Scilab Textbook Companion for Industrial Instrumentation by K. Krishnaswamy And S. Vijayachitra[1]

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July 31, 2019

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

Book Description

Title: Industrial Instrumentation

Author: K. Krishnaswamy And S. Vijayachitra

Publisher: New Age International Publishers, New Delhi

Edition: 2

Year: 2010

ISBN: 978-81-224-2750-9

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 1

Temperature

Scilab code Exa 1.1 Temperature Conversion

```
// Example 1.1, page no-53
clear
clc

c=-40
k=c+273
printf("\nK=%d K", k)
F=((9/5)*c)+32
printf("\nF=%d F",F)
R=((9/5)*c)+492
printf("\nR=%d R",R)
```

Scilab code Exa 1.2 percentage Accuracy and Error

```
// Example 1.2, page no-53
clear
clc

```

```
span=1000
accuracy=1/100
err=span*accuracy
printf("(a)\nAs error can be either positive or
   negative ,\n the probable error at any point on
   the scale = %d C",err)
max_scale=1200
Range_instr=max_scale+span
printf("\n(b)\nRange of the Instrument = %d C",
   Range_instr)
meter_reading=700
per_of_err=(err/meter_reading)*100
printf("\n(c)\nPercentage of Error =   %.2f%% ",
   per_of_err)
```

Scilab code Exa 1.3 Two wire RTD

```
// Example 1.3, page no-54
clear
clc
resi_per_leg=5
temp_coeff=0.385
R_due_to_leadwires=2*resi_per_leg
err=R_due_to_leadwires/temp_coeff
err=ceil(err)
printf("(a)\nThe contribution of 10 ohms lead wire
   resistance \nto the measurement error = %d C",
   err)
temp_obj=200
temp_measured=temp_obj+err
per_of_err=((temp_measured-temp_obj)/temp_obj)*100
printf("\n(b)\nPercentage of Error = %d%%",
   per_of_err)
```

Scilab code Exa 1.4 Thermocouple temperature measurement

```
// Example 1.4, page no-54
clear
clc

temp=2.022
millivolt_cor=37.325
op=millivolt_cor-temp
printf("Millivolt output available=%.3f",op)
```

Scilab code Exa 1.5 Hot junction temperature of thermocouple

```
// Example 1.5, page no-54
clear
clc
millivolt_cor=2.585
pot_reading=30.511
corrected_millivolt=pot_reading+millivolt_cor
printf("Temperature correspond to %.3f mV from the
    table = 600 C ",corrected_millivolt)
```

Scilab code Exa 1.6 Caliberation of an instrument

```
// Example 1.6, page no-54
clear
clc
ref_jun=100
mV_100=0.645
```

```
mV_1000=9.585
mV_1200=11.947
op1=mV_1000-mV_100
op2=mV_1200-mV_100
printf("Millivolt to be fed checking 1000 C = %.3f
  mV",op1)
printf("\nMillivolt to be fed checking 1200 C = %.3f
   mV",op2)
```

Scilab code Exa 1.7 Wall temperature measurement

```
// Example 1.7, page no-55
clear
clc
E_rec_pyro=0.95*0.85
T=1100/E_rec_pyro
printf("Pyrometer reading T = %.2f C",T)
```

Scilab code Exa 1.8 Thermocouple output

```
// Example 1.8, page no-55
clear
clc
//(a)
hot1_mV=41.29
cold1_mV=2.022
op1=hot1_mV-cold1_mV

//(b)
hot2_mV=33.096
cold2_mV=2.585
op2=hot2_mV-cold2_mV

```

```
//(c)
hot3_mV=11.947
cold3_mV=0.299
op3=hot3_mV-cold3_mV

printf("(a)\nOutput Millivolt = %.3f",op1)
printf("\n(b)\nOutput Millivolt = %.3f",op2)
printf("\n(c)\nAs the wrongly formed thermocouples at J1 and J2 will always oppose\n the main millivolt output, the net output will be lower than normal value.\nOutput mV<%.3f",op3)
```

Scilab code Exa 1.9 `electtronic temperature transmitter`

```
// Example 1.9, page no-56
clear
clc

Rl_ind=250
Rl_rec=250
load_connected= Rl_ind+Rl_rec
load_allowable=600
max_load_controller=load_allowable-load_connected
printf("(a)\nThe max load to the controller = %d ohms",max_load_controller)

op_cont=600
total=Rl_ind+Rl_rec+load_allowable
extra_load=total-op_cont
printf("\n(b)\nExtra Load = %d ohms",extra_load)

printf("\nAdditional Power Supply voltage required =10 V")

printf("\nMinimum Power Supply Voltage=34 ")
```

Chapter 2

Pressure

Scilab code Exa 2.1 Pressure conversion

```
// Example 2.1, page no-116
clear
clc

//(a)
//1kg/cm^2=10000 mmWG
x=10000*10
printf("(a)\n 10kg/cm^2 = %d mmWG",x)

//(b)
onemm_Hg=13.546
y=10^5/onemm_Hg
y=y/10^3
printf("\n(b)\n10kg/cm^2 = 10^5 mmWG = %.2f * 10^3
   mmHg",y)

//(c)
onebar=1.03
z=10/onebar
printf("\n(c)\n10kg/cm^2 = %.2f bars",z)
```

