in speed in rpm
18 printf('No of pressings that can be made per hour= %
    .0f\n Reduction in speed after the pressing is
    over= %.2f rpm ',n,R)

```

Scilab code Exa 6.10 minimum mass moment of inertia of flywheel

```

1
2
3 //CHAPTER 6 ILLUSTRATION 10 PAGE NO 183
4 //TITLE:Turning Moment Diagram and Flywheel
5 clc
6 clear
7 pi=3.141
8 Cs=.02//          coefficient of fluctuation of speed
9 N=200//           speed of the engine in rpm
10 //T2=15000-6000 cos      Torque required by the
    machine in Nm
11 //T1=15000+8000 sin2     Torque supplied by the
    engine in Nm
12 //T1-T2=8000 sin2 +6000 cos      Change in torque
13 theta1=acosd(0)
14 theta2=asind(-6000/16000)
15 theta2=180-theta2
16 //=====
17 //largest area, representing fluctuation of energy
    lies between theta1 and theta2
18 E=6000*sind(theta2)-8000/2*cosd(2*theta2)-(6000*sind
    (theta1)-8000/2*cosd(2*theta1))//      total

```



```

    fluctuation of energy in Nm
19 Theta=180//    angle with which cycle will be
    repeated in degrees
20 Theta1=0
21 Tmean=1/pi*((15000*pi+(-8000*cosd(2*Theta))/2)
    -((15000*Theta1+(-8000*cosd(2*Theta1))/2)))/2) //
    mean torque of engine in Nm
22 P=2*pi*N*Tmean/60000//    power of the engine in
    kw
23 w=2*pi*N/60//    angular speed of the engine
    in rad/s
24 I=E/(w^2*Cs)//    mass moment of inertia of
    flywheel in kg-m^2
25 printf('Power of the engine= %.3f kw\n minimum mass
    moment of inertia of flywheel= %.3f kg-m^2\n E
    value calculated in the textbook is wrong. Its
    value is -15,124. In textbook it is given as
    -1370.28 ',P,-I)

```

Chapter 7

GOVERNORS

Scilab code Exa 7.1 PERCENTAGE CHANGE IN SPEED

```
1 //CHAPTER 7 ILLUSRTATION 1 PAGE NO 196
2 //TITLE:GOVERNORS
3 clc
4 clear
5 //

```

```
6 //INPUT DATA
7 L=.4//          LENGTH OF UPPER ARM IN m
8 THETA=30//     INCLINATION TO THE
   VERTICAL IN degrees
9 K=.02//        RISED LENGTH IN m
10 //

```

```
11 h2=L*cosd(THETA)//    GOVERNOR HEIGHT IN m
12 N2=(895/h2)^.5//     SPEED AT h2 IN rpm
13 h1=h2-K//          LENGTH WHEN IT IS RAISED
   BY 2 cm
14 N1=(895/h1)^.5//     SPEED AT h1 IN rpm
15 n=(N1-N2)/N2*100//   PERCENTAGE CHANGE IN
```

```

16 // SPEED


---


17 printf('PERCENTAGE CHANGE IN SPEED= %.f PERCENTAGE',
n)


---



```

Scilab code Exa 7.2 RANGE OF SPEED

```

1 //CHAPTER 7 ILLUSTRATION 2 PAGE NO 197
2 //TITLE:GOVERNORS
3 //FIGURE 7.5(A),7.5(B)
4 clc
5 clear
6 //


---


7 //INPUT DATA
8 OA=.3// LENGTH OF UPPER ARM
   IN m
9 m=6// MASS OF EACH BALL
   IN Kg
10 M=18// MASS OF SLEEVE IN
   Kg
11 r2=.2// RADIUS OF ROTATION
   AT BEGINING IN m
12 r1=.25// RADIUS OF ROTATION
   AT MAX SPEED IN m
13 //


---


14 h1=(OA^2-r1^2)^.5// HIEGHT OF GOVERNOR
   AT MAX SPEED IN m
15 N1=(895*(m+M)/(h1*m))^.5// MAX SPEED IN rpm
16 h2=(OA^2-r2^2)^.5// HEIGHT OF GONERNOR

```

```

    AT BEGINING IN m
17 N2=(895*(m+M)/(h2*m))^.5//      MIN SPEED IN rpm
18 //

```

```

19 printf('MAX SPEED = %.3 f rpm\n MIN SPEED = %.3 f rpm\n
    n RANGE OF SPEED = %.3 f rpm ',N1 ,N2 ,N1-N2)

```

Scilab code Exa 7.3 RANGE OF SPEED

```

1 //CHAPTER 7 ILLUSRTATION 3 PAGE NO 197
2 //TITLE:GOVERNORS
3 //FIGURE 7.6
4 clc
5 clear
6 //

```

```

7 //INPUT DATA
8 OA=.25//      LENGHT OF
    UPPER ARM IN m
9 CD=.03//      DISTANCE
    BETWEEN LEEVE AND LOWER ARM IN m
10 m=6//      MASS OF
    BALL IN Kg
11 M=48//      MASS OF
    SLEEVE IN Kg
12 AE=.17//      FROM
    FIGURE 7.6
13 AE1=.12//      FROM
    FIGURE 7.6
14 r1=.2//      RADIUS OF
    ROTATION AT MAX SPEED IN m
15 r2=.15//      RADIUS OF
    ROTATION AT MIN SPEED IN m

```

```

16 //


---


17 h1=(OA^2-r1^2)^.5//           HIEGHT OF
    GOVERNOR AT MIN SPEED IN m
18 TANalpha=r1/h1
19 TANbeeta=AE/(OA^2-AE^2)^.5
20 k=TANbeeta/TANalpha
21 N1=(895*(m+(M*(1+k)/2))/(h1*m))^.5//   MIN SPEED IN
    rpm
22 h2=(OA^2-r2^2)^.5//           HIEGHT OF
    GOVERNOR AT MAX SPEED IN m
23 CE=(OA^2-AE1^2)^.5
24 TANalpha1=r2/h2
25 TANbeeta1=(r2-CD)/CE
26 k=TANbeeta1/TANalpha1
27 N2=(895*(m+(M*(1+k)/2))/(h2*m))^.5//   MIN SPEED IN
    rpm
28 //


---


29 printf('MAX SPEED = %.3 f rpm\n MIN SPEED = %.3 f rpm\n
    n RANGE OF SPEED = %.3 f rpm ',N1 ,N2 ,N1-N2)


---



```

Scilab code Exa 7.4 GOVERNOR POWER

```

1 //CHAPTER 7 ILLUSRTATION 4 PAGE NO 199
2 //TITLE:GOVERNORS
3 //FIGURE 7.7
4 clc
5 clear
6 //


---


7 //INPUT DATA

```

```

8  g=9.81 //          ACCELERATION DUE TO
   GRAVITY
9  OA=.20 //          LENGHT OF UPPER ARM IN m
10 AC=.20 //          LENGTH OF LOWER ARM IN m
11 CD=.025 //         DISTANCE BETWEEN AXIS AND
   LOWER ARM IN m
12 AB=.1 //           RADIUS OF ROTATION OF
   BALLS IN m
13 N2=250 //          SPEED OF THE GOVERNOR IN
   rpm
14 X=.05 //           SLEEVE LIFT IN m
15 m=5 //             MASS OF BALL IN Kg
16 M=20 //            MASS OF SLEEVE IN Kg
17 //



---


18 h2=(OA^2-AB^2)^.5 //          OB DISTANCE IN m
   IN FIGURE
19 h21=(AC^2-(AB-CD)^2)^.5 //    BD DISTANCE IN m
   IN FIGURE
20 TANbeeta=(AB-CD)/h21 //       TAN OF ANGLE OF
   INCLINATION OF THE LINK TO THE VERTICAL
21 TANalpha=AB/h2 //             TAN OF ANGLE OF
   INCLINATION OF THE ARM TO THE VERTICAL
22 k=TANbeeta/TANalpha
23 c=X/(2*(h2*(1+k)-X)) //       PERCENTAGE
   INCREASE IN SPEED
24 n=c*N2 //              INCREASE IN SPEED
   IN rpm
25 N1=N2+n //            SPEED AFTER LIFT
   OF SLEEVE
26 E=c*g*((2*m/(1+k))+M) //      GOVERNOR EFFORT
   IN N
27 P=E*X //              GOVERNOR POWER IN
   N-m
28
29 printf('SPEED OF THE GOVERNOR WHEN SLEEVE IS LIFT BY
   5 cm = %.3 f rpm\n GOVERNOR EFFORT = %.3 f N\n

```

GOVERNOR POWER = $0.3 f N-m', N1, E, P)$

Scilab code Exa 7.5 RANGE OF SPEED OF GOVERNOR

```
1 //CHAPTER 7 ILLUSTRATION 5 PAGE NO 200
2 //TITLE:GOVERNORS
3 //FIGURE 7.8
4 clc
5 clear
6 //

```

```
7 //INPUT DATA
8 g=9.81// ACCELERATION DUE TO
   GRAVITY
9 OA=.30// LENGHT OF UPPER ARM IN m
10 AC=.30// LENGTH OF LOWER ARM IN m
11 m=10// MASS OF BALL IN Kg
12 M=50// MASS OF SLEEVE IN Kg
13 r=.2// RADIUS OF ROTATION IN m
14 CD=.04// DISTANCE BETWEEN AXIS AND
   LOWER ARM IN m
15 F=15// FRICTIONAL LOAD ACTING IN
   N
16 //

```

