

Scilab Textbook Companion for
Manufacturing Engineering & Technology
by S. Kalpakjian and S. R. Schmid¹

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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 2

Mechanical Behavior Testing and Manufacturing Properties of Materials

Scilab code Exa 2.1 Calculation of Ultimate Tensile Strength

```
1
2 clc
3 // Given that
4 //True stress=100000*(True strain)^0.5
5
6 // Sample Problem on page no. 63
7
8 printf("\\n # Calculation of Ultimate Tensile
   Strength # \\n")
9 //from the data given
10 n=0.5
11 E=0.5
12 K=100000
13 Truестress=K*((E)^n)
14 //let An(area of neck)/Ao=t
15 //from log(Ao/An)=n
16 t=exp(-n)
```



```
17 UTS=Truестress*exp(-n)//from the expression UTS= P/  
    Ao where P(Maximum Load)=Truестress*An  
18 printf("\n\n Ultimate Tensile Strength = %f psi",UTS  
    )  
19 //answer in the book is approximated to 42850 psi
```

Chapter 9

Composite Materials Structure General Properties and Applications

Scilab code Exa 9.1 Calculation of fraction of load supported by fibre

```
1  clc
2  // Given that
3  x=0.2 // Area fraction of the fibre in the composite
4  Ef= 300 // Elastic modulus of the fibre in GPa
5  Em= 100 // Elastic modulus of the matrix in GPa
6
7  // Sample Problem on page no. 229
8
9  printf("\n # application of reinforced plastics # \n
        ")
10
11  Ec = x*Ef + (1-x)*Em
12  printf("\n\n The Elastic Modulus of the composite is
        = %d GPa", Ec)
13
14  //Let Pf/Pm be r
15  r=x*Ef/((1-x)*Em)
```

```
16
17 //Let Pc/Pf be R
18 R=1+(1/r) // from the relation Pc = Pf + Pm
19 P=(1*100)/R
20 printf("\n\n The Fraction of load supported by Fibre
        is = %f Percent",P)
21 // Answer in the book is approximated to 43 %
```

Chapter 10

Fundamental of Metal Casting

Scilab code Exa 10.1 solidification time for various shapes

```
1  clc
2  // Given that
3  //three metal piece being cast have the same volume
   but different shapes
4  //shapes are sphere ,cube ,cylinder (height=diameter)
5
6  // Sample Problem on page no. 252
7
8  printf("\n #solidification time for various shapes#
   \n")
9
10 //solidification time is inversely proportional to
   the square of surface area
11
12 //for sphere
13 r=(3/(4*3.14))^(1/3)//radius of the sphere from
   volume of sphere v=(4*3.14*r^3)/3
14 A=4*3.14*((r)^2)
15 time1=1/(A)^2
16 printf("\n the solidification time for the sphere is
   %fC" ,time1)
```

```
17
18 //for cube
19 a=1//edge of the cube
20 A=6*a^2
21 time2=1/(A)^2
22 printf("\n the solidification time for the cube is
        %fC",time2)
23
24 //for cylinder
25 //given height =diameter
26 //radius=2*height
27 r=(1/(2*3.14))^(1/3)//radius of the cylinder from
        volume of the cylinder v=3.14*r^2*h
28 A=(6*3.14*(r^2)) //area of the cylinder = (2*3.14*
        radius^2) + (2*3.14*radius*height)
29 time3=1/(A)^2
30 printf("\n the solidification time for the sphere is
        %fC",time3)
```