Scilab code Exa 2.2 Gauge and absolute pressure

```
// Example 2.2, page no-116
clear
clc

//(a)
gamm=1000
d=35
dens_Hg=13.546
press_in_kg_cm=gamm*d*10^-4
press_in_mmHg=gamm*d/dens_Hg
press_in_mmHg=press_in_mmHg/10^3
printf("(a)\nThe pressure at depth of %d meters in a
    water tank=%.1f kg/cm^2 = %.2f*10^3 mmHg",d,
   press_in_kg_cm,press_in_mmHg)

//(b)
press_atm=1.03
abspress=press_in_kg_cm+press_atm
abspress_mmHg=press_in_mmHg*1000+760
abspress_mmHg=abspress_mmHg/1000
printf("\n(b)\nAbsolute Pressure= %.2f kg/cm^2 Abs =
    %.2f*10^3 mmHg Abs",abspress,abspress_mmHg)
```

Scilab code Exa 2.3 Gauge and absolute pressure

```
// Example 2.3, page no-116
clear
clc

egp=260
```

```
abspress=760-egp
printf("Absolute Presssure = %d mmHg",abspress)
```

Scilab code Exa 2.4 pressure measurement using U tube manometer

```
// Example 2.4, page no-117
clear
clc

//(a)
p_diff=500
pdiff=p_diff*13.546/10000
printf("(a)\np1-p2 = %.3f kg/cm^2",pdiff)

//(b)
p1=6770
p_atm=10300
abs_p1=p1+p_atm
printf("\n(b)If p2 is open to atmosphere:\nAbsolute
    Pressure P1 = %d mmWG abs.",abs_p1)

//(c)
P1=500
P1_gauge=P1-760
printf("\n(c)If p2 is evacuated and sealed:\np1= %d
   mmHg gauge Pressure",P1_gauge)
```

Scilab code Exa 2.5 Specific Gravity and weight density

```
// Example 2.5, page no-117
clear
clc

```

```
spe_grav_water=1
spe_grav_X=spe_grav_water*100/50
wt_dens_water=1000
wt_dens_X=wt_dens_water*2
printf("Weight Density of X = %d kg/m^3",wt_dens_X)
```

Scilab code Exa 2.6 water flow rate using mercury manometer

```
// Example 2.6, page no-117
clear
clc

A=1/20
p_diff=1500
printf("(a)\nAs Delta_h=A2/A1*h << h and normally
    negligiblefor well type manometer\nhence, p1-p2 =
     h = %d =111 mmHg",p_diff)

printf("\n(b)\nh measured above the oriinal
    reference will be half of H, i.e. 111/2=55.5 mmHg
    \n(Since area of both legs are same)")
```

Scilab code Exa 2.7 readings and errors in Bourdon gauge reading

```
// Example 2.7, page no-119
clear
clc

printf("1 kg/cm^2 = 10 mWG\n")
//(a)
press=10+2
```

```
printf("\n(a)Bourdon Gauge is mounted 20 meters
   below water line:\nPressure read by the Gauge =
   %d kg/cm^2",press)

//(b)
press2=10-3
printf("\n\n(b)Bourdon Gauge is located 30 meters
   above the water line:\nPressure read by the Gauge
    = %d kg/cm^2",press2)
```

Scilab code Exa 2.8 Specific Gravity and density of liquid

```
// Example 2.8, page no-120
clear
clc

dens_water=1000
h1=125
h2=250
d2=(h1/h2)*dens_water
printf("(a)\nDensity of Liquid = %d kg/m^3",d2)
printf("\nSpecific Density of the liquid = %.1f",(h1
   /h2))

//(b)
printf("\n\n(b)\nIf Values of water and liquid
   interchanged:\n")
d3=(h2/h1)*dens_water
printf("\nDensity of Liquid = %d kg/m^3",d3)
printf("\nSpecific Density of the liquid = %.1f",(h2
   /h1))
```

Scilab code Exa 2.9 strain gauge wire length and cross section area

```
// Example 2.9, page no-120
clear
clc

R=120
l=122
a=0.1
rho=R*a/l
R1=140
l1=sqrt(R1*a*l/rho)
l1=ceil(l1)
printf("Length l1 = %d meters",l1)
A1=a*l/l1
printf("\nArea A1 = %.4f mm^2",A1)
```

Scilab code Exa 2.10 Capacitance calculation for variable dielectric

```
// Example 2.10, page no-121
clear
clc

c=0.57

//(a)
d=0.1
di1=100
di2=1000
c1=c*di1*10/d
c1=ceil(c1)
printf("(a)\nC1=%d pf",c1)

//(b)
c2=c*di2*10/d
printf("\n(b)\nC2=%d pf",c2)

```

```
//(c)
ds=0.09
c11=c*di1*10/ds
c12=c*di2*10/ds
printf("\n(c)\nC1 = %.1f pf\nC2 = %d pf",c11,c12)
```

Scilab code Exa 2.11 pressure gauge caliberation

```
// Example 2.11, page no-121
clear
clc

A=1
p1=10
W1=A*p1
printf("W1 = %d kg",W1)
printf("\nWith the 4 standard weights of 10kg, 20kg,
    30kg and 40kg ")
```