```
17 h=(OA^2-r^2)^.5// HIEGTH OF THE GOVERNOR
   IN m
18 AE=r-CD// AE VALUE IN m
19 CE=(AC^2-AE^2)^.5// BD DISTANCE IN m
20 TANalpha=r/h// TAN OF ANGLE OF
   INCLINATION OF THE ARM TO THE VERTICAL
21 TANbeeta=AE/CE// TAN OF ANGLE OF
   INCLINATION OF THE LINK TO THE VERTICAL
```

```

22 k=TANbeta/TANalpha
23 N=((895/h)*(m+(M*(1+k)/2))/m)^.5//      EQUILIBRIUM
      SPEED IN rpm
24 N1=((895/h)*((m*g)+(M*g+F)/2)*(1+k)/(m*g))^.5//
      MAX SPEED IN rpm
25 N2=((895/h)*((m*g)+(M*g-F)/2)*(1+k)/(m*g))^.5//
      MIN SPEED IN rpm
26 R=N1-N2//                                RANGE OF
      SPEED
27 printf('EQUILIBRIUM SPEED OF GOVERNOR = %.3 f rpm\n
      RANGE OF SPEED OF GOVERNOR= %.3 f rpm ',N,R)

```

Scilab code Exa 7.6 RANGE OF SPEED OF GOVERNOR

```

1 //CHAPTER 7 ILLUSTRATION 6 PAGE NO 202
2 //TITLE:GOVERNORS
3 //FIGURE 7.9
4 clc
5 clear
6 //

```

```

7 //INPUT DATA
8 g=9.81//      ACCELERATION DUE TO
      GRAVITY
9 OA=.30//      LENGHT OF UPPER ARM IN m
10 AC=.30//     LENGTH OF LOWER ARM IN m
11 m=5//        MASS OF BALL IN Kg
12 M=25//      MASS OF SLEEVE IN Kg
13 X=.05//     LIFT OF THE SLEEVE
14 alpha=30//  ANGLE OF INCLINATION OF
      THE ARM TO THE VERTICAL
15 //=====
16 h2=OA*cosd(alpha)//      HEIGHT OF THE GOVERNOR AT
      LOWEST POSITION OF SLEEVE

```



```

17 h1=h2-X/2//          HEIGHT OF THE GOVERNOR AT
    HEIGHT POSITION OF SLEEVE
18 F=((h2/h1)*(m*g+M*g)-(m*g+M*g))/(1+h2/h1)//
    FRICTION AT SLEEVE IN N
19 N1=((m*g+M*g+F)*895/(h1*m*g))^.5//          MAX
    SPEED OF THE GOVERNOR IN rpm
20 N2=((m*g+M*g-F)*895/(h2*m*g))^.5//          MIN
    SPEED OF THE GOVERNOR IN rpm
21 R=N1-N2//          RANGE OF
    SPEED IN rpm
22
23 printf('THE VALUE OF FRICTIONAL FORCE= %.3 f F\n
    RANGE OF SPEED OF THE GOVERNOR = %.0 f rpm ',F,R)

```

Scilab code Exa 7.7 EQUILIBRIUM SPEED CORRESPONDING TO LIFT

```

1 //CHAPTER 7 ILLUSRTATION 7 PAGE NO 203
2 //TITLE:GOVERNORS
3 clc
4 clear
5 //

```

```

6 //INPUT DATA
7 PI=3.147
8 m=3//          MASS OF EACH BALL IN Kg
9 a=.12//          LENGTH OF VERTICAL ARM OF BELL
    CRANK LEVER IN m
10 b=.08//          LENGTH OF HORIZONTAL ARM OF
    BELL CRANK LEVER IN m
11 r2=.12//          RADIUS OF ROTATION OF THE BALL
    FOR LOWEST POSITION IN m
12 N2=320//          SPEED OF GOVERNOR AT THE
    BEGINING IN rpm
13 S=20000//          STIFFNESS OF THE SPRING IN

```

```

    N/m
14 h=.015//          SLEEVE LIFT IN m
15 //=====
16 Fc2=m*(2*PI*N2/60)^2*r2//          CENTRIFUGAL
    FORCE ACTING AT MIN SPEED OF ROTATION IN N
17 L=2*a*Fc2/b//          INITIAL LOAD
    ON SPRING IN N
18 r1=a/b*h+r2//          MAX RADIUS
    OF ROTATION IN m
19 Fc1=(S*(r1-r2)*(b/a)^2/2)+Fc2//          CENTRIFUGAL
    FORCE ACTING AT MAX SPEED OF ROTATION IN N
20 N1=(Fc1/(m*r1)*(60/2/PI)^2)^.5
21 printf('INITIAL LOAD ON SPRING =%.3 f N\n EQUILIBRIUM
    SPEED CORRESPONDING TO LIFT OF 15 cm =%.0 f rpm',
    L,N1)

```

Scilab code Exa 7.8 STIFFNESS OF THE SPRING

```

1 //CHAPTER 7 ILLUSRTATION 8 PAGE NO 204
2 //TITLE:GOVERNORS
3 clc
4 clear
5 //

```

```

6 //INPUT DATA
7 PI=3.147
8 m=3//          MASS OF BALL IN Kg
9 r2=.2//          INITIAL RADIUS OF
    ROTATION IN m
10 a=.11//          LENGTH OF VERTICAL ARM OF BELL
    CRANK LEVER IN m
11 b=.15//          LENGTH OF HORIZONTAL ARM OF
    BELL CRANK LEVER IN m
12 h=.004//          SLEEVE LIFT IN m

```

```

13 N2=240 // INITIAL SPEED IN rpm
14 n=7.5 // FLUCTUATION OF SPEED IN %
15 //=====
16 w2=2*PI*N2/60 // INITIAL ANGULAR
    SPEED IN rad/s
17 w1=(100+n)*w2/100 // FINAL ANGULAR SPEED
    IN rad/s
18 F=2*a/b*m*w2^2*r2 // INITIAL COMPRESSIVE
    FORCE IN N
19 r1=r2+a/b*h // MAX RDIUS OF
    ROTATION IN m
20 S=2*((m*w1^2*r1)-(m*w2^2*r2))/(r1-r2)*(a/b)^2
21 printf('INITIAL COMPRESSIVE FPRCE = %.3 f N\n
    STIFFNESS OF THE SPRING = %.3 f N/m',F,S/1000)

```

Scilab code Exa 7.9 ALTERATION IN SPEED

```

1 //CHAPTER 7 ILLUSRTATION 9 PAGE NO 204
2 //TITLE:GOVERNORS
3 //FIGURE 7.3(C)
4 clc
5 clear
6 //

```

```

7 //INPUT DATA
8 g=9.81 // ACCELERATION DUE TO
    GRAVITY
9 PI=3.147
10 r=.14 // DISTANCE BETWEEN
    THE CENTRE OF PIVOT OF BELL CRANK LEVER AND AXIS
    OF GOVERNOR SPINDLE IN m
11 r2=.11 // INITIAL RADIUS OF
    ROTATION IN m
12 a=.12 // LENGTH OF VERTICAL

```

ARM OF BELL CRANK LEVER IN m

13 $b = .10 //$ LENGTH OF
HORIZONTAL ARM OF BELL CRANK LEVER IN m

14 $h = .05 //$ SLEEVE LIFT IN m

15 $N_2 = 240 //$ INITIAL SPEED IN
rpm

16 $F = 30 //$ FRICTIONAL FORCE
ACTING IN N

17 $m = 5 //$ MASS OF EACH BALL
IN Kg

18 $//$ =====

19 $r_1 = r_2 + a/b * h //$ MAX RADIUS OF
ROTATION IN m

20 $N_1 = 41 * N_2 / 39 //$ MAX SPEED OF ROTATION
IN rpm

21 $N = (N_1 + N_2) / 2 //$ MEAN SPEED IN rpm

22 $F_{c1} = m * (2 * PI * N_1 / 60)^2 * r_1 //$ CENTRIFUGAL FORCE
ACTING AT MAX SPEED OF ROTATION IN N

23 $F_{c2} = m * (2 * PI * N_2 / 60)^2 * r_2 //$ CENTRIFUGAL FORCE
ACTING AT MIN SPEED OF ROTATION IN N

24 $c_1 = r_1 - r //$ FROM FIGURE 7.3(C) IN
m

25 $a_1 = (a^2 - c_1^2)^{.5} //$ FROM FIGURE 7.3(C) IN
m

26 $b_1 = (b^2 - (h/2)^2)^{.5} //$ FROM FIGURE 7.3(C)
IN m

27 $c_2 = r - r_2 //$ FROM FIGURE 7.3(C) IN
m

28 $a_2 = a_1 //$ FROM FIGURE 7.3(C) IN
m

29 $b_2 = b_1 //$ FROM FIGURE 7.3(C) IN
m

30 $S_1 = 2 * ((F_{c1} * a_1) - (m * g * c_1)) / b_1 //$ SPRING FORCE
EXERTED ON THE SLEEVE AT MAXIMUM SPEED IN NEWTONS

31 $S_2 = 2 * ((F_{c2} * a_2) - (m * g * c_2)) / b_2 //$ SPRING FORCE
EXERTED ON THE SLEEVE AT MAXIMUM SPEED IN NEWTONS

32 $S = (S_1 - S_2) / h //$ STIFFNESS OF THE
SPRING IN N/m

