Scilab Textbook Companion for Manufacturing Engineering & Technology by S. Kalpakjian and S. R. Schmid[1]

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Book Description

Title: Manufacturing Engineering & Technology

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

Contents

List of Scilab Codes

Chapter 2

Mechanical Behavior Testing and Manufacturing Properties of Materials

Scilab code Exa 2.1 Calculation of Ultimate Tensile Strength

`Calculation of Ultimate Tensile Strength`

```

clc
// Given that
//True stress=100000*(True strain)^0.5

// Sample Problem on page no. 63

printf("\n # Calculation of Ultimate Tensile
    Strength # \n")
//from the data given
n=0.5
E=0.5
K=100000
Truestress=K*((E)^n)
//let An(area of neck)/Ao=t
```

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

Chapter 9

Composite Materials Structure General Properties and Applicatons

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

Calculation of fraction of load supported by fibre

```
clc
// Given that
x=0.2// Area fraction of the fibre in the composite
Ef= 300 // Elastic modulus of the fibre in GPa
Em= 100 // Elastic modulus of the matrix in GPa

// Sample Problem on page no. 229

printf("\n # application of reinforced plastics # \n
   ")

Ec = x*Ef + (1-x)*Em
printf("\n\n The Elastic Modulus of the composite is
    = %d GPa",Ec)

```

```
//Let Pf/Pm be r
r=x*Ef/((1-x)*Em)

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

Chapter 10

Fundamental of Metal Casting

Scilab code Exa 10.1 solidification time for various shapes

`solidification time for various shapes`

```
clc
// Given that
//three metal piece being cast have the same volume
   but different shapes
//shapes are sphere,cube,cylinder(height=diameter)

// Sample Problem on page no. 252

printf("\n #solidification time for various shapes#
   \n")

//solidification time is inversely proportional to
   the square of surface area

//for sphere
r=(3/(4*3.14))^(1/3)//radius of the sphere from
   volume of sphere v=(4*3.14*r^3)/3
A=4*3.14*((r)^2)
time1=1/(A)^2
```

```
printf("\n the solidification time for the sphere is
    %fC",time1)

//for cube
a=1//edge of the cube
A=6*a^2
time2=1/(A)^2
printf("\n the solidification time for the cube is
    %fC",time2)

//for cylinder
//given height =diameter
//radius=2*height
r=(1/(2*3.14))^(1/3)//radius of the cylinder from
    volume of the cylinder v=3.14*r^2*h
A=(6*3.14*(r^2)) //area of the cylinder = (2*3.14*
    radius^2) + (2*3.14*radius*height)
time3=1/(A)^2
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

Calculation of Roll Force and Torque

```
clc
// Given that
w=9 //in inch width of thee strip
ho=1 //in inch initial thickness of the strip
hf=0.80 //in inch thickness of the strip after one
   pass
r=12 //in inch roll radius
N=100 //in rpm

// Sample Problem on page no. 323

printf("\n #Calculation of roll force and torque# \n
   ")

L=(r*(ho-hf))^(1/2)

E=log(1/hf)//absolute value of true strain

```

```
Y=26000 //in psi average stress from the data in the
    book
F=L*w*Y // roll force
F1=F*4.448/(10^6)//in mega newton
printf("\n\nRoll force = %f MN ",F1)

//answer in the book is round off and given 363000lb

P=(2*3.14*F*L*N)/(33000*12)
P1=P*7.457*(10^2)/(10^3)//in KW
printf("\n\npower per roll = %f KW ",P1)

//answer in the book is 670 KW due to round off of
    the roll force

Tp=2*P1//total power
printf("\n\nTotal power = %f KW ",Tp)

//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

Calculation of Forging Force

```
clc
// Given that
d=150//in mm Diameter of the solid cylinder
Hi=100 //in mm Height of the cylinder
u=0.2 // Cofficient of friction

// Sample Problem on page no. 344

printf("\n # Calculation of forging force # \n")

//cylinder is reduced in height by 50%
Hf=100/2
//Volume before deformation= Volume after
   deformation
r=sqrt((3.14*75^2*100)/(3.14*50))//r is the final
   radius of the cylinder
E=log(Hi/Hf)//absolute value of true strain
//given that cylinder is made of 304 stainless steel
```

```
Yf=1000 //in Mpa flow stress of the material from
    data in the book
F = Yf*(10^6)*3.14*(r^2)*10^-6*(1+((2*u*r)/(3*Hf)))
    //Forging Force
F1=F/(10^6)
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

