

Scilab Textbook Companion for
Industrial Instrumentation
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August 10, 2013

¹Funded 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.

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Chapter 1

Temperature

Scilab code Exa 1.1 Temperature Conversion

```
1 // Example 1.1, page no-53
2 clear
3 clc
4
5 c=-40
6 k=c+273
7 printf("\nK=%d K", k)
8 F=((9/5)*c)+32
9 printf("\nF=%d F", F)
10 R=((9/5)*c)+492
11 printf("\nR=%d R", R)
```

Scilab code Exa 1.2 percentage Accuracy and Error

```
1 // Example 1.2, page no-53
2 clear
3 clc
4
```



```

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

```

Scilab code Exa 1.3 Two wire RTD

```

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

```

Scilab code Exa 1.4 Thermocouple temperature measurement

```
1 // Example 1.4, page no-54
2 clear
3 clc
4
5 temp=2.022
6 millivolt_cor=37.325
7 op=millivolt_cor-temp
8 printf(" Millivolt output available=%0.3f",op)
```

Scilab code Exa 1.5 Hot junction temperature of thermocouple

```
1 // Example 1.5, page no-54
2 clear
3 clc
4 millivolt_cor=2.585
5 pot_reading=30.511
6 corrected_millivolt=pot_reading+millivolt_cor
7 printf("Temperature correspond to %0.3f mV from the
   table = 600 C",corrected_millivolt)
```

Scilab code Exa 1.6 Calibration of an instrument

```
1 // Example 1.6, page no-54
2 clear
3 clc
4 ref_jun=100
5 mV_100=0.645
```

```

6 mV_1000=9.585
7 mV_1200=11.947
8 op1=mV_1000-mV_100
9 op2=mV_1200-mV_100
10 printf(" Millivolt to be fed checking 1000 C = %.3 f
      mV", op1)
11 printf("\n Millivolt to be fed checking 1200 C = %.3 f
      mV", op2)

```

Scilab code Exa 1.7 Wall temperature measurement

```

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

```

Scilab code Exa 1.8 Thermocouple output

```

1 // Example 1.8, page no-55
2 clear
3 clc
4 //(a)
5 hot1_mV=41.29
6 cold1_mV=2.022
7 op1=hot1_mV-cold1_mV
8
9 //(b)
10 hot2_mV=33.096
11 cold2_mV=2.585
12 op2=hot2_mV-cold2_mV
13

```

```

14 //(c)
15 hot3_mV=11.947
16 cold3_mV=0.299
17 op3=hot3_mV-cold3_mV
18
19 printf("(a)\nOutput Millivolt = %.3f",op1)
20 printf("\n(b)\nOutput Millivolt = %.3f",op2)
21 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 electronic temperature transmitter

```

1 // Example 1.9, page no-56
2 clear
3 clc
4
5 Rl_ind=250
6 Rl_rec=250
7 load_connected= Rl_ind+Rl_rec
8 load_allowable=600
9 max_load_controller=load_allowable-load_connected
10 printf("(a)\nThe max load to the controller = %d
    ohms",max_load_controller)
11
12 op_cont=600
13 total=Rl_ind+Rl_rec+load_allowable
14 extra_load=total-op_cont
15 printf("\n(b)\nExtra Load = %d ohms",extra_load)
16
17 printf("\nAdditional Power Supply voltage required
    =10 V")
18
19 printf("\nMinimum Power Supply Voltage=34 ")

```


Chapter 2

Pressure

Scilab code Exa 2.1 Pressure conversion

```
1 // Example 2.1, page no-116
2 clear
3 clc
4
5 //(a)
6 //1kg/cm^2=10000 mmWG
7 x=10000*10
8 printf("(a)\n 10kg/cm^2 = %d mmWG",x)
9
10 //(b)
11 onemm_Hg=13.546
12 y=10^5/onemm_Hg
13 y=y/10^3
14 printf("\n(b)\n10kg/cm^2 = 10^5 mmWG = %.2f * 10^3
        mmHg",y)
15
16 //(c)
17 onebar=1.03
18 z=10/onebar
19 printf("\n(c)\n10kg/cm^2 = %.2f bars",z)
```

Scilab code Exa 2.2 Gauge and absolute pressure