```

33 Is=S2/S//          INITIAL COMPRESSION
    OF SPRING IN m
34 P=S2+(h/2*S)//    SPRING FORCE OF MID
    PORTION IN N
35 n1=N*((P+F)/P)^.5// SPEED, WHEN THE
    SLEEVE BEGINS TO MOVE UPWARDS FROM MID POSITION
    IN rpm
36 n2=N*((P-F)/P)^.5// SPEED, WHEN THE
    SLEEVE BEGINS TO MOVE DOWNWARDS FROM MID POSITION
    IN rpm
37 A=n1-n2//         ALTERATION IN SPEED
    IN rpm
38 printf('INITIAL COMPRESSION OF SPRING= %.3 f cm\n
    ALTERATION IN SPEED = %.3 f rpm ', Is*100, A)

```

Scilab code Exa 7.10 EQUILIBRIUM SPEED OF GOVERNOR

```

1 //CHAPTER 7 ILLUSRTATION 10 PAGE NO 206
2 //TITLE:GOVERNORS
3 //FIGURE 7.10
4 clc
5 clear
6 //

```

```

7 //INPUT DATA
8 PI=3.147
9 AE=.25//          LENGTH OF UPPER ARM IN m
10 CE=.25//         LENGTH OF LOWER ARM IN m
11 EH=.1//          LENGTH OF EXTENDED ARM IN
    m
12 EF=.15//         RADIUS OF BALL PATH IN m
13 m=5//            MASS OF EACH BALL IN Kg
14 M=40//           MASS OF EACH BALL IN Kg
15 //

```

```

16 h=(AE^2-EF^2)^.5//          HEIGHT OF THE GOVERNOR
    IN m
17 EM=h
18 HM=EH+EM//                FROM FIGURE 7.10
19 N=((895/h)*(EM/HM)*((m+M)/m))^.5
20 printf('EQUILIBRIUM SPEED OF GOVERNOR = %.3 f rpm ',N)

```

Scilab code Exa 7.11 TENSION IN UPPER ARM

```

1 //CHAPTER 7 ILLUSRTATION 11 PAGE NO 207
2 //TITLE:GOVERNORS
3 //FIGURE 7.11
4 clc
5 clear
6 //

```

```

7 //INPUT DATA
8 PI=3.147
9 g=9.81//          ACCELERATION DUE TO
    GRAVITY IN N/mm^2
10 AE=.25//        LENGTH OF UPPER ARM IN m
11 CE=.25//        LENGTH OF LOWER ARM IN m
12 ER=.175//       FROM FIGURE 7.11
13 AP=.025//       FROM FIGURE 7.11
14 FR=AP//         FROM FIGURE 7.11
15 CQ=FR//         FROM FIGURE 7.11
16 m=3.2//         MASS OF BALL IN Kg
17 M=25//          MASS OF SLEEVE IN Kg
18 h=.2//          VERTICAL HEIGHT OF
    GOVERNOR IN m
19 EM=h//          FROM FIGURE 7.11
20 AF=h//          FROM FIGURE 7.11

```

```

21 N=160 //          SPEED OF THE GOVERNOR IN
    rpm
22 HM=(895*EM*(m+M)/(h*N^2*m))
23 x=HM-EM //      LENGTH OF EXTENDED LINK IN
    m
24 T1=g*(m+M/2)*AE/AF //  TENSION IN UPPER ARM IN N
25 printf('LENGTH OF EXTENDED LINK = %.3 f m\n TENSION
    IN UPPER ARM =%.3 f N' ,x ,T1)

```

Scilab code Exa 7.12 MAXIMUM SPEED OF ROTATION

```

1 //CHAPTER 7 ILLUSRTATION 12 PAGE NO 208
2 //TITLE:GOVERNORS
3 //FIGURE 7.12 ,7.13
4 clc
5 clear
6 //

```

```

7 //INPUT DATA
8 PI=3.147
9 EF=.20 //      MINIMUM RADIUS OF ROTATION IN
    m
10 AE=.30 //     LENGTH OF EACH ARM IN m
11 A1E1=AE //    COMPARING FIRUES 7.12&7.13
12 EC=.30 //     LENGTH OF EACH ARM IN m
13 E1C1=EC //    LENGTH OF EACH ARM IN m
14 ED=.165 //    FROM FIGURE 7.12 IN m
15 MC=ED //      FROM FIGURE 7.12
16 EH=.10 //     FROM FIGURE 7.12 IN m
17 m=8 //        MASS OF BALL IN Kg
18 M=60 //       MASS OF SLEEVE IN Kg
19 DF=.035 //    SLEEVE DISTANCE FROM AXIS IN
    m
20 E1F1=.25 //   MAX RADIUS OF ROTATION IN m

```

```

21 g=9.81
22 //

```

```

23 alpha=asind(EF/AE) //      ANGLE OF INCLINATION OF THE
      ARM TO THE VERTICAL IN DEGREES
24 beeta=asind(ED/EC) //      ANGLE OF INCLINATION OF THE
      ARM TO THE HORIZONTAL IN DEGREES
25 k=tand(beeta)/tand(alpha)
26 h=(AE^2-EF^2)^.5 //      HEIGHT OF GOVERNOR IN m
27 EM=(EC^2-MC^2)^.5 //      FROM FIGURE 7.12 IN m
28 HM=EM+EH
29 N2=(895*EM*(m+(M/2*(1+k)))/(h*HM*m))^.5 //
      EQUILIBRIUM SPEED AT MAX RADIUS
30 HC=(HM^2+MC^2)^.5 //      FROM FIGURE
      7.13 IN m
31 H1C1=HC
32 gama=atand(MC/HM)
33 alpha1=asind(E1F1/A1E1)
34 E1D1=E1F1-DF //      FROM
      FIGURE 7.13 IN m
35 beeta1=asind(E1D1/E1C1)
36 gama1=gama-beeta+beeta1
37 r=H1C1*sind(gama1)+DF //      RADIUS
      OF ROTATION IN m
38 H1M1=H1C1*cosd(gama1)
39 I1C1=E1C1*cosd(beeta1)*(tand(alpha1)+tand(beeta1)) //
      FROM FIGURE IN m
40 M1C1=H1C1*sind(gama1)
41 w1=(((m*g*(I1C1-M1C1))+(M*g*I1C1)/2)/(m*r*H1M1))^.5
      //      ANGULAR SPEED IN rad/s
42 N1=w1*60/(2*PI) //      //SPEED IN
      m/s
43 printf('MINIMUM SPEED OF ROTATION = %.3 f rpm\n
      MAXIMUM SPEED OF ROTATION = %.3 f rpm ',N2,N1)

```

Chapter 8

balancing of rotating masses

Scilab code Exa 8.1 magnitude of balancing mass

```
1 //CHAPTER 8 ILLUSRTATION 1 PAGE NO 221
2 //TITLE: BALANCING OF ROTATING MASSES
3 pi=3.141
4 clc
5 clear
6 mA=12//      mass of A in kg
7 mB=10//      mass of B in kg
8 mC=18//      mass of C in kg
9 mD=15//      mass of D in kg
10 rA=40//     radius of A in mm
11 rB=50//     radius of B in mm
12 rC=60//     radius of C in mm
13 rD=30//     radius of D in mm
14 theta1=0//  angle between A-A in degrees
15 theta2=60// angle between A-B in degrees
16 theta3=130// angle between A-C in degrees
17 theta4=270// angle between A-D in degrees
18 R=100//     radius at which mass to be determined in mm
19 //
```

```

20 Fh=(mA*rA*cosd(theta1)+mB*rB*cosd(theta2)+mC*rC*cosd
    (theta3)+mD*rD*cosd(theta4))/10//    vertical
    component value in kg cm
21 Fv=(mA*rA*sind(theta1)+mB*rB*sind(theta2)+mC*rC*sind
    (theta3)+mD*rD*sind(theta4))/10//    horizontal
    component value in kg cm
22 mb=(Fh^2+Fv^2)^.5/R*10//    unbalanced mass in kg
23 theta=atand(Fv/Fh)//    position in degrees
24 THETA=180+theta//    angle with mA
25 printf('magnitude of unbalaced mass=%0.3f kg\n angle
    with mA= %0.3f degrees ',mb,THETA)

```

Scilab code Exa 8.2 masses of D and E

