Scilab Textbook Companion for Electronic Devices and Circuits by S. L. Kakani and K. C. Bhandari[1]

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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.

Contents

List of Scilab Codes 4

1 Electronic Materials and Components 5

2 Semiconductor Physics 10

3 Semiconductor Diodes 19

4 Diode Circuits 34

5 Transistors 46

6 Thermal Stability 49

7 Amplifiers 53

8 Feedback Amplifiers 60

9 Negative Feedback Amplifier using Opamp 64

10 Operational Amplifier 69

11 Power Amplifiers 74

12 Oscillators 79

14 Optical Fibres and Communication **83**

15 Communication System **93**

18 Optoelectronic Devices **98**

19 Digital Electronics **103**

21 Integrated Circuits **118**

List of Scilab Codes

Exa 1.1 Color Coding Resistance 5
Exa 1.2 Color Coding Resistance 6
Exa 1.3 Color Coding Resistance 6
Exa 1.4 Current Source Representation 7
Exa 1.5 Percentage Variation in Load Voltage and Current 8
Exa 2.1 Conductivity and Resistivity 10
Exa 2.2 Resistivity 10
Exa 2.3 Resistance 11
Exa 2.4 Density Ratio 11
Exa 2.5 Number Density of Donor Atoms 12
Exa 2.6 Silicon and Germanium Semiconductors . . 12
Exa 2.7 Average Relaxation Time 13
Exa 2.8 Conduction Current Density 13
Exa 2.9 Number of Mobile Carriers Derivation . . . 15
Exa 2.10 Hall Voltage 16
Exa 2.11 Hall Effect Experiment 17
Exa 2.12 Wavelength of Electromagnetic Radiation . 17
Exa 3.1 Ohms Law 19
Exa 3.2 Voltage across Junction 19
Exa 3.3 PN Junction Forward Voltage 20
Exa 3.4 Incremental Resistance 20
Exa 3.5 Forward and Reverse Biased 21
Exa 3.6 AC Resistance 21
Exa 3.7 Change in Temperature 22
Exa 3.8 Forward Current 23
Exa 3.9 Static and Dynamic Resistance 24
Exa 3.10 Voltage across Junction 24

Exa 3.11 Value of Resistance and Power Dissipation . 25
Exa 3.12 DC Resistance 26
Exa 3.13 Current through Diode 26
Exa 3.14 Current through Resistor 28
Exa 3.15 Current Drawn from Battery 28
Exa 3.16 Breakdown Voltage Ranges 29
Exa 3.17 Capacitance 30
Exa 3.18 Voltage across each Diode 30
Exa 3.19 LED Current 31
Exa 3.20 AC Resistance 32
Exa 3.21 AC Resistance 32
Exa 4.1 Half Wave Rectifier 34
Exa 4.2 No Load Voltage 35
Exa 4.3 AC Input Power 35
Exa 4.4 Half Wave Rectifier 36
Exa 4.5 Bridge Rectifier 37
Exa 4.6 Half Wave Rectifier 37
Exa 4.7 Full Wave Rectifier 38
Exa 4.8 Full Wave Rectifier 39
Exa 4.9 Full Wave Rectifier 40
Exa 4.10 Full Wave Rectifier 41
Exa 4.11 Full Wave Rectifier 41
Exa 4.12 Zener Current 42
Exa 4.13 Current and Wattage of Elements 43
Exa 4.14 Zener Diode 44
Exa 4.15 Voltage Regulator Circuit 44
Exa 5.1 Current component of a Transistor 46
Exa 5.2 Transistor Components 46
Exa 5.3 Transistor Components 47
Exa 6.1 Collector Base Junction Temperature 49
Exa 6.2 Dissipation Capacity of a Transistor 50
Exa 6.3 Fixed Bias Circuit 51
Exa 6.4 Collector to Base Bias Circuit 51
Exa 7.1 Coupling 53
Exa 7.2 Bypassing 53
Exa 7.3 Small Signal Amplifiers 54
Exa 7.4 Amplifier Circuit 55
Exa 7.5 RC Coupled CE Amplifier 56

Exa 7.6	Audio Amplifier	57
Exa 7.7	RC Coupled CE Amplifier	57
Exa 7.8	RC Coupled Amplifier	58
Exa 7.9	FET Amplifier	58
Exa 8.1	Voltage Gain of Amplifier	60
Exa 8.2	Bandwidth of Amplifier	61
Exa 8.3	Negative Feedback Factor	61
Exa 8.4	Feedback Voltage Gain	61
Exa 8.5	Feedback Voltage Gain	62
Exa 8.6	Feedback Amplifier	62
Exa 9.1	VCVS Amplifier	64
Exa 9.2	ICVS Amplifier	64
Exa 9.3	ICIS Amplifier	65
Exa 9.4	VCVS Amplifier	65
Exa 9.5	VCVS Amplifier	66
Exa 9.6	VCVS Amplifier	66
Exa 9.7	ICIS Amplifier	67
Exa 9.8	VCIS Amplifier	67
Exa 10.1	Common Mode Voltage Gain	69
Exa 10.2	Differential Amplifier	69
Exa 10.3	Opamp Operating Circuit	70
Exa 10.4	Opamp Operating in Inverting Mode	71
Exa 10.5	Closed Loop Voltage Gain	71
Exa 10.6	Opamp Operating in Inverting Mode	72
Exa 10.7	Power Bandwidth of Opamp	73
Exa 10.8	Resistances of Opamp	73
Exa 11.1	RC Coupled Amplifier	74
Exa 11.2	Class B Transformer Coupled Amplifier	75
Exa 11.3	Tuned Amplifier	76
Exa 11.4	RC Coupled Amplifier	76
Exa 11.5	Class C Tuned Amplfier	78
Exa 12.1	Colpitts Oscillator	79
Exa 12.2	Phase Shift Oscillator	80
Exa 12.3	Oscillator	80
Exa 12.4	Pierce Oscillator	81
Exa 12.5	Oscillator	82
Exa 14.1	Optical fibre	83
Exa 14.2	Multimode Index Fibre	83

Exa 14.3	Multimode Step Index Fibre	84
Exa 14.4	Optical Fibre	85
Exa 14.5	Step Index Fibre	85
Exa 14.6	Optical Fibre	86
Exa 14.7	Optical Fibre	86
Exa 14.8	Optical Fibre	87
Exa 14.9	Step Index Fibre	87
Exa 14.10	Step Index Fibre Single Mode	88
Exa 14.11	Loss in Optical Fibre	88
Exa 14.12	Communication System Output Power	89
Exa 14.13	GRIN Optical Fibre	89
Exa 14.14	Multimode Step Index Optical Fibre	90
Exa 14.15	Optical Fibre	91
Exa 14.16	Single Mode Step Index Fibre	91
Exa 15.1	Transmitter Modulation	93
Exa 15.2	Transmitter Modulation	93
Exa 15.3	AM Wave Modulation	94
Exa 15.4	AM Wave Modulation	95
Exa 15.5	AM Wave Modulation	95
Exa 15.6	AM Wave Modulation	96
Exa 15.7	AM Wave Modulation	97
Exa 18.1	DC Circuit of LED	98
Exa 18.2	Spontaneous and Stimulated Emission	98
Exa 18.3	Relative Populations	99
Exa 18.4	Silicon Crystal Problem	100
Exa 18.5	Electrons Diffusion	101
Exa 18.6	Frequency Bandwidth Limitations	101
Exa 18.7	SemiconductorLaser	102
Exa 18.8	Photoconductor Device	102
Exa 19.1	Binary to Decimal	103
Exa 19.2	Binary to Decimal	103
Exa 19.3	Binary to Decimal	104
Exa 19.4	Binary to Decimal	104
Exa 19.5	Binary to Decimal	104
Exa 19.6	Decimal to Binary	105
Exa 19.7	Decimal to Binary	105
Exa 19.8	Decimal to Binary	106
Exa 19.9	Decimal to Binary	106

Exa 19.10 Binary to Decimal 107
Exa 19.11 Octal to Decimal 107
Exa 19.12 Octal to Decimal 108
Exa 19.13 Decimal to Octal 108
Exa 19.14 Decimal to Octal 108
Exa 19.15 Octal to Binary 109
Exa 19.16 Octal to Binary 109
Exa 19.17 Binary to Octal 110
Exa 19.18 Hexadecimal to Binary 110
Exa 19.19 Hexadecimal to Binary 111
Exa 19.20 Binary to Hexadecimal 111
Exa 19.21 Hexadecimal to Decimal 111
Exa 19.22 Decimal to Hexadecimal 112
Exa 19.23 Decimal to Hexadecimal 112
Exa 19.24 Binary Addittion 113
Exa 19.25 Binary Subtraction 113
Exa 19.26 Binary Subtraction 113
Exa 19.27 Boolean Expression 114
Exa 19.28 Boolean Expression 115
Exa 19.30 Boolean Expression 115
Exa 19.31 Boolean Expression 116
Exa 21.1 AC Coupled Trigger Pulse 118
Exa 21.2 Astable Mode Time Output 118
Exa 21.3 Astable Mode Time Output 119
Exa 21.4 Astable Mode Output Frequency 119
Exa 21.5 Astable Mode Duty Cylce 120
Exa 21.6 Resistor Values in Astable Mode 120
Exa 21.7 Time Delay Mode 120
Exa 21.8 Decimal to TTL Voltage Terms 121

Chapter 1

Electronic Materials and Components

Scilab code Exa 1.1 Color Coding Resistance

```
//Ex1_1 Pg-43
clc
disp("Refer to the figure 1.52")
disp("Hold the resistor as shown in the figure such that tolerance is on your extreme right.")
disp("Now the value of the resistor is equal to")
disp("   Red        Black        Blue        Gold")
disp("    2           0           6          (+/-)5%")
red=2 //red value
blk=0 //black value
blu=6 //blue value
gld=5 //gold value
value_res=(red*10+blk)*10^blu //value of resistor
printf("\n The value of resistor is %.0f ohm (+/-)%.0f%%",value_res,gld)
per_val=0.05*value_res
pos_value_res=value_res+per_val //positive range of resistor
neg_value_res=value_res-per_val //negative range of
```

```
resistor
printf("\n The value of resistor is %.0f Mohm and %.0f Mohm",neg_value_res*1e-6,pos_value_res*1e-6)
```

Scilab code Exa 1.2 Color Coding Resistance

```
//Ex1_2 Pg-43
clc
disp("With the help of colour coding table, one finds")
disp("  1st_Band    2nd_Band    3rd_Band    4th_Band  ")
printf("     Yellow      Violet      Orange      Gold  ")
disp("      4           7           10^3      (+/-)5%")
yel=4 //yellow value
vio=7 //violet value
org=1e3 //orange value
gld=5 //gold value in %
val_res=(yel*10+vio)*org
printf("\n The value of resistor is %.2f kohm (+/-)%.0f%%",val_res*1e-3,gld)
gld_ab=0.05 //absolute gold value
per_val=gld_ab*val_res
printf("\n Now, 5%% of 47k_ohm = %.0f ohm",per_val)
range_high=val_res+per_val //higher range
range_low=val_res-per_val //lower range
printf("\n\n Thus resistance should be within the range %.2f kohm(+/-)%.2f Kohm,\n or between %.2f kohm and %.2f kohm.",val_res*1e-3,per_val*1e-3,range_low*1e-3,range_high*1e-3)
```

Scilab code Exa 1.3 Color Coding Resistance

```
//Ex1_3 Pg-44
clc
disp("The specification of the resistor from the color coding table is as follows")
disp("  1st_Band    2nd_Band    3rd_Band    4th_Band  ")
printf("      Gray          Blue          Gold        Silver")
disp("       8            6           10^(-1)       (+/-)10%  ")
gray=8 //gray value
blu=6 //blue value
gld=10^-1 //gold value
sil=10 //silver value in %
val_res=(gray*10+blu)*gld
printf("\n The value of resistor is %.1f ohm (+/-)%.0f%%",val_res,sil)
sil_ab=0.1 //absolute gold value
per_val=sil_ab*val_res
printf("\n Now, 10%% of 8.6 ohm = %.2f ohm",per_val)
range_high=val_res+per_val //higher range
range_low=val_res-per_val //lower range
printf("\n\n Obviously resistance should lie within the range %.2f ohm(+/-)%.2f ohm,\n or between %.2f ohm and %.2f ohm.",val_res,per_val,range_high,range_low)
```

Scilab code Exa 1.4 `Current Source Representation`

```
//Ex1_4 Pg-44
clc
disp("Refer to the figure 1.53")
Vs=2 //supply voltage in V
Rs=1 //resistance in ohm
Is=Vs/Rs
```

```
printf("\n Current Is = %.0f A \n",Is)
disp("     Internal resistance remains the same but is now connected in parralel with the current sourceIS,as shown in Figure 1.51(a)")
disp("    Now,we connect a load resistance R_L=1 ohm across the terminals of two representations ,and find I_L and V_L. From Figure 1.54(b) and using the current-divider concept,one obtains")
RL=1 //load resistance in ohm
IL=Is*(Rs/(Rs+RL)) //load current using current-divider
VL=IL*RL //load voltage
printf("\n Load voltage = %.0f V",VL)
printf("\n Load current = %.0f A \n",IL)
disp("From equation 53(b),using the voltage-divider concept,one obtains")
VD_vl=Vs*(RL/(RL+Rs)) //load voltage using voltage divider
VD_il=VL/RL //load current
printf("\n Load voltage = %.0f V",VD_vl)
printf("\n Load current = %.0f A \n",VD_il)
```

Scilab code Exa 1.5 Percentage Variation in Load Voltage and Current

```
//Ex1_5 Pg-45
clc
disp("Refer to the figure 1.55")
disp("(a) R_L varies from 1 ohm to 10 ohm.")
disp("Currents for two extreme values of R_L are")
Vs=10 //supply voltage
RL1=1 //resistance RL1
Rs=100 //source resistance
IL1=(Vs/(RL1+Rs))
RL2=10
IL2=(Vs/(RL2+Rs))
```

```
per_var_cur=((IL1-IL2)/IL1)*100
printf("\n Percentage variation in current = %.2f %%
   \n",per_var_cur)//answer in the text book took a
   .3 decimal round off value
disp("   Now,load voltage for the two extreme values
    of R_L are")
VL1=IL1*RL1
VL2=IL2*RL2
per_var_vol=((VL2-VL1)/VL2)*100
printf("\n Percentage variation in current = %.2f %%
   \n",per_var_vol)

disp("(b) R_L varies from 1 k-ohm to 10 k-ohm
                (Figure 1.55(b))")
disp("Currents for the two extreme values R_L are")
RL11=1000
IL11=(Vs/(RL11+Rs))
RL22=10000
IL22=(Vs/(RL22+Rs)) //mistake in book value
per_var_cur11=((IL11-IL22)/IL11)*100
printf("\n Percentage variation in current = %.2f %%
   \n",per_var_cur11) //mistake in book value
```

Chapter 2

Semiconductor Physics

Scilab code Exa 2.1 Conductivity and Resistivity

```
//Ex2_1 Pg-87
clc
disp("Conductivity of pure silicon crystal is given
   by")
disp("    sigma = ni*e*(ue + uh)")
uh=480 //mobility in cm^2/Volt-sec
ue=1350 //mobility of electrons in cm^2/Volt-sec
e=1.6*10^(-19) //electron charge
ni=1.072*10^10 //density of electron hole
sigma_i=ni*e*(uh+ue) //conductivity of silicon
printf("\n Conductivity of pure silicon crystal = %
   .8f ohm^(-1)/cm \n",sigma_i)
disp("Resistivity of silicon is given by")
rho=1/sigma_i //resistivity of silicon
printf("\n Resistivity of pure silicon crystal = %.0
   f ohm-cm \n",rho)
```