```
1 // Example 2.2, page no-116
2 clear
3 clc
4
5 //(a)
6 gamm=1000
7 d=35
8 dens_Hg=13.546
9 press_in_kg_cm=gamm*d*10^-4
10 press_in_mmHg=gamm*d/dens_Hg
11 press_in_mmHg=press_in_mmHg/10^3
12 printf("(a)\nThe pressure at depth of %d meters in a
        water tank=%0.1f kg/cm^2 = %0.2f*10^3 mmHg",d,
        press_in_kg_cm,press_in_mmHg)
13
14 //(b)
15 press_atm=1.03
16 abspress=press_in_kg_cm+press_atm
17 abspress_mmHg=press_in_mmHg*1000+760
18 abspress_mmHg=abspress_mmHg/1000
19 printf("\n(b)\nAbsolute Pressure= %0.2f kg/cm^2 Abs =
        %0.2f*10^3 mmHg Abs",abspress,abspress_mmHg)
```

Scilab code Exa 2.3 Gauge and absolute pressure

```
1 // Example 2.3, page no-116
2 clear
3 clc
4
5 egp=260
```

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

Scilab code Exa 2.4 pressure measurement using U tube manometer

```
1 // Example 2.4, page no-117
2 clear
3 clc
4
5 //(a)
6 p_diff=500
7 pdiff=p_diff*13.546/10000
8 printf("(a)\np1-p2 = %.3f kg/cm^2",pdiff)
9
10 //(b)
11 p1=6770
12 p_atm=10300
13 abs_p1=p1+p_atm
14 printf("\n(b) If p2 is open to atmosphere:\nAbsolute
    Pressure P1 = %d mmWG abs.",abs_p1)
15
16 //(c)
17 P1=500
18 P1_gauge=P1-760
19 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

```
1 // Example 2.5, page no-117
2 clear
3 clc
4
```



```

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

```

Scilab code Exa 2.6 water flow rate using mercury manometer

```

1 // Example 2.6, page no-117
2 clear
3 clc
4
5 A=1/20
6 p_diff=1500
7 printf("(a)\nAs Delta_h=A2/A1*h << h and normally
      negligiblefor well type manometer\nhence, p1-p2 =
      h = %d =111 mmHg",p_diff)
8
9 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

```

1 // Example 2.7, page no-119
2 clear
3 clc
4
5 printf("1 kg/cm^2 = 10 mWG\n")
6 //(a)
7 press=10+2

```

```

8 printf("\n(a) Bourdon Gauge is mounted 20 meters
   below water line:\nPressure read by the Gauge =
   %d kg/cm^2",press)
9
10 //(b)
11 press2=10-3
12 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

```

1 // Example 2.8, page no-120
2 clear
3 clc
4
5 dens_water=1000
6 h1=125
7 h2=250
8 d2=(h1/h2)*dens_water
9 printf("\n(a)\nDensity of Liquid = %d kg/m^3",d2)
10 printf("\nSpecific Density of the liquid = %.1f", (h1
   /h2))
11
12 //(b)
13 printf("\n\n(b)\nIf Values of water and liquid
   interchanged:\n")
14 d3=(h2/h1)*dens_water
15 printf("\nDensity of Liquid = %d kg/m^3",d3)
16 printf("\nSpecific Density of the liquid = %.1f", (h2
   /h1))

```

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

```

1 // Example 2.9, page no-120
2 clear
3 clc
4
5 R=120
6 l=122
7 a=0.1
8 rho=R*a/l
9 R1=140
10 l1=sqrt(R1*a*l/rho)
11 l1=ceil(l1)
12 printf("Length l1 = %d meters",l1)
13 A1=a*l/l1
14 printf("\nArea A1 = %.4f mm^2",A1)

```

Scilab code Exa 2.10 Capacitance calculation for variable dielectric

```

1 // Example 2.10, page no-121
2 clear
3 clc
4
5 c=0.57
6
7 //(a)
8 d=0.1
9 di1=100
10 di2=1000
11 c1=c*di1*10/d
12 c1=ceil(c1)
13 printf("(a)\nC1=%d pf",c1)
14
15 //(b)
16 c2=c*di2*10/d
17 printf("\n(b)\nC2=%d pf",c2)
18

```

```

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

```

Scilab code Exa 2.11 pressure gauge calibration

```

1 // Example 2.11, page no-121
2 clear
3 clc
4
5 A=1
6 p1=10
7 W1=A*p1
8 printf("W1 = %d kg",W1)
9 printf("\nWith the 4 standard weights of 10kg, 20kg,
        30kg and 40kg ")

```

Scilab code Exa 2.12 pressure calculation using McLeod gauge

```

1 // Example 2.12, page no-122
2 clear
3 clc
4
5 p1=10^-2
6 h1=20
7 K=p1/h1^2
8 p2=K*30^2
9 p2=p2*100
10 printf("The unknown pressure p2 = %.2f * 10^-2 torr"
        ,p2)