Chapter 13

Rolling of Metals

Scilab code Exa 13.1 Calculation of Roll Force and Torque

```
1  clc
2  // Given that
3  w=9 //in inch width of thee strip
4  ho=1 //in inch initial thickness of the strip
5  hf=0.80 //in inch thickness of the strip after one
    pass
6  r=12 //in inch roll radius
7  N=100 //in rpm
8
9  // Sample Problem on page no. 323
10
11 printf("\n #Calculation of roll force and torque# \n
    ")
12
13 L=(r*(ho-hf))^(1/2)
14
15 E=log(1/hf)//absolute value of true strain
16
17 Y=26000 //in psi average stress from the data in the
    book
18 F=L*w*Y // roll force
```

```
19 F1=F*4.448/(10^6)//in mega newton
20 printf("\n\nRoll force = %f MN ",F1)
21
22 //answer in the book is round off and given 363000lb
23
24 P=(2*3.14*F*L*N)/(33000*12)
25 P1=P*7.457*(10^2)/(10^3)//in KW
26 printf("\n\npower per roll = %f KW ",P1)
27
28 //answer in the book is 670 KW due to round off of
   the roll force
29
30 Tp=2*P1//total power
31 printf("\n\nTotal power = %f KW ",Tp)
32
33 //answer in the book is 1340KW due to round off of
   the roll force
```

Chapter 14

Forging of Metals

Scilab code Exa 14.1 Calculation of Forging Force

```
1  clc
2  // Given that
3  d=150 //in mm Diameter of the solid cylinder
4  Hi=100 //in mm Height of the cylinder
5  u=0.2 // Coefficient of friction
6
7  // Sample Problem on page no. 344
8
9  printf("\n # Calculation of forging force # \n")
10
11 //cylinder is reduced in height by 50%
12 Hf=100/2
13 //Volume before deformation= Volume after
    deformation
14 r=sqrt((3.14*75^2*100)/(3.14*50)) //r is the final
    radius of the cylinder
15 E=log(Hi/Hf) //absolute value of true strain
16 //given that cylinder is made of 304 stainless steel
17 Yf=1000 //in Mpa flow stress of the material from
    data in the book
18 F = Yf*(10^6)*3.14*(r^2)*10^-6*(1+((2*u*r)/(3*Hf)))
```



```
    //Forging Force
19 F1=F/(10^6)
20 printf("\n\n Forging force = %d MN" ,F1)
```

Chapter 15

Extrusion and Drawing of Metals

Scilab code Exa 15.1 Calculation of Force in Hot Extrusion

```
1  clc
2  // Given that
3  di=5//in inch Diameter of the round billet
4  df=2//in inch Diameter of the round billet after
    extrusion
5
6  // Sample Problem on page no. 372
7
8  printf("\n # Calculation of force in Hot Extrusion#
    \n")
9
10 //As 70–30 Brass is given, so the value of the
    extrusion constant is 35000 psi from the diagram
    given in the book
11 k=35000//in psi
12 F=3.14*(di/2)^2*k*log((3.14*(di^2))/(3.14*(df^2)))
13 F1=F*4.448/(10^6)
14 printf("\n\n Extrusion force=%f MN",F1)
15
```

16 //Answer in the book is approximated to 5.5MN

Chapter 16

Sheet Metal Forming Processes

Scilab code Exa 16.1 Calculation of Punch Force

```
1  clc
2  // Given that
3  d=1//in inch Diameter of the hole
4  T=(1/8)//in inch thickness of the sheet
5
6  // Sample Problem on page no. 396
7
8  printf("\n # Calculation of Punch Force# \n")
9
10 UTS=140000//in psi Ultimate Tensile Strength of the
    titanium alloy Ti-6Al-4V
11 L=3.14*d//total length sheared which is the
    perimeter of the hole
12 F=0.7*T*L*UTS
13 F1=F*4.448/(10^6)
14 printf("\n\n Extrusion force=%f MN" ,F1)
15
16 //Answer in the book is approximated to 0.17MN
```