Scilab code Exa 2.12 pressure calculation using McLeod gauge

```
// Example 2.12, page no-122
clear
clc

p1=10^-2
h1=20
K=p1/h1^2
p2=K*30^2
p2=p2*100
printf("The unknown pressure p2 = %.2f * 10^-2 torr"
    ,p2)
```

Chapter 3

Force Torque and Velocity

Scilab code Exa 3.1 Force calculation

```
// Example 3.1, page no-163
clear
clc
m1=20
a=5
F=m1*a
printf("F = %d Newtons",F)
```

Scilab code Exa 3.2 Weight calculation

```
// Example 3.2, page no-163
clear
clc

m1=50
g1=9.8
W2=m1*g1
printf("W = %d Newtons = %d kgf",W2,m1)
```

Scilab code Exa 3.3 calculation of specific gravity

```
// Example 3.3, page no-164
clear
clc
wt_material=2500
wt_water=1000
spe_grav=wt_material/wt_water

printf("Specific gravity of the material = %.1f",
   spe_grav)
```

Scilab code Exa 3.4 Estimation of uncertainty due to sensitivity

```
// Example 3.4, page no-164
clear
clc

L=20
W=2000
db=0.02
Wb=100
dG=0.5
S=L/(2*W*db+Wb*dG)
printf("S = %.3f rad/g",S)

fi=0.2
DeltaW=fi*3.14/(180*S)
printf("\nDeltaW = %.3f g",DeltaW)
```

Scilab code Exa 3.5 Torque Calculation

```
// Example 3.5, page no-164
clear
clc
hp=746
P=5*hp
N=1500
n=N/60
T=P*60/(2*3.14*n)
printf("T = %d Newton meters",T)
```

Scilab code Exa 3.6 Force calculation

```
// Example 3.6 page no-165
clear
clc
ch_l=0.075
orig_l=50

S=ch_l/orig_l
E=9.66*10^5
stress=E*S
area=1.5
f=stress*area
printf("Strain = %.4f cm/cm\nStress =%d kg/cm^2\
    nForce = %.1f kg",S,stress,f)
```

Scilab code Exa 3.7 resistance strain gauge

```
// Example 3.7, page no-165
clear
clc
```

```

//(a)
R1=120
R2=120
R3=120
R4=120
Rg=100
C=(R1*R2*R4)+(R1*R3*R4)+(R1*R2*R3)+(R2*R3*R4)+(Rg*(
    R1+R4)*(R2+R3))
C=C/10^7
printf("(a)\nC=%.3f*10^7",C)
E=10
F=E*R3*R1*2*10^3/(C*10^7)
printf("\nF = %.1f *10^3 A/mm = %.1f mA/mm",F,F)

//(b)
Fe=2*10^-4
E=10
DeltaE=Fe*E/(4+4*10^-4)
DeltaE=DeltaE*10^3
printf("\n(b)\nDeltaEg=%.1f mV",DeltaE)
```

Scilab code Exa 3.8 speed measurement using stroboscope

```
// Example 3.8, page no-167
clear
clc

//(a)
r1=2500
r2=1500
n=(r1*r2)/(r1-r2)
printf("(a)\nn = %d rpm",n)

//(b)
```

```
N=5
r5=n*r1/((r1*(N-1))+n)
r5=ceil(r5)
printf("\n(b)\nr5=%d",r5)
```

Scilab code Exa 3.9 `speed measurement using proximity`

```
// Example 3.9, page no-167
clear
clc
rpm=1500
f=200
N=60*f/rpm

printf("No of teeth on the wheel\nN=%d",N)
```

Chapter 4

Acceleration Vibration and Density

Scilab code Exa 4.1 mechanical system for a seismic instrument

```
// Example 4.1, page no-209
clear
clc

//(a)
k=50
m=0.005
wn=sqrt(k/m)
printf("(a)\nNatural frequency(wn)= %d rad/s",wn)
//(b)
Cc=2*sqrt(m*k)
printf("\n(b)\nCc=%d",Cc)
```

Scilab code Exa 4.2 Frequency and phase angle of motion

```
// Example 4.2, page no-209
```

```
clear
clc

//(a)
Cc=1.0
C=0.7*Cc
m=0.005
k=50
w=sqrt((k/m)-(C/(2*m))^2)
printf("(a)\nw=%.1f rad/s",w)
//(b)
w1=250
theta=C*w1/(k-m*w1^2)
printf("\ntheta=%f",theta)
fi=atan(-theta)
fi=fi*180/%pi
printf("\nfi = %d ",fi)
```

Scilab code Exa 4.3 time calculation for exponetial transient term

```
// Example 4.3, page no-210
clear
clc
m=0.005
c=0.7
y=-log(0.01)
//printf("y=%.2f",y)
t=y*2*m/c
printf("t=%.4f Secs",t)
```

Scilab code Exa 4.4 Acceleration measurement

```
// Example 4.4, page no-210
```

```
clear
clc
rg1=1200
rg2=1200
rg3=1200
rg4=1200
D1=rg1*5/100
D2=rg2*5/100
D3=rg3*5/100
D4=rg4*5/100
E=12
v=E*(((rg1+D1)/(rg1+D1+rg2-D2))-((rg4-D4)/(rg3+D3+
    rg4-D4)))
v=v*1000
printf("V0=%d mV",v)
```