Scilab code Exa 2.2 Resistivity

```
//Ex2_2 Pg-87
clc
disp("sigma = u*e*n")
u=1200 //mobility
e=1.6*10^(-19) //electron charge
n=10^13 //phosphorous concentration
sigma=u*e*n //conductivity
printf("\n Conductivity of pure silicon crystal = %
    .5f ohm^(-1)/cm \n",sigma)
rho=1/sigma //resistivity
printf("\n Resistivity of pure phosphorous = %.0f
    ohm-cm \n",rho)
```

Scilab code Exa 2.3 Resistance

```
//Ex2_4 Pg-88
clc
disp("(n_i)^2 = n*p = n_p*N_a")
ni=2.5*10^19 //density of electron hole
Na=1.1*10^20 //acceptor density
np=(ni^2)/Na
N=np/ni
printf("\n The ratio of n_p/n_i = %.4f",N)
```

Scilab code Exa 2.4 Density Ratio

```
//Ex2_4 Pg-88
clc
clear

disp("(n_i)^2 = n*p = n_p*N_a")
ni=2.5*10^19 //density of electron hole per m^3
Na=1.1*10^20 //acceptor density in atoms/m^3
```

```
np=(ni^2)/Na //number of holes
N=np/ni //The ratio of np/ni
printf("\n The ratio of n_p/n_i = %.2f",N)
```

Scilab code Exa 2.5 Number Density of Donor Atoms

```
//Ex2_5 Pg-88
clc
disp("sigma_n = u_n*e*N_d")
e=1.6*1e-19 //electron charge
sigma=5 //conductivity in mho/cm
un=3850 //mobility of electrons
Nd=sigma/(e*un) //concentration
printf("Number density of donor atoms = %.1f*1e16
   per cm^3",Nd*1e-16)
//the answer in the book is wrong the correct answer
    is 0.8*1e16 per cm^3
```

Scilab code Exa 2.6 Silicon and Germanium Semiconductors

```
//Ex2_6 Pg-88
clc
printf("We know forbidden energy gap between
   conduction and valence \n bands for a
   semiconductor is nearly 1 eV. For Ge and Si,
   energy \n gap is 0.785 eV and 1.21 eV
   respectively at 0K. Energy gap \n decreases with
   increase in temperature which is represented \n
   by the expression . Obviously, Si and Ge will
   remain \n semiconductors at 1000K ambient
   temperature. \n\n")

disp("Eg(T) = 1.21 - 3.6*10^(-4)*T (For Si)")
```

```
T=1000 //temperature
Eg(T) = 1.21 - 3.6*10^(-4)*T
printf("\n Eg(1000) = 1.21 - 3.6*10^(-4)*1000 = %.2f eV",Eg(T))
```

Scilab code Exa 2.7 `Average Relaxation Time`

```
//Ex2_7 Pg-88
clc
disp("Relaxation time in terms of mobility is given by")
disp("          t=m*u/e")
printf("\n\n Taking effective mass of electron an holes in consideration,\n relaxation time is given by \n")
disp("          t=m_star*u/e")
disp("(a) foe electrons, m_star = 0.259*m_0")
m0=9.1*10^(-31)
ue=0.135 //mobility of electrons
e=1.6*10^(-19) //electron charge
t_e=(0.259*m0*ue)/e
printf("\n Average relaxation time of eletrons = %.2f*1e-13 secs\n ",t_e*1e13)

uh=0.048 //mobility of holes
disp("(b) For holes in the valance band,m=0.537*m_0")
t_h=(0.537*m0*uh)/e
printf("\n Average relaxation time of eletrons = %.2f*1e-13 secs\n ",t_h*1e13)
```

Scilab code Exa 2.8 `Conduction Current Density`

```
//Ex2_8 Pg-89
clc

disp("Conductivity of an intrinsic material is given by ")
disp("     sigma = e*ni*un*(1+up/un)")
sigma_i=100/60
ni=2.5*10^19 //concentration of intrinsic carrier in m^3
up_un=0.5
e=1.6*10^(-19) //electron charge
un=(sigma_i/(e*ni*(1+(up_un)))) //concentration of electrons
up=un/2 //holes concentratin

disp("     Let n be eletron concentration and p be hole con-centration for doped sample. Sincethe sample is electrically neutral,we have")
disp("          Nd + p = Na + n")
disp("   Where Nd is donor concentration and Na is acceptor concentration,assumed to be fully ionized. From mass action law,we have np =ni^2*S0 ")
disp("          Nd + (ni^2)/n = Na + n")
disp("or        n^2 + (Na-Nd)*n-ni^2 = 0")
disp("or        n=0.5*([Nd-N])(+/-) sqrt(Nd-Na)^2 + 4*ni^2)")
disp("   n is positive and hence we can drop negative sign before the radical")

Nd=10^20 //number density of donor atoms /m^3
Na=5*10^19 //number of acceptor atoms in /m^3
n=0.5*((Nd-Na)+ sqrt((Nd-Na)^2 + 4*ni^2)) //electron concentration for doped sample
p=ni^2/n //hole concentration for doped sample
conduct_doped=e*(n*un+p*up) //conductivity of doped sample(value in textbook is wrong)
printf("\n Conductivity of doped sample = %.2f S/m \
```

```
n",conduct_doped)

disp("      We have assumed that carrier mobilities in the doped signal sample are the same as those in the intrinsic material.This assumption is justified by the low doping level, and Coulomb scaterring Applied by the ionized impurities is weak at 300K.")
disp("Applied electric field")

F_cm=2 //applied electric field in V/cm
F_m=2*100 //applied electric field in V/m
J=conduct_doped*F_m //total conduction current density
J_cm=J/1000 //cm^2 to m^2s

printf("Total conduction current density = %.0f A/m^2",J)
printf("\n                                   = %.2f A/cm^2",J_cm)
```

Scilab code Exa 2.9 Number of Mobile Carriers Derivation

```
//Ex2_9 Pg-91
clc

disp("For P-type,Nd=0. By charge neutrality and mass action law,")

disp("        p + Nd = p = +na = (ni)^2/n")

disp("or      n^2 + Na*n - (ni)^2 = 0")

disp("Solving the quadratic equation for n and discharging the extraneous negative root,one
```

```
    obtains")

disp("        n = 0.5*(-Na + sqrt(Na^2 + 4*ni^2))")

disp("Knowing n,one obtains from mass action law p =
     ni^2/n")

disp("For N-type doping,Na=0. By analogous procedure
    ,")

disp("        p = 0.5*(-Nd +sqrt(Nd^2 + 4*Ni^2));   n=
    ni^2/p")
```

Scilab code Exa 2.10 Hall Voltage

```
//Ex2_10 Pg-91
clc

e=1.6*10^(-19) //electron charge
un=700 //mobility of silicon
n=10^17 //concentration of phosphorous atoms
sigma=e*un*n //conductivity
printf("Conductivity = %.1f (ohm-cm)^-1",sigma)
res=sigma^(-1) //resistivity
printf("\n Resistivity = %.4f ohm-cm",res)
Rh=-(e*n)^(-1) //hall coefficient
printf("\n Hall coefficient = %.1f cm^3/C",Rh)
Ix=10^-3
Bz=10^(-5)
x=10^(-2)
Vh=(Ix*Bz*Rh)/x
printf("\n Hall Volage = %.1f uV",Vh*10^6)
```

Scilab code Exa 2.11 Hall Effect Experiment

```
//Ex2_11 Pg-91
clc

disp("(a) Hall coefficient is")
disp("        Rh = Eh/(Jx*B)")
Vh=21.4*10^(-3) //hall voltage
b=1.7*10^(-2) //breadth
Eh=Vh/b //electric field
t=0.052*10^(-3) //thickness
I=200*10^(-6) //current
Jx=I/(b*t) //current density
B=0.5 //magnetic field
Rh=Eh/(Jx*B)
printf("\n Hall coefficient = %.6f m^3/C \n\n",Rh)

disp("(b) Electrons per unit volume,")
e=1.6*10^(-19) //electron charge
n=1/(Rh*e) //electrons per unit volume
printf("\n\n Electrons per unit volume = %.0f
    electrons/m^3 \n\n",n)
V=195*10^(-3) //voltage
I=200*10^(-6) //current
R=V/I //resistance
disp("Since R=(l/(A*sigma) = (l/(A*e*n*R))")
l=2.65*10^(-2) //length
w=1.7*10^(-2) //width
t=0.052*10^(-3) //thicknes
A=t*w //area
sigma=l/(A*e*n*R) //conductivity
printf("\n\n Conductivity = %.3f m^3/Vs",sigma)
```

Scilab code Exa 2.12 Wavelength of Electromagnetic Radiation

```
//Ex2_12 Pg-92
clc

C=3*10^8 //speed of light in m/s
h=6.6*10^(-34) //plank's constant in J
Eg=1.98*1.6*10^(-19) //band gap
lamda=(C*h)/Eg //wavelength
printf("Wavelength = %.0f nm \n",lamda*10^9)
disp("      Since lamda is in the red region of the
   visible light and hence the colour of emitted
   radiation is RED")
```

Chapter 3

Semiconductor Diodes

Scilab code Exa 3.1 Ohms Law

```
//Ex3_1 Pg-127
clc

disp("Refer to the diagram 3.11(b)")
disp("Using ohm''s law")
disp("Vt = Vd1 + Vr1")
Vd1=0.7 //voltage drop in V
Vt=12 //supply voltage in V
R1=1.2*10^3 //resistor R1 in ohm
Vr1=Vt-Vd1 //voltage across R1 in V
It=Vr1/R1 //current in A
disp("Ohm''s law")
printf("\n Current I_t = %.2f mA",It*10^3)
```

Scilab code Exa 3.2 Voltage across Junction

```
//Ex3_2 Pg-182
clc
```

```
J=10^5 //forward current density
Js=250*10^(-3) //saturation current density
e=1.6*10^(-19) //electron charge
T=300 //temperature
k=1.38*10^(-23) //Boltzmann constant
V=(log(J/Js)*k*T)/e //voltage applied across
    junction
printf("The voltage applied across the junction =%.2
    f V",V)
```

Scilab code Exa 3.3 PN Junction Forward Voltage

```
//Ex3_3 Pg-182
clc

I=2*10^6 //forward current density
Is=30 //saturation current density
ekt=40
V=(1/40)*log(I/Is) //Applied forward voltage
printf("Applied forward voltage = %.3f V",V)
```

Scilab code Exa 3.4 Incremental Resistance

```
//Ex3_4 Pg-182
clc

disp("          I = Is*exp(eV/kT) = Is*exp(40V)")
disp("          Re = del_V/del_I = 1/40I")
disp("     Dividing throughtout by volume, one
    obtains the equation in the form of current
    density as")
disp("          J = Js*(exp(eV/kT)-1)")
J=10^5 //forward current density
```

```
Js=250*10^(-3) //saturation current density
e=1.6*10^(-19) //electron charge
T=300 //temperature
k=1.38*10^(-23) //Boltzmann constant
V=(log(J/Js)*k*T)/e //voltage applied across junction
printf("\n The voltage applied across the junction = %.2f V",V)
```

Scilab code Exa 3.5 Forward and Reverse Biased

```
//Ex3_5 Pg-183
clc

disp("(a) Forward-bias")
Av=50 //applied voltage
Jr=5000 //junction resistance
Er=50 //external resistance
cur=Av/(Er+Jr) //current
printf("\n Current = %.1f mA \n",cur*10^3)

disp("(b) Reverse-bias")
cur_rev=Av/(Jr+10^6) //book expression is wrong
printf("\n Current = %.3f*1e-2 mA \n",cur_rev*10^5)
```

Scilab code Exa 3.6 AC Resistance

```
//Ex3_6 Pg-183
clc

disp("We know that")
disp("   r_ac = dV/dI - 1/(dI/dV) = 1/((I0/KT)exp(V/KT))")
```

```
k=8.62*10^(-5)
T=300 //temperaturein K
kT=k*T
I0=10^(-6) //saturation current
V=150*10^(-3) //voltage forward biased
r_ac = 1/((I0/kT)*exp(V/kT)) //value of exp
    (0.15/0.02586)=330.45 and not the textbook value
    of 332.66
printf("\n The AC resistance = %.2f ohm",r_ac) //
    text book value wrong
```

Scilab code Exa 3.7 Change in Temperature

```
//Ex3_7 Pg-184
clc

disp("We know that (I0)*T2 = (I0)*T1*(2)^((T2-T1/10)
    )")

disp("Substituting the given values,we have ")

disp("(40*10^(-6)) = (25*10^(-6)*(2)^x) where x=(T2-
    T1)/10")

disp("(2)^x = 1.6")

disp("Taking log on both sides,one obtains")

disp("        x*log(2) = log(1.6)")

disp("or      x = log(1.6)/log(2)")

x=log(1.6)/log(2)

disp(" Now x = (T2-T1)/10 or 0.678 = (T2-25)/10")
```

```
T1=25 //temperature T1
T2=x*10+T1 //temperature T2
diff_temp=T2-T1 //change in temperature
printf("\n So the change in temperature = %.2f degree celsius",diff_temp)
```

Scilab code Exa 3.8 Forward Current

```
//Ex3_8 Pg-185
clc
disp("Forward current I is given by ")
disp("  I=I0*exp(V/(n*Vt))-1")

I_22=poly(0,"I_22")
V=0.3 //voltage
n=1 //constant
T1=22+273 //temperature T1 in Kelvin
Vt1=T1/11600
I=I_22*(exp(V/0.025)-1)
disp("When temperature rises to 72 degree celcius, then")

T2=72+273 //temperature T2 in Kelvin
Vt2=T2/11600
TR=T2-T1 //temperature rise
I_72=poly(0,"I_72")
I_72=I_22*(2)^(TR/10)

I_hash=I_72*(exp(V/(Vt2))-1)
for_cur_rises=I_hash/I
disp("Thus, at 72 degree celcius Forward current rises by ")
disp(for_cur_rises)
cur_I=768849.72
cur_I_hash=162753.79
```

```
FCR=cur_I/cur_I_hash
printf("\n      = %.2f",FCR)
 //answer in the book  is wrong
```

Scilab code Exa 3.9 Static and Dynamic Resistance

```
//Ex3_9 Pg-185
clc

n=1 //constant
T=27+273 //temperature in K
Vt=T/11600
V=0.2 //voltage
I0=10^(-6) //saturation current
I=I0*(exp(V/Vt)-1)
stat_res=V/I //static resistance
printf("Static resistance = %.2f ohm \n",stat_res)

dyn_res=Vt/(I+I0) //dynamic resistance
printf("Dynamic resistance = %.2f ohm",dyn_res)
```

Scilab code Exa 3.10 Voltage across Junction

```
//Ex3_10 Pg-186
clc

 disp("We know that          I = I0*(exp(V/n*Vt)-1)")
 disp("Dividing on both sides by area A, one obtains
    ")
 disp("                   I/A = I0/A*(exp(V/n*Vt)-1)")
 disp("or                 J = J0*(exp(V/n*Vt)-1)")
n=1 //constant
T=300 //temperature in K
```

```
Vt=T/11600
J=10^5 //forward current density
J0=250*10^(-3) //saturation current density
V=Vt*log(J/J0)
printf("\n The voltage applied across the junction =
    %.4f V",V)
```