```

Chapter 3

Force Torque and Velocity

Scilab code Exa 3.1 Force calculation

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

Scilab code Exa 3.2 Weight calculation

```
1 // Example 3.2, page no-163
2 clear
3 clc
4
5 m1=50
6 g1=9.8
7 W2=m1*g1
8 printf("W = %d Newtons = %d kgf",W2,m1)
```

Scilab code Exa 3.3 calculation of specific gravity

```
1 // Example 3.3, page no-164
2 clear
3 clc
4 wt_material=2500
5 wt_water=1000
6 spe_grav=wt_material/wt_water
7
8 printf("Specific gravity of the material = %.1f",
    spe_grav)
```

Scilab code Exa 3.4 Estimation of uncertainty due to sensitivity

```
1 // Example 3.4, page no-164
2 clear
3 clc
4
5 L=20
6 W=2000
7 db=0.02
8 Wb=100
9 dG=0.5
10 S=L/(2*W*db+Wb*dG)
11 printf("S = %.3f rad/g",S)
12
13 fi=0.2
14 DeltaW=fi*3.14/(180*S)
15 printf("\nDeltaW = %.3f g",DeltaW)
```

Scilab code Exa 3.5 Torque Calculation

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

Scilab code Exa 3.6 Force calculation

```
1 // Example 3.6 page no-165
2 clear
3 clc
4 ch_l=0.075
5 orig_l=50
6
7 S=ch_l/orig_l
8 E=9.66*10^5
9 stress=E*S
10 area=1.5
11 f=stress*area
12 printf("Strain = %.4f cm/cm\nStress =%d kg/cm^2\n
        nForce = %.1f kg",S,stress,f)
```

Scilab code Exa 3.7 resistance strain gauge

```
1 // Example 3.7, page no-165
2 clear
3 clc
```

```

4
5 // (a)
6 R1=120
7 R2=120
8 R3=120
9 R4=120
10 Rg=100
11 C=(R1*R2*R4)+(R1*R3*R4)+(R1*R2*R3)+(R2*R3*R4)+(Rg*(
      R1+R4)*(R2+R3))
12 C=C/10^7
13 printf("(a)\nC=%0.3f*10^7",C)
14 E=10
15 F=E*R3*R1*2*10^3/(C*10^7)
16 printf("\nF = %0.1f *10^3 A/mm = %0.1f mA/mm",F,F)
17
18 // (b)
19 Fe=2*10^-4
20 E=10
21 DeltaE=Fe*E/(4+4*10^-4)
22 DeltaE=DeltaE*10^3
23 printf("\n(b)\nDeltaEg=%0.1f mV",DeltaE)

```

Scilab code Exa 3.8 speed measurement using stroboscope

```

1 // Example 3.8, page no-167
2 clear
3 clc
4
5 // (a)
6 r1=2500
7 r2=1500
8 n=(r1*r2)/(r1-r2)
9 printf("(a)\nn = %d rpm",n)
10
11 // (b)

```



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

Scilab code Exa 3.9 speed measurement using proximity

```
1 // Example 3.9, page no-167
2 clear
3 clc
4 rpm=1500
5 f=200
6 N=60*f/rpm
7
8 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

```
1 // Example 4.1, page no-209
2 clear
3 clc
4
5 //(a)
6 k=50
7 m=0.005
8 wn=sqrt(k/m)
9 printf("(a)\nNatural frequency (wn)= %d rad/s",wn)
10 //(b)
11 Cc=2*sqrt(m*k)
12 printf("\n(b)\nCc=%d",Cc)
```

Scilab code Exa 4.2 Frequency and phase angle of motion

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

```

2 clear
3 clc
4
5 //(a)
6 Cc=1.0
7 C=0.7*Cc
8 m=0.005
9 k=50
10 w=sqrt((k/m)-(C/(2*m))^2)
11 printf("(a)\nw=%0.1f rad/s",w)
12 //(b)
13 w1=250
14 theta=C*w1/(k-m*w1^2)
15 printf("\ntheta=%f",theta)
16 fi=atan(-theta)
17 fi=fi*180/%pi
18 printf("\nfi = %d ",fi)

```

Scilab code Exa 4.3 time calculation for exponential transient term

```

1 // Example 4.3, page no-210
2 clear
3 clc
4 m=0.005
5 c=0.7
6 y=-log(0.01)
7 // printf("y=%0.2f",y)
8 t=y*2*m/c
9 printf("t=%0.4f Secs",t)

```

Scilab code Exa 4.4 Acceleration measurement

```

1 // Example 4.4, page no-210

```

```

2 clear
3 clc
4 rg1=1200
5 rg2=1200
6 rg3=1200
7 rg4=1200
8 D1=rg1*5/100
9 D2=rg2*5/100
10 D3=rg3*5/100
11 D4=rg4*5/100
12 E=12
13 v=E*((rg1+D1)/(rg1+D1+rg2-D2))-((rg4-D4)/(rg3+D3+
    rg4-D4))
14 v=v*1000
15 printf("V0=%d mV",v)

```

Scilab code Exa 4.5 output voltage of quartz piezoelectric crystal