Chapter 17

Processing of Powder Metals Ceramics Glass and Superconductors

Scilab code Exa 17.1 Calculation of Dimensional Changes During Shaping of Ceramic

```
1  clc
2  // Given that
3  L=20//in mm Final length of the ceramic part
4  //Linear shrinkage during drying and firing is 7%
   and 6% respectively
5  Sd=0.070//Linear shrinkage during drying
6  Sf=0.06//Linear shrinkage during firing
7
8  // Sample Problem on page no. 466
9
10 printf("\n # Dimensional changes during the shaping
   of ceramic components # \n")
11
12 //part (a)
13
14 Ld=L/(1-Sf)//dried length
15 Lo=(1+Sd)*Ld//initial length
```

```
16 printf("\n\n Initial Length=%f mm",Lo)
17
18 //Answer in the book is approximated to 22.77mm
19
20 //part(b)
21
22 Pf=0.03//Fired Porosity
23 r = (1-Pf)// Where r = Va/Vf
24 R = 1/((1-Sf)^3)// Where R = Vd/Vf
25 Pd = (1-r/R)
26 printf("\n\nDried porosity is %d percent",Pd*100)
```

Chapter 18

Forming and Shaping Plastics And Composite Materials

Scilab code Exa 18.1 Calculation of Diameter of Die in Extrusion

```
1 clc
2 // Given that
3 W=400//in mm Lateral(width) Dimension of a plastic
   shopping bag
4
5 // Sample Problem on page no. 484
6
7 printf("\\n # Blown Film # \\n")
8
9 //part(a)
10
11 P=2*W//in mm Perimeter of bag
12 D=P/3.14//in mm blown diameter calculated from
   Perimeter=3.14*diameter
13 //Given in this process , a tube is expanded to form
   1.5 to 2.5 in times the extrusion die diameter ,
   so take maximum value 2.5
14 Dd=D/2.5//Extrusion die diameter
15 printf("\\n\\n Extrusion Die Diameter =%d mm",Dd)
```

```
16
17 //Answer in the book is approximated to 100mm
18
19 //part(b) is theoritical
```

Scilab code Exa 18.2 Calculation of number of Gears In Injection Moulding

```
1 clc
2 // Given that
3 W=250//in ton Weight of injection moulding machine
4 d=4.5//in inch diameter of spur gear
5 t=0.5//in inch thickness of spur gear
6 //Gears have a fine tooth profile
7
8 // Sample Problem on page no. 488
9
10 printf("\\n # Injection Molding of Parts # \\n")
11
12 //because of fine tooth profile pressure required in
    the mould cavity is assumed to be of the order
    100MPa or 15Ksi
13 p=15//inKsi
14 A=(3.14*(d^2))/4//in inch^2 area of the gear
15 F=A*15*1000
16 n=(W*2000)/F //weight is converted into lb by
    multiplying it by 2000
17 printf("\\n\\n Number of gears that can be injected =
    %d",n)
18
19 // Second part of this question is theoritical
```

Chapter 20

Machining Processes Used to Produce Round Shape

Scilab code Exa 20.1 Calculation of Energy used as friction In cutting

```
1  clc
2  // Given that
3  to=0.005//in inch depth of cut
4  V=400//in ft/min cutting speed
5  X=10//in degree rake angle
6  w=0.25//in inch width of cut
7  tc=0.009//in inch chip thickness
8  Fc=125//in lb Cutting force
9  Ft=50//in lb thrust force
10
11 // Sample Problem on page no. 548
12
13 printf("\n # Relative Energies in cutting # \n")
14
15 r=to/tc//cutting ratio
16 R=sqrt((Ft^2)+(Fc^2))
17 B=acosd(Fc/R)+X//friction angle
18 F=R*sind(B)
19 P=((F*r)/Fc)*100
```

```

20 printf("\n\n Percentage of total energy going into
    overcoming friction =%d peccent",P)
21
22 //Answer in the book is approximated to 32 due to
    approximation in calculation of R and B

```

Scilab code Exa 20.2 Change in Tool Life by Changing the Cutting Speed

```

1  clc
2  // Given that
3  n=0.5//exponent that depends on tool and workpiece
    material
4  C=400//constant
5
6  // Sample Problem on page no. 555
7
8  printf("\n # Increasing tool life by Reducing the
    Cutting Speed # \n")
9
10 V1=poly(0,"V1")
11 r=0.5// it is the ratio of V2/V1 where V1 and V2 are
    the initial and final cutting speed of the tool
12 //let t=T2/T1 where T1 and T2 are the initial and
    final tool life
13 t=1/(r^(1/n))//from the relation V1*(T1^n)=V2*(T2^n)
14 P=(t-1)*100
15 printf("\n\n Percent increase in tool life =%d
    Percent",P)