Scilab code Exa 3.11 `Value of Resistance and Power Dissipation`

```
//Ex3_11 Pg-186
clc

Vmin=0.7 //minimum voltage across diode in V
V=5 //supply voltage in V
V_R1=V-Vmin //voltage across resistor R in V
Imin=10^(-3) //minimum current
R1=V_R1/Imin

printf("Maximum value of R =%.1f kohm \n ",R1*1e-3)

I=5*10^(-3) //current through resistance in A
V_R2=V-Vmin //voltage across resistor R in V
R2=V_R2/I
printf("\n\n Minimum value of R =%.0f ohm ",R2)

Vb=6 //supply voltage
Vb_res=Vb-Vmin //voltage across resistor
P=I*Vb_res //power dissipated across resistor
printf("\n\n Power dissipated across R =%.1f W",P
    *10^3)

P_diode=I*Vmin //power dissipated across diode
printf("\n power dissipated across diode =%.1f mW",
    P_diode*1e3)
R=10^3 //resistor in ohm
```

```
V_R=R*Imin //voltage drop across resistor R in V
Vb=V_R+Vmin
printf("\n\n The minimum voltage across diode = %.1f
    V",Vb)
```

Scilab code Exa 3.12 DC Resistance

```
//Ex3_12 Pg-188
clc

disp("Refer to the figure 3.51")
Id1=2*10^(-3) //diode current in I
Vd1=0.5 //diode voltage in V
Rf1=Vd1/Id1 //Dc resistance
disp("At Id=2mA and Vd=0.5V")
printf("\n Rf = %.0f ohm \n\n",Rf1)

Id2=20*10^(-3) //diode current in I
Vd2=0.75 //diode voltage in V
Rf2=Vd2/Id2 //Dc resistance
disp("At Id=20mA and Vd=0.75V")
printf("\n Rf = %.1f ohm \n\n",Rf2)

Id3=2*10^(-6) //diode current in I
Vd3=10 //diode voltage in V
Rf3=Vd3/Id3 //Dc resistance
disp("At Id=2*10^(-6)A and Vd=10V")
printf("\n Rf = %.0f Mohm \n\n",Rf3*10^-6)
```

Scilab code Exa 3.13 Current through Diode

```
//Ex3_13 Pg-188
clc
```

```
disp("Refer to the figure 3.52")
disp("(a) Assuming the diode D to be ideal ")
disp("    Ignoring diode D,voltage across R2 is given as (By applying potential divider concept)")
R1=45 //resistor R1
R2=5 //resistor R2
Vaa=10 //supply voltage
Vab=Vaa*(R2/(R1+R2))
printf("\n Vab= %.0f V \n",Vab)

disp(" Thus,diode D is forward biased.It conducts, offering zero resistance  Hence no current would flow through the parallel bransh R2.The circuit equivalent to that shown in figure 3.53(a)")
ID=Vaa/R1 //diode current
printf("\n Current through diode = %.0f mA \n\n",ID*10^3)

disp("(b)Assuming the diode to be real")
disp("     Voltage Vab is much larger than Vt hencethe diode conducts.It is replaced by its equivalent as shown in figure 3.53(b).To determine current Id through the diode we first find the Thevenin''s equivalent of the circuit on the left of AB.Vth=open circuit voltage across AB")
Vth=Vaa*(R2/(R1+R2))
printf("\n Vth=%.0f V \n",Vth)
Rth=R1*R2/(R1+R2)
printf("\n Rth=%.0f ohm \n",Rth) //textbook value is wrong
 disp("Thus,the equivalent circuit becomes as shown in figure 3.53(c)")
 Vt=0.3 //load voltage
 tf=25 //load resistance
 Id=(Vth-Vt)/(Rth+tf)
```

```
printf("\n Current through diode =%.1f mA \n\n",Id*10^3)
```

Scilab code Exa 3.14 `Current through Resistor`

```
//Ex3_14 Pg-190
clc

disp("       Diodes D2 and D3 are reverse-biased. Therefore,  these are like open-switches. Diodes D1 and D2 are forward biased. These are replaced by their equivalent circuits,as shown in figure 3.54. Since the diodes are silicon V=0.7V. ")
Vt=0.7 //voltage drop
Vaa=20 //supply voltage in V
net_emf=Vaa-Vt-Vt //net emf
R1=5
R2=90
R3=5 //R1,R2,R3 are resistances
tot_res=R1+R2+R3 //total resistance
disp("Therefore, current through 90 ohm resistor is")
I=net_emf/tot_res
printf("\n Current I =%.0f mA",I*10^3)
```

Scilab code Exa 3.15 `Current Drawn from Battery`

```
//Ex3_15 Pg-190
clc

disp("(a) When the diode is forward biased figure 3.55(b),it offers zero resistance. It is like shorted switch.This shorted switch across AB also
```

```
short-circuits the resistance R2.Obviously,a parallel combination of the diode and R2 is equivalent to a resistance of zero ohms.")
R1=100 //reisitor R1 in ohm
R=R1
Vaa=10 //supply voltage in V
I=Vaa/R
printf("\n Current drawn from battery =%.1f A \n\n",I)

disp("(a) When the diode is reverse biased figure 3.55(b).It is like open switch.Obviously,it then does not make any difference whether the diode is connected or not.")
R2=100 //resistor R2 in ohm
tot_R=R1+R2
I1=Vaa/tot_R

printf("\n Current drawn from battery =%.2f A \n\n",I1)
```

Scilab code Exa 3.16 Breakdown Voltage Ranges

```
//Ex3_16 Pg-191
clc

Vz=9 //breakdown voltage in V
per=0.1 //10% tolerance
Tol=Vz*per
printf("Tolerance =%.1f V",Tol)
tol_high=Vz+Tol
tol_low=Vz-Tol //ranges in tolerance
printf("\n Range of breakdown voltage= %.1f to %.1f V",tol_low,tol_high)
// in the textbook the value 8.2 is wrong the
```

```
    correct value is 8.1
T1=25 //temperature T1 in degree celcius
T2=75 //temperature T2 in degree celcius
diff_temp=T2-T1 //chnage in temperature
Vzener=2*10^(-3) //zener voltage
fall_break_vol=Vzener*diff_temp //fall in breakdown
    voltage
new_break_vol=Vz-fall_break_vol //new break don
    voltage
printf("\n New break don voltage =%.1f V",
    new_break_vol)

range_high=tol_low-fall_break_vol
range_low=tol_high-fall_break_vol
printf("\n Range of breakdown voltage= %.1f to %.1f
    V",range_high,range_low)
```

Scilab code Exa 3.17 Capacitance

```
//Ex3_17 Pg-192
clc
 C=20 //capacitance in pF
 V=5 //supply voltage in V
 K=C*sqrt(V)
C_V1=K/sqrt(V+1)
printf("Capacitance for 1V increase =%.1f pF",C_V1)
```

Scilab code Exa 3.18 Voltage across each Diode

```
//Ex3_18 Pg-192
clc

```

```
printf("(a) The two diodes are connected in series and hence the \n current I flows in D1 and D2. Obviously,it is in forward \n direction through D2 and in reverse direction through D1.\n Since D2 diode is forward biased,V2 will be very small and\n  hence V1=(5-V2) will be very much larger than Vt=0.026V.\n This means the current will be equal to reverse saturation \n  current I0. Now, we consider diode D2.We have  \n\n")
disp("        I = I0*(exp(V/Vt)-1)")
disp("Putting I=I0 and V=V2, we have")
disp("        I0 = I0*(exp(V2/Vt)-1)")
disp("        exp(V2/Vt)-1 = 1")
Vt=0.026 //threshold voltage
V2=Vt*log(2)
V=5 //supply voltage in V
V1=V-V2 //value in textbook incorrect
printf("\n V2 = %.3f V",V2)
printf("\n V2 = %.3f V\n ",V1)
disp("Effect of temperature : V2=Vt*ln(2) = kT*ln(2)")
disp("So V2 will increase with temperature ")
disp("(b) If Vz is 4.9V then D1 will breakdown. This means V1=4.9V")
Vz=4.9 //breakdown voltage
V2=V-Vz
disp("Now using I0=5*10^(-6)A and V2=0.1V,one obtains")
I0=5*10^(-6) //current in ampere
I=I0*(exp(V2/Vt)-1)
printf("\n Current I=%.0f microA",I*10^6)
```

Scilab code Exa 3.19 LED Current

```
//Ex3_19 Pg-193
```

```
clc

disp("We have Iv=40*iD")
Iv=1 //luminous intensity
iD=Iv/(40*10^(-3)) //LED current
printf("LED current = %.0f mA",iD)
```

Scilab code Exa 3.20 AC Resistance

```
//Ex3_20 Pg-193
clc

disp("(a) At Id=10mA,")
V=25 //voltage in mV
Id=10 //current in mA
Rac=V/Id
//AC resistance (value in textbook is wrong)
printf("\n AC resistance Rac=%.1f ohm",Rac)

Id=20 //current in mA
Rac=V/Id
//AC resistance (value in textbook is wrong)
printf("\n AC resistance Rac=%.2f ohm",Rac)
```

Scilab code Exa 3.21 AC Resistance

```
//Ex3_21 Pg-194
clc

disp("We know that")
disp("   r_ac = dV/dI - 1/(dI/dV) = 1/((I0/KT)exp(V/
   KT))")
k=8.62*10^(-5)
```

```
T=300 //temperaturein K
kT=k*T
I0=10^(-6) //saturation current
V=150*10^(-3) //voltage forward biased
r_ac = 1/((I0/kT)*exp(V/kT))
 //value of exp(0.15/0.02586)=330.45 and not the
    textbook value of 332.66

printf("\n The AC resistance = %.2f ohm",r_ac) //
   text book value wrong
```

Chapter 4

Diode Circuits

Scilab code Exa 4.1 Half Wave Rectifier

```
//Ex4_1 Pg-213
clc

Vrms=110 //rms volatage in V
Vm=Vrms/0.707 //peak source voltage
printf("Peak source voltage=%.1f V",Vm) //textbook
   answer wrong

disp("(a) With an ideal diode ")
Vpout=Vm //peak output voltage
printf("\n Peak output voltage=%.1f V",Vpout)
Vdc=Vm/%pi //Dc load voltage
printf("\n DC load voltage=%.2f V \n",Vdc) //
   textbook answer wrong

disp("(b) With second approximation")
Vpin=Vm //peak input voltage
Vpout=Vpin-0.7
printf("\n Peak output voltage=%.1f V",Vpout)
Vdc=Vpout/%pi //Dc load voltage
printf("\n DC load voltage=%.1f V \n",Vdc) //
```

```
textbook answer wrong
```

Scilab code Exa 4.2 No Load Voltage

```
//Ex4_2 Pg-214
clc

disp("      VR = (V_NoLoad - V_FullLoad)/V_FullLoad *100%")
disp("(a) VR = 0%")
V_FullLoad=20 //full load voltage
V_NoLoad=V_FullLoad//no load voltage
printf("\n V_FullLoad = V_NoLoad= %.0f V \n",V_NoLoad)

disp("(b) VR = 100%")
VR=100 //voltage regulation in %
V_NoLoad=(VR*V_FullLoad)/(100)+V_FullLoad
printf("\n V_NoLoad= %.0f V \n",V_NoLoad)
```

Scilab code Exa 4.3 AC Input Power

```
//Ex4_3 Pg-214
clc

disp("    Ratio of rectification or efficiency of halfwave rectifier,")
disp("   n = 0.406 = DC power deliverd to the load/AC input powerfrom transformer secondary ")
DC_power=500 //ddc power deliverd to the load
n=0.406 //efficiency
AC_in_power=DC_power/n //AC input powerfrom transformer secondary
```

```
printf("\n AC input powerfrom transformer secondary
    =%.0f Watt",AC_in_power)
```

Scilab code Exa 4.4 Half Wave Rectifier

```
//Ex4_4 Pg-220
clc

Rl=3.5*10^(3) //resistance in k-ohm
rF=800 //secondary resistance in k-ohm
Vm=240 // input voltage
disp("(1)(a) Peak value of current flowing")
Im=Vm/(rF+Rl) //peak current
printf("        Im = %.2f mA\n ",Im*10^3)

disp("(b) Average or DC current flowing")
Idc=Im/%pi //DC current
printf("        Idc = %.2f mA\n ",Idc*10^3)

disp("(c) R.M.S value of current flowing")
Irms=Im/2 //rms current
printf("        Irms = %.2f mA\n ",Irms*10^3)

disp("(2) DC output power")
Pdc=(Idc)^2*Rl //dc output power
printf("        Pdc = %.1f Watt\n ",Pdc)

disp("(3) AC input power")
Pac=(Irms)^2*(rF+Rl)
printf("        Pac = %.2f Watt\n ",Pac)

disp("(4)Efficiency of rectifier")
n=(Pdc/Pac)*100 //efficiency
printf("        n = %.2f %%\n ",n)
```

Scilab code Exa 4.5 Bridge Rectifier

```
//Ex4_5 Pg-221
clc

Vr=0.7 //diodes voltage drop
Rl=820 //load resistor in ohm
Vin=40 //input voltage in V

disp("(1)  Peak output volatge: Current flows through load only when two diodes conduct. While conducting, there is voltage drop across the diode.")
V_drop_2=2*Vr //voltage drop across 2 diodes
Vm=Vin-V_drop_2 //peak voltage
printf("\n        Vm = %.2f V\n ",Vm)

disp("(2) Average output current")
Idc=(2*Vm/%pi)/Rl //average output current
printf("         Idc = %.0f mA\n ",Idc*10^3)

disp("(3) Diode dissipation")
DD=Idc*Vr //Diode dissipation
printf("           = %.0f mW\n ",DD*10^3)
```

Scilab code Exa 4.6 Half Wave Rectifier

```
//Ex4_6 Pg-222
clc

Vr=0.7 //voltage drop
Vi=120 //input voltage
```

```
disp("RMS value of secondary voltage")
V_sec=Vi/5 //RMS value of secondary voltage
printf("          = %.0f V\n ",V_sec)

disp("Peak secondary voltage")
Vm=V_sec*sqrt(2) //Peak secondary voltage
printf("          = %.0f V\n ",Vm)

disp("Peak inverse voltage of diode")
Vinv=-(Vm) //Peak inverse voltage of diode
printf("          = %.0f V\n ",Vinv)

printf("\n Peak load voltage =%.0f V\n ",Vm)

disp("DC load voltage")
Vdc=Vm/%pi //DC load voltage
printf("          = %.1f V\n ",Vdc)

disp("Assuming second approximation")
disp("Vm'' = Vm - Vr ")
disp("Peak load voltage")
Vm_dash=Vm-Vr //Peak load voltage
printf("          = %.1f V\n ",Vm_dash)

disp("DC load voltage")
Vdc=Vm_dash/%pi //DC load voltage
printf("          = %.1f V\n ",Vdc)
```

Scilab code Exa 4.7 Full Wave Rectifier

```
//Ex4_7 Pg-222
clc

Vi=120 //supply voltage n V
Rl=5*10^3 //load resistance
```

```
disp("Secondary RMS voltage")
Vrms=Vi/5 //Secondary RMS voltage
printf("         = %.0f V\n ",Vrms)

disp("Secondary pek voltage")
Vm=Vrms*sqrt(2) //Secondary pek voltage
printf("         = %.0f V\n ",Vm)

disp("  Half of the secondary voltage is input to the half section.")
disp("So input to the half section")
in=Vm/2 //input to the half section
printf("         = %.0f V\n ",in)

disp("Peak voltage across load")
printf("         = %.0f V\n ",in)

disp("   DC voltage across load = 17V. Since the capacitor gets changed up to peak value,")
disp("DC load current")
Vdc=in
Idc=Vdc/Rl //DC load current
printf("         = %.1f mA\n ",Idc*10^3)
```