Scilab code Exa 4.5 output voltage of quartz piezoelectric crystal

```
// Example 4.5, page no-211
clear
clc
g=0.06
t=2.5*10^-3
p=20*9.8*10^4
E=g*t*p
printf("E=%d V",E)
```

Scilab code Exa 4.6 Differential values of capacitor

```
// Example 4.6, page no-211
clear
clc

```

```
c0=25
x0=0.5
x1=0.05
c1=c0*x0/(x0-x1)
c2=c0*x0/(x0+x1)
printf("C1=%.2f pF\nC2=%.2f pF",c1,c2)
```

Scilab code Exa 4.7 Specific Gravity Conversion

```
// Example 4.7, page no-211
clear
clc

//(a)
sg_at_60=1.02
API=(141.5/sg_at_60)-131.5
printf("(a)\nDegrees API = %.2f API",API)
//(b)
Be=145-145/sg_at_60
printf("\n(b)\nDegrees Baume(heavy) = %.1f Be",Be)
//(c)
Bk=(sg_at_60-1)*1000
printf("\n(c)\nDegrees Barkometer = %d Bk",Bk)
//(d)
Q=(sg_at_60-1)*1000
printf("\n(c)\nDegrees Quevenne = %d Q",Q)
//(e)
Tw=200*(sg_at_60-1.0)
printf("\n(d)\nDegrees Twaddel = %d Tw",Tw)
```

Scilab code Exa 4.8 calculation of the volume of displacer

```
// Example 4.8, page no-212
```

```
clear
clc
T=0.5
sg1=1.02
sg2=0.98
wt=1000*10^-6
v=T/((sg1-sg2)*wt)
v=ceil(v)
printf("V=%d cm^3",v)
```

Scilab code Exa 4.9 Differential pressure Sensor

```
// Example 4.9, page no-212
clear
clc
sg1=0.85
sg2=0.8
span=150
H=span/(sg1-sg2)
printf("(a)\nH=%d mm = %dm",H,H/1000)
span_min=1500
span2=span_min*(sg1-sg2)
span2=ceil(span2)
printf("\n(b)\nD/P span = %d mm",span2)
```

Scilab code Exa 4.10 Specific Gravity of unknown liquid

```
// Example 4.10, page no-212
clear
clc
Ww=12-2
dw=1000
v=Ww/dw
```

```
dx=(10-2)/v
sg=dx/dw

printf("Specific Gravity of X =%.1f",sg)
```

Scilab code Exa 4.11 calculation of specific gravity

```
// Example 4.11, page no-213
clear
clc

//(a)
v_obj=2/1000
wt=1.5
dx=wt/v_obj
sg=dx/1000
printf("(a)\nSpecific Gravity = %.2f",sg)

//(b)
sgl=0.8
dens=800
W1=dens*v_obj-wt
printf("\n(b)\nW1 = %.1f kg",W1)

//(c)
sg2=1.2
dens2=1200
W2=dens2*v_obj-wt
printf("\n(c)\nW2 = %.1f kg",W2)
```

Chapter 5

Flow

Scilab code Exa 5.1 flow rate calulation

```
// Example 5.1, page no-310
clear
clc
//(i)
d=75*10^-3
a=3.141*d^2/4
v=760*10^-3
Q=v*a
Q=Q*10^3
printf("(i)\nVolume Flow Rate Q=%.3f *10^-3 m^3/sec"
    ,Q)
rho=1000
W=rho*Q*10^-3
printf("\n(ii)\nMass Flow rate W=%.3f kg/sec",W)
```

Scilab code Exa 5.2 Volumetric flow rate calculation

```
// Example 5.2, page no-310
```

```
clear
clc

D=40
d=20
mr=15
h=(13.6-1)*15*10
B=d/D
M=1/sqrt(1-B^4)
//printf("%f\n",B)
Cd=0.5999
x=sqrt(2*9.8*h*10^-3)
Q=x*Cd*M*(3.14*(20*10^-3)^2)/4
Q=Q*3600
printf("Volumetric flow rate Q= %.4f m^3/hr",Q)
```

Scilab code Exa 5.3 Nominal flow velocity

```
// Example 5.3, page no-310
clear
clc
Re=10^5
D=40*10^-3
v=10^-6
V1=Re*v/D
A1=(3.14*(40*10^-3)^2)/4
A2=(3.14*(20*10^-3)^2)/4
V2=V1*A1/A2
printf("V2=%.1f m/sec",V2)
```

Scilab code Exa 5.4 pressure difference calculation

```
// Example 5.4, page no-311
```

```
clear
clc
Cd=0.61
D=40*10^-3
d=20*10^-3
M=1/sqrt(1-(d/D)^4)
//printf("%.4f\n",M)
V2=10
rho=1000
g=9.8
X=V2*sqrt(rho/(2*g))/(Cd*M)
p_diff=X^2

p_diff=floor(p_diff/100)
p_diff=p_diff/100
printf("P1-P2 = %.2f kg/cm^2",p_diff)
```