```

1 //CHAPTER 8 ILLUSRTATION 2 PAGE NO 222
2 //TITLE: BALANCING OF ROTATING MASSES
3 pi=3.141
4 clc
5 clear
6 mA=5//    mass of A in kg
7 mB=10//    mass of B in kg
8 mC=8//    mass of C in kg
9 rA=10//    radius of A in cm
10 rB=15//    radius of B in cm
11 rC=10//    radius of C in cm
12 rD=10//    radius of D in cm
13 rE=15//    radius of E in cm
14 //=====
15 mD=182/rD//    mass of D in kg by mearument
16 mE=80/rE//    mass of E in kg by mearument
17 printf('mass of D= %0.3f kg\nmass of E= %0.3f kg ',mD,
    mE)

```

Scilab code Exa 8.3 balancing mass and angular position

```
1 //CHAPTER 8 ILLUSRTATION 3 PAGE NO 223
2 //TITLE:BALANCING OF ROTATING MASSES
3 pi=3.141
4 clc
5 clear
6 mA=200//      mass of A in kg
7 mB=300//      mass of B in kg
8 mC=400//      mass of C in kg
9 mD=200//      mass of D in kg
10 rA=80//      radius of A in mm
11 rB=70//      radius of B in mm
12 rC=60//      radius of C in mm
13 rD=80//      radius of D in mm
14 rX=100//     radius of X in mm
15 rY=100//     radius of Y in mm
16 //=====
17 mY=7.3/.04//  mass of Y in kg by mearurement
18 mX=35/.1//   mass of X in kg by mearurement
19 thetaX=146// in degrees by mesurement
20 printf('mass of X=%0.3f kg\n mass of Y=%0.3f kg\n
        angle with mA=%0.0f degrees ',mX,mY,thetaX)
```

Scilab code Exa 8.4 balancing mass and angular position

```
1 //CHAPTER 8 ILLUSRTATION 4 PAGE NO 225
2 //TITLE:BALANCING OF ROTATING MASSES
3 pi=3.141
4 clc
5 clear
6 mB=30//      mass of B in kg
7 mC=50//      mass of C in kg
8 mD=40//      mass of D in kg
9 rA=18//      radius of A in cm
```

```

10 rB=24//          radius of B in cm
11 rC=12//          radius of C in cm
12 rD=15//          radius of D in cm
13 //=====
14 mA=3.6/.18//     mass of A by measurement in kg
15 theta=124//      angle with mass B in degrees by
    measurement in degrees
16 y=3.6/ (.18*20)// position of A from B
17 printf('mass of A=%i kg\n angle with mass B=%i
    degrees\n position of A from B=%i m towards right
    of plane B',mA,theta,y)

```

Scilab code Exa 8.5 balancing mass and angular position

```

1 //CHAPTER 8 ILLUSRTATION 5 PAGE NO 226
2 //TITLE: BALANCING OF ROTATING MASSES
3 pi=3.141
4 clc
5 clear
6 mB=10//          mass of B in kg
7 mC=5//           mass of C in kg
8 mD=4//           mass of D in kg
9 rA=10//          radius of A in cm
10 rB=12.5//        radius of B in cm
11 rC=20//          radius of C in cm
12 rD=15//          radius of D in cm
13 //=====
14 mA=7//           mass of A in kg by mesurement
15 BC=118//         angle between B and C in degrees by
    measurement
16 BA=203.5//       angle between B and A in degrees by
    measurement
17 BD=260//         angle between B and D in degrees by
    measurement
18 printf('Mass of A=%i kg\n angle between B and C=%i

```

```
degrees\nangle between B and A= %.1f degrees\n
angle between B and D= %i degrees ',mA,BC,BA,BD)
```

Scilab code Exa 8.6 mass of D

```
1 //CHAPTER 8 ILLUSRTATION 6 PAGE NO 228
2 //TITLE:BALANCING OF ROTATING MASSES
3 pi=3.141
4 clc
5 clear
6 mB=36//          mass of B in kg
7 mC=25//          mass of C in kg
8 rA=20//          radius of A in cm
9 rB=15//          radius of B in cm
10 rC=15//          radius of C in cm
11 rD=20//          radius of D in cm
12 //=====
13 mA=3.9/.2//      mass of A in kg by measurement
14 mD=16.5//        mass of D in kg by measurement
15 theta=252//      angular position of D from B by
    measurement in degrees
16 printf('Mass of A= %.1f kg\n Mass od D= %.1f kg\n
    Angular position of D from B= %i degrees ',mA,mD,
    theta)
```

Scilab code Exa 8.7 load on each bearing

```
1 //CHAPTER 8 ILLUSRTATION 7 PAGE NO 229
2 //TITLE:BALANCING OF ROTATING MASSES
3
4 clc
5 clear
6 pi=3.141
```

```

7 mA=48//      mass of A in kg
8 mB=56//      mass of B in kg
9 mC=20//      mass of C in kg
10 rA=1.5//    radius of A in cm
11 rB=1.5//    radius of B in cm
12 rC=1.25//   radius of C in cm
13 N=300//     speed in rpm
14 d=1.8//     distance between bearing in cm
15 //=====
16 w=2*pi*N/60// angular speed in rad/s
17 BA=164//    angle between pulleys B&A in degrees by
    measurement
18 BC=129//    angle between pulleys B&C in degrees by
    measurement
19 AC=67//    angle between pulleys A&C in degrees by
    measurement
20 C=.88*w^2// out of balance couple in N
21 L=C/d//    load on each bearing in N
22 printf('angle between pulleys B&A=%i degrees\n angle
    between pulleys B&C= %i degrees\n angle between
    pulleys A&C= %i degrees\n out of balance couple=
    %.3f N\n load on each bearing= %.3f N',BA,BC,AC,C
    ,L)

```

Chapter 9

cams and followers

Scilab code Exa 9.2 maximum velocity and acceleration

```
1 //CHAPTER 9 ILLUSRTATION 2 PAGE NO 247
2 //TITLE:CAMS AND FOLLOWERS
3 clc
4 clear
5 pi=3.141
6 s=4//          follower movement in cm
7 theta=60//     cam rotation in degrees
8 THETA=60*pi/180//  cam rotation in rad
9 thetaD=45//    after outstroke in degrees
10 thetaR=90//... angle with which it reaches its
    original position in degrees
11 THETAR=90*pi/180//  angle with which it reaches its
    original position in rad
12 THETAd=360-theta-thetaD-thetaR//      angle after
    return stroke in degrees
13 N=300//      speed in rpm
14 w=2*pi*N/60//  speed in rad/s
15 Vo=pi*w*s/2/THETA//  Maximum velocity of follower
    during outstroke in cm/s
16 Vr=pi*w*s/2/THETAR// Maximum velocity of follower
    during return stroke in cm/s
```

```

17 Fo=pi^2*w^2*s/2/THETA^2/100//Maximum acceleration of
    follower during outstroke in m/s^2
18 Fr=pi^2*w^2*s/2/THETAR^2/100//Maximum acceleration
    of follower during return stroke in m/s^2
19 printf('Maximum acceleration of follower during
    outstroke =%.3f m/s^2\nMaximum acceleration of
    follower during return stroke= %.3f m/s^2',Fo,Fr)

```

Scilab code Exa 9.3 maximum velocity and acceleration

```

1 //CHAPTER 9 ILLUSRTATION 3 PAGE NO 249
2 //TITLE:CAMS AND FOLLOWERS
3 clc
4 clear
5 pi=3.141
6 s=5//          follower movement in cm
7 theta=120//    cam rotation in degrees
8 THETA=theta*pi/180//    cam rotation in rad
9 thetaD=30//    after outstroke in degrees
10 thetaR=60//.... angle with which it reaches its
    original position in degrees
11 THETAR=60*pi/180//    angle with which it reaches its
    original position in rad
12 THETAd=360-theta-thetaD-thetaR//    angle after
    return stroke in degrees
13 N=100//    speed in rpm
14 w=2*pi*N/60//    speed in rad/s
15 Vo=pi*w*s/2/THETA//    Maximum velocity of follower
    during outstroke in cm/s
16 Vr=pi*w*s/2/THETAR//    Maximum velocity of follower
    during return stroke in cm/s
17 Fo=pi^2*w^2*s/2/THETA^2/100//Maximum acceleration of
    follower during outstroke in m/s^2
18 Fr=pi^2*w^2*s/2/THETAR^2/100//Maximum acceleration
    of follower during return stroke in m/s^2

```



```
19 printf('Maximum acceleration of follower during
    outstroke =%.3f m/s^2\nMaximum acceleration of
    follower during return stroke= %.3f m/s^2',Fo,Fr)
```

Scilab code Exa 9.5 maximum velocity and acceleration

```
1 //CHAPTER 9 ILLUSRTATION 5 PAGE NO 252
2 //TITLE:CAMS AND FOLLOWERS
3 clc
4 clear
5 pi=3.141
6 N=1000// speed of cam in rpm
7 w=2*pi*N/60// angular speed in rad/s
8 s=2.5// stroke of the follower in cm
9 THETA=120*pi/180// ANGULAR DISPLACEMENT OF CAM
    DURING OUTSTROKE IN RAD
10 THETAR=90*pi/180//ANGULAR DISPLACEMENT OF CAM DURING
    DWELL IN RAD
11 Vo=2*w*s/THETA// Maximum velocity of follower
    during outstroke in cm/s
12 Vr=2*w*s/THETAR//Maximum velocity of follower during
    return stroke in cm/s
13 Fo=4*w^2*s/THETA^2//Maximum acceleration of follower
    during outstroke in m/s^2
14 Fr=4*w^2*s/THETAR^2//Maximum acceleration of
    follower during return stroke in m/s^2
15 printf('Maximum acceleration of follower during
    outstroke =%.3f m/s^2\nMaximum acceleration of
    follower during return stroke= %.3f m/s^2',Fo,Fr)
```

Chapter 10

Brakes and Dynamometers

Scilab code Exa 10.1 Torque transmitted by the block brake