Scilab code Exa 4.8 Full Wave Rectifier

```
//Ex4_8 Pg-227
clc

f=50 //frequency in Hz
C=100*10^(-6) //capacitance in F
Rl=2*10^3 //load resistance
Vrms=40 //rms secondary voltage

```

```
disp("(a) Ripple factor for a full wave rectifier")
r=1/(4*sqrt(3)*f*C*Rl) //Ripple factor for a full
    wave rectifier
printf("          = %.3f \n ",r)

disp("(b) DC output voltage")
Vm=Vrms*sqrt(2)
Vdc=Vm/(1+(1/(4*f*C*Rl))) //DC output voltage
printf("          = %.1f V \n ",Vdc)

disp("(c) Percentage voltage regulation")
per=100/(4*f*C*Rl) //Percentage voltage regulation
printf("          = %.1f %%\n ",per)
```

Scilab code Exa 4.9 Full Wave Rectifier

```
//Ex4_9 Pg-237
clc

Vrms=300 //rms voltage in V
f=60 //frequency
Idc=0.2 //load current
C=10 //shunt capacitor in microFarad

Vm=Vrms*sqrt(2) //peak voltage
Vdc=(2*Vm)/%pi //Dc voltage

disp("Connected load")
Rl=Vdc/Idc //Connected load
printf("          Rl = %.0f ohm = (955.6)*sqrt(2) ohm\n
    ",Rl)

disp("Ripple factor in case of shunt capacitor
    filter ")
disp("            =2410/C*Rl")
```

```
r=2410/(C*Rl) //ripple factor
printf("\n              = %.2f \n ",r)
```

Scilab code Exa 4.10 Full Wave Rectifier

```
//Ex4_10 Pg-238
clc

f=60 //frequency in Hz
C=100*10^(-6) //capacitance in F
Rl=1*10^3 //load resistance

disp("Since the transformer is center tapped ,the
   rms value of voltage across half the secondary
   coil")
Vct=12.6 //voltage of center tapped transformer
Vrms=Vct/2 //rms voltage

disp("Peak voltage")
Vm=Vrms*sqrt(2) //peak voltage
printf("        = %.2f V\n ",Vm)

disp("(b) DC output voltage")
Vdc=Vm/(1+(1/(4*f*C*Rl))) //DC output voltage
printf("        = %.2f V \n ",Vdc)

disp("Ripple factor in case of capacitor filter ")
disp("          =2410/C*Rl")
r=2410/(100*Rl)*100 //ripple factor
printf("\n              = %.1f %%\n ",r)
```

Scilab code Exa 4.11 Full Wave Rectifier

```
//Ex4_11 Pg-238
clc
Vdc=9 //dc voltage
Idc=100*10^(-3) //dc load current
disp("Ripple factor with an L-C filter ,r=(0.83/LC)")
disp("                    where L-> Henry ,C->microFarad")
gamm=0.02 //maximum ripple
LC=0.83/gamm
printf("         LC = %.1f \n ",LC) //let LC=42

disp("LOad connected to the filter ,")
RL=Vdc/Idc //load resistance in ohm
printf("        RL   = %.0f ohm\n ",RL)

disp("Critical value of inductor ,")
Lk=RL/900 //Critical value of inductor
printf("        Lk   = %.1f \n ",Lk)

disp("Capacitance")
LC=42 //rounding of 41.5 to 42
C=LC/Lk //capacitance in microFarad
printf("        C   = %.0f uF\n ",C)
```

Scilab code Exa 4.12 Zener Current

```
//Ex4_12 Pg-245
clc

V=20 //source voltage
Vz=12 //zener voltage
Vr=V-Vz //voltage across resistor
Rs=330 //series resistance
 disp("Voltage across resistor ")
printf("          = %.0f V \n ",Vr)

```

```
disp("Current through series resistor")
Iser=Vr/Rs //Current through series resistor
printf("         = %.1f mA \n ",Iser*10^3)

disp("Since Zener diode is in series with resistor, current through it is equal to current flowing through resistor,i.e 24.2mA ")
```

Scilab code Exa 4.13 Current and Wattage of Elements

```
//Ex4_13 Pg-245
clc

V=20 //source voltage in V
Vz=12 //zener voltage in V
Vs=V-Vz //voltage across resistor in V
Rs=330 //series resistance in ohm
RL=1.5*10^3 //load resistance in ohm
 disp("Voltage across resistor ")
printf("         = %.0f V \n ",Vs)

disp("(1) Current through series resistor Is")
Is=Vs/Rs //Current through series resistor
printf("       Is   = %.1f mA \n ",Is*10^3)

disp("(2) Current through series load Il")
VL=Vz //voltage across load
IL=VL/RL //Current through series load
printf("       IL   = %.0f mA \n ",IL*10^3)

disp("(3)Current through zener diode")
Iz=Is-IL //Current through zener diode
printf("       IL   = %.1f mA \n ",Iz*10^3)

disp("(4)Respective wattage of elements used")
```

```
disp("(a) Series resistor -> W=Is*Vs")
W=Vs*Is //wattage of series resistor
printf("              = %.1f mW \n ",W*10^3)

disp("(b) Zener diode -> W=Iz*Vz")
W=Vz*Iz //wattage of zener diode
printf("              = %.1f mW \n ",W*10^3)


disp("(b) Load resistor -> W=IL*VL")
W=VL*IL //wattage of zener diode
printf("              = %.0f mW \n ",W*10^3)
```

Scilab code Exa 4.14 Zener Diode

```
//Ex4_14 Pg-246
clc

RL=1*10^3 //load resistance in ohm
Rs=270 //series resistor in ohm
Vs=18 //supply voltage in V
vz=10 //xener voltage

disp("Applying Thevenin''s theorem, Thevenin voltage
    across the zener diode")
Vth=(RL/(RL+Rs))*Vs //Thevenin voltage
printf("\n        Vth = %.1f V \n ",Vth)

disp("Thus Vth is greater than Vz(zener voltage),i.e
    14.2 >10. So Zener diode is operating in the
   breakdown voltage.")
```

Scilab code Exa 4.15 Voltage Regulator Circuit

```
//Ex4_15 Pg-246
clc

IL1=10*10^(-3)
IL2=20*10^(-3) //IL1,IL2 range of load current in A
Vin=20 //supply voltage in V
Izt=6*10^(-3) //zener current in A
Vz=15 //zener voltage in V

disp("Average load current")
IL=(IL1+IL2)/2 // Average load current
printf("\n       IL = %.0f mA \n ",IL*10^3)

disp("Total current entering the circuit")
Is=IL+Izt //current entering the circuit
printf("\n       Is = %.0f mA \n ",Is*10^3)

disp("Series resistor")
Rs=(Vin-Vz)/Is //Series resistor in ohm
printf("\n       Rs = %.0f ohm \n ",Rs)

disp("Power rating of resistor")
Vs=Vin-Vz
P=(Vs^2)/Rs //Power rating of resistor
printf("\n       P = %.1f W \n ",P)
```

Chapter 5

Transistors

Scilab code Exa 5.1 Current component of a Transistor

```
//Ex5_1 Pg-278
clc

alpha_dc=0.97 //transistor current gain
ICBO=10*10^(-6) //collector to base leakage current
    in A
Ib=50*10^(-6) //base current in A

Ic=((alpha_dc*Ib)/(1-alpha_dc))+(ICBO/(1-alpha_dc))
    //collector current
printf("Collector current = %.2f mA \n",Ic*10^3)

Ie=Ic+Ib //emitter current
printf(" Emitter current = %.0f mA",Ie*10^3)
```

Scilab code Exa 5.2 Transistor Components

```
//Ex5_2 Pg-279
```

```
clc

Ic=5.255*10^(-3) //collector current in A
Ib=100*10^(-6) //base current in A
ICBO=5*10^(-6) //collector to base leakage current
    in A

alpha_dc=(Ic-ICBO)/(Ib+Ic) //common current gain
    factor
printf("Common current gain factor alpha_dc = %.2f",
    alpha_dc)

Beta=alpha_dc/(1-alpha_dc) //Dc emitter current gain
     factor value in text book is wrong
printf("\n Dc emitter current gain factor beta = %.2
    f",Beta)

Ie=Ic+Ib //emitter current value in text book wrong
printf("\n Emitter current = %.3f mA",Ie*10^3)
```

Scilab code Exa 5.3 Transistor Components

```
//Ex5_3 Pg-279
clc

Ic=12.427*10^(-3) //collector current in A
Ib=200*10^(-6) //base current in A
ICBO=7*10^(-6) //collector to base leakage current
    in A

Beta=(Ic-ICBO)/(Ib+ICBO) //Dc emitter current gain
    factor (value in texbook is wrong)
printf("\n Dc emitter current gain factor beta = %.0
    f",Beta)

```

```
Ie=Ic+Ib //emitter current
printf("\n Emitter current = %.1f mA",Ie*10^3)

alpha_dc=(Ic-ICBO)/(Ib+Ic) //common current gain
    factor
printf("\n Common current gain factor alpha_dc = %.2
    f",alpha_dc)

Ib=150*10^(-6) //new base current
Ic=Beta*Ib+(Beta+1)*ICBO //collector current (value
    in textbook is wrong)
printf("\n Collector current = %.3f mA \n",Ic*10^3)
```

Chapter 6

Thermal Stability

Scilab code Exa 6.1 Collector Base Junction Temperature

```
//Ex6_1 Pg-333
clc

Ta=25 //ambient temperature in degree celsius
tetha=10 //thermal resistance
Pd=2 //power dessipated in transistor

Tj=Ta+tetha*Pd //collector base junction transistor
    temperature
printf(" \n Collector base junction transistor
    temperature = %.0f degree celcius \n",Tj)

disp("   tetha=10 degree celcius/watt means for
    every watt consumed its temperature will rise by
    10 degree celcius")

printf("\n While using a transistor,we must keep in
    mind that it must \n not reach a condition called
     thermal runaway. The heat \n released at
    collector base junction must not exceed the rate
    \n at which heat can dissipated under steady
```

```
state. For this,\n ")

disp("(del_Pd/del_Tj) < (1/tetha)")

disp("This is the relation for thermal stability.")
```

Scilab code Exa 6.2 Dissipation Capacity of a Transistor

```
//Ex6_2 Pg-335
clc

printf("Draw a vertical line from temperature axis at 50 degree \n celcius to cut the 71 degree celcius line. Join the point of \n intersection P through a horizontal line at Y-axis. The point \n where it intersects Y-axis gives the value of permissible \n dissipation equal to 45%% of maximum rating. \n")

per=.45 //permissible dissipation in percentage
max_diss=165 //maximum dissipation
diss_cap=per*max_diss //dissipation capability
disp("The dissipation capability at 50 degree celcius")

printf("                              = %.0f mW \n ",diss_cap)

disp("     Its value ranges from (0.2) degree celcius/watt to (1000) degree celcius/watt for a transistor  that has an efficient heat sink")

disp("               Tj = Ta + tetha*Pd")

disp("  The above equation reflects that collector-
```

junction temperature Tj of the transistor will be higher than ambient temperature Ta by an amount equal to the product of tetha and Pd.")
```

**Scilab code Exa 6.3** Fixed Bias Circuit

```
//Ex6_3 Pg-336
clc

Rb=200*10^(3) //base resistance in ohm
Vcc=10 //supply voltage in V
Vbe=0.7 //voltage drop in V
Rl=2*10^(3) //load resistor in ohm
Beta=50 //transistor gain

disp("If Beta=50")
Ib=(Vcc-Vbe)/Rb //base current in A
Ic=Beta*Ib //collector current
Vce=Vcc-Ic*Rl //collector emitter voltage
printf("\n The operating point coordinates are [%.2f
    V, %.2f mA]\n ",Vce,Ic*10^3)

disp("If Beta=60")
Beta2=60 //second transistor gain
Ic2=Beta2*Ib //collector current
Vce2=Vcc-Ic2*Rl //collector emitter voltage
printf("\n The operating point coordinates are [%.2f
    V, %.2f mA]\n ",Vce2,Ic2*10^3)
```

Scilab code Exa 6.4 Collector to Base Bias Circuit

```
//Ex6_4 Pg-335
clc
```
```

```
Rb=330*10^(3) //base resistance in ohm
Vcc=15 //supply voltage in V
Vbe=0.7 //voltage drop in V
Rl=3.3*10^(3) //load resistor in ohm
Beta=60 //transistor gain

Ib=(Vcc-Vbe)/Rb //base current in A
Ic=Beta*Ib //collector current (value in textbook is
    wrong)
Vce=Vcc-(Ic+Ib)*Rl
printf("\n The collector emitter voltage = %.2f V\n
   ",Vce)
//collector emitter voltage (value in textbook is
   wrong)
```

Chapter 7

Amplifiers

Scilab code Exa 7.1 Coupling

```
//Ex7_1 Pg-369
clc

disp("Refer to the figure 7.19")
disp("For good coupling")
disp("                 Xc <= 0.1*R")
R=10*10^(3) //resistor R in ohm
C=68*10^(-6) //capacitance in Farad
f=1/(2*%pi*C*0.1*R)
disp("Lowest frequency, f")
printf("                    = %.2f Hz",f)
disp("or lowest frequency is approximately 3 Hz")
```

Scilab code Exa 7.2 Bypassing

```
//Ex7_2 Pg-369
clc

```

```
disp("Refer to the figure 7.20")
disp("For good coupling")
disp("                Xc <= 0.1*R")
R=10*10^(3) //resistor R in ohm
C=220*10^(-6) //capacitance in Farad
f=1/(2*%pi*C*0.1*R)
disp("Lowest frequency, f")
printf("                   = %.2f Hz",f)
disp("or lowest frequency is approximately 1 Hz")
```

Scilab code Exa 7.3 Small Signal Amplifiers

```
//Ex7_3 Pg-369
clc

Beta=250 //transistor gain
Vcc=15 //supply voltage
R1=2000 //resistor R1 in ohm
R2=470 //resistor R2 in ohm
Vce=0.7 //voltage drop in V
Re=220 //emitter resistor in ohm

Vb=(Vcc*R2)/(R1+R2) //base voltage in V
disp("(1) Base voltage Vb")
printf("                = %.2f V",Vb)
Ve=Vb-Vce //emitter voltage in V
disp("Emitter voltage Vb")
printf("                = %.2f V",Ve)
Ie=Ve/Re //emitter current
disp("Emitter current ")
printf("            Ie  = %.3f*10^-2 A",Ie*10^2)
disp("For small signal operation, ie <= 0.1*Ie")
ie=0.1*Ie
printf("                =%.3f mA \n",ie*10^3)

```

```
disp("(2) AC emitter diode resistance =25mV/ie")
Re_ac=25*10^(-3)/ie //AC emitter diode resistance
printf("                              =%.0f ohm \n",Re_ac)

disp("(3) Z''vm = Beta*r''e")
Re_ac=26 //AC emitter diode resistance assumed 26 ohm not 25.53 ohm
Zvm=Beta*Re_ac
printf("          =%.0f ohm",Zvm)
```