Scilab code Exa 5.5 volume flow rate for orifice and venturi Tubes

```
// Example 5.5, page no-312
clear
clc
Cd=0.6
D=150*10^-3
d=75*10^-3
p=250
g=9.8
rho=1000
s=75*10^-3
//(a)

Q=Cd*3.14*s^2*sqrt(2*g*p/rho)/(4*sqrt(1-(d/D)^4))
printf("(a) For orifice plate\nQ=%f m^3/sec = %.3f
    litres/sec",Q,Q*1000)
Cd1=0.99
```

```
Q2=Cd1*3.14*s^2*sqrt(2*g*p/rho)/(4*sqrt(1-(d/D)^4))
printf("\n\n(b)For venturi tube\nQ=%f m^3/sec = %.2f litres/sec",Q2,Q2*1000)
```

Scilab code Exa 5.6 `determination of Reynolds number`

```
// Example 5.6, page no-312
clear
clc

//(i)
V=0.02
d=10*10^-2
A=%pi*d^2/4
v=V/A
rho=1000
Re=rho*v*d/10^-3
Re=Re/100000
printf("(i)\nReynolds number(Re) = %.3f * 10^5",Re)

//(ii)
Cd=0.98
D=20*10^-2
d=10*10^-2
M=1/sqrt(1-(d/D)^4)
a2=3.14*d^2/4
Q=0.02
g=9.8
X=Q*sqrt(rho)/(M*Cd*a2*sqrt(2*g))
p_diff=ceil(X^2)
printf("\n(ii)\nPressur_difference = %d kg/m^2 = %.4f kg/cm^2",p_diff,p_diff/10000)
```

Scilab code Exa 5.7 Fluid velocity and Volumetric flow rate

```
// Example 5.7 , page no-313
clear
clc
//1kg/m^2=10 meters water head
g=9.81
h=20
v=sqrt(2*g*h)
d=300*10^-3
A=(3.14*d^2)/4
A=floor(A*1000)
A=A/1000
Q=A*v
printf("Q=%.3f m^3/sec",Q)
```

Scilab code Exa 5.8 Fluid velocity calculation

```
// Example 5.8 , page no-313
clear
clc
Cd=0.6
g=9.8
h=400*10^-3
V=Cd*sqrt(2*g*h)
printf("V = %.2f m/sec",V)
```

Scilab code Exa 5.9 velocity measurement using pilot tube

```
// Example 5.9 , page no-314
clear
clc

```

```
Cd=0.98
g=9.8
h=900*10^-3
V=Cd*sqrt(2*g*h)
V=floor(V*100)
V=(V/100)
printf("V = %.2f m/sec",V)
```

Scilab code Exa 5.11 detemination of flow velocity

```
// Example 5.11, page no-314
clear
clc
dens=1026
p=25*10^3
V=sqrt(2*p/dens)
printf("V=%.2f m/sec =%.3f km/hr",V,V*18/5)
```

Scilab code Exa 5.12 calculation of flying speed of aircraft

```
// Example 5.12, page no-314
clear
clc
dens=1.29
p=12.5*10^3
V=sqrt(2*p/dens)
printf("V=%.2f m/sec =%.2f km/hr",V,V*18/5)
```

Scilab code Exa 5.13 Maximum fluid handling capacity of Rotameter

```
// Example 5.13, page no-315
clear
clc
Cd=0.6
Dp=0.05
Df=0.035
g=9.8
rho_f=3.9*10^3
rho=1000
Vf=3.36*10^-5
Q=Cd*((Dp^2-Df^2)/Df)*sqrt(3.14*g*Vf*(rho_f-rho)/(2*
    rho))
Q=Q*10000
printf(" Volumetric flow Q=%.4f *10^-4 m^3/sec",Q)
```

Scilab code Exa 5.14 Determination of range of flow for ratameter

```
// Example 5.14, page no-315
clear
clc

Cd=1
Dp=0.018
Df=0.015
g=9.81
rho_f=2.7
rho=0.8
Vf=520*10^-9
//case 1

Qmin=Cd*((Dp^2-Df^2)/Df)*sqrt(%pi*g*Vf*(rho_f-rho)
    /(2*rho))
Qmin=Qmin*100000
printf("Case 1: When float is at the bottom\n
    Volumetric flow Qmin=%.3f *10^-5 m^3/sec",Qmin)
```

```
//case 2
Dp2=0.0617
Qmax=Cd*((Dp2^2-Df^2)/Df)*sqrt(%pi*g*Vf*(rho_f-rho)
    /(2*rho))
Qmax=Qmax*100000
printf("\n\nCase 2: When float is at the bottom\n
    Volumetric flow Qmax=%.2f *10^-5 m^3/sec",Qmax)
```

Scilab code Exa 5.15 calculation of coal delivery for coal conveyor system

```
// Example 5.15, page no-316
clear
clc
W=165
R=328
L=16
Q=W*R/L
printf(" Flow Rate Q=%.2f kg/min =%.1f kg/hour",Q,Q
    /60)
```

Scilab code Exa 5.16 Fluid velocity calculation

```
// Example 5.16, page no-316
clear
clc
f=100
d=300*10^-3
a=45
a_rad=45*%pi/180
v=f*d/(2*cos(a_rad))
printf(" Fluid Velocity V=%.1f m/sec",v)
```

Scilab code Exa 5.17 volume flow rate

```
// Example 5.17, page no-316
clear
clc

r=150
v=120
Q=4*v*r
printf(" Volume flow rate Q=%d cm^3/min = %d litres/
    min",Q,Q/1000)
```