`Calculation of Force in Hot Extrusion`

```
clc
// Given that
di=5//in inch Diameter of the round billet
df=2//in inch Diameter of the round billet after
    extrusion

// Sample Problem on page no. 372

printf("\n # Calculation of force in Hot Extrusion#
    \n")

//As 70−30 Brass is given , so the value of the
    extrusion constant is 35000 psi from the diagram
    given in the book
k=35000//in psi
F=3.14*(di/2)^2*k*log((3.14*(di^2))/(3.14*(df^2)))
F1=F*4.448/(10^6)
```

```
printf("\n\n Extrusion force=%f MN",F1)

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

Chapter 16

Sheet Metal Forming Processes

Scilab code Exa 16.1 Calculation of Punch Force

Calculation of Punch Force

```
clc
// Given that
d=1//in inch Diameter of the hole
T=(1/8)//in inch thickness of the sheet

// Sample Problem on page no. 396

printf("\n # Calculation of Punch Force# \n")

UTS=140000//in psi Ultimate Tensile Strength of the
    titanium alloy Ti-6Al-4V
L=3.14*d//total length sheared which is the
    perimeter of the hole
F=0.7*T*L*UTS
F1=F*4.448/(10^6)
printf("\n\n Extrusion force=%f MN",F1)

//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 Components

`Calculation of Dimensional Changes During Shaping of Ceramic Components`

```
clc
// Given that
L=20//in mm Final length of the ceramic part
//Linear shrinkage during drying and firing is 7%
   and 6% respectively
Sd=0.070//Linear shrinkage during drying
Sf=0.06//Linear shrinkage during firing

// Sample Problem on page no. 466

printf("\n # Dimensional changes during the shaping
   of ceramic components # \n")

//part (a)
```

```
Ld=L/(1-Sf)//dried length
Lo=(1+Sd)*Ld//initial length
printf("\n\n Initial Length=%f mm",Lo)

//Answer in the book is approximated to 22.77mm

//part(b)

Pf=0.03//Fired Porosity
r = (1-Pf)// Where r = Va/Vf
R = 1/((1-Sf)^3)// Where R = Vd/Vf
Pd = (1-r/R)
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

Calculation of Diameter of Die in Extrusion

```
clc
// Given that
W=400//in mm Lateral(width) Dimension of a plastic
   shopping bag

// Sample Problem on page no. 484

printf("\n # Blown Film # \n")

//part(a)

P=2*W//in mm Perimeter of bag
D=P/3.14//in mm blown diameter calculated from
   Permeter=3.14*diameter
//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
```

```
Dd=D/2.5//Extrusion die diameter
printf("\n\n Extrusion Die Diameter =%d mm",Dd)

//Answer in the book is approximated to 100mm

//part(b) is theoritical
```

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

Calculation of number of Gears In Injection Moulding

```
clc
// Given that
W=250//in ton Weight of injection moulding machine
d=4.5//in inch diameter of spur gear
t=0.5//in inch thickness of spur gear
//Gears have a fine tooth profile

// Sample Problem on page no. 488

printf("\n # Injection Molding of Parts # \n")

//because of fine tooth profile pressure required in
    the mould cavity is assumed to be of the order
    100MPa or 15Ksi
p=15//inKsi
A=(3.14*(d^2))/4//in inch^2 area of the gear
F=A*15*1000
n=(W*2000)/F //weight is converted into lb by
    multiplying it by 2000
printf("\n\n Number of gears that can be injected =
    %d",n)
```

```

// 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

`Calculation of Energy used as friction In cutting`

```
clc
// Given that
to=0.005//in inch depth of cut
V=400//in ft/min cutting speed
X=10//in degree rake angle
w=0.25//in inch width of cut
tc=0.009//in inch chip thickness
Fc=125//in lb Cutting force
Ft=50//in lb thrust force

// Sample Problem on page no. 548

printf("\n # Relative Energies in cutting # \n")

r=to/tc//cutting ratio
R=sqrt((Ft^2)+(Fc^2))
B=acosd(Fc/R)+X//friction angle
```

```
F=R*sind(B)
P=((F*r)/Fc)*100
printf("\n\n Percentage of total energy going into
    overcoming friction =%d pecrent",P)

//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

`Change in Tool Life by Changing the Cutting Speed`

```
clc
// Given that
n=0.5//exponent that depends on tool and workpiece
    material
C=400//constant

// Sample Problem on page no. 555

printf("\n # Increasing tool life by Reducing the
    Cutting Speed # \n")

V1=poly(0,"V1")
r=0.5// it is the ratio of V2/V1 where V1 and V2 are
     the initial and final cutting speed of the tool
//let t=T2/T1 where T1 and T2 are the initial and
    final tool life
t=1/(r^(1/n))//from the relation V1*(T1^n)=V2*(T2^n)
P=(t-1)*100
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