Scilab code Exa 7.4 `Amplifier Circuit`

```
//Ex7_4 Pg-370
clc

Beta=100 //transistor gain
Vcc=10 //supply voltage
R1=10*10^(3) //resistor R1 in ohm
R2=2200 //resistor R2 in ohm
Vce=0.7 //voltage drop in V
Re=2000 //emitter resistor in ohm
Rs=600 //source resistor in ohm

Vb=(Vcc*R2)/(R1+R2) //base voltage in V
disp("Base voltage Vb")
printf("            = %.1f V",Vb)
Ve=Vb-Vce //emitter voltage in V
disp("Emitter voltage Vb")
printf("            = %.1f V",Ve)
Ie=Ve/Re //emitter current
disp("Emitter current")
printf("            = %.2f mA",Ie*10^3)
disp("AC emitter diode resistance =25mV/ie")
re=25*10^(-3)/Ie //AC emitter diode resistance
```

```
printf("                              =%.0f ohm \n",
  re)
rc=((3.6*10)/(3.6+10))*10^(3) //Collector dioed
  resistance
A=rc/re //voltage gain(value in text book is wrong)
disp("Voltage gain A")
printf("     ‘         = %.0f",A)
zin_1=((10*2.2)/(10+2.2))
zin=((zin_1*Beta*A)/(zin_1+(Beta*A)))*1000
disp("Zin stage")
printf("              = %.3f kohm",zin*10^-3)
Vin=(zin/(Rs+zin))*10^(-3) //input voltage (value in
   text book is wrong)
disp("Input voltage")
printf("              = %.2f mV",Vin*10^3)
Vout=A*Vin //output voltage (value in textbook is
  wrong)
disp("Output voltage")
printf("              = %.2f mV",Vout*10^3)
```

Scilab code Exa 7.5 RC Coupled CE Amplifier

```
//Ex7_5 Pg-371
clc

hfe=50 //current gain
Rl=10*10^(3) //load resistor in ohm
Rs=500 //source resistor in ohm
hie=10^(3) //input resitance in ohm

A=hfe*Rl/(Rs+hie) //volatge gain
printf("Voltage gain = %.1f \n",A)
Vs=0.02 //source voltage in V
Vout=A*Vs //output voltage
printf("Output voltage = %.2f V",Vout)
```

Scilab code Exa 7.6 Audio Amplifier

```
//Ex7_6 Pg-372
clc

Vout=5 //output voltage
Vin=0.5 //input voltage
Ri=10*10^(3) //input resistance in ohm
Ro=10 //output resistance

A=Vout/Vin //voltage gain
printf("Voltage gain =%.0f \n",A)
Pi=Vin^2/Ri //input power
Po=Vout^2/Ro //output power
Pow_gain=10*(log10(Po)-log10(Pi)) //power gain
printf(" Power gain(in decibel) = %.0f dB \n\n",
    Pow_gain)

disp("When Ri=Ro")
Ri=Ro
A=Vout/Vin //voltage gain
Pi=Vin^2/Ri //input power
Po=Vout^2/Ro //output power
Pow_gain=10*(log10(Po)-log10(Pi)) //power gain
printf(" Power gain(in decibel) = %.0f dB",Pow_gain)
```

Scilab code Exa 7.7 RC Coupled CE Amplifier

```
//Ex7_7 Pg-372
clc

```

```
Rl=2*10^(3) //load resistance in ohm
Ri=500 //input resistance in ohm
C=2*10^(-6) //capacitor in microFarad

f=(1/(2*%pi*C*(Rl+Ri))) //textbook answer is wrong
printf("Lowest cut-off frequency = %.0f Hz",f)
```

Scilab code Exa 7.8 RC Coupled Amplifier

```
//Ex7_8 Pg-372
clc

Rl=20*10^(3) //load resistance in ohm
Ri=5000 //input resistance in ohm
f=33 //lower cut-off frequency in Hz
f2=33*10^(3) //higher cut-off frequency

C=(1/(2*%pi*f*(Rl+Ri))) //coupling capacitance (
    value in textbook is wrong)
printf("Coupling Capacitor = %.1f uF \n",C*10^6)

Req=(Rl*Ri)/(Rl+Ri) //equivalent resistance
Cs=1/(2*%pi*f2*Req) //shunting capacitance (value in
    textbook is wrong)
printf(" Coupling Capacitor = %.0f uF \n",Cs*10^12)
```

Scilab code Exa 7.9 FET Amplifier

```
//Ex7_9 Pg-373
clc

Rd=3000 //source resistance in ohm
Rl=5000 //load resistance in ohm
```

```
Req=Rd*Rl/(Rd+Rl) //equivqlent resistance

gm=4500*10^(-6) //voltage gain in microMhos
Av=(-1)*gm*Req //voltage amplification
printf("Voltage Amplification = %.2f \n",Av)
Vi=100*10^(-3) //input voltage
Vout=abs(Av)*Vi //output voltage (value in textbook
    is wrong)
printf(" Output voltage = %.1f V",Vout)
```

Chapter 8

Feedback Amplifiers

Scilab code Exa 8.1 `Voltage Gain of Amplifier`

```
//Ex8_1 pg-434
clc

A=120 //amplification gain
Vi=50*10^(-3) //input voltage
Beta=0.1 //feedback factor

Vo= A*Vi //output voltage without feedback
printf("Input signal = %.2f V \n",Vo)

Vs=Vi-Beta*Vo
//input signal +ve output because of -ve feedback (calue in texxtbook is wrong)
printf(" Input signal = %.2f V \n",abs(Vs))

vg=A/(1+Beta*A) //voltage gain
printf(" Gain after feedback = %.1f \n",vg)

fb=(-1)*20*log10(1+(Beta*A))
printf(" Feedback (db)= %.3f \n",fb)
```

Scilab code Exa 8.2 Bandwidth of Amplifier

```
//Ex8_2 pg-435
clc

ff=4 //feedback factor
BW=6*10^(6) //bandwidth in Hz

BW_fb=BW*(1+ff) //Bandwidth with feedback factor(since Beta is +ve)
printf("Bandwidth with feedback factor = %.0f MHz",BW_fb*10^-6)
```

Scilab code Exa 8.3 Negative Feedback Factor

```
//Ex8_3 pg-435
clc

openA=60000 //open loop gain
closeA=10000 //closed loop gain
Beta=((openA/closeA)-1)/closeA
printf("Negative Feedback factor = %.4f \n",Beta)
BA=Beta*openA //value of Beta*A
printf(" Beta*A = %.0f",BA)
```

Scilab code Exa 8.4 Feedback Voltage Gain

```
//Ex8_4 pg-435
clc
```

```

Df=0.5/100 //distortion after negative feedback
D=8/100 //harmonic distortion

BA=D/Df-1 //value of Beta*A
A=200
Beta=BA/A //feedback factor
printf("Feedback factor = %.3f \n",Beta)
Af=A/(1+BA) //Gain after -ve feedback
printf("Gain after negative feedback = %.1f",Af)
```

Scilab code Exa 8.5 Feedback Voltage Gain

```
//Ex8_5 pg-436
clc

A=100 //voltage gain
per=10/100 //percentage of negative feedback applied
BA=A*per //value of Beta*A
Af=A/(1+BA) //gain after negative feedback
printf("Decrement in distortion ,D-Df = D-(D/(1+Beta*
   A)) \n")
printf("                              = %.1f\n ",Af)
per_dis=(BA/(1+BA))*100 //percentage change in
   distortion
printf("Percentage change in distortion = %.0f %% \n
   ",per_dis)
red=100-per_dis //reduction
printf(" Therefore reduction is = %.0f %%",red)
```

Scilab code Exa 8.6 Feedback Amplifier

```
//Ex8_6 pg-436
```

```
clc

A=50 //voltage gain
per=10/100 //percentage of negative feedback applied
BA=per*A //value of Beta*A
Af=A/(1+BA) //gain after negative feedback
printf("(1) Voltage gain after negative feedback \n")
printf("                                        = %.2f\n ",Af)

A=50 //voltage gain
per=5/100 //percentage of negative feedback applied
BA=per*A //value of Beta*A
Af1=A/(1+BA) //gain after negative feedback
printf("(2) Voltage gain after negative feedback \n")
printf("                                        = %.1f\n ",Af1)
disp("So the new gain is not double the previous case")
disp("   The difference between expected value and actual value of gain obtained is")
diff_value=2*Af-Af1
printf("                                       = %.2f",diff_value)

printf("\n\n(3) To have the gain double of case(1) i.e 16.66,let the \n feedback introduced be Beta(assuming negative feedback)")
Af=16.66 //voltage gain with negative feedback
A=50 //voltage gain
Beta=((A/Af)-1)/A //feedback in percentage
printf("\n                          Beta = %.2f",Beta)
```

Chapter 9

Negative Feedback Amplifier using Opamp

Scilab code Exa 9.1 `VCVS Amplifier`

```
//Ex9_1 Pg-475
clc

Aol= 250000 //open loop gain
fol=160 //open loop frequency in HZ
Acl=50 //close loop gain

fcl=Aol/Acl*fol //close loop frequency in Hz
printf("Close loop Bandwidth = %.0f kHz",fcl*10^-3)
```

Scilab code Exa 9.2 `ICVS Amplifier`

```
//Ex9_2 Pg-475
clc

Aol= 50000 //open loop gain
```

```
fol=14 //open loop frequency in HZ
fcl=(Aol+1)*fol //close loop frequency in Hz
printf("Close loop Bandwidth = %.0f kHz",fcl*10^-3)
```

Scilab code Exa 9.3 `ICIS Amplifier`

```
//Ex9_3 Pg-475
clc

Aol_Beta_1= 2500 //open loop gain
fol=20 //open loop frequency in HZ
fcl=Aol_Beta_1*fol //close loop frequency in Hz
printf("Close loop Bandwidth = %.0f kHz",fcl*10^-3)
```

Scilab code Exa 9.4 `VCVS Amplifier`

```
//Ex9_4 Pg-475
clc

funi=1*10^(6) //unity frequency in Hz
Sr=0.5/10^(-6) //slew rate in V/sec
Acl=10 //close loop gain

fcl=funi/Acl //close loop frequency in Hz
printf("(1) Close loop Bandwidth = %.0f kHz \n",fcl*10^-3)

Vp_max=Sr/(2*%pi*fcl) //output peak value
printf(" (2) Peak value of output = %.3f V \n",Vp_max)
```

Scilab code Exa 9.5 VCVS Amplifier

```
//Ex9_5 Pg-475
clc

Aol= 88 //open loop gain in db
R1=2.7*10^(3) //resistor R1 in ohm
R2=68*10^(3) //resistor R2 in ohm

Beta=R1/(R1+R2) //Feedback fraction
printf("Feedback fraction = %.3f \n",Beta)

Acl=1/Beta //ideal closed loop gain
printf(" Ideal closed loop gain = %.2f \n",Acl)

Aol=10^(88/20) //open loop gain
Acl=Aol/(1+Beta*Aol) //exact closed loop voltage
    gain
printf(" Exact closed loop voltage gain = %.2f",Acl)
```

Scilab code Exa 9.6 VCVS Amplifier

```
//Ex9_6 Pg-476
clc

Aol=20000 //open loop gain
R1=100 //resistor R1 in ohm
R2=7.5*10^(3) //resistor R2 in ohm
Rin=3*10^(6) //input resistor in ohm
Rcm=500*10^(6)

Beta=R1/(R1+R2) //Feedback fraction
printf("Feedback fraction = 1\\76 = %.5f \n",Beta)

Req=(Rin*Rcm)/(Rin+Rcm) //equivalent resistance of
```

```
   Rin and Rcm
Zcl=(1+Beta*Aol)*Req //closed loop input impedance (
   textbook answer is wrong)
printf(" Closed loop input impedance = %.0f Mohm",
   Zcl*10^-6)
```

Scilab code Exa 9.7 ICIS Amplifier

```
//Ex9_7 Pg-477
clc

R1=1.8 //resistor R1 in ohm
R2=1.5*10^(3) //resistor R2 in ohm
Iin=1*10^(-3) //input current in A

Ai=1+(R2/R1) //Current gain
printf("Current gain = %.0f \n",Ai)

Il=Ai*Iin //Output current
printf(" Output current = %.0f mA pp",Il*10^3)
```

Scilab code Exa 9.8 VCIS Amplifier

```
//Ex9_8 Pg-477
clc

R1=2.7 //resistor R1 in ohm
R2=1//resistor R2 in ohm
Vin=0.5 //input voltage in V

Io=Vin/R1 //output current
printf("(1) Output current = %.0f mA \n",Io*10^3)

```

```
P=Io^2*R2 //load power
printf(" (2) Load power = %.1f mW \n",P*10^3)

R2=2 // new load resistor R2 in ohm
P=Io^2*R2 //load power
printf(" (2) Load power = %.1f mW",P*10^3)
```

Chapter 10

Operational Amplifier

Scilab code Exa 10.1 Common Mode Voltage Gain

```
//Ex10_1 Pg-490
clc

Rc=1*10^(6) //collector resisstor in ohm
Re=2*10^(6) //emitter resistor in ohm
Vin=1*10^(-3) //input voltage in V

Acm=Rc/Re //Common moce voltage gain
printf("Common moce voltage gain = %.1f \n",Acm)

Vo=Acm*Vin //output voltage
printf(" Output voltage = %.1f mV",Vo*1e3)

disp("Thus a differential amplifier in common mode
    attenuates the input signal rather than
    amplifying it")
```

Scilab code Exa 10.2 Differential Amplifier

```
//Ex10_2 Pg-491
clc

A=150 //voltage gain
Acm=0.5 //common mode voltage gain
Vin=1*10^(-3) //input voltage in V

Vo=A*Vin //output voltage
printf("Amplified output voltage = %.2f V \n",Vo)

Vo=Acm*Vin //output voltage
printf(" Attenuated output voltage = %.1f mV",Vo*1e3
  )
```

Scilab code Exa 10.3 Opamp Operating Circuit

```
//Ex10_3 Pg-517
clc

R1=10*10^(3) //resistor R1 in ohm
Rf=50*10^(3) //feedback resistor in ohm
Vin=10*10^(-3) //input voltage in V
Ro=5000 //load resistor in ohm

disp("A'' = Vo/Vi = (-1)*Rf/R1*(1+1/A*(1+Rf/R1))^-1
  ")
A=5000
Vo=Vin*(Rf/R1)/(1+1/A*(1+Rf/R1)) //output voltage
printf("\n When gain A=%.0f",A)
printf(" \n Amplified output voltage = %.1f mV \n",
  Vo*1e3)

A=10000
Vo=Vin*(Rf/R1)/(1+1/A*(1+Rf/R1))
printf("\n When gain A=%.0f",A)
```

```
printf(" \n Amplified output voltage = %.2f mV \n",
    Vo*1e3)

A=5000
Rout=Ro/(1+A*R1/Rf) //load resistance
printf(" \n Ro'' = %.3f ohm \n",Rout)

A=10000
Rout=Ro/(1+A*R1/Rf) //load resistance
printf(" \n Ro'' = %.3f ohm \n",Rout)
```

Scilab code Exa 10.4 Opamp Operating in Inverting Mode

```
//Ex10_4 Pg-518
clc

R1=1.5*10^(3) //resistor R1 in ohm
Rf=75*10^(3) //feedback resistor in ohm
Vin=10*10^(-3) //input voltage in V
funi=1*10^(6) //unity frequency in Hz

Acl=(-1)*Rf/R1 //closed loop gain
printf("Magnitude of Closed loop gain = %.0f \n",abs
    (Acl))

fcl=funi/abs(Acl) //closed loop frequency
printf(" Closed loop frequency = %.0f kHz \n",fcl*1e
    -3)

Vout=abs(Acl)*Vin //output voltage
printf(" Output voltage = %.1f mV pp",Vout*1e3)
```