```

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

```

Scilab code Exa 4.6 Differential values of capacitor

```

1 // Example 4.6, page no-211
2 clear
3 clc
4

```

```

5 c0=25
6 x0=0.5
7 x1=0.05
8 c1=c0*x0/(x0-x1)
9 c2=c0*x0/(x0+x1)
10 printf("C1=%0.2 f pF\nC2=%0.2 f pF" ,c1 ,c2)

```

Scilab code Exa 4.7 Specific Gravity Conversion

```

1 // Example 4.7, page no-211
2 clear
3 clc
4
5 //(a)
6 sg_at_60=1.02
7 API=(141.5/sg_at_60)-131.5
8 printf("(a)\nDegrees API = %0.2 f API" ,API)
9 //(b)
10 Be=145-145/sg_at_60
11 printf("\n(b)\nDegrees Baume(heavy) = %0.1 f B e" ,Be)
12 //(c)
13 Bk=(sg_at_60-1)*1000
14 printf("\n(c)\nDegrees Barkometer = %d Bk" ,Bk)
15 //(d)
16 Q=(sg_at_60-1)*1000
17 printf("\n(c)\nDegrees Quevenne = %d Q" ,Q)
18 //(e)
19 Tw=200*(sg_at_60-1.0)
20 printf("\n(d)\nDegrees Twaddel = %d Tw" ,Tw)

```

Scilab code Exa 4.8 calculation of the volume of displacer

```

1 // Example 4.8, page no-212

```

```

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

```

Scilab code Exa 4.9 Differential pressure Sensor

```

1 // Example 4.9, page no-212
2 clear
3 clc
4 sg1=0.85
5 sg2=0.8
6 span=150
7 H=span/(sg1-sg2)
8 printf("(a)\nH=%d mm = %dm",H,H/1000)
9 span_min=1500
10 span2=span_min*(sg1-sg2)
11 span2=ceil(span2)
12 printf("\n(b)\nD/P span = %d mm",span2)

```

Scilab code Exa 4.10 Specific Gravity of unknown liquid

```

1 // Example 4.10, page no-212
2 clear
3 clc
4 Ww=12-2
5 dw=1000
6 v=Ww/dw

```

```

7 dx=(10-2)/v
8 sg=dx/dw
9
10 printf(" Specific Gravity of X =%.1f",sg)

```

Scilab code Exa 4.11 calculation of specific gravity

```

1 // Example 4.11 , page no-213
2 clear
3 clc
4
5 //(a)
6 v_obj=2/1000
7 wt=1.5
8 dx=wt/v_obj
9 sg=dx/1000
10 printf("(a)\nSpecific Gravity = %.2f",sg)
11
12 //(b)
13 sgl=0.8
14 dens=800
15 W1=dens*v_obj-wt
16 printf("\n(b)\nW1 = %.1f kg",W1)
17
18 //(c)
19 sg2=1.2
20 dens2=1200
21 W2=dens2*v_obj-wt
22 printf("\n(c)\nW2 = %.1f kg",W2)

```

Chapter 5

Flow

Scilab code Exa 5.1 flow rate calculation

```
1 // Example 5.1, page no-310
2 clear
3 clc
4 //(i)
5 d=75*10^-3
6 a=3.141*d^2/4
7 v=760*10^-3
8 Q=v*a
9 Q=Q*10^3
10 printf("(i)\nVolume Flow Rate Q=%0.3f *10^-3 m^3/sec"
        ,Q)
11 rho=1000
12 W=rho*Q*10^-3
13 printf("\n(ii)\nMass Flow rate W=%0.3f kg/sec",W)
```

Scilab code Exa 5.2 Volumetric flow rate calculation

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



```

2 clear
3 clc
4
5 D=40
6 d=20
7 mr=15
8 h=(13.6-1)*15*10
9 B=d/D
10 M=1/sqrt(1-B^4)
11 // printf("%f\n",B)
12 Cd=0.5999
13 x=sqrt(2*9.8*h*10^-3)
14 Q=x*Cd*M*(3.14*(20*10^-3)^2)/4
15 Q=Q*3600
16 printf("Volumetric flow rate Q= %.4f m^3/hr",Q)

```

Scilab code Exa 5.3 Nominal flow velocity

```

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

```

Scilab code Exa 5.4 pressure difference calculation