```

Chapter 22

Machining Processes Used to Produce Round Shape

Scilab code Exa 22.1 Calculation of Material Removal Rate and Cutting Force in Turning

```
1  clc
2  // Given that
3  l=6//in inch Length of rod
4  di=1/2//in inch initial diameter of rod
5  df=0.480//in inch final diameter of rod
6  N=400//in rpm spindle rotation
7  Vt=8//in inch/minute axial speed of the tool
8
9  // Sample Problem on page no. 600
10
11 printf("\n # Material Removal Rate and Cutting Force
        in Turning # \n")
12
13 V=3.14*di*N
14 printf("\n\n Cutting speed=%d in/min",V)
15
16 v1=3.14*df*N//cutting speed from machined diameter
17 d=(di-df)/2//depth of cut
18 f=Vt/N//feed
```

```

19 Davg=(di+df)/2
20 MRR=3.14*Davg*d*f*N
21 printf("\n\n Material Removal Rate %f=in^3/min",MRR)
22
23 t=1/(f*N)
24 printf("\n\n Cutting time=%f min",t)
25
26 P=(4/2.73)*MRR//average value of stainless steel is
    taken as 4 ws/mm3 or 4/2.73 hpmin/mm3
27 printf("\n\n Cutting power=%f hp",P)
28
29 Fc=((P*396000)/(N*2*3.14))/(Davg/2)
30 printf("\n\n Cutting force=%d lb",Fc)
31
32 //answer in the book is given 118 lb due to
    approximation

```

Scilab code Exa 22.2 Calculation of Material Removal Rate and Torque in Drilling

```

1 clc
2 // Given that
3 d=10//in mm diameter of drill bit
4 f=0.2//in mm/rev feed
5 N=800//in rpm spindle rotation
6
7 // Sample Problem on page no. 632
8
9 printf("\n # Material Removal Rate and Torque in
    Drilling # \n")
10
11 MRR=[((3.14*(d^2))/4)*f*N]/60
12 printf("\n\n Material Removal Rate %d=mm^3/sec",MRR)
13

```

```
14 //Answer in the book is given 210 mm3/sec
15
16 //from the book data an average unit power of 0.5Ws/
    mm2 for magnesium is taken
17 T=(MRR*0.5)/((N*2*3.14)/60)
18 printf("\n\n Torque on the drill %f=Nm",T)
```

Chapter 23

Machining Processes Used to Produce Various Shape

Scilab code Exa 23.1 Calculation of Material Removal Rate Power Required Torque and

```
1  clc
2  // Given that
3  l=12//in inch Length of block
4  w=4//in inch width
5  f=0.01//in inch/tooth feed
6  d=1/8//in inch depth of cut
7  D=2//in inch diameter of cutter
8  n=20//no. of teeth
9  N=100//in rpm spindle rotation
10 Vt=8//in inch/minute axial speed of the tool
11
12 // Sample Problem on page no. 600
13
14 printf("\n # Material Removal Rate , Power required
        and Cutting Time in slab milling # \n")
15
16 v=f*N*n
17 MRR=w*d*v
18 printf("\n\n Material Removal Rate = %d in^3/min",
```

```

MRR)
19
20 //for annealed mild steel unit power is taken as 1.1
    hp min/in3
21 P=1.1*MRR
22 printf("\n\n Cutting power=%d hp",P)
23
24 T=P*33000/(N*2*3.14)
25 printf("\n\n Cutting torque=%d lb-ft",T)
26
27 lc=sqrt(d*D)
28 t=((1+lc)/20)*60
29 printf("\n\n Cutting time=%f sec",t)