```
1 //CHAPTER 10 ILLUSTRATION 1 PAGE NO 268
2 //TITLE: Brakes and Dynamometers
3 clc
4 clear
5 //


---


6 //INPUT DATA
7 d=0.32; //Diameter of the drum in m
8 qq=90; //Angle of contact in degree
9 P=820; //Force applied in N
10 U=0.35; //Coefficient of friction
11
12
13 U1=((4*U*sind(qq/2))/((qq*(3.14/180))+sind(qq))); //
    Equivalent coefficient of friction
14 F=((P*0.66)/((0.3/U1)-0.06)); //Force value in N
    taking moments
15 TB=(F*(d/2)); //Torque transmitted in N.m
16
17 printf('Torque transmitted by the block brake is %3
```

.4 f N.m', TB)

Scilab code Exa 10.2 DISTANCE TRAVELLED BY CYCLE

```
1 //CHAPTER 10 ILLUSRTATION 2 PAGE NO 269
2 //TITLE: Brakes and Dynamometers
3 clc
4 clear
5 //
6 //INPUT DATA
7 m=120; //Mass of rider in kg
8 v=16.2; //Speed of rider in km/hr
9 d=0.9; //Diameter of the wheel in m
10 P=120; //Pressure applied on the brake in N
11 U=0.06; //Coefficient of friction
12
13 F=(U*P); //Frictional force in N
14 KE=((m*(v*(5/18))^2)/2); //Kinematic Energy in N.m
15 S=(KE/F); //Distance travelled by the bicycle before
    it comes to rest in m
16 N=(S/(d*3.14)); //Required number of revolutions
17
18 printf('The bicycle travels a distance of %3.2f m
    and makes %3.2f turns before it comes to rest', S,
    N)
```

Scilab code Exa 10.3 Maximum torque absorbed

```
1 //CHAPTER 10 ILLUSRTATION 3 PAGE NO 270
2 //TITLE: Brakes and Dynamometers
3 clc
```

```

4 clear
5 //

```

```

6 //INPUT DATA
7 S=3500; //Force on each arm in N
8 d=0.36; //Diameter of the wheel in m
9 U=0.4; //Coefficient of friction
10 qq=100; //Contact angle in degree
11
12 qqr=(qq*(3.14/180)); //Contact angle in radians
13 UU=((4*U*sind(qq/2))/(qqr+(sind(qq)))); //Equivalent
    coefficient of friction
14 F1=(S*0.45)/((0.2/UU)+((d/2)-0.04)); //Force on
    fulcrum in N
15 F2=(S*0.45)/((0.2/UU)-((d/2)-0.04)); //Force on
    fulcrum in N
16 TB=(F1+F2)*(d/2); //Maximum torque absorbed in N.m
17
18 printf('Maximum torque absorbed is %3.2f N.m',TB)

```

Scilab code Exa 10.4 The maximum braking torque on the drum

```

1 //CHAPTER 10 ILLUSTRATION 4 PAGE NO 271
2 //TITLE: Brakes and Dynamometers
3 clc
4 clear
5 //

```

```

6 //INPUT DATA
7 a=0.5; //Length of lever in m
8 d=0.5; //Diameter of brake drum in m
9 q=(5/8)*(2*3.14); //Angle made in radians
10 b=0.1; //Distance between pin and fulcrum in m

```

```

11 P=2000; // Effort applied in N
12 U=0.25; // Coefficient of friction
13
14 T=exp(U*q); // Ratios of tension
15 T2=((P*a)/b); // Tension in N
16 T1=(T*T2); // Tension in N
17 TB=((T1-T2)*(d/2))/1000; // Maximum braking torque in
    kNm
18
19 printf('The maximum braking torque on the drum is %3
    .3 f kNm',TB)

```

Scilab code Exa 10.5 Tensions in the side

```

1 //CHAPTER 10 ILLUSTRATION 5 PAGE NO 271
2 //TITLE: Brakes and Dynamometers
3 clc
4 clear
5 //

```

```

6 //INPUT DATA
7 q=220; // Angle of contact in degree
8 T=340; // Torque in Nm
9 d=0.32; // Diameter of drum in m
10 U=0.3; // Coefficient of friction
11
12 Td=(T/(d/2)); // Difference in tensions in N
13 Tr=exp(U*(q*(3.14/180))); // Ratio of tensions
14 T2=(Td/(Tr-1)); // Tension in N
15 T1=(Tr*T2); // Tension in N
16 P=((T2*(d/2))-(T1*0.04))/0.5; // Force applied in N
17 b=(T1/T2)*4; // Value of b in cm when the brake is
    self-locking
18

```

```

19 printf('The value of b is %3.2f cm when the brake is
    self-locking \n Tensions in the sides are %3.3f
    N and %3.3f N',b,T1,T2)

```

Scilab code Exa 10.6 Torque required

```

1 //CHAPTER 10 ILLUSTRATION 6 PAGE NO 272
2 //TITLE: Brakes and Dynamometers
3 clc
4 clear
5 //

```

```

6 //INPUT DATA
7 d=0.5; //Drum diameter in m
8 U=0.3; //Coefficient of friction
9 q=250; //Angle of contact in degree
10 P=750; //Force in N
11 a=0.1; //Band width in m
12 b=0.8; //Distance in m
13 ft=(70*10^6); //Tensile stress in Pa
14 f=(60*10^6); //Stress in Pa
15 b1=0.1; //Distance in m
16
17 T=exp(U*(q*(3.14/180))); //Tensions ratio
18 T2=(P*b*10)/(T+1); //Tension in N
19 T1=(T*T2); //Tension in N
20 TB=(T1-T2)*(d/2); //Torque in N.m
21 t=(max(T1,T2)/(ft*a))*1000; //Thickness in mm
22 M=(P*b); //bending moment at fulcrum in Nm
23 X=(M/((1/6)*f)); //Value of th^2
24 //t varies from 10mm to 15 mm. Taking t=15mm,
25 h=sqrt(X/(0.015))*1000; //Section of the lever in m
26
27 printf('Torque required is %3.2f N.m \nThickness

```

necessary to limit the tensile stress to 70 MPa
is %3.3f mm \n Section of the lever taking stress
to 60 MPa is %3.1f mm',TB,t,h)

Scilab code Exa 10.7 Power TO BD ratio

```
1 //CHAPTER 10 ILLUSTRATION 7 PAGE NO 273
2 //TITLE: Brakes and Dynamometers
3 clc
4 clear
5 //
6 //INPUT DATA
7 P1=30; //Power in kW
8 N=1250; //Speed in r.p.m
9 P=60; //Applied force in N
10 d=0.8; //Drum diameter in m
11 q=310; //Contact angle in degree
12 a=0.03; //Length of a in m
13 b=0.12; //Length of b in m
14 U=0.2; //Coefficient of friction
15 B=10; //Band width in cm
16 D=80; //Diameter in cm
17
18 T=(P1*60000)/(2*3.14*N); //Torque in N.m
19 Td=(T/(d/2)); //Tension difference in N
20 Tr=exp(U*(q*(3.14/180))); //Tensions ratio
21 T2=(Td/(Tr-1)); //Tension in N
22 T1=(Tr*T2); //Tension in N
23 x=((T2*b)-(T1*a))/P; //Distance in m;
24 X=(P1/(B*D)); //Ratio
25
26 printf('Value of x is %3.4f m \n Value of (Power/bD)
        ratio is %3.4f',x,X)
```

Scilab code Exa 10.8 Time required to bring the shaft to the rest from its running

```
1 //CHAPTER 10 ILLUSTRATION 8 PAGE NO 274
2 //TITLE: Brakes and Dynamometers
3 clc
4 clear
5 //
6 //INPUT DATA
7 m=80; //Mass of flywheel in kg
8 k=0.5; //Radius of gyration in m
9 N=250; //Speed in r.p.m
10 d=0.32; //Diameter of the drum in m
11 b=0.05; //Distance of pin in m
12 q=260; //Angle of contact in degree
13 U=0.23; //Coefficient of friction
14 P=20; //Force in N
15 a=0.35; //Distance at which force is applied in m
16
17 Tr=exp(U*q*(3.14/180)); //Tensions ratio
18 T2=(P*a)/b; //Tension in N
19 T1=(Tr*T2); //Tension in N
20 TB=(T1-T2)*(d/2); //Torque in N.m
21 KE=((1/2)*(m*k^2)*((2*3.14*N)/60)^2); //Kinematic
    energy of the rotating drum in Nm
22 N1=(KE/(TB*2*3.14)); //Speed in rpm
23 aa=((2*3.14*N)/60)^2/(4*3.14*N1); //Angular
    acceleration in rad/s^2
24 t=((2*3.14*N)/60)/aa; //Time in seconds
25
26 printf('Time required to bring the shaft to the rest
    from its running condition is %3.1f seconds',t)
```

Scilab code Exa 10.9 Minimum force required