Scilab code Exa 10.5 Closed Loop Voltage Gain

```
//Ex10_5 Pg-518
clc

R1=2*10^(3) //resistor R1 in ohm
Rf=0 //feedback resistor in ohm

disp("(1) When resistor 100 k-ohm is in zero
    position")
A=1+Rf/R1 //gain
printf(" Gain = %.0f \n",A)

Rf=100*10^(3)
disp("(1) When resistor 100 k-ohm is in maximum
    position")
A=1+Rf/R1 //gain
printf(" Gain = %.0f",A)
```

Scilab code Exa 10.6 Opamp Operating in Inverting Mode

```
//Ex10_6 Pg-519
clc

R1=50*10^(3) //resistor R1 in ohm
Rf=300*10^(3) //feedback resistor in ohm
Vin=1 //input voltage in V

disp("In the inverting mode,voltage gain is ")
disp("A'' = Vo/Vi = (-1)*Rf/R1*(1+1/A*(1+Rf/R1))^-1
    ")
A=10000
Vo=(-1)*Vin*(Rf/R1)/(1+1/A*(1+Rf/R1)) //output
    voltage
printf(" \n Amplified output voltage = %.3f V \n",Vo
    )
```

Scilab code Exa 10.7 Power Bandwidth of Opamp

```
//Ex10_7 Pg-519
clc

Sr=15/1e-6 //slew rate in V/sec
Vp=10 //peak output voltage

fmax=Sr/(2*%pi*Vp) //Power Bandwidth
printf("Power Bandwidth = %.0f kHz",fmax*1e-3)
```

Scilab code Exa 10.8 Resistances of Opamp

```
//Ex10_8 Pg-519
clc

A=5000 //voltage gain
Ri=10000 //input resistor in ohm
Ro=100 //load resistor in ohm
Rf=0 //feedback resistor in ohm

Rin=A*Ri/(1+Rf/Ri) //input resistance of buffer
   circuit
printf("Input resistance of buffer circuit = %.0f*1
   e7 ohm \n",Rin*1e-7)

Rout=Ro/A*(1+Rf/Ri) //output resistance of buffer
   circuit
printf(" Output resistance of buffer circuit = %.2f
   ohm",Rout)
```

Chapter 11

Power Amplifiers

Scilab code Exa 11.1 RC Coupled Amplifier

```
//Ex11_1 Pg-536
clc

Vcc=15 //supply voltage in V
R1=2*10^(3) //resistor R1 in ohm
R2=470 //resistor R2 in ohm
Rc=680 //collector resistor in ohm
Rl=2.7*10^(3) //load resistor in ohm
Re=220 //emitter resistor

Idc=Vcc/(Rc+Re) //saturation current
printf("(1) Idc_sat = %.1f mA \n",Idc*1e3)

DCload=Rc //Dc load resistance
printf(" (2) DC load = %.0f ohm \n",DCload)

ACload=Rc*Rl/(Rc+Rl) //Ac load resistance
printf(" (3) AC load = %.0f ohm \n",ACload)

Vb=R2/(R1+R2)*Vcc //base voltage
Icq=(Vb-0.7)/Re //collector current
```

```
printf("(4) Icq = %.1f mA \n",Icq*1e3)
//answer in the book is wrong

Vc=Vcc-Icq*Rc //collector emitter voltage
Vceq=Vc-Icq*Re
printf("(5) Vceq = %.1f V \n",Vceq)
//answer in the book is wrong

Pac=Vcc^2/(8*Rl) //ac power
Pdc=Vcc*Idc //dc power
n=Pac/Pdc*100 //efficiency
printf(" Efiiciency = %.0f %%",n)
```

Scilab code Exa 11.2 Class B Transformer Coupled Amplifier

```
//Ex11_2 Pg-551
clc

Po=4 //power in watts
n=80/100 //transformer efficiency in percentage
Vcc=30 //supply voltage

Pout=Po/n //effective power
printf("Effective power to be transfered = %.0f W\n"
    ,Pout)

disp("Impedance seen when ""looking into"" the whole
     winding of centertapped transformer ")
Vp=Vcc //peak voltage
Rload=Vp^2/(2*Pout)
Rload_4=4*Rload //effective load
printf("\n Effective load = %.0f ohm \n",Rload_4)

disp("Transformer specification Po=4W,RL=16ohm,RL""
    =360ohm")
```

```

Vce=2*Vcc //Maximum transistor voltage
printf("\n Maximum transistor voltage = %.0f V\n",
   Vce)

Ip=2*Pout/Vp //Maximum transistor current
Ic=Ip
printf("\n Maximum transistor current = %.0f mA \n",
   Ip*1e3)
// answer in the book is different due to
   approximate value
printf("\n Transformer specification Vce=60V,Ic=%.0f
    mA",Ic*1e3)
// answer in the book is different  due to
   approximate value
```

Scilab code Exa 11.3 Tuned Amplifier

```
//Ex11_3 Pg-564
clc

L=2*10^(-6) //inductance in H
C=220*10^(-12) //capacitance in F

f0=1/(2*%pi*sqrt(L*C)) //resonant frequency (
   textbook answer is wrong)
printf("Resonant frequency = %.1f MHz \n",f0*1e-6)

Q=125 //quality factor
BW=f0/Q //Bandwidth (textbook answer is wrong)
printf(" Bandwidth = %.0f kHz",BW*1e-3)
```

Scilab code Exa 11.4 RC Coupled Amplifier

```
//Ex11_4 Pg-564
clc

Vcc=10 //supply volage in V
Rc=3600 //collector resistor in ohm
Re=680 //emitter resistor in ohm
Ri=10000 //input resistor in ohm
R2=2.2 //resistor R2 in ohm
R1=10 //resistor R1 in ohm

Vb=R2/(R1+R2)*Vcc //bias voltage
printf("(1) Bias voltage = %.1f V \n",Vb)

Ie=(Vb-0.7)/Re //emitter current
printf(" Emitter current = %.2f mA\n",Ie*1e3)

Vc=Vcc-Rc*Ie //Dc collector voltage
printf(" DC collector voltage = %.2f V\n",Vc)

Vceq=Vc-Ie*Re //DC collector to emitter voltage
printf(" DC collector to emitter voltage = %.2f V\n",Vceq)

Pd=Vceq*Ie //power dissipation
printf(" Power dissipation = %.2f mW\n",Pd*1e3)

printf("\n(2)If collector resistance Rc is replaced by tank circuit \n there is no voltage drop across it. \n")
Vc=Vcc
printf(" DC collector voltage = %.0f V\n",Vc)

Vceq=Vc-Ie*Re //DC collector to emitter voltage
printf(" DC collector to emitter voltage = %.2f V\n",Vceq)

Pd=Vceq*Ie //power dissipation
printf(" Power dissipation = %.2f mW\n",Pd*1e3)
```

Scilab code Exa 11.5 `Class C Tuned Amplfier`

```
//Ex11_5 Pg-565
clc

Vin=5 //input voltage
Vp=Vin*sqrt(2) //peak voltage
printf("The peak value(maximum amplication) of input signal \n")
printf("                                    = %.2f V",Vp)

Vin_pp=2*Vp //peak-to-peak value of input voltage
printf("\n Peak-to-peak value of input voltage \n")
printf("                                    = %.2f V",Vin_pp)

Vbg=-1*(Vp-0.7) //base to ground voltage 0.7 is the voltage drop
printf("\n Base to ground voltage = %.2f",Vbg)
```

Chapter 12

Oscillators

Scilab code Exa 12.1 Colpitts Oscillator

```
//Ex12_1 Pg-587
clc

C1=0.001e-6 //capacitor c1 in farad
C2=0.01e-6 //capacitor c2 in farad
L=5e-6 //inductance in Henry

disp("To maintain vibrations in a colpitts oscilator,")
disp("                    hfe >= C2/C1")
hfe=C2/C1 //transistor current gain
printf("                              = %.f \n",hfe)

printf("So the value of hfe of transistor used must be greater \n than 10. \n")
disp("Frequency of oscillations produced")
x=inv(C1)+inv(C2)
y=inv(L)
f=sqrt(x*y)
printf("                    = %.1f*1e7 Hz",f*1e-7)
// answer in the book is wrong
```

Scilab code Exa 12.2 Phase Shift Oscillator

```
//Ex12_2 Pg-588
clc

RL=3.3*10^(3) //load resistor in ohm
R=5.6*10^(3) //resistor R in ohm
C=0.001*10^(-6) //capacitance in farad

disp("For oscillations to be maintained in a RC oscillator, ")
hfe=(23+(29*R/RL)+(4*RL/R)) //transistor current gain
printf("                          = %.f \n",hfe)

disp("Frequency of oscillations,")
f=1/(2*%pi*C*sqrt((4*R*RL)+(6*R^2)))
//frequency of oscillation (textbook answer is wrong
// because of the used of wrong value of C)
printf("                = %.1f Hz",f)
```

Scilab code Exa 12.3 Oscillator

```
//Ex12_3 Pg-588
clc

L=0.33 //inductance in henry
C=0.065*10^(-12) //capacitance in farad
Cm=10^(-12) //capacitance in farad
R=0.55*10^(3) //resistor R in ohm

```

```
disp("Series resonant frequency, fs = 1/2*pi*sqrt(L*C)")
fs=1/(2*%pi*sqrt(L*C))
printf("              = %.2f MHz \n",fs*1e-6)

disp("Q of the crystal = 2*pi*fs*L/R")
Q=(2*%pi*fs*L)/R //quality factor (textbook answer wrong)
printf("              = %.0f \n",Q)
```

Scilab code Exa 12.4 Pierce Oscillator

```
//Ex12_4 Pg-602
clc

L=3 //inductance in henry
Cs=0.05*10^(-12) //capacitance in farad
Cm=10*10^(-12) //capacitance in farad
R=2*10^(3) //resistor R in ohm

disp("Series resonant frequency, fs = 1/2*pi*sqrt(LC)")
fs=1/(2*%pi*sqrt(L*Cs))
printf("              = %.0f KHz \n",fs*1e-3)

disp("The equialent parallel capacitance, Cp = Cm*Cs/Cm+Cs")
Cp=Cm*Cs/(Cm+Cs) //quality factor
printf("              = %.4f pF \n",Cp*1e12)

disp("Parallel resonant frequency, fp = 1/2*pi*sqrt(L*Cp)")
fp=1/(2*%pi*sqrt(L*Cp))
printf("              = %.0f kHz \n",fp*1e-3)
```

Scilab code Exa 12.5 `Oscillator`

```
//Ex12_5 Pg-602
clc

disp("Fundamental frequency of oscillations of crystal")
disp("                 fr = K/t")
disp("Let new thickness of the crystal be t''")
disp("            fr''/fr = t''/t = 99/100")
disp("So, new frequency fr'' = k/t''")
disp("or               fr'' = (99/100)*fr")
disp("or reduction in frequency,")
disp("           fr-fr'' = fr-(99/100)*fr")
disp("                   = fr(1/100)")
disp(" or      fr-fr''/fr = 1/100  ")
disp(" Therefore, fr'' reduces by 1%")
```

Chapter 14

Optical Fibres and Communication

Scilab code Exa 14.1 `Optical fibre`

```
//Ex14_1 Pg-695
clc

n1=1.545 //core refracrive index
n2=1.510 //cladding refractive index
d=3*10^(-6) //diamter of optical fiber in m

a=d/2 //core radius in m
del=(n1-n2)/n1 //fractional difference of refractive
    indices
lamda_c=(2*%pi*a*n1*sqrt(2*del))/2.405 //cut-off
    wavelength
printf("Cut-off wavelength = %.2f um",lamda_c*1e6)
```

Scilab code Exa 14.2 `Multimode Index Fibre`

```
//Ex14_2 Pg-695
clc

n1=1.53 //core refracrive index
n2=1.5 //cladding refractive index
lamda=10^(-6) //cut-off wavelength
a=50*10^(-6) //core radius in m


V=(2*%pi*a*sqrt(n1^2-n2^2))/lamda //normalised frequency
printf("Normalised frequency = %.2f \n",V)

ms=V^2/2 //total number of guided mode
printf("Total number of guided mode = %.0f",ms)
```

Scilab code Exa 14.3 Multimode Step Index Fibre

```
//Ex14_3 Pg-695
clc

n1=1.5//core refracrive index
n2=1.46 //cladding refractive index

tetha_rad=asin(n2/n1) //critical angle in radians
tetha=tetha_rad*180/%pi //critical angle in degree
printf("Critical angle = %.1f degree \n",tetha)

tetha_m_rad=asin(sqrt(n1^2-n2^2)) //acceptance angle in radians
tetha_m=tetha_m_rad*180/%pi
printf(" Acceptance angle = %.1f degree \n",tetha_m)

NA=sin(tetha_m_rad)
printf(" Numerical Apperture = %.3f",NA)
```

Scilab code Exa 14.4 Optical Fibre

```
//Ex14_4 Pg-696
clc

NA=0.5 //numerical apperture
n1=1.54 //core refractive index

n2=sqrt(n1^2-NA^2) //cladding refractive index
printf("(1) Cladding refractive index = %.3f \n",n2)

RI=(n1-n2)/n1 //change in core cladding refractive index
printf(" (2) RI of the core = %.4f",RI)
```

Scilab code Exa 14.5 Step Index Fibre

```
//Ex14_5 Pg-696
clc

n1=1.5//core refracrive index
n2=1.48 //cladding refractive index
n=1

NA=sqrt(n1^2-n2^2) //numerical apperture
printf("(1) Numerical apperture = %.5f \n",NA)

AA_rad=asin(NA/n) //maximum Acceptance angle in rad
AA=AA_rad*180/%pi //maximum entrance angle in degree
printf(" (2) The maximum entrance angle i0 = %.2f degree",AA)
```

Scilab code Exa 14.6 Optical Fibre

```
//Ex14_6 Pg-697
clc

n2=1.59 //cladding refractive index
NA=0.2 //numerical apperture
n0=1 //when fiber is in air

n1=sqrt(n2^2+NA^2) //core refractive index
printf("Core refractive index = %.3f \n",n1)

n=1.33 //water refractive index
NA=sqrt(n1^2-n2^2)/n0 //numerical apperture
printf(" Numerical apperture = %.2f \n",NA)

AA_rad=asin(NA/n) //maximum Acceptance angle in rad
AA=AA_rad*180/%pi //maximum entrance angle in degree
printf(" The maximum entrance angle i0 = %.2f degree
    ",AA)
```

Scilab code Exa 14.7 Optical Fibre

```
//Ex14_7 Pg-697
clc

NA=0.22 //numerical apperture
del=0.012 //fractional difference of refractive
    indices

n1=NA/(sqrt(2*del)) //core refractive index
printf("Core refractive index = %.2f \n",n1)
```

```

n2=n1-del*n1 //cladding refractive index
printf(" Cladding refractive index = %.2f \n",n2)
```