```

1 // Example 5.4, page no-311

```

```

2 clear
3 clc
4 Cd=0.61
5 D=40*10^-3
6 d=20*10^-3
7 M=1/sqrt(1-(d/D)^4)
8 // printf("%.4f\n",M)
9 V2=10
10 rho=1000
11 g=9.8
12 X=V2*sqrt(rho/(2*g))/(Cd*M)
13 p_diff=X^2
14
15 p_diff=floor(p_diff/100)
16 p_diff=p_diff/100
17 printf("P1-P2 = %.2f kg/cm^2",p_diff)

```

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

```

1 // Example 5.5, page no-312
2 clear
3 clc
4 Cd=0.6
5 D=150*10^-3
6 d=75*10^-3
7 p=250
8 g=9.8
9 rho=1000
10 s=75*10^-3
11 //(a)
12
13 Q=Cd*3.14*s^2*sqrt(2*g*p/rho)/(4*sqrt(1-(d/D)^4))
14 printf("(a) For orifice plate\nQ=%f m^3/sec = %.3f
        litres/sec",Q,Q*1000)
15 Cd1=0.99

```

```

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

```

Scilab code Exa 5.6 determination of Reynolds number

```

1 // Example 5.6, page no-312
2 clear
3 clc
4
5 //(i)
6 V=0.02
7 d=10*10^-2
8 A=%pi*d^2/4
9 v=V/A
10 rho=1000
11 Re=rho*v*d/10^-3
12 Re=Re/100000
13 printf("(i)\nReynolds number(Re) = %.3 f * 10^5",Re)
14
15 //(ii)
16 Cd=0.98
17 D=20*10^-2
18 d=10*10^-2
19 M=1/sqrt(1-(d/D)^4)
20 a2=3.14*d^2/4
21 Q=0.02
22 g=9.8
23 X=Q*sqrt(rho)/(M*Cd*a2*sqrt(2*g))
24 p_diff=ceil(X^2)
25 printf("\n(ii)\nPressur_difference = %d kg/m^2 = %.4
    f kg/cm^2",p_diff,p_diff/10000)

```

Scilab code Exa 5.7 Fluid velocity and Volumetric flow rate

```
1 // Example 5.7, page no-313
2 clear
3 clc
4 //1kg/m^2=10 meters water head
5 g=9.81
6 h=20
7 v=sqrt(2*g*h)
8 d=300*10^-3
9 A=(3.14*d^2)/4
10 A=floor(A*1000)
11 A=A/1000
12 Q=A*v
13 printf("Q=%0.3 f m^3/sec",Q)
```

Scilab code Exa 5.8 Fluid velocity calculation

```
1 // Example 5.8, page no-313
2 clear
3 clc
4 Cd=0.6
5 g=9.8
6 h=400*10^-3
7 V=Cd*sqrt(2*g*h)
8 printf("V = %0.2 f m/sec",V)
```

Scilab code Exa 5.9 velocity measurement using pilot tube

```
1 // Example 5.9, page no-314
2 clear
3 clc
4
```

```

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

```

Scilab code Exa 5.11 detemination of flow velocity

```

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

```

Scilab code Exa 5.12 calculation of flying speed of aircraft

```

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

```

Scilab code Exa 5.13 Maximum fluid handling capacity of Rotameter

```

1 // Example 5.13, page no-315
2 clear
3 clc
4 Cd=0.6
5 Dp=0.05
6 Df=0.035
7 g=9.8
8 rho_f=3.9*10^3
9 rho=1000
10 Vf=3.36*10^-5
11 Q=Cd*((Dp^2-Df^2)/Df)*sqrt(3.14*g*Vf*(rho_f-rho)/(2*
    rho))
12 Q=Q*10000
13 printf(" Volumetric flow Q=%0.4f *10^-4 m^3/sec",Q)

```

Scilab code Exa 5.14 Determination of range of flow for ratameter

```

1 // Example 5.14, page no-315
2 clear
3 clc
4
5 Cd=1
6 Dp=0.018
7 Df=0.015
8 g=9.81
9 rho_f=2.7
10 rho=0.8
11 Vf=520*10^-9
12 // case 1
13
14 Qmin=Cd*((Dp^2-Df^2)/Df)*sqrt(%pi*g*Vf*(rho_f-rho)
    /(2*rho))
15 Qmin=Qmin*100000
16 printf("Case 1: When float is at the bottom\n
    Volumetric flow Qmin=%0.3f *10^-5 m^3/sec",Qmin)

```

```

17
18 //case 2
19 Dp2=0.0617
20 Qmax=Cd*((Dp2^2-Df^2)/Df)*sqrt(%pi*g*Vf*(rho_f-rho)
    /(2*rho))
21 Qmax=Qmax*100000
22 printf("\n\nCase 2: When float is at the bottom\n
    Volumetric flow Qmax=%0.2 f *10^-5 m^3/sec",Qmax)

```

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