```
1 //CHAPTER 10 ILLUSTRATION 9 PAGE NO 275
2 //TITLE: Brakes and Dynamometers
3 clc
4 clear
5 //


---


6 //INPUT DATA
7 n=12; //Number of blocks
8 q=15; //Angle subtended in degree
9 P=185; //Power in kW
10 N=300; //Speed in r.p.m
11 U=0.25; //Coefficient of friction
12 d=1.25; //Diameter in m
13 b1=0.04; //Distance in m
14 b2=0.14; //Distance in m
15 a=1; //Distance in m
16 m=2400; //Mass of rotor in kg
17 k=0.5; //Radius of gyration in m
18
19 Td=(P*60000)/(2*3.14*N*(d/2)); //Tension difference
    in N
20 T=Td*(d/2); //Torque in Nm
21 Tr=((1+(U*tand(q/2)))/(1-(U*tand(q/2))))^n; //Tension
    ratio
22 To=(Td/(Tr-1)); //Tension in N
23 Tn=(Tr*To); //Tension in N
24 P=((To*b2)-(Tn*b1))/a; //Force in N
25 aa=(T/(m*k^2)); //Angular acceleration in rad/s^2
26 t=((2*3.14*N)/60)/aa; //Time in seconds
27
28 printf('Minimum force required is %3.0f N \nTime
```

taken to bring to rest is %3.1f seconds',P,t)

Scilab code Exa 10.10 Maximum braking torque

```
1 //CHAPTER 10 ILLUSTRATION 10 PAGE NO 275
2 //TITLE: Brakes and Dynamometers
3 clc
4 clear
5 //
6 //INPUT DATA
7 n=12; // Number of blocks
8 q=16; //Angle subtended in degrees
9 d=0.9; //Effective diameter in m
10 m=2000; //Mass in kg
11 k=0.5; //Radius of gyration in m
12 b1=0.7; //Distance in m
13 b2=0.03; //Distance in m
14 a=0.1; //Distance in m
15 P=180; //Force in N
16 N=360; //Speed in r.p.m
17 U=0.25; //Coefficient of friction
18
19 Tr=((1+(U*tand(q/2)))/(1-(U*tand(q/2))))^n; //
    Tensions ratio
20 T2=(P*b1)/(a-(b2*Tr)); //Tension in N
21 T1=(Tr*T2); //Tension in N
22 TB=(T1-T2)*(d/2); //Torque in N.m
23 aa=(TB/(m*k^2)); //Angular acceleration in rad/s^2
24 t=((2*3.14*N)/60)/aa; //Time in seconds
25
26 printf('(i) Maximum braking torque is %3.4f Nm \n(ii)
    ) Angular retardation of the drum is %3.4f rad/s
    ^2 \n(iii) Time taken by the system to come to
```

rest is %3.1f s',TB,aa,t)

Chapter 11

VIBRATIONS

Scilab code Exa 11.1 FREQUENCY OF TRANSVERSE VIBRATION

```
1 //CHAPTER 11 ILLUSRTATION 1 PAGE NO 290
2 //TITLE:VIBRATIONS
3 clc
4 clear
5 //

```

```
6 //INPUT DATA
7 PI=3.147
8 D=.1//          DIAMETER OF SHAFT
   IN m
9 L=1.10//       LENGTH OF SHAFT IN
   m
10 W=450//        WEIGHT ON THE OTHER
   END OF SHAFT IN NEWTONS
11 E=200*10^9//   YOUNGS MODUKUS OF
   SHAFT MATERIAL IN Pascals
12 //

```

```
13 A=PI*D^2/4//   AREA OF SHAFT IN mm
```

```

      ^2
14 I=PI*D^4/64//          MOMENT OF INERTIA
15 delta=W*L/(A*E)//     STATIC DEFLECTION IN
      LONGITUDINAL VIBRATION OF SHAFT IN m
16 Fn=0.4985/(delta)^.5// FREQUENCY OF
      LONGITUDINAL VIBRATION IN Hz
17 delta1=W*L^3/(3*E*I)// STATIC DEFLECTION
      IN TRANSVERSE VIBRATION IN m
18 Fn1=0.4985/(delta1)^.5// FREQUENCY OF
      TRANSVERSE VIBRATION IN Hz
19 //

```

```

20 //OUTPUT
21 printf('FREQUENCY OF LONGITUDINAL VIBRATION =%.3 f Hz
      \n FREQUENCY OF TRANSVERSE VIBRATION =%.3 f Hz ',Fn
      ,Fn1)

```

Scilab code Exa 11.2 NATURAL FREQUENCY OF TRANSVERSE VIBRATION

```

1 //CHAPTER 11 ILLUSRTATION 2 PAGE NO 290
2 //TITLE:VIBRATIONS
3 //FIGURE 11.10
4 clc
5 clear
6 //

```

```

7 //INPUT DATA
8 PI=3.147
9 L=.9//          LENGTH OF THE SHAFT
      IN m
10 m=100//        MASS OF THE BODY IN
      Kg
11 L2=.3//        LENGTH WHERE THE

```

```

    WEIGHT IS ACTING IN m
12 L1=L-L2//          DISTANCE FROM THE
    OTHER END
13 D=.06//          DIAMETER OF SHAFT IN
    m
14 W=9.81*m//      WEGHT IN NEWTON
15 E=200*10^9//    YOUNGS MODUKUS OF
    SHAFT MATERIAL IN Pascals
16 //


---


17 //CALCULATION
18 I=PI*D^4/64//    MOMENT OF INERTIA IN
    m^4
19 delta=W*L1^2*L2^2/(3*E*I*L)//  STATIC DEFLECTION
20 Fn=.4985/(delta)^.5//    NATURAL FREQUENCY OF
    TRANSVERSE VIBRATION
21 //


---


22 //OUTPUT
23 printf('NATURAL FREQUENCY OF TRANSVERSE VIBRATION=%
    .3 f Hz',Fn)


---



```

Scilab code Exa 11.3 FREQUENCY OF TORSIONAL VIBRATION

```

1 //CHAPTER 11 ILLUSRTATION 3 PAGE NO 291
2 //TITLE:VIBRATIONS
3 //FIGURE 11.11
4 clc
5 clear
6 //


---


7 //INPUT DATA

```

```

8  PI=3.147
9  g=9.81 //
    ACCELERATION DUE TO GRAVITY IN N /m^2
10 D=.050 //
    DIAMETER OF SHAFT IN m
11 m=450 //
    WEIGHT
    OF FLY WHEEL IN IN Kg
12 K=.5 //
    RADIUS
    OF GYRATION IN m
13 L2=.6 //
    FROM
    FIGURE IN m
14 L1=.9 //
    FROM
    FIGURE IN m
15 L=L1+L2
16 E=200*10^9 //
    YOUNGS MODUKUS OF
    SHAFT MATERIAL IN Pascals
17 C=84*10^9 //
    MODUKUS OF RIDITY
    OF SHAFT MATERIAL IN Pascals
18 //



---


19 A=PI*D^2/4 //
    AREA OF
    SHAFT IN mm^2
20 I=PI*D^4/64 //
21 m1=m*L2/(L1+L2) //
    MASS OF
    THE FLYWHEEL CARRIED BY THE LENGTH L1 IN Kg
22 DELTA=m1*g*L1/(A*E) //
    EXTENSION OF LENGTH L1 IN m
23 Fn=0.4985/(DELTA)^.5 //
    FREQUENCY OF LONGITUDINAL VIBRATION IN Hz
24 DELTA1=(m*g*L1^3*L2^3)/(3*E*I*L^3) //
    STATIC
    DEFLECTION IN TRANSVERSE VIBRATION IN m
25 Fn1=0.4985/(DELTA1)^.5 //
    FREQUENCY OF TRANSVERSE VIBRATION IN Hz
26 J=PI*D^4/32 //
    POLAR
    MOMENT OF INERTIA IN m^4
27 Q1=C*J/L1 //
    TORSIONAL STIFFNESS OF SHAFT DUE TO L1 IN N-m

```

```

28 Q2=C*J/L2//
    TORSIONAL STIFFNESS OF SHAFT DUE TO L2 IN N-m
29 Q=Q1+Q2//
    TORSIONAL STIFFNESS OF SHAFT IN Nm
30 Fn2=(Q/(m*K^2))^.5/(2*PI)//
    FREQUENCY OF TORSIONAL VIBRATION IN Hz
31 //

```

```

32 printf('FREQUENCY OF LONGITUDINAL VIBRATION = %.3 f
    Hz\n FREQUENCY OF TRANSVERSE VIBRATION = %.3 f Hz\n
    n FREQUENCY OF TORSIONAL VIBRATION = %.3 f Hz',Fn,
    Fn1,Fn2)

```

Scilab code Exa 11.6 FREQUENCY OF TRANSVERSE VIBRATION