Calculation of Material Removal Rate and Cutting Force in Turning

```
clc
// Given that
l=6//in inch Length of rod
di=1/2//in inch initial diameter of rod
df=0.480//in inch final diameter of rod
N=400//in rpm spindle rotation
Vt=8//in inch/minute axial speed of the tool

// Sample Problem on page no. 600

printf("\n # Material Removal Rate and Cutting Force
    in Turning # \n")

V=3.14*di*N
printf("\n\n Cutting speed=%d in/min",V)

```

```
v1=3.14*df*N//cutting speed from machined diameter
d=(di-df)/2//depth of cut
f=Vt/N//feed
Davg=(di+df)/2
MRR=3.14*Davg*d*f*N
printf("\n\n Material Removal Rate %f=in^3/min",MRR)

t=l/(f*N)
printf("\n\n Cutting time=%f min",t)

P=(4/2.73)*MRR//average value of stainless steel is taken as 4 ws/mm3 or 4/2.73 hpmin/mm3
printf("\n\n Cutting power=%f hp",P)

Fc=((P*396000)/(N*2*3.14))/(Davg/2)
printf("\n\n Cutting force=%d lb",Fc)

//answer in the book is given 118 lb due to approximation
```

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

`Calculation of Material Removal Rate and Torque in Drlling`

```
clc
// Given that
d=10//in mm diameter of drill bit
f=0.2//in mm/rev feed
N=800//in rpm spindle rotation

// Sample Problem on page no. 632

```

```
printf("\n # Material Removal Rate and Torque in Drilling # \n")

MRR=[((3.14*(d^2))/4)*f*N]/60
printf("\n\n Material Removal Rate %d=mm^3/sec",MRR)

//Answer in the book is given 210 mm^3/sec

//from the book data an average unit power of 0.5Ws/mm2 for magnesium is taken
T=(MRR*0.5)/((N*2*3.14)/60)
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 Cutting Time in Slab Milling

`Calculation of Material Removal Rate Power Required Torque and Cutting Time in Sla`

```
clc
// Given that
l=12//in inch Length of block
w=4//in inch width
f=0.01//in inch/tooth feed
d=1/8//in inch depth of cut
D=2//in inch diameter of cutter
n=20//no. of teeth
N=100//in rpm spindle rotation
Vt=8//in inch/minute axial speed of the tool

// Sample Problem on page no. 600

printf("\n # Material Removal Rate , Power required
   and Cutting Time in slab milling # \n")

```

```
v=f*N*n
MRR=w*d*v
printf("\n\n Material Removal Rate = %d in^3/min", MRR)

//for annealed mild steel unit power is taken as 1.1 hp min/in3
P=1.1*MRR
printf("\n\n Cutting power=%d hp",P)

T=P*33000/(N*2*3.14)
printf("\n\n Cutting torque=%d lb-ft",T)

lc=sqrt(d*D)
t=((l+lc)/20)*60
printf("\n\n Cutting time=%f sec",t)
```

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

Calculation of Material Removal Rate Power Required and Cutting Time in Face Milli

```
clc
// Given that
l=500//in mm Length
w=60//in mm width
v=0.6//in m/min
d=3//in mm depth of cut
D=150//in mm diameter of cutter
n=10//no. of inserts
N=100//in rpm spindle rotation

// Sample Problem on page no. 655
```

```

printf("\n # Material Removal Rate , Power Required and Cutting Time in Face Milling # \n")

MRR=w*d*v*1000
printf("\n\n Material Removal Rate = %d mm3/min",MRR)

lc=D/2
t=((l+(2*lc))/((v*1000)/60)) // velocity is converted into mm/sec
t1=t/60
printf("\n\n Cutting time= %ff min",t1)

f=(v*1000*60)/(60*N*n) // N is converted into rev/sec by dividing by 60 , velocity is converted into mm/sec
printf("\n\n Feed per Tooth= %f mm/tooth",f)

//for high strength aluminium alloy unit power is taken as 1.1 W s/mm3
P=(1.1*MRR)/60 // MRR is converted into mm3/sec by dividing by 60
P1=P/(1000)//in KW
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

```
Calculation of Chip Dimensions in Surface Grinding
```

```
clc
// Given that
D=200//in mm Grinding Wheel diameter
d=0.05//in mm depth of cut
v=30//m/min workpiece velocity
V=1800//in m/min wheel velocity

// Sample Problem on page no. 713

printf("\n # Chip Dimensions in Surface Grinding # \
   n")

l=sqrt(D*d)
l1=l/2.54*(10^-1)
printf("\n\n Undeformed Chip Length = %f mm",l1)

//the answer in the book is approximated to 0.13 in
```

```

//assume
C=2//in mm
r=15
t=sqrt(((4*v)/(V*C*r))*sqrt(d/D))
t1=t/2.54*(10^-1)
printf("\n\n Undeformed chip Thickness = %f in",t1)

//the answer in the book is approximated to 0.00023 in
```