```

1 // Example 5.15, page no-316
2 clear
3 clc
4 W=165
5 R=328
6 L=16
7 Q=W*R/L
8 printf(" Flow Rate Q=%0.2 f kg/min =%0.1 f kg/hour",Q,Q
    /60)

```

Scilab code Exa 5.16 Fluid velocity calculation

```

1 // Example 5.16, page no-316
2 clear
3 clc
4 f=100
5 d=300*10^-3
6 a=45
7 a_rad=45*%pi/180
8 v=f*d/(2*cos(a_rad))
9 printf(" Fluid Velocity V=%0.1 f m/sec",v)

```

Scilab code Exa 5.17 volume flow rate

```
1 // Example 5.17, page no-316
2 clear
3 clc
4
5 r=150
6 v=120
7 Q=4*v*r
8 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

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

Scilab code Exa 5.19 velocity of flow in electromagnetic flow meter

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



```

3  clc
4
5  e=0.2*10^-3
6  B=0.08
7  l=10*10^-2
8  v=e/(B*l)
9  printf("V = %.3 f m/sec = %.2 f cm/sec",v,v*100)

```

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

```

1  //Example 5.20, page no-317
2  clear
3  clc
4
5  ei=0.15*10^-3
6  em=2*ei
7  B=0.1
8  l=60*10^-3
9  v=em/(B*l)
10 printf("Velocity of flow V = %.2 f m/sec = %.1 f cm/
      sec",v,v*100)

```

Chapter 6

Level

Scilab code Exa 6.1 output current of two wire pressure transmitter

```
1 // Example 6.1, page no-370
2 clear
3 clc
4 //(a)
5 p=1.5
6 a=4
7 b=20
8 wh=(((b-a)/2)*p)+a
9 printf("(a) just at the bottom level of the tank\
      nWater head applied to the transmitter =%d mA ",
      wh)
10 //(b)
11 wh2=(((b-a)/2)*p)+2*a
12 printf("\n\n(b) 5m below the bottom of the tank\
      nWater head applied to the transmitter =%d mA ",
      wh2)
13 //(c)
14 wh3=(((b-a)/2)*p)
15 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

```
1 // Example 6.2, page no-371
2 clear
3 clc
4 //(a)
5 b=20
6 a=4
7 op=16
8 p=(op-a)*2/(b-a)
9 p_h=p*10
10 h=p_h-2-5
11 printf("(a)\nh = %dm",h)
12 //(b)
13 p1=1
14 t_op=((b-a)/2)*p1+4
15 printf("\n(b)\nTransmitter output =%d mA",t_op)
16 //(c)
17 p2=0.5
18 t_op1=((b-a)/2)*p2+4
19 printf("\n(c)\nTransmitter output =%d mA",t_op1)
```

Scilab code Exa 6.3 Differential pressure output at different levels

```
1 // Example 6.3, page no-372
2 clear
3 clc
4 //(a)
5 b=20
6 a=4
7 op=16
```

```

8 wt_l1=25
9 t_op=((b-a)/100)*(100-75)+4
10 printf("(a)\nWater level=+25cm\nTransmitter output =
      %d mA",t_op)
11
12 //(b)
13 wt_l2=-25
14 t_op2=((b-a)/100)*(100-25)+4
15 printf("\n(b)\nWater level=-25cm\nTransmitter output
      = %d mA",t_op2)
16
17 //(c)
18 t_op3=12
19 H=(100/(b-a))*(12-4)
20 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

```

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

```

```

16 sbr2=22
17 wloss2=w-sbr2
18 L2=wloss2/(1000*a)
19 printf("\n(ii)\tL2=%dm",L2)
20 //(iii)
21 sbr3=21
22 wloss3=w-sbr3
23 L3=wloss3/(1000*a)
24 printf("\n(iii)\tL3=%dm",L3)
25
26 //(b)
27 level=8
28 wt=a*level*1000
29 spring=w-wt
30 printf("\n(b):when the tank is full\nSpring Balance
    reading = %d kg",spring)

```

Scilab code Exa 6.5 Buoyancy Force calculation

```

1 // Example 6.5, page no-374
2 clear
3 clc
4 rho=1000
5 v=3
6 Bw=rho*v
7 printf("Buoyance Force(Bw) = %d kg",Bw)

```

Scilab code Exa 6.6 Determination of displaced volume from Buoyancy Force

```

1 // Example 6.6, page no-374
2 clear
3 clc