Scilab code Exa 14.8 Optical Fibre

```
//Ex14_8 Pg-698
clc

n1=1.52 //core refracrive index
n2=1.46 //cladding refractive index

del=(n1-n2)/n1 //fractional difference of refractive
    indices

NA=n1*sqrt(2*del) //numerical apperture
printf("Numerical apperture = %.3f \n",NA)

AA_rad=asin(NA) //maximum Acceptance angle in rad
AA=AA_rad*180/%pi //maximum entrance angle in degree
printf(" Acceptance angle i0 = %.2f degree \n",AA)

tetha_rad=asin(n2/n1) //critical angle in radians
tetha=tetha_rad*180/%pi //critical angle in degree
printf(" Critical angle = %.1f degree \n",tetha)
```

Scilab code Exa 14.9 Step Index Fibre

```
//Ex14_9 Pg-698
clc

n1=1.45 //core refracrive index
NA=0.16//cladding refractive index
```

```
lamda=0.9*10^(-6) //cut-off wavelength
d=60/100 //core radius in m


V=(%pi*d*NA)/lamda //normalised frequency
printf("Normalised frequency = %.2f*1e5 \n",V*1e-5)
```

Scilab code Exa 14.10 Step Index Fibre Single Mode

```
//Ex14_10 Pg-698
clc

n1=1.48 //core refracrive index
n2=1.47 //cladding refractive index
lamda=850e-6 //cut-off wavelength
V=2.405 //normalised frequency
//In the book cut off wavelength in the question is 850 um but in
// the calcution part it is taken as 850nm. Here I've taken 850um
d=V*lamda/(%pi*sqrt(n1^2-n2^2)) //diamter of core
a=d/2 //radius of core
printf("Radius of core = %.2f mm \n",a*1e3)//answer in the book is wrong

NA=sqrt(n1^2-n2^2) //numerical apperture
printf(" Numerical apperture = %.4f \n",NA)

AA_rad=asin(NA) //maximum Acceptance angle in rad
AA=AA_rad*180/%pi //maximum entrance angle in degree
printf(" Acceptance angle i0 = %.2f degree \n",AA)
```

Scilab code Exa 14.11 Loss in Optical Fibre

```
//Ex14_11 Pg-699
clc

L=500/1000 //length of fiber in m
Pin=1*10^(-3) //input power in watt
Pout=85/100*10^(-3) //output power in watt

alpha=(10/L)*log10(Pin/Pout) //loss
printf("Loss in the fiber = %.2f dB/Km",alpha)
```

Scilab code Exa 14.12 Communication System Output Power

```
//Ex14_12 Pg-699
clc

L=10 //length of fiber in km
alpha=2.5 //loss in the fiber per km
Pin=500*10^(-6) //input power in watt

tot_alpha=-1*alpha*L //total loss in the fiber
Pout=Pin*10^(tot_alpha/10) //output power in watt
printf("Output power = %.2f uW",Pout*1e6)
```

Scilab code Exa 14.13 GRIN Optical Fibre

```
//Ex14_13 Pg-700
clc

del=1/100 //fractional difference of refractive
    indices
lamda=1.3*10^(-6) //cutoff wavelength in m
n1=1.5 //refractive index
d=6.6*10^(-6) //diameter of the core
```

```
alpha=2 //loss in fiber

disp("     We have for a GRIN , maximum value of
   normalized frequency for single mode operation is
    given by")
disp("             V = 2.4*sqrt(1+2/alpha)")
V=2.4*sqrt(1+2/alpha) //normalzed frequency

disp("     For maximum core radiation , we have")
r=V*lamda/(2*%pi*n1*sqrt(2*del)) //radius of the
   core
printf("                    r = %.1f um \n",r*1e6)

rr=2*r //diameter of the core
printf("\n Maximum core diameter which permit single
    mode operation \n = 2*r = %.1f um",rr*1e6)
```

Scilab code Exa 14.14 Multimode Step Index Optical Fibre

```
//Ex14_14 Pg-700
clc

del=1.5/100 //fractional difference of refractive
   indices
lamda=0.85*10^(-6) //cutoff wavelength in m
n1=1.48 //refractive index
d=6.6*10^(-6) //diameter of the core
V=2.4 //normalzed frequency


disp("     For maximum core radiation , we have")
r=V*lamda/(2*%pi*n1*sqrt(2*del))
printf("                    r = %.1f um \n",r*1e6)

r=1.3*10^(-6) //actual radius=1.266 micrometer and
```

```
    assumed to 1.3 micometer
rr=2*r //diameter of the core
printf("\n Maximum core diameter which permit single
     mode operation \n = 2*r = %.1f um",rr*1e6)
```

Scilab code Exa 14.15 Optical Fibre

```
//Ex14_15 Pg-701
clc

alpha=3.5 //loss in fiber
Pi=0.5//input power in milli watt
L=4 //length of fiber in km

disp("The attenuation of an optical fiber is given
    by")
disp("                alpha = (10/L)*log(Pi/Po)")

Po=Pi/(10^(alpha*L/10))
printf("\n Output power = %.2f mW",Po*1e3)
```

Scilab code Exa 14.16 Single Mode Step Index Fibre

```
//Ex14_16 Pg-701
clc

n1=1.46 //core refracrive index
r=4.5*10^(-6)  //radius of the core
del=0.25/100 //fractional difference of refractive
    indices
Vc=2.405 //normalzed frequency

disp("We have, cut-off wavelength expression")
```

```
lamda=(2*%pi*r*n1*sqrt(2*del))/Vc
printf("                = %.3f  um",lamda*1e6)
```

Chapter 15

Communication System

Scilab code Exa 15.1 Transmitter Modulation

```
//Ex15_1 Pg-773
clc

Pc=10000 //carrier input power in watt
m=30/100 //modulation of 30%

disp("Total power = carrier power*(1+m^2/2)")
Pt=Pc*(1+m^2/2) //total power
printf("              = %.2f kW",Pt*1e-3)
```

Scilab code Exa 15.2 Transmitter Modulation

```
//Ex15_2 Pg-774
clc

Ic=100 //carrier current in A
m=80/100 //modulation of 80%

```

```
disp("Total current = carrier current*(1+m^2/2)")
It=Ic*sqrt(1+m^2/2) //total power
printf("                    = %.1f A \n",It)

change_I=It-Ic //change in current
printf("Therefore, increase in current due to
   modulation = %.1f A",change_I)
```

Scilab code Exa 15.3 AM Wave Modulation

```
//Ex15_3 Pg-774
clc

Em=5 //modulated wave amplitude
Ec=100 //carrier wave amplitude
Fm=50 //frequency of modulated wave
Fc=10*10^(3) //frequency of carrier wave

disp("(1) Modulation Factor")
m=Em/Ec //modulation factor
per_m=m*100 //modulation factor in percentage
printf("                    m = %.0f %%",per_m)

disp("(2) Amplitude of each sideband = m*Ec/2")
Amp=m*Ec/2 //amplitude of each sideband
printf("                    = %.1f",Amp)

USB=Fc+Fm //upper side band
LSB=Fc-Fm //lower side band
disp("(3) Frequenc of sidebands")
printf("          USB = %.0f Hz \n",USB)
printf("          LSB = %.0f Hz \n",LSB)

disp("(4) Bandwidth of the wave")
BW=2*Fm //Bandwidth
```

```
printf("           BW = %.0f",BW)
```

Scilab code Exa 15.4 AM Wave Modulation

```
//Ex15_4 Pg-774
clc

Vmax=600 //peak to peak voltage
Vmin=100 //valley to valley voltage

disp("From figure 15.49, we have")
m=(Vmax-Vmin)/(Vmax+Vmin) //modulation factor
per_m=m*100 //modulation factor in percentage
printf(" \n Modulation factor = %.1f %%",per_m )
```

Scilab code Exa 15.5 AM Wave Modulation

```
//Ex15_5 Pg-775
clc

disp("The standard equation of AM wave is")
disp(" e = Ec*(1+m*sin(omega_m*t)*sin(omega_c*t))
    -->eqn 1")
disp("Given the equation")
disp(" e = 20*(1+0.7*sin(6280*t)*sin(628000*t))    --
    eqn 2")
disp("Comparing eqn 1 and eqn 2 one obtains")
disp("(1) Modulation factor, m = 0.7")
m=0.7 //modulation factor
disp("(2) Carrier Amplitude, Ec = 20 V")
Ec=20 //carrier wave amplitude in V
disp("(3) omega_m = 6280")
omega_m=6280 //modulating frequency
```

```
Fm=omega_m/(2*%pi) //signal frequency
printf("     Signal frequency = %.0f kHz \n\n",Fm*1e-3)

omega_c=628000 //carrier frequency in Hz
Fc=omega_c/(2*%pi)
printf("(4) Signal frequency = %.0f kHz \n\n",Fc*1e-3)

Emax=Ec+m*Ec //minimum amplitude of wave
printf("(5) Emax = %.0f V \n\n",Emax)

Emin=Ec-m*Ec //minimum amplitude of wave
printf("(5) Emin = %.0f V\n\n",Emin)

BW=2*Fm //Bandwidth
printf("(6) BW = %.0f kHZ",BW*1e-3)
```

Scilab code Exa 15.6 AM Wave Modulation

```
//Ex15_6 Pg-776
clc

Pc=10000 //carrier power in watt
m=0.9 //modulation factor
disp("We have")

disp("Total power = carrier power*(1+m^2/2)")
Pt=Pc*(1+m^2/2) //total power
printf("                 = %.0f kW \n\n",Pt*1e-3)

printf("This will be the maximum power handeled by the transmitter.\n Now,increased unmodulated carrier power can be obtained by \n\n")
m=40/100 //modulation in terms of percentage
```

```
Pt=14000 //total power
Pc=Pt/(1+m^2/2) //neew carrier power
printf("          Pc = %.2f kW",Pc*1e-3)
```

Scilab code Exa 15.7 AM Wave Modulation

```
//Ex15_7 Pg-776
clc

disp("Given the equation")
printf("\n E = 100*sin(628000*t) + 25*sin(621720*t) \n    - 25*cos(634280*t)) \n")
 m=50/100 //modulation factor in percentage
 Ec=100 //carrier wave amplitude in V
 Em=10 //modulated wave amplitude in V
Fc=100000 //carier frequency in Hz
Fm=1000 //modulating frequency in Hz
pi=3.14

omega_c=2*pi*Fc //carier frequency
omega_m=2*pi*Em //modulating frequency

disp("Now,putting these equation in the standard equations for modulated voltage wave,")
disp("  e = Ec*sin(omega_c*t)+m*Ec/2*cos(omega_c-omega_m)*t-m*Ec/2*cos(omega_c-omega_m)*t")
USB=omega_c+omega_m //upper sideband
LSB=omega_c-omega_m //lower sideband
mEc=m*Ec/2
printf("\n      = 100*sin(628000*t) + %.0f*sin(%.0f*t) \n        - %.0f*cos(%.0f*t))",mEc,USB,mEc,LSB)
```

Chapter 18

Optoelectronic Devices

Scilab code Exa 18.1 DC Circuit of LED

```
//Ex18_1 Pg-901
clc

Vs=12 //supply voltage in V
Vd=2 //forward bias voltage in V
Id=20*10^(-3) //forward bias current

Rs=(Vs-Vd)/Id //source resistor
printf("Source resistance = %.0f ohm \n",Rs)

P=Id^2*Rs //power
printf(" Wattage rating = %.1f mW",P*1e3)
disp("Therefore a standard size 0.25 watt = 250mW
    resistor is required")
```

Scilab code Exa 18.2 Spontaneous and Stimulated Emission

```
//Ex18_2 Pg-945
```

```
clc

T=2000 //temperature in Kelvin
f=5*10^(14) // frequency in Hz
h=6.6*10^(-34) //planck constant
k=1.38*10^(-23) //Boltzmann constant

R=exp((h*f)/(k*T)) //ratio of spontaneous and
    stimulated emisson
printf("      R = %.2f*1e5",R*1e-5)
```

Scilab code Exa 18.3 Relative Populations

```
//Ex18_3 Pg-946
clc

disp("Average wavelength of visible radiation = 550
    nm")
disp("       E1 - E2 = hc/lamda")
h=6.6*10^(-34) //planck constant
c=3*10^(8) //speed of light in sec
lamda= 550*10^(-9) //wavelength in m
E=h*c/lamda //difference in energy levels in Joules
e=1.6*10^(-19) //electron charge in eV
E_eV=E/e //difference in energy levels in
    electronVolt
printf("                    = %.1f*1e-19 J \n",E*1e19)
printf("                    = %.2f eV \n",E_eV)

T=300 //temperature in Kelvin
k=1.38*10^(-23) //Boltzmann constant
disp("Average room temperature=300K and g1=g2,we
    have")
N=exp((-E)/(k*T))
printf(" N2/N1 = %.2f*1e-37",N*1e37)
```

```
//answer in the book is wrong
```

Scilab code Exa 18.4 Silicon Crystal Problem

```
//Ex18_4 Pg-946
clc

w=0.3*10^(-6)*100 //width of silicon in cm
alpha=4*10^(4)
phi=10^(-2)
e=1.6*10^(-19) //electron charge in eV

disp("(1) Energy absorbed/sec is given by ")
E=phi*(1-exp(alpha*w)) //energy absorbed(textbook answer is wrong)
printf("                    = %.1f mW \n",abs(E)*1e3)

disp("(2) The portion of each photo energy that is converted into heat is obtained as hv-Eg/hv")
Heat=(3-1.12)/3*100 //photon energy coverted to heat
printf("                    = %.0f %%",Heat)
E1=(62/100)*0.0232 //energy dissipated/sec (textbook answer is wrong)
printf("\n Obviously, the amount of energy dissipated/sec to lattice \n is %.1f mW \n",E1*1e3)

disp("(3) Number of photons/sec from recombination is")
num_photons=2.4/(e*1.12)
printf("                    = %.1f*1e19 photon/sec \n",num_photons*1e-19)
//textbook answer is wrong

disp("Therefore recombination radiation")
```

```
RR=abs(E)-E1 //recombination radiation (textbok answer is wrong)
printf("                    = %.1f mW",RR*1e3)
```

Scilab code Exa 18.5 Electrons Diffusion

```
//Ex18_5 Pg-947
clc

d=5*10^(-6) //thickness of silicon in m
Dc=3.4*10^(-3) //diffusion coefficient in m^2sec^(-1)

t=d^2/(2*Dc) //time taken to diffuse
printf("Time taken to diffuse = %.1f*1e-9 sec",t*1e9)
```

Scilab code Exa 18.6 Frequency Bandwidth Limitations

```
//Ex18_6 Pg-947
clc

A=10^(-6) //diode area in m
epsilon_r=11.7 //relative permitivity
Nd=10^(21) //number of doping carriers
V=10 //bias potential in V
e=1.6*10^(-19) //electron charge in eV
epsilon_0=8.85*10^(-12) //permitivity of free space

Cj=A/2*sqrt(2*e*epsilon_r*epsilon_0*Nd)/sqrt(V)
printf("Diode capacitance = %.f pF",Cj*1e12)
//textbook answer is wrong
```

Scilab code Exa 18.7 SemiconductorLaser

```
//Ex18_7 Pg-947
clc

L=10^(-6) //length of cavity in m
r2=0.5 //relative coefficient of semiconductor
r1=1.5 //relative coefficient of semiconductor

disp("No internal loss means di=0; we have")
g=log10(1/(r1*r2))/(2*L) //gain of the laser (textbook answer is wrong)
printf(" Gain g = %.2f*1e3 cm^(-1)",g*1e-3)
```