Scilab code Exa 25.2 Calculation of Force in Surface Grinding

```
Calculation of Force in Surface Grinding
```

```
clc
// Given that
D=10//in inch Grinding Wheel diameter
N=4000//in rpm
w=1//in inch
d=0.002//in inch depth of cut
v=60//inch/min feed rate of the workpiece

// Sample Problem on page no. 715

printf("\n # force in Surface Grinding # \n")

Mrr=d*w*v//material removal rate
//for low carbon steel , the specific energy is 15hp min/in3
u=15//in hp min/in3
P=u*Mrr*396000//in lb/min
Fc = P/(2*3.14*N*(D/2))
```

```
printf("\n\n Cutting Force = %f lb",Fc)
// Answer in the book is approximated to 5.7 lb

// from the experimental data in book thrust force
   is taken as 30% higher than cutting force
Fn = Fc+(30/100)*Fc

printf("\n\n Thrust Force = %f lb",Fn)
// 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

`Calculation of Heat Generated in Spot Welding`

```
clc
// Given that
t=1//in mm thickness of chip
I=5000//in Ampere current
T=0.1//in sec
d=5//in mm diameter of electrode


// Sample Problem on page no. 805

printf("\n # Heat Generated in Spot Welding # \n")

//It is assumed in the book that effective restiance
    = 200 micro ohm
R=200*(10^-6)
H=(I^2)*R*T

printf("\n\n Heat Generated = %d J",H)

```

```
// It is assumed in the book that
V=30//in mm3 volume
D=0.008//in g/mm3 density
M=D*V
//Heat required to melt 1 g of steel is about 1400J
m1=1400*M
printf("\n\n Heat Required to melt weld nugget = %d
    J",m1)

m2=H-m1
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 Cofficient of Friction

```
Calculation of Cofficient of Friction
```

```
clc
// Given that
hi=10//in mm height of specimen
ODi=30//in mm outside diameter
IDi=15//in mm inside diameter
ODf=38//in mm outside diameter after deformaton
//Specimen is reduced in thickness by 50%
hf=(50/100)*hi

// Sample Problem on page no. 886

printf("\n # Determination of Cofficient of Friction
    # \n")

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
ID=((IDi-IDf)/IDi)*100//change in internal diameter

printf("\n\n With a 50 percent reduction in height
   and a %d reduction in internal diameter, from the
    book data Cofficient 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 Tubing

Calculation of Loss Function and Payback Period in Polymer Tubing

```

clc
// Given that
T=2.6//in mm wall thickness
USL=3.2//in mm upper specification limit
LSL=2//in mm lower specification limit
Y=2.6//in mm mean
s=0.2//in mm standard deviation
C1=10//in dollar shipping included cost
C2=50000//in dollars improvement cost
n=10000//sections of tube per month
// Sample Problem on page no. 978

printf("\n # Production of Polymer Tubing # \n")

k=C1/(USL-T)^2
```

```
LossCost=k*(((Y-T)^2)+(s^2))
//after improvement the variation is half
s1=0.2/2
LossCost1=k*(((Y-T)^2)+(s1^2))
printf("\n\n Taguchi Loss Function = $ %f per unit "
    ,LossCost1)
//answer in the book is approximated to $0.28 per
    unit

savings=(LossCost-LossCost1)*n
paybackperiod=C2/savings
printf("\n\n Payback Period = %f months",
    paybackperiod)
//answer in the book is 6.02 months due to
    approximation savings
```

Scilab code Exa 36.2 Calculation of Control Limits and Standard Deviation

Calculation of Control Limits and Standard Deviation

```
clc
// Given that
n=5// in inch sample size
m=10// in inch number of samples
// The table of the queston is given of page no.990
    Table 36.3

// Sample Problem on page no. 990

printf("\n # Calculation of Control Limits and
    Standard Deviation# \n")
```

```
avgx=44.296 //from the table 36.3 by adding values
    of mean of x
x = avgx/m
avgR=1.03 //from the table 36.3 by adding values of
    R
R = avgR/m
//from the data in the book
A2=0.577
D4=2.115
D3=0
UCLx = x+(A2*R)
LCLx = x-(A2*R)
printf("\n\n Control Limits for Averages are =\n
    UCLx =  %f in \n UCLy =  %f in",UCLx,LCLx)

UCLR =D3*R
LCLR =D4*R

printf("\n\n Control Limits for Ranges are =\n UCLR
    =  %f in \n UCLR =  %f in",UCLR,LCLR)

//from table
d2=2.326
sigma= R/d2
printf("\n\n Standard Deviation = %f in",sigma)
```