```

```
4 rho=1000
5 Bw=5000
6 v=Bw/rho
7 printf("V = %d m^3",v)
```

Scilab code Exa 6.7 Determination of hydrostatic pressure in open tank

```
1 // Example 6.7, page no-374
2 clear
3 clc
4
5 rho=1000
6 h=10
7 P=rho*h
8 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

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

Scilab code Exa 6.9 Determination of height from hydrostatic pressure

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

```
2 clear
3 clc
4 rho=1000
5 ex_p=0.5*10^4
6 P=1.6*10^4// (rho*h/10000)+ex_p
7 h=(P-ex_p)/1000
8 printf("h = %d m",h)
```

Scilab code Exa 6.10 calculation of level on the probe

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

Chapter 7

Viscosity Humidity and Moisture

Scilab code Exa 7.1 calculation of absolute viscosity

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

Scilab code Exa 7.2 calculation of kinematic relative and absolute viscosity

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



```

2 clear
3 clc
4 //(a)
5 v=10
6 F=1/v
7 printf("(a)\nFluidity = %.1f rhe",F)
8
9 //(b)
10 mu=10
11 rho=0.8
12 ve=mu/rho
13 printf("\n(b)\nKinematic viscosity (v)= %.1f cm^2/
        sec",ve)
14 //(c)
15 ab=1000
16 abwt=1.002
17 rv=ab/abwt
18 printf("\n(c)\nRelative viscosity = %d centipoises",
        rv)
19 //(d)
20 PAS=10
21 printf("\n(c)\nAbsolute viscosity = 1000 centipoises
        =10 poises = 1PAS")

```

Scilab code Exa 7.3 Absolute viscosity of the Newtonian fluid

```

1 //Example 7.3, page no-438
2 clear
3 clc
4 //(b)
5 R=0.5
6 L=5
7 p_diff=800
8 V=10
9 mu=(3.14*R^4)*p_diff/(8*V*L)

```

```
10 printf("(b)\nmu=%0.4f poise =%0.2f centipoise",mu,mu
    *100)
```

Scilab code Exa 7.4 kinematic viscosity and density calculation

```
1 //Example 7.4 , page no-439
2 clear
3 clc
4 //(a)
5 g=980
6 h=4
7 R=0.5
8 t=1
9 V=10
10 l=5
11 v=(3.14*g*h*t*R^4)/(8*l*V)
12 printf("(a)\n v = %0.2f stokes",v)
13 mu=0.3925
14 rho=mu/v
15 printf("\n(b)\n Density of the fluid rho = %0.3f gm/
    cm^3",rho)
```

Scilab code Exa 7.5 Kinematic Viscosity in Saybolts Universal viscometer

```
1 //Example 7.5 , page no-440
2 clear
3 clc
4 //(a)
5 A=0.226
6 B=195
7 t=60
8 v=A*t-B/t
9 printf("(a) Fluid X\n v = %0.2f centipoises",v)
```

```

10 A1=0.220
11 B1=135
12 t1=140
13 v1=A1*t1-B1/t1
14 printf("\n(b) Fluid Y\n v = %.1f centipoises",v1)

```

Scilab code Exa 7.6 calculation of absolute viscosity

```

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

```

Scilab code Exa 7.7 calculation of relative humidity

```

1 //Example 7.7 , page no-441
2 clear
3 clc
4 //(a)
5 B=45
6 W=25
7 printf("(a)\nPsychromatic differential : %d C\n
    Relative humidity is 80%% corresponding to \
    ntemperature 45 C and psychromatic differential
    20 C ",(B-W))
8 //(b)
9 //(a)

```

```

10 B1=30
11 W1=27
12 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 content

```

1 //Example 7.8, page no-441
2 clear
3 clc
4 D=80
5 W=66.5
6 //(a)
7 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%% ")
8 //(b)
9 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 ")
10 //(c)
11 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

```
1 //Example 7.9 , page no-442
2 clear
3 clc
4
5 wt_vap=500
6 wt_vap_to_sat=1500
7 total=wt_vap+wt_vap_to_sat
8 Rh=(wt_vap/total)*100
9 printf("RH = %d%%" ,Rh)
```

Scilab code Exa 7.10 percentage relative humidity

```
1 //Example 7.10 , page no-442
2 clear
3 clc
4 pv=30
5 ps=60
6 Rh=(pv/ps)*100
7 printf("%d%%RH = %d%%" ,Rh)
```

Scilab code Exa 7.11 percentage increase in moisture content

```
1 //Example 7.11 , page no-442
2 clear
3 clc
4
5 i1=250
6 i2=350
7 m=(i2-i1)*100/i1
8 printf("%d%% increase in moisture content = %d%%" ,m)
```

Scilab code Exa 7.12 calculation of moisture content