Scilab code Exa 5.18 induced emf in electromagnetic flow meter

```
// Example 5.18, page no-317
clear
clc
Q=2500
d=2.75
a=(%pi*d^2)/4
v=Q/(60*a)
B=60
e=B*d*10^-2*v*10^-2
printf(" Induced emf e =%.4f V=%.1f mV",e,e*1000)
```

Scilab code Exa 5.19 velocity of flow in electromagnetic flow meter

```
//Example 5.19, page no-317
clear
```

```
clc

e=0.2*10^-3
B=0.08
l=10*10^-2
v=e/(B*l)
printf("V = %.3f m/sec = %.2f cm/sec",v,v*100)
```

Scilab code Exa 5.20 average velocity of flow in electromagnetic flow meter

```
//Example 5.20, page no-317
clear
clc

ei=0.15*10^-3
em=2*ei
B=0.1
l=60*10^-3
v=em/(B*l)
printf("Velocity of flow V = %.2f m/sec = %.1f cm/
    sec",v,v*100)
```

Chapter 6

Level

Scilab code Exa 6.1 output current of two wire pressure transmitter

```
// Example 6.1, page no-370
clear
clc
//(a)
p=1.5
a=4
b=20
wh=(((b-a)/2)*p)+a
printf("(a)just at the bottom level of the tank\nWater head applied to the transmitter =%d mA ",wh)
//(b)
wh2=(((b-a)/2)*p)+2*a
printf("\n\n(b)5m below the bottom of the tank\nWater head applied to the transmitter =%d mA ",wh2)
//(c)
wh3=(((b-a)/2)*p)
printf("\n\n(c)5m above the bottom of the tank\nWater head applied to the transmitter =%d mA ",wh3)
```

Scilab code Exa 6.2 water level and current at different positions

```
// Example 6.2, page no-371
clear
clc
//(a)
b=20
a=4
op=16
p=(op-a)*2/(b-a)
p_h=p*10
h=p_h-2-5
printf("(a)\nh = %dm",h)
//(b)
p1=1
t_op=((b-a)/2)*p1+4
printf("\n(b)\nTransmitter output =%d mA",t_op)
//(c)
p2=0.5
t_op1=((b-a)/2)*p2+4
printf("\n(c)\nTransmitter output =%d mA",t_op1)
```

Scilab code Exa 6.3 Differential pressure output at different levels

```
// Example 6.3, page no-372
clear
clc
//(a)
b=20
a=4
op=16
```

```
wt_l1=25
t_op=((b-a)/100)*(100-75)+4
printf("(a)\nWater level=+25cm\nTransmitter output =
    %d mA",t_op)

//(b)
wt_l2=-25
t_op2=((b-a)/100)*(100-25)+4
printf("\n(b)\nWater level=-25cm\nTransmitter output
    = %d mA",t_op2)

//(c)
t_op3=12
H=(100/(b-a))*(12-4)
printf("\n(c)\nHead Applied = %d cm\nLevel
    corresponding to 50 cm head =0 cm ",H)
```

Scilab code Exa 6.4 Displacer with spring balance

```
// Example 6.4, page no-373
clear
clc
//(a)
a=5*10^-4
l=8
dens=6*1000
w=a*l*dens
printf("(a)\nWeight of the displacer if weighed in
    air = %d kg",w)
//(i)
sbr1=23
wloss1=w-sbr1
L1=wloss1/(1000*a)
printf("\n(i)\tL1=%dm",L1)
//(ii)
```

```
sbr2=22
wloss2=w-sbr2
L2=wloss2/(1000*a)
printf("\n(ii)\tL2=%dm",L2)
//(iii)
sbr3=21
wloss3=w-sbr3
L3=wloss3/(1000*a)
printf("\n(iii)\tL3=%dm",L3)

//(b)
level=8
wt=a*level*1000
spring=w-wt
printf("\n(b):when the tank is full\nSpring Balance
    reading = %d kg",spring)
```

Scilab code Exa 6.5 Buoyancy Force calculation

```
// Example 6.5, page no-374
clear
clc
rho=1000
v=3
Bw=rho*v
printf("Buoyance Force(Bw) = %d kg",Bw)
```

Scilab code Exa 6.6 Determination of displaced volume from Buoyancy Force

```
// Example 6.6, page no-374
clear
clc
rho=1000
```

```
Bw=5000
v=Bw/rho
printf("V = %d m^3",v)
```

Scilab code Exa 6.7 Determination of hydrostatic pressure in open tank

```
// Example 6.7, page no-374
clear
clc

rho=1000
h=10
P=rho*h
printf("P = %d kg/m^2 = %d kg/cm^2 ",P,P/10000)
```

Scilab code Exa 6.8 Determination of hydrostatic pressure in closed tank

```
// Example 6.8, page no-374
clear
clc
rho=1000
h=15
ex_p=1
P=(rho*h/10000)+ex_p
printf("P = %.1f kg/cm^2",P)
```

Scilab code Exa 6.9 Determination of height from hydrostatic pressure

```
// Example 6.9, page no-374
clear
```

```
clc
rho=1000
ex_p=0.5*10^4
P=1.6*10^4//(rho*h/10000)+ex_p
h=(P-ex_p)/1000
printf("h = %d m",h)
```