```

1 //CHAPTER 11 ILLUSTRATION 6 PAGE NO 294
2 //TITLE:VIBRATIONS
3 //FIGURE 11.14
4 clc
5 clear
6 //

```

```

7 //INPUT DATA
8 PI=3.147
9 g=9.81//
    ACCELERATION DUE TO GRAVITY IN N /m^2
10 D=.06//
    DIAMETER OF SHAFT IN m
11 L=3//
    OF SHAFT IN m
    LENGTH
12 W1=1500//
    ACTING AT C IN N
    WEIGHT
13 W2=2000//
    WEIGHT

```



```

    ACTING AT D IN N
14 W3=1000 // WEIGHT
    ACTING AT E IN N
15 L1=1 // LENGTH
    FROM A TO C IN m
16 L2=2 // LENGTH
    FROM A TO D IN m
17 L3=2.5 //
    LENGTH FROM A TO E IN m
18 I=PI*D^4/64
19 E=200*10^9 // YOUNGS MODUKUS OF
    SHAFT MATERIAL IN Pascals
20 //


---


21 DELTA1=W1*L1^2*(L-L1)^2/(3*E*I*L) // STATIC
    DEFLECTION DUE TO W1
22 DELTA2=W2*L2^2*(L-L2)^2/(3*E*I*L) // STATIC
    DEFLECTION DUE TO W2
23 DELTA3=W2*L3^2*(L-L3)^2/(3*E*I*L) // STATIC
    DEFLECTION DUE TO W2
24 Fn=.4985/(DELTA1+DELTA2+DELTA3)^.5 //
    FREQUENCY OF TRANSVERSE VIBRATION IN Hz
25 //


---


26 printf('FREQUENCY OF TRANSVERSE VIBRATION = %.3 f Hz'
    ,Fn)

```

Scilab code Exa 11.10 FREQUENCY OF TRANSVERSE VIBRATION

```

1 //CHAPTER 11 ILLUSRTATION 10 PAGE NO 296
2 //TITLE:VIBRATIONS
3 //FIGURE 11.18
4 clc

```

```

5 clear
6 //

```

```

7 //INPUT DATA
8 PI=3.147
9 g=9.81//
  ACCELERATION DUE TO GRAVITY IN N /m^2
10 E=200*10^9// YOUNGS
  MODULUS OF SHAFT MATERIAL IN Pascals
11 D=.03//
  DIAMETER OF SHAFT IN m
12 L=.8// LENGTH
  OF SHAFT IN m
13 r=40000//
  DENSITY OF SHAFT MATERIAL IN Kg/m^3
14 W=10// WEIGHT
  ACTING AT CENTRE IN N
15 //

```

```

16 I=PI*D^4/64// MOMENT
  OF INERTIA OF SHAFT IN m^4
17 m=PI*D^2/4*r// MASS
  PER UNIT LENGTH IN Kg/m
18 w=m*g
19 DELTA=W*L^3/(48*E*I)// STATIC
  DEFLECTION DUE TO W
20 DELTA1=5*w*L^4/(384*E*I)// STATIC
  DEFLECTION DUE TO WEIGHT OF SHAFT
21 Fn=.4985/(DELTA+DELTA1/1.27)^.5
22 //

```

```

23 printf('FREQUENCY OF TRANSVERSE VIBRATION = %.3 f Hz'
,Fn)

```

Scilab code Exa 11.11 CRITICAL SPEED OF SHAFT

```
1 //CHAPTER 11 ILLUSRTATION 11 PAGE NO 297
2 //TITLE:VIBRATIONS
3 //FIGURE 11.19
4 clc
5 clear
6 //


---


7 //INPUT DATA
8 PI=3.147
9 g=9.81//
   ACCELERATION DUE TO GRAVITY IN N /m^2
10 E=210*10^9//
   MODUKUS OF SHAFT MATERIAL IN Pascals
   YOUNGS
11 D=.18//
   DIAMETER OF SHAFT IN m
12 L=2.5//
   OF SHAFT IN m
   LENGTH
13 M1=25//
   ACTING AT E IN Kg
   MASS
14 M2=50//
   ACTING AT D IN Kg
   MASS
15 M3=20//
   ACTING AT C IN Kg
   MASS
16 W1=M1*g
17 W2=M2*g
18 W3=M3*g
19 L1=.6//
   FROM A TO E IN m
   LENGTH
20 L2=1.5//
   FROM A TO D IN m
   LENGTH
21 L3=2//
   LENGTH
```

```

                FROM A TO C IN m
22  w=1962//                                          SELF
                WEIGHT OF SHAFT IN N
23  //


---


24  I=PI*D^4/64//                                    MOMENT
                OF INERTIA OF SHAFT IN m^4
25  DELTA1=W1*L1^2*(L-L1)^2/(3*E*I*L)//            STATIC
                DEFLECTION DUE TO W1
26  DELTA2=W2*L2^2*(L-L2)^2/(3*E*I*L)//            STATIC
                DEFLECTION DUE TO W2
27  DELTA3=W3*L3^2*(L-L3)^2/(3*E*I*L)//            STATIC
                DEFLECTION DUE TO W3
28  DELTA4=5*w*L^4/(384*E*I)//                      STATIC
                DEFLECTION DUE TO w
29  Fn=.4985/(DELTA1+DELTA2+DELTA3+DELTA4/1.27)^.5
30  Nc=Fn*60//
                CRITICAL SPEED OF SHAFT IN rpm
31  //


---


32  printf('CRITICAL SPEED OF SHAFT = %.3 f rpm ',Nc)

```

Scilab code Exa 11.12 FREQUENCY OF FREE TORSIONAL VIBRATION

```

1  //CHAPTER 11 ILLUSRTATION 12 PAGE NO 298
2  //TITLE:VIBRATIONS
3  //FIGURE 11.20
4  clc
5  clear
6  //


---


7  //INPUT DATA

```

```

8  PI=3.147
9  g=9.81//
    ACCELERATION DUE TO GRAVITY IN N /m^2
10 Na=1500//
    OF SHAFT A IN rpm
    SPEED
11 Nb=500//
    OF SHAFT B IN rpm
    SPEED
12 G=Na/Nb//
    RATIO
    GERA
13 L1=.18//
    LENGTH OF SHAFT 1 IN m
14 L2=.45//
    LENGTH OF SHAFT 2 IN m
15 D1=.045//
    DIAMETER OF SHAFT 1 IN m
16 D2=.09//
    DIAMETER OF SHAFT 2 IN m
17 C=84*10^9//
    OF SHAFT MATERIAL IN Pascals
    MODUKUS OF RIDITY
18 Ib=1400//
    OF PUMP IN Kg-m^2
    MOMENT OF INERTIA
19 Ia=400//
    OF MOTOR IN Kg-m^2
    MOMENT OF INERTIA
20
21 //

```

```

22 J=PI*D1^4/32//
    MOMENT OF INERTIA IN m^4
    POLAR
23 Ib1=Ib/G^2//
    INERTIA OF EQUIVALENT ROTOR IN m^2
    MASS MOMENT OF
24 L3=G^2*L2*(D1/D2)^4//
    OF THE EQUIVALENT SHAFT
    ADDITIONAL LENGTH
25 L=L1+L3//
    EQUIVALENT SHAFT
    TOTAL LENGTH OF
26 La=L*Ib1/(Ia+Ib1)
27 Fn=(C*J/(La*Ia))^0.5/(2*PI)//
    TORSIONAL VIBRATION IN Hz
    FREQUENCY OF FREE

```

```

28 //


---


29 printf('FREQUENCY OF FREE TORSIONAL VIBRATION = %.2 f
      Hz ',Fn)


---



```

Scilab code Exa 11.13 THE RANGE OF SPEED

```

1 //CHAPTER 11 ILLUSRTATION 13 PAGE NO 300
2 //TITLE:VIBRATIONS
3 //FIGURE 11.21
4 clc
5 clear
6 //


---


7 //INPUT DATA
8 PI=3.147
9 g=9.81//
      ACCELERATION DUE TO GRAVITY IN N /m^2
10 D=.015//
      DIAMETER OF SHAFT IN m
11 L=1.00//
      LENGTH OF SHAFT IN m
12 M=15//
      MASS OF SHAFT IN Kg
13 W=M*g
14 e=.0003//
      ECCENTRICITY IN m
15 E=200*10^9//
      MODUKUS OF SHAFT MATERIAL IN Pascals
      YOUNGS
16 f=70*10^6//
      PERMISSIBLE STRESS IN N/m^2
17 //


---



```

```

18 I=PI*D^4/64 //           MOMENT OF INERTIA OF
    SHAFT IN m^4
19 DELTA=W*L^3/(192*E*I) //  STATIC DEFLECTION IN m
20 Fn=.4985/(DELTA)^.5 //   NATURAL FREQUENCY OF
    TRANSVERSE VIBRATION
21 Nc=Fn*60 //             CRITICAL SPEED OF SHAFT
    IN rpm
22 M1=16*f*I/(D*g*L)
23 W1=M1*g //             ADDITIONAL LOAD ACTING
24 y=W1/W*DELTA //        ADDITIONAL DEFLECTION
    DUE TO W1
25 N1=Nc/(1+e/y)^.5 //     MIN SPEED IN rpm
26 N2=Nc/(1-e/y)^.5 //     MAX SPEED IN rpm
27 //

```