```
1 //Example 7.12, page no-443
2 clear
3 clc
4
5 i2=150
6 i1=125
7 m=(i2-i1)*100/i1
8 printf("Moisture percentage = %d%%",m)
```

Chapter 8

Fundamentals of measuring instruments

Scilab code Exa 8.1 Flux density calculation

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

Scilab code Exa 8.2 Power Dissipation and accuracy of result

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

```

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

```

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

```

1 //Example 8.3, page no-508
2 clear
3 clc
4 i1=37
5 i2=42
6 i3=13
7 i4=6.7
8 Imax=(i1+i2)+(i1+i2)*(3/100)+(i3+i4)+(i3+i4)*(1/100)
9
10 Imin=(i1+i2)-(i1+i2)*(3/100)+(i3+i4)-(i3+i4)*(1/100)
11
12 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

```

1 //Example 8.4, page no-508
2 clear
3 clc
4 //(a)
5 T=200
6 T0=300

```



```

7 Ti=70
8 t=3
9 x=(T-T0)/(Ti-T0)
10 tow=-t/log(x)
11 printf("(a)\nTime constant tow=%0.1f s",tow)
12 //(b)
13 t1=5
14 T5=T0+((Ti-T0)*%e^(-t1/tow))
15 printf("\n(b)\nTemperature after 5 seconds T5 = %0.2
    f C ",T5)

```

Scilab code Exa 8.5 Error calculation of second order instrument

```

1 //Example 8.4, page no-509
2 clear
3 clc
4 w=9
5 wn=6
6 x=w/wn
7 dr=0.6
8 Ar=1/sqrt(((1-(x)^2)^2)+(2*dr*x)^2)
9 printf("A=%0.3f",Ar)
10 err=(1-Ar)*100
11 printf("\nError = %0.2f%%",err)

```

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

```

1 //Example 8.6, page no-510
2 clear
3 clc
4 t=2
5 y=1-%e^(-(t-1.5)/0.5)
6 printf("y(t) at t=2 will be y(t)=%0.3f",y)

```

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

```
1 //Example 8.7, page no-510
2 clear
3 clc
4 T=[98.5 99 99.5 100 100.5 101 101.5]
5 f=[4 13 19 35 17 10 2]
6 //(i)
7 k=0
8 a=0
9 for i=1:length(T)
10 k=k+(T(i)*f(i))
11 a=a+f(i)
12 end
13 x_bar=k/a
14 printf("(i)\nArithmetic Mean x_bar = %.2 f C ",x_bar)
15
16 //(ii)
17 m=0
18 n=0
19 for i=1:length(T)
20 x=(T(i)-x_bar)
21 if x<0 then
22 x=-x
23 end
24 m=m+(x*f(i))
25 n=n+f(i)
26 end
27 D=m/a
28 printf("\n(ii)\nAverage Deviation D = %.4 f C ",D)
29
30 //(iii)
31
```

```

32 m=0
33 n=0
34 for i=1:length(T)
35 x=(T(i)-x_bar)
36 m=m+(x^2)*f(i)
37 n=n+f(i)
38 end
39 sigma=sqrt(m/n)
40 printf("\n(iii)\nStandard Deviation (Sigma) = %.3
    f C ",sigma)
41
42 //(iv)
43 v=sigma^2
44 printf("\n(iv)\nVariance = %.4 f C ",v)
45
46 //(v)
47 err=sigma*0.6745
48 printf("\n(v)\nProbable error = %.4 f C ",err)

```

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

```

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

```

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

```

1 //Example 8.9, page no-512
2 clear
3 clc
4 w=100
5 fi=-atan(0.1*w)-atan(0.5*w)
6 A=1/(sqrt(1+(0.1*w)^2)*(sqrt(1+(0.5*w)^2)))
7 A=1*1000/ceil(1000*A)
8 err=(1-1/A)*100
9 printf("A=K/%d\n%% error = %.1f%%\nfi=%%.2 f ",A,err,
        fi*180/%pi)

```

Scilab code Exa 8.10 temperature and altitude calculation from first order thermometer placed in balloon

```

1 //Example 8.10, page no-512
2 clear
3 clc
4 R=0.15*10/50
5 K=1
6 tow=15
7 deg=K*R*tow
8 //(i)
9 a=15-deg
10 printf("(i)The actual temperature when instrument
        reads 15 C is %.2 f C\n The true temperature at
        5000 metres = %.2 f ",a,a)
11
12 //(ii)
13 alt_red=deg*50/0.15
14 h=5000-alt_red
15 printf("\n(ii)\nThe true altitude at which 15 C
        occurs is %d metres",h)

```