Scilab code Exa 6.10 calculation of level on the probe

```
// Example 6.10, page no-375
clear
clc
c2=100*10^-6
r1=10*10^3
r2=100*10^3
r3=50*10^3
Cx=r1*c2/r3
Cx=Cx*10^6
printf("Cx = %d microFarad",Cx)
c=5
l=Cx/c
printf("\nLevel on the probe = %dm",l)
```

Chapter 7

Viscosity Humidity and Moisture

Scilab code Exa 7.1 calculation of absolute viscosity

```
//Example 7.1, page no-436
clear
clc
f=2*9.8*10^5
A=100
V=20
l=10
mu=(f/A)/(V/l)
mu=mu/1000
printf("The absolute viscosity mu = %.1f*10^5
   centipoises",mu)
```

Scilab code Exa 7.2 calculation of kinematic relative and absolute viscosity

```
//Example 7.2, page no-437
clear
```

```
clc
//(a)
v=10
F=1/v
printf("(a)\nFluidity = %.1f rhe",F)

//(b)
mu=10
rho=0.8
ve=mu/rho
printf("\n(b)\nKinematic viscosity (v)= %.1f cm^2/
    sec",ve)
//(c)
ab=1000
abwt=1.002
rv=ab/abwt
printf("\n(c)\nRelative viscosity = %d centipoises",
    rv)
//(d)
PAS=10
printf("\n(c)\nAbsolute viscosity = 1000 centipoises
    =10 poises = 1PAS")
```

Scilab code Exa 7.3 Absolute viscosity of the Newtonian fluid

```
//Example 7.3, page no-438
clear
clc
//(b)
R=0.5
L=5
p_diff=800
V=10
mu=(3.14*R^4)*p_diff/(8*V*L)
printf("(b)\nmu=%.4f poise =%.2f centipoise",mu,mu
```

```
*100)
```

Scilab code Exa 7.4 kinematic viscosity and density calculation

```
//Example 7.4, page no-439
clear
clc
//(a)
g=980
h=4
R=0.5
t=1
V=10
l=5
v=(3.14*g*h*t*R^4)/(8*l*V)
printf("(a)\n v = %.2f stokes",v)
mu=0.3925
rho=mu/v
printf("\n(b)\n Density of the fluid rho = %.3f gm/
    cm^3",rho)
```

Scilab code Exa 7.5 Kinematic Viscosity in Saybolts Universal viscometer

```
//Example 7.5, page no-440
clear
clc
//(a)
A=0.226
B=195
t=60
v=A*t-B/t
printf("(a) Fluid X\n v = %.2f centipoises",v)
A1=0.220
```

```
B1=135
t1=140
v1=A1*t1-B1/t1
printf("\n(b)Fluid Y\n v = %.1f centipoises",v1)
```

Scilab code Exa 7.6 calculation of absolute viscosity

```
//Example 7.6, page no-441
clear
clc
t=12
Rsb=7
Rsf=1.12
B=1.5
mu=t*(Rsb-Rsf)*B
printf("mu= %.2f centipoises = %d centipoises(approx
    )",mu,ceil(mu))
```

Scilab code Exa 7.7 calculation of relative humidity

```
//Example 7.7, page no-441
clear
clc
//(a)
B=45
W=25
printf("(a)\nPsychromatic differential : %d C\n
    Relative humidity is 80%% corresponding to \
    ntemperature 45 C  and psychromatic differential
     20 C ",(B-W))
//(b)
//(a)
B1=30
```

```
W1=27
printf("\n(b)\nPsychromatic differential : %d C\n
    Relative humidity is 80%% corresponding to \
    ntemperature 30 C  and psychromatic differential
     3 C ",(B1-W1))
```

Scilab code Exa 7.8 calculation of Relative Humidity dew point and moisture conten

```
//Example 7.8, page no-441
clear
clc
D=80
W=66.5
//(a)
printf("(a)\nThe intersection point of DB
    temperature 80 F  and WB temperature 66.5 F  \
    nlines on the relative humidity curve for 50%%.\n
     RH = 50%% ")
//(b)
printf("\n(b)\nFrom the point of intersection of the
     dry and wet bulb curves, move left \
    nhorizontally to the dew point temperature curve
    where it meets at 60 F \nDew Point = 60 F ")
//(c)
printf("\n(c)\nFrom the point of intersection of the
     dry and wet bulb curves,\nhorizontally to the
    right to the moisture content plot where it meets
     at 76.\nMoisture Content : 76 grains of water
    per pound of dry air.")
```

Scilab code Exa 7.9 calculation of relative humidity

```
//Example 7.9, page no-442
```

```
clear
clc

wt_vap=500
wt_vap_to_sat=1500
total=wt_vap+wt_vap_to_sat
Rh=(wt_vap/total)*100
printf("RH = %d%%",Rh)
```

Scilab code Exa 7.10 percentage relative humidity

```
//Example 7.10, page no-442
clear
clc
pv=30
ps=60
Rh=(pv/ps)*100
printf("%%RH = %d%%",Rh)
```

Scilab code Exa 7.11 percentage increase in moisture content

```
//Example 7.11, page no-442
clear
clc

i1=250
i2=350
m=(i2-i1)*100/i1
printf("%% increase in moisture content = %d%%",m)
```