```

Scilab code Exa 23.2 Calculation of Material Removal Rate Power Required and Cutting Time

```

1  clc
2  // Given that
3  l=500//in mm Length
4  w=60//in mm width
5  v=0.6//in m/min
6  d=3//in mm depth of cut
7  D=150//in mm diameter of cutter
8  n=10//no. of inserts
9  N=100//in rpm spindle rotation
10
11 // Sample Problem on page no. 655
12
13 printf("\n # Material Removal Rate , Power Required
    and Cutting Time in Face Milling # \n")
14
15 MRR=w*d*v*1000
16 printf("\n\n Material Removal Rate = %d mm3/min",MRR)

```

```

    )
17
18 lc=D/2
19 t=((1+(2*lc))/((v*1000)/60)) // velocity is
    converted into mm/sec
20 t1=t/60
21 printf("\n\n Cutting time= %ff min",t1)
22
23 f=(v*1000*60)/(60*N*n) // N is converted into rev/
    sec by dividing by 60 , velocity is converted
    into mm/sec
24 printf("\n\n Feed per Tooth= %f mm/tooth",f)
25
26 //for high strength aluminium alloy unit power is
    taken as 1.1 W s/mm3
27 P=(1.1*MRR)/60 // MRR is converted into mm3/sec by
    dividing by 60
28 P1=P/(1000) //in KW
29 printf("\n\n Cutting power=%f KW",P1)

```

Chapter 25

Abrasive Machining and Finishing Operations

Scilab code Exa 25.1 Calculation of Chip Dimensions in Surface Grinding

```
1  clc
2  // Given that
3  D=200//in mm Grinding Wheel diameter
4  d=0.05//in mm depth of cut
5  v=30//m/min workpiece velocity
6  V=1800//in m/min wheel velocity
7
8  // Sample Problem on page no. 713
9
10 printf("\n # Chip Dimensions in Surface Grinding # \
      n")
11
12 l=sqrt(D*d)
13 l1=1/2.54*(10^-1)
14 printf("\n\n Undeformed Chip Length = %f mm",l1)
15
16 //the answer in the book is approximated to 0.13 in
17
18 //assume
```

```

19 C=2//in mm
20 r=15
21 t=sqrt(((4*v)/(V*C*r))*sqrt(d/D))
22 t1=t/2.54*(10^-1)
23 printf("\n\n Undeformed chip Thickness = %f in",t1)
24
25 //the answer in the book is approximated to 0.00023
    in

```

Scilab code Exa 25.2 Calculation of Force in Surface Grinding

```

1  clc
2  // Given that
3  D=10//in inch Grinding Wheel diameter
4  N=4000//in rpm
5  w=1//in inch
6  d=0.002//in inch depth of cut
7  v=60//inch/min feed rate of the workpiece
8
9  // Sample Problem on page no. 715
10
11 printf("\n # force in Surface Grinding # \n")
12
13 Mrr=d*w*v//material removal rate
14 //for low carbon steel , the specific energy is 15hp
    min/in3
15 u=15//in hp min/in3
16 P=u*Mrr*396000//in lb/min
17 Fc = P/(2*3.14*N*(D/2))
18
19 printf("\n\n Cutting Force = %f lb",Fc)
20 // Answer in the book is approximated to 5.7 lb
21

```

```
22 // from the experimental data in book thrust force
    is taken as 30% higher than cutting force
23 Fn = Fc+(30/100)*Fc
24
25 printf("\n\n Thrust Force = %f lb",Fn)
26 // Answer in the book is approximated to 7.4 lb
```

Chapter 28

Solid State Welding Processes

Scilab code Exa 28.1 Calculation of Heat Generated in Spot Welding

```
1  clc
2  // Given that
3  t=1//in mm thickness of chip
4  I=5000//in Ampere current
5  T=0.1//in sec
6  d=5//in mm diameter of electrode
7
8
9  // Sample Problem on page no. 805
10
11 printf("\n # Heat Generated in Spot Welding # \n")
12
13 //It is assumed in the book that effective restiance
    = 200 micro ohm
14 R=200*(10^-6)
15 H=(I^2)*R*T
16
17 printf("\n\n Heat Generated = %d J" ,H)
18
19 // It is assumed in the book that
20 V=30//in mm3 volume
```

```
21 D=0.008//in g/mm3 density
22 M=D*V
23 //Heat required to melt 1 g of steel is about 1400J
24 m1=1400*M
25 printf("\n\n Heat Required to melt weld nugget = %d
        J",m1)
26
27 m2=H-m1
28 printf("\n\n Heat Dissipitated into the metal
        surrounding the nugget = %d J",m2)
```