Scilab code Exa 18.8 Photoconductor Device

```
//Ex18_8 Pg-947
clc

L=100*10^(-6) //length of semiconductor in m
A=10^(-7) //area of semiconductor in cm^2
V=10 //applied voltage in V
mew_n=1350 //mobility of electrons
mew_p=480 //mobiltiy of protons
tp=10^(-6) //lifetime of protons in sec

tn=L/(mew_n*V) //lifetime of electrons in sec

Gain=tp/tn*(1+(mew_p/mew_n)) //gain of photoconductor
printf("Gain = %.2f*1e2",Gain*1e-2)
```

Chapter 19

Digital Electronics

Scilab code Exa 19.1 Binary to Decimal

```
//Ex19_1 Pg-957
clc

bin='101'; //binary input
dec=bin2dec(bin) //decimal output
disp("The decimal equivqlent of 101 is")
disp(dec)
```

Scilab code Exa 19.2 Binary to Decimal

```
//Ex19_2 Pg-958
clc

bin='11101'; //binary input
dec=bin2dec(bin) //decimal output
disp("The decimal equivqlent of 11101 is")
disp(dec)
```

Scilab code Exa 19.3 Binary to Decimal

```
//Ex19_3 Pg-958
clc

a=1
b=0
c=1
dec=a*2^(-1)+b*2^(-2)+c*2^(-3) //decimal output
disp("The decimal equivqlent of 0.101 is")
disp(dec)
```

Scilab code Exa 19.4 Binary to Decimal

```
//Ex19_4 Pg-958
clc

a=1
b=1
c=0
d=1
dec=a*2^(-1)+b*2^(-2)+c*2^(-3)+d*2^(-4) //decimal
   output
disp("The decimal equivqlent of 0.1101 is")
disp(dec)
```

Scilab code Exa 19.5 Binary to Decimal

```
//Ex19_5 Pg-958
```

```
clc

//Integer part
bin='10101'; //binary input
dec_I=bin2dec(bin) //decimal output

//Decimal part
a=1
b=0
c=1
dec_D=a*2^(-1)+b*2^(-2)+c*2^(-3)
dec=dec_I+dec_D //decimal output
disp("The decimal equivqlent of 10101.101 is")
disp(dec)
```

Scilab code Exa 19.6 Decimal to Binary

```
//Ex19_6 Pg-959
clc

dec=9 //decimal input
bin=dec2bin(dec) //binary output
disp("The binary equivalent of 9 is")
disp(bin)
```

Scilab code Exa 19.7 Decimal to Binary

```
//Ex19_7 Pg-959
clc

dec=31 //decimal input
bin=dec2bin(dec) //binary output
disp("The binary equivalent of 31 is")
```

```
disp(bin)
```

Scilab code Exa 19.8 Decimal to Binary

```
//Ex19_8 Pg-959
clc

dec=13 //decimal input
bin=dec2bin(dec) //binary output
disp("The binary equivalent of 13 is")
disp(bin)
```

Scilab code Exa 19.9 Decimal to Binary

```
//Ex19_9 Pg-960
clc
disp("Conversion of decimal number 31.65 base to its
    binary equivalent ")
a=31.65;
z=modulo(a,1)
x=floor(a);//separating the decimal from the integer
    part
b=0;
c=0;
d=0;
while(x>0)  //taking integer part into a matrix and
   convert to equivalent binary
y=modulo(x,2);
b=b+(10^c)*y;
x=x/2;
x=floor(x);
c=c+1;
end
```

```
for i=1:10;//converting the values after the decimal
    point into binary
    z=z*2;
    q=floor(z);
    d=d+q/(10^i);
    if z>=1 then
        z=z-1;
    end
end
s=b+d;
printf("\n                    =%.6f",s);
```

Scilab code Exa 19.10 Binary to Decimal

```
//Ex19_10 Pg-961
clc

bin='1111'; //binary input
dec=bin2dec(bin) //decimal output
disp("(1) Binary number -> 1111")
disp("Here we have 4 bits")
disp("The decimal equivqlent is")
disp(dec)


bin='1111111'; //binary input
dec=bin2dec(bin) //decimal output
disp("(2) Binary number -> 1111111")
disp("Here we have 7 bits")
disp("The decimal equivqlent is")
disp(dec)
```

Scilab code Exa 19.11 Octal to Decimal

```
//Ex19_11 Pg-962
clc

oct='23'; //binary input
dec=oct2dec(oct) //decimal output
disp("The decimal equivqlent of 23 is")
disp(dec)
```

Scilab code Exa 19.12 Octal to Decimal

```
//Ex19_12 Pg-962
clc

oct='257'; //binary input
dec=oct2dec(oct) //decimal output
disp("The decimal equivalent of 257 is")
disp(dec)
```

Scilab code Exa 19.13 Decimal to Octal

```
//Ex19_13 Pg-962
clc

dec=175; //binary input
oct=dec2oct(dec) //decimal output
disp("The octal equivslent of 175 is")
disp(oct)
```

Scilab code Exa 19.14 Decimal to Octal

```
//Ex19_14 Pg-963
clc

disp("Conversion of decimal number 0.85 base  to its
    octal equivalent ")
a=[0.85] //0.75 value in textbook is wrong
z=modulo(a,1)
d=0
for i=1:10//converting the values after the decimal
   point into octal
    z=z*8
    q=floor(z)
    d=d+q/(10^i)
    if z>=1 then
        z=z-q
    end
end
s=d
printf("\n                    = %.6f",s);
```

Scilab code Exa 19.15 Octal to Binary

```
//Ex19_15 Pg-963
clc

oct='34' //octal input
dec=oct2dec(oct) //decimal output
bin=dec2bin(dec) //binary output
disp("The binary equivalent of octal 34 is")
disp(bin)
```

Scilab code Exa 19.16 Octal to Binary

```
//Ex19_16 Pg-963
clc

oct='357' //octal input
dec=oct2dec(oct) //decimal output
bin=dec2bin(dec) //binary output
disp("The binary equivalent of octal 34 is")
disp(bin)
```

Scilab code Exa 19.17 `Binary to Octal`

```
//Ex19_17 Pg-963
clc

//Integer part
bin='1011'; //binary input
dec_I=bin2dec(bin) //decimal output
oct_I=dec2oct(dec_I) //octal output

//Decimal part
bin='11010'; //binary input
dec_D=bin2dec(bin) //decimal output
oct_D=dec2oct(dec_D) //octal output
oct=oct_I + oct_D //final octal output
b = strcat([ oct_I , oct_D ], '.' ) // combining intger and decimal part
disp("The octal equivqlent of 1011.01101 is")
disp(b)
```

Scilab code Exa 19.18 `Hexadecimal to Binary`

```
//Ex19_18 Pg-965
clc
```

```

hex='9AF' //hexadecimal input
dec=hex2dec(hex) //decimal output
bin=dec2bin(dec) //binary output
disp("The binary equivalent of 9AF is")
disp(bin)
```

Scilab code Exa 19.19 `Hexadecimal to Binary`

```
//Ex19_19 Pg-965
clc

hex='C5E2' //hexadecimal input
dec=hex2dec(hex) //decimal output
bin=dec2bin(dec) //binary output
disp("The binary equivalent of C5E2 is")
disp(bin)
```

Scilab code Exa 19.20 `Binary to Hexadecimal`

```
//Ex19_20 Pg-957
clc

bin='10001100'; //binary input
dec=bin2dec(bin) //decimal output
hex=dec2hex(dec) //hexadecimal output
disp("The hexadecimal equivqlent of 10001100 is")
disp(hex)
```

Scilab code Exa 19.21 `Hexadecimal to Decimal`

```
//Ex19_21 Pg-965
clc

//Integer part
hex='F8E6'; //binary input
dec_I=hex2dec(hex) //decimal output

//Decimal part
a=3
b=9
dec=dec_I+a*16^(-1)+b*16^(-2) //decimal output
disp("The decimal equivalent of F8E6.39 is")
printf("\n    %.4f",dec)
```

Scilab code Exa 19.22 Decimal to Hexadecimal

```
//Ex19_22 Pg-966
clc

dec=2479 //decimal input
hex=dec2hex(dec) //hexadecimal output
disp("The Hexadecimal equivalent of 2479 is")
disp(hex)
```

Scilab code Exa 19.23 Decimal to Hexadecimal

```
//Ex19_23 Pg-966
clc

dec=65535 //decimal input
hex=dec2hex(dec) //hexadecimal output
disp("The Hexadecimal equivalent of 65535 is")
disp(hex)
```

```
bin=dec2bin(dec) //binary output
disp("The Binary equivalent of 65535 is ")
disp(bin)
```

Scilab code Exa 19.24 Binary Addittion

```
//Ex19_24 Pg-969
clc

x=bin2dec('11100') //1st input
y=bin2dec('11010') //2nd input
z=x+y //binary addition
add=dec2bin(z)
disp(" 11100 + 11010 = ")
disp(add)
```

Scilab code Exa 19.25 Binary Subtraction

```
//Ex19_25 Pg-970
clc

x=bin2dec('1101') //1st input
y=bin2dec('1010') //2nd input
z=x-y //subtraction
sub=dec2bin(z,4)
disp(" 1101 - 1010 = ")
disp(sub)
```

Scilab code Exa 19.26 Binary Subtraction

```
//Ex19_26 Pg-970
clc


x=200 //1st input
y=125 //2nd input
z=x-y //subtraction
disp("For decimal system 200 - 125 = ")
disp(z)

a=dec2hex(z) //hexadeciaml output of 200-125
disp("For hexadecimal system C8 - 7D is")
disp(a)

b=dec2bin(z,8) //binary output of 200-125
disp("For binary system 11001000 - 01111101 is")
disp(b)
```

Scilab code Exa 19.27 Boolean Expression

```
//Ex19_27 Pg-997
clc

disp("(A+B)(A+C) = AA + AC + AB + BC ")
//by distributive law
disp("               = A + AC + AB +BC")
//by theorem(6)
disp("               = A(1 + C) + AB + BC")
//by distributive law
disp("               = A.1 + AB + BC ")
//by theorem(3)
disp("               = A(B + 1) + BC")
//by distributive law
disp("               = A + BC")
disp("Therefore (A+B)(A+C) = A + BC")
```

Scilab code Exa 19.28 Boolean Expression

```
//Ex19_28 Pg-998
clc

disp("AB + A(B + C) + B(B + C)   = AB + AB + AC + BB + BC")
//using distributive law
disp("                           = AB + AC + B +BC        ")
//using law 6
disp("                           = AB + AC + B(1 + C)     ")
//taking common B from B + BC
disp("                           = AB + AC + B")
//using law 7
disp("                           = B(A + 1) + AC")
//taking common B from AB + B
disp("                           = B + AC")
//using law 7
disp("Therefore AB + A(B + C) + B(B + C) = B + AC")
```

Scilab code Exa 19.30 Boolean Expression

```
//Ex19_30 Pg-998
clc

// question in the textbook is wrong7
disp("LHS : (A + B + C)(A + B + C) ")
disp("          = AA + AB + AC + BA + BB +BC + CA + CB + CC")
```

```
//using distributive law
disp("            = A + AB + AC + BA + B +BC + CA + CB +
   C")
//using law 6
disp("            = A + AB + AC +BC + CB + C")
//using law 5
disp("            = A(B + 1) + AC + B + C(B + 1)")
//taking A common from A+AB and C from CB+C
disp("            = A + AC + B + C")
//using law 3
disp("            = A + B + C(A + 1)")
//taking common C from AC+C
disp("            = A + B + C")
//using law 3
disp("Therefore (A'' + B + C)(A'' + B'' + C) = A'' +
   C")
```

Scilab code Exa 19.31 `Boolean Expression`

```
//Ex19_31 Pg-999
clc

disp("LHS : (A+ C)(A'' + B) ")
disp("             = AA'' + AB + CA'' + BC") //using
   distributive law
disp("             = 0 + AB + CA'' + BC") //using law 8
disp("             = AB + (A + A'')BC + CA''") //using
   law 7
disp("             = AB + ABC + A''BC + CA''")
//using distributive law
disp("             = AB + ABC + A''C(B + 1)")
//taking common A'C from A'BC + CA'
disp("             = AB + ABC + A''C") //using law 3
disp("             = AB(C + 1)+ A''C")
//taking common AB from AB + ABC
```

```
disp("            = AB + A''C") //using law 3
disp("Therefore (A+ C)(A'' + B) = AB + A''C")
```

Chapter 21

Integrated Circuits

Scilab code Exa 21.1 AC Coupled Trigger Pulse

```
//Ex21_1 Pg-1067
clc

disp("Refer to figure 21.10")

R=5000 //resistor R in ohm
C=0.1*10^(-6) //capacitance in farad
tau=1.1 //time constant

tON=tau*R*C //pulse width in sec
printf(" Pulse width = %.2f msec",tON*1e3)
```

Scilab code Exa 21.2 Astable Mode Time Output

```
//Ex21_2 Pg-1068
clc

disp("Refer to figure 21.12")
```

```
R1=20000 //timing resistor R1 in ohm
R2=R1 //timing resistor R2 in ohm
C=0.1*10^(-6) //capacitance in farad
tau=0.69 //time constant

tHIGH=tau*(R1+R2)*C //time output that will remain
    high
printf(" Time output = %.2f msec",tHIGH*1e3)
```

Scilab code Exa 21.3 Astable Mode Time Output

```
//Ex21_3 Pg-1069
clc

disp("Refer to figure 21.12")
R2=20000 //timing resistor R2 in ohm
C=0.1*10^(-6) //capacitance in farad
tau=0.69 //time constant

tLOW=tau*(R2)*C //time output that will remain high
printf(" Time output = %.2f msec",tLOW*1e3)
```

Scilab code Exa 21.4 Astable Mode Output Frequency

```
//Ex21_4 Pg-1069
clc

R1=20000 //timing resistor R1 in ohm
R2=R1 //timing resistor R2 in ohm
C=0.1*10^(-6) //capacitance in farad

f0=1.45/((R1+2*R2)*C) //output frequency
printf("Output frequency = %.2f Hz",f0)
```

Scilab code Exa 21.5 `Astable Mode Duty Cylce`

```
//Ex21_5 Pg-1069
clc

disp("Refer to figure 21.12")
R1=20000 //timing resistor R1 in ohm
R2=R1 //timing resistor R2 in ohm

D=(R1+R2)/(R1+2*R2)*100 //duty cylce
printf(" Duty cycle = %.1f %%",D)
```

Scilab code Exa 21.6 `Resistor Values in Astable Mode`

```
//Ex21_6 Pg-1070
clc

C=0.01*10^(-6) //capacitance in farad
f0=2000 //frequency in Hz

Req=1.45/(f0*C) //equivalent resistance or R1+R2
disp("    Because a square wavw has duty cycle of 50
   % each resistor must be the same")
R1=Req/2
R2=R1
printf("       R1 = R2 = %.2f kohm",R2*1e-3)
```

Scilab code Exa 21.7 `Time Delay Mode`

```
//Ex21_7 Pg-1073
clc

R=260000 //resistor R in ohm
C=25*10^(-6) //capacitance in farad
tau=1.1 //time constant

t_delay=tau*R*C //pulse width in sec
printf(" Pulse width = %.2f sec",t_delay)
```

Scilab code Exa 21.8 Decimal to TTL Voltage Terms

```
//Ex21_8 Pg-1076
clc

dec=253 //decimal number
bin=dec2bin(dec) //binary value of 253
disp("Binary value of 253 =")
disp(bin)
disp("In TTL for 1s it is represented in 5V and 0s
   as 0V")
disp("Therefore 253 in TTL voltage terms is")
disp("5V,5V,5V,5V,5V,5V,0V,5V")
```