Scilab code Exa 7.12 calculation of moisture content

```
//Example 7.12, page no-443
clear
clc

i2=150
i1=125
m=(i2-i1)*100/i1
printf("Moisture percentage = %d%%",m)
```

Chapter 8

Fundamentals of measuring instruments

Scilab code Exa 8.1 Flux density calculation

```
//Example 8.1, page no-507
clear
clc
fi=10*10^-6
inch=2.54*10^-2
A=inch^2
B =fi/A
printf("Flux Density B= %.1f mT",B*1000)
```

Scilab code Exa 8.2 Power Dissipation and accuracy of result

```
//Example 8.2, page no-508
clear
clc
i=10*10^-3
R=1000
```

```
P=(i^2)*R
err_R=10
err_I=(2/100)*25*100/10
err_I2=2*err_I
err_p=err_I2+err_R
printf("%% error in I^2 =   %d%%\n%% error in Power
    =   %d%%",err_I2,err_p)
```

Scilab code Exa 8.3 max and min levels of input supply current

```
//Example 8.3, page no-508
clear
clc
i1=37
i2=42
i3=13
i4=6.7
Imax=(i1+i2)+(i1+i2)*(3/100)+(i3+i4)+(i3+i4)*(1/100)

Imin=(i1+i2)-(i1+i2)*(3/100)+(i3+i4)-(i3+i4)*(1/100)

printf("Maximum level of total supply current = %.3f
    mA\nMinimum level of total supply current = %.3f
    mA",Imax,Imin)
```

Scilab code Exa 8.4 Time constant for thermometer

```
//Example 8.4, page no-508
clear
clc
//(a)
T=200
T0=300
```

```
Ti=70
t=3
x=(T-T0)/(Ti-T0)
tow=-t/log(x)
printf("(a)\nTime constant  tow=%.1f s",tow)
//(b)
t1=5
T5=T0+((Ti-T0)*%e^(-t1/tow))
printf("\n(b)\nTemperature after 5 seconds T5 = %.2f C",T5)
```

Scilab code Exa 8.5 Error calculation of second order instrument

```
//Example 8.4, page no-509
clear
clc
w=9
wn=6
x=w/wn
dr=0.6
Ar=1/sqrt(((1-(x)^2)^2)+(2*dr*x)^2)
printf("A=%.3f",Ar)
err=(1-Ar)*100
printf("\nError = %.2f%%",err)
```

Scilab code Exa 8.6 Output of first order instrument for unit step input

```
//Example 8.6, page no-510
clear
clc
t=2
y=1-%e^(-(t-1.5)/0.5)
printf("y(t)at t=2 will be y(t)=%.3f",y)
```

Scilab code Exa 8.7 Calculation of different parameters from given frequency distr

```
//Example 8.7, page no-510
clear
clc
T=[98.5 99 99.5 100 100.5 101 101.5]
f=[4 13 19 35 17 10 2]
//(i)
k=0
a=0
for i=1:length(T)
k=k+(T(i)*f(i))
a=a+f(i)
end
x_bar=k/a
printf("(i)\nArithmatic Mean x_bar = %.2f C",x_bar)

//(ii)
m=0
n=0
for i=1:length(T)
x=(T(i)-x_bar)
if x<0 then
x=-x
end
m=m+(x*f(i))
n=n+f(i)
end
D=m/a
printf("\n(ii)\nAverage Deviation D = %.4f C",D)

//(iii)

m=0
```

```
n=0
for i=1:length(T)
x=(T(i)-x_bar)
m=m+(x^2)*f(i)
n=n+f(i)
end
sigma=sqrt(m/n)
printf("\n(iii)\nStandard Deviation (Sigma) = %.3f C",sigma)

//(iv)
v=sigma^2
printf("\n(iv)\nVariancce= %.4f C",v)

//(v)
err=sigma*0.6745
printf("\n(v)\nProbable error = %.4f C",err)
```

Scilab code Exa 8.8 Calculation of damping coefficient and natural frequency for 2

```
//Example 8.8, page no-511
clear
clc
wn=sqrt(3)
x=3.2/(2*wn)
printf("Damping coefficient = %.3f\nNatural frequency of Oscillation = %.3f",x,wn)
```

Scilab code Exa 8.9 calculation of Amplitude inaccuracy and phase shift from trans

```
//Example 8.9, page no-512
clear
clc
```

```
w=100
fi=-atan(0.1*w)-atan(0.5*w)
A=1/(sqrt(1+(0.1*w)^2)*(sqrt(1+(0.5*w)^2)))
A=1*1000/ceil(1000*A)
err=(1-1/A)*100
printf("A=K/%d\n%% error = %.1f%%\nfi=%.2f  ",A,err,
   fi*180/%pi)
```

Scilab code Exa 8.10 temperature and altitude calculation from first order thermom

```
//Example 8.10, page no-512
clear
clc
R=0.15*10/50
K=1
tow=15
deg=K*R*tow
//(i)
a=15-deg
printf("(i)The actual temperature when instrument
   reads 15 C  is %.2f  C\n The true temperature at
   5000 metres = %.2f ",a,a)

//(ii)
alt_red=deg*50/0.15
h=5000-alt_red
printf("\n(ii)\nThe true altitude at which 15 C
   occurs is %d metres",h)
```