Chapter 32

Tribology Friction Wear and Lubrication

Scilab code Exa 32.1 Calculation of Coefficient of Friction

```
1  clc
2  // Given that
3  hi=10//in mm height of specimen
4  ODi=30//in mm outside diameter
5  IDi=15//in mm inside diameter
6  Odf=38//in mm outside diameter after deformaton
7  //Specimen is reduced in thickness by 50%
8  hf=(50/100)*hi
9
10 // Sample Problem on page no. 886
11
12 printf("\n # Determination of Coefficient of Friction
        # \n")
13
14 IDf=sqrt((ODf^2)-((((ODi^2)-(IDi^2))*hi)/hf)) //new
        internal diameter calculated , by comparing the
        volume before and after deformation (3.14/4)*(ODi
        ^2-IDi^2)*hi=(3.14/4)*(ODf^2-IDf^2)*hf
15 ID=((IDi-IDf)/IDi)*100//change in internal diameter
```

16

```
17 printf("\n\n With a 50 percent reduction in height  
    and a %d reduction in internal diameter, from the  
    book data Coefficient of Friction = 0.21",ID)
```

Chapter 36

Quality Assurance Testing And Inspection

Scilab code Exa 36.1 Calculation of Loss Function and Payback Period in Polymer Tu

```
1
2  clc
3  // Given that
4  T=2.6//in mm wall thickness
5  USL=3.2//in mm upper specification limit
6  LSL=2//in mm lower specification limit
7  Y=2.6//in mm mean
8  s=0.2//in mm standard deviation
9  C1=10//in dollar shipping included cost
10 C2=50000//in dollars improvement cost
11 n=10000//sections of tube per month
12 // Sample Problem on page no. 978
13
14 printf("\\n # Production of Polymer Tubing # \\n")
15
16 k=C1/(USL-T)^2
17 LossCost=k*((Y-T)^2)+(s^2)
18 //after improvement the variation is half
19 s1=0.2/2
```



```

20 LossCost1=k*(((Y-T)^2)+(s1^2))
21 printf("\n\n Taguchi Loss Function = $ %f per unit "
    ,LossCost1)
22 //answer in the book is approximated to $0.28 per
    unit
23
24 savings=(LossCost-LossCost1)*n
25 paybackperiod=C2/savings
26 printf("\n\n Payback Period = %f months",
    paybackperiod)
27 //answer in the book is 6.02 months due to
    approximation savings

```

Scilab code Exa 36.2 Calculation of Control Limits and Standard Deviation

```

1  clc
2  // Given that
3  n=5// in inch sample size
4  m=10// in inch number of samples
5  // The table of the question is given of page no.990
    Table 36.3
6
7  // Sample Problem on page no. 990
8
9  printf("\n # Calculation of Control Limits and
    Standard Deviation# \n")
10 avgx=44.296 //from the table 36.3 by adding values
    of mean of x
11 x = avgx/m
12 avgR=1.03 //from the table 36.3 by adding values of
    R
13 R = avgR/m
14 //from the data in the book

```

```
15 A2=0.577
16 D4=2.115
17 D3=0
18 UCLx = x+(A2*R)
19 LCLx = x-(A2*R)
20 printf("\n\n Control Limits for Averages are =\n
        UCLx = %f in \n UCLy = %f in",UCLx,LCLx)
21
22 UCLR =D3*R
23 LCLR =D4*R
24
25 printf("\n\n Control Limits for Ranges are =\n UCLR
        = %f in \n UCLR = %f in",UCLR,LCLR)
26
27 //from table
28 d2=2.326
29 sigma= R/d2
30 printf("\n\n Standard Deviation = %f in",sigma)
```