```

28 printf('CRITICAL SPEED OF SHAFT = %.3 f rpm\n THE
    RANGE OF SPEED IS FROM %.3 f rpm TO %.3 f rpm ',Nc ,
    N1 ,N2)

```

Chapter 12

balancing of reciprocating masses

Scilab code Exa 12.1 Magnitude of balance mass required

```
1 //CHAPTER 12 ILLUSRTATION 1 PAGE NO 310
2 //TITLE:Balancing of reciprocating of masses
3 clc
4 clear
5 pi=3.141
6 N=250//          speed of the reciprocating
   engine in rpm
7 s=18//          length of stroke in mm
8 mR=120//        mass of reciprocating parts in
   kg
9 m=70//          mass of revolving parts in kg
10 r=.09//        radius of revolution of
   revolving parts in m
11 b=.15//        distance at which balancing
   mass located in m
12 c=2/3//        portion of reciprocating mass
   balanced
13 teeta=30//      crank angle from inner dead
   centre in degrees
```



```

14 //=====
15 B=r*(m+c*mR)/b//          balance mass required
    in kg
16 w=2*pi*N/60//          angular speed in rad/s
17 F=mR*w^2*r*((1-c)^2*(cosd(teeta))^2)+(c^2*(sind(
    teeta))^2))^0.5//      residual unbalanced forces
    in N
18 printf('Magnitude of balance mass required= %.0f kg\
    n Residual unbalanced forces= %.3f N',B,F)

```

Scilab code Exa 12.2 swaying couple

```

1 //CHAPTER 12 ILLUSTRATION 2 PAGE NO 310
2 //TITLE:Balancing of reciprocating of masses
3 clc
4 clear
5 pi=3.141
6 g=10//          acceleration due to gravity approximately
    in m/s^2
7 mR=240//        mass of reciprocating parts per cylinder
    in kg
8 m=300//         mass of rotating parts per cylinder in
    kg
9 a=1.8//distance between cylinder centres in m
10 c=.67//        portion of reciprocating mass to be
    balanced
11 b=.60//        radius of balance masses in m
12 r=24//         crank radius in cm
13 R=.8//radius of thread of wheels in m
14 M=40
15 //=====
16 Ma=m+c*mR//    total mass to be balanced in
    kg
17 mD=211.9//     mass of wheel D from figure in kg
18 mC=211.9//     mass of wheel C from figure in kg

```

```

19 theta=171//      angular position of balancing mass C
      in degrees
20 Br=c*mR/Ma*mC//      balancing mass for
      reciprocating parts in kg
21 w=(M*g^3/Br/b)^.5//      angular speed in rad/s
22 v=w*R*3600/1000// speed in km/h
23 S=a*(1-c)*mR*w^2*r/2^.5/100/1000//      swaying couple
      in kNm
24 printf('speed=%0.3f kmph\n swaying couple=%0.3f kNm',v
      ,S)

```

Scilab code Exa 12.3 swaying couple

```

1 //CHAPTER 12 ILLUSTRATION 3 PAGE NO 313
2 //TITLE:Balancing of reciprocating of masses
3 clc
4 clear
5 pi=3.141
6 g=10//      acceleration due to gravity approximately
      in m/s^2
7 a=.70//distance between cylinder centres in m
8 r=60// crank radius in cm
9 m=130//mass of rotating parts per cylinder in kg
10 mR=210// mass of reciprocating parts per cylinder in
      kg
11 c=.67// portion of reciprocating mass to be balanced
12 N=300//engine speed in rpm
13 b=.64//      radius of balance masses in m
14 //=====
15 Ma=m+c*mR//      total mass to be balanced in
      kg
16 mA=100.44//      mass of wheel A from figure in
      kg
17 Br=c*mR/Ma*mA//      balancing mass for
      reciprocating parts in kg

```

```

18 H=Br*(2*pi*N/60)^2*b// hammer blow in N
19 w=(2*pi*N/60)// angular speed
20 T=2^.5*(1-c)*mR*w^2*r/2/100//tractive effort in N
21 S=a*(1-c)*mR*w^2*r/2/2^.5/100// swaying couple in
    Nm
22
23 printf('Hammer blow=%0.3f in N\n tractive effort= %0.3
    f in N\n swaying couple= %0.3f in Nm',H,T,S)

```

Scilab code Exa 12.4 unbalanced primary couple

```

1 //CHAPTER 12 ILLUSTRATION 4 PAGE NO 314
2 //TITLE:Balancing of reciprocating of masses
3 clc
4 clear
5 pi=3.141
6 mR=900// mass of reciprocating parts in kg
7 N=90// speed of the engine in rpm
8 r=.45//crank radius in m
9 cP=.9*mR*(2*pi*N/60)^2*r*2^.5/1000// maximum
    unbalanced primary couple in kNm
10 printf('maximum unbalanced primary couple=%0.3f k Nm
    ',cP)

```

Scilab code Exa 12.5 maximum unbalanced secondary force

```

1 //CHAPTER 12 ILLUSTRATION 5 PAGE NO 315
2 //TITLE:Balancing of reciprocating of masses
3 clc
4 clear
5 pi=3.141
6 mRA=160// mass of reciprocating cylinder A in kg
7 mRD=160// mass of reciprocating cylinder D in kg

```

```

8 r=.05// stroke lenght in m
9 l=.2// connecting rod length in m
10 N=450// engine speed in rpm
11 //=====
12 theta2=78.69// crank angle between A & B
   cylinders in degrees
13 mRB=576.88// mass of cylinder B in kg
14 n=l/r// ratio between connecting rod length and
   stroke length
15 w=2*pi*N/60// angular speed in rad/s
16 F=mRB*2*w^2*r*cosd(2*theta2)/n
17 printf('Maximum unbalanced secondary force=%0.3f N in
   anticlockwise direction thats why - sign ',F)

```

Scilab code Exa 12.6 hammer blow

```

1 //CHAPTER 12 ILLUSRTATION 6 PAGE NO 316
2 //TITLE:Balancing of reciprocating of masses
3 clc
4 clear
5 pi=3.141
6 rA=.25// stroke length of A piston in m
7 rB=.25// stroke length of B piston in m
8 rC=.25// stroke length C piston in m
9 N=300// engine speed in rpm
10 mRL=280// mass of reciprocating parts in inside
   cylinder kg
11 mRO=240// mass of reciprocating parts in outside
   cylinder kg
12 c=.5// portion of reciprocating masses to be
   balanced
13 b1=.5// radius at which masses to be balanced in m
14 //=====
15 mA=c*mRO// mass of the reciprocating parts to be
   balanced foreach outside cylinder in kg

```

```

16 mB=c*mRL//      mass of the reciprocating parts to be
    balanced foreach inside cylinder in kg
17 B1=79.4//      balancing mass for reciprocating
    parts in kg
18 w=2*pi*N/60//   angular speed in rad/s
19 H=B1*w^2*b1//   hammer blow per wheel in N
20 printf('Hammer blow per wheel= %.3f N',H)

```

Scilab code Exa 12.7 swaying couple

```

1 //CHAPTER 12 ILLUSTRATION 7 PAGE NO 318
2 //TITLE:Balancing of reciprocating of masses
3 clc
4 clear
5 pi=3.141
6 mR=300//      reciprocating mass per cylinder in kg
7 r=.3//      crank radius in m
8 D=1.7//      driving wheel diameter in m
9 a=.7//      distance between cylinder centre lines in m
10 H=40//      hammer blow in kN
11 v=90//      speed in kmph
12 //=====
13 R=D/2//      radius of driving wheel in m
14 w=90*1000/3600/R//      angular velocity in rad/s
15 //Br*b=69.625*c by measurement from diagram
16 c=H*1000/(w^2)/69.625//      portion of reciprocating
    mass to be balanced
17 T=2^.5*(1-c)*mR*w^2*r//      variation in tractive
    effort in N
18 M=a*(1-c)*mR*w^2*r/2^.5//      maximum swaying couple
    in N-m
19 printf('portion of reciprocating mass to be balanced
    =%.3f\n variation in tractive effort=%.3f N\n
    maximum swaying couple=%.3f N-m',c,T,M)

```

Scilab code Exa 12.8 unbalanced secondary couple

```
1 //CHAPTER 12 ILLUSTRATION 8 PAGE NO 320
2 //TITLE:Balancing of reciprocating of masses
3 clc
4 clear
5 pi=3.141
6 N=1800//      speed of the engine in rpm
7 r=6//      length of crank in cm
8 l=24//      length of connecting rod in cm
9 m=1.5//      mass of reciprocating cylinder in kg
10 //=====
11 w=2*pi*N/60//      angular speed in rad/s
12 UPC=.019*w^2//      unbalanced primary couple in N-m
13 n=l/r//      ratio of length of crank to the connecting
      rod
14 USC=.054*w^2/n//      unbalanced secondary couple in N
      -m
15 printf('unbalanced primary couple= %.3 f N-m\n
      unbalanced secondary couple=%.3 f N-m',UPC,USC)
```
