Scilab Textbook Companion for Optical Fiber Communication by A. Selvarajan, S. Kar and T Srinivas[1]

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Book Description

Title: Optical Fiber Communication

Author: A. Selvarajan, S. Kar and T Srinivas

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

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List of Scilab Codes

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Chapter 2

Light propagation in optical fiber

Scilab code Exa 2.1 1

```
//Optical Fiber communication by A selvarajan
//example 2.1
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//case-1
ncore=1.46//refractive index of core
nclad=1//refractive index of cladding
c=3e5//velocity of light in Km/s
L=1// length of path in Km
NA=sqrt(ncore^2-nclad^2)//Numerical aperture
delt_tau_by_L=(NA^2)/(2*c*ncore) //multipath pulse
    broadening in s/Km
delt_tau=delt_tau_by_L*L//bandwidth distance product
     Hz
BL=(1/delt_tau)*L//bandwidth distance product Hz
mprintf('Numerical aperture=%f',NA);//The answers
    vary due to round off error
```

```
mprintf('\nMultipath pulse broadening=%fns/Km',
    delt_tau_by_L*1e9);//The answer provided in the
    textbook is wrong//multiplication by 1e9  to
    convert s/Km to ns/Km
mprintf('\nBandwidth distance product=%fMHz',BL*1e
    -6);//The answer provided in the textbook is
    wrong//multiplication by 1e-6 to convert Hz to
    MHz
//case-2
ncore=1.465//refractive index of core
nclad=1.45//refractive index of cladding
NA=sqrt(ncore^2-nclad^2)//Numerical aperture
delt_tau_by_L=(NA^2)/(2*c*ncore) //multipath pulse
    broadening in s/m
BL=(1/delt_tau_by_L)*L//bandwidth distance product
    Hz
mprintf('\n\nNumerical aperture=%f',NA);
mprintf('\nMultipath pulse broadening=%fns/Km',
    delt_tau_by_L*1e9);//The answer provided in the
    textbook is wrong//multiplication by 1e9 to
    convert s/Km to ns/Km
mprintf('\nBandwidth distance product=%fGHz',BL*1e
    -9);//The answer provided in the textbook is
    wrong//multiplication by 1e-6 to convert Hz to
    GHz
```

Scilab code Exa 2.2 2

```
//Optical Fiber communication by A selvarajan
//example 2.2
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
```

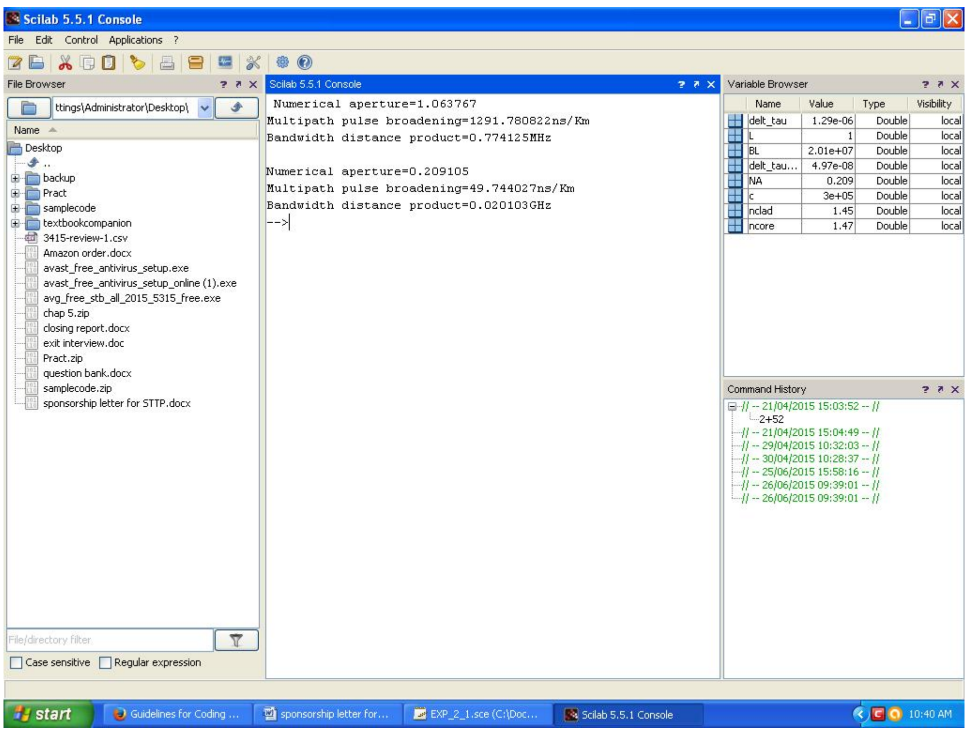
Scilab 5.5.1 Console
File Edit Control Applications ?
File Browser
Scilab 5.5.1 Console
Numerical aperture=1.063767
Multipath pulse broadening=1291.780822ns/Km
Bandwidth distance product=0.774125MHz
Numerical aperture=0.209105
Multipath pulse broadening=49.744027ns/Km
Bandwidth distance product=0.020103GHz
-->
Variable Browser
Name Value Type Visibility
delt_tau 1.29e-06 Double local
L 1 Double local
BL 2.01e+07 Double local
delt_tau... 4.97e-08 Double local
NA 0.209 Double local
c 3e+05 Double local
nclad 1.45 Double local
ncore 1.47 Double local
Command History
start
10:40 AM

Figure 2.1: 1

```
clear all;
lamda1=0.7//wavelength in um
lamda2=1.3//wavelength in um
lamda3=2//wavelength in um
f_lambda1=(303.33*(lamda1^-1)-233.33)//equation for
    lambda1
f_lambda2=(303.33*(lamda2^-1)-233.33)//equation for
    lambda2
f_lambda3=(303.33*(lamda3^-1)-233.33)//equation for
    lambda3
mprintf("Material dispersion at Lambda 0.7um=%f",
    f_lambda1)
mprintf("\nMaterial dispersion at Lambda 1.3um=%f",
    f_lambda2)//The answers vary due to round off
    error
mprintf("\nMaterial dispersion at Lambda 2um=%f",
    f_lambda3)//The answers vary due to round off
    error
mprintf('\nIts is a standard silica fiber')
```

Scilab code Exa 2.3 3

```
//Optical Fiber communication by A selvarajan
//example 2.3
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//given
ncore=1.505//refractive index of core
nclad=1.502//refractive index of cladding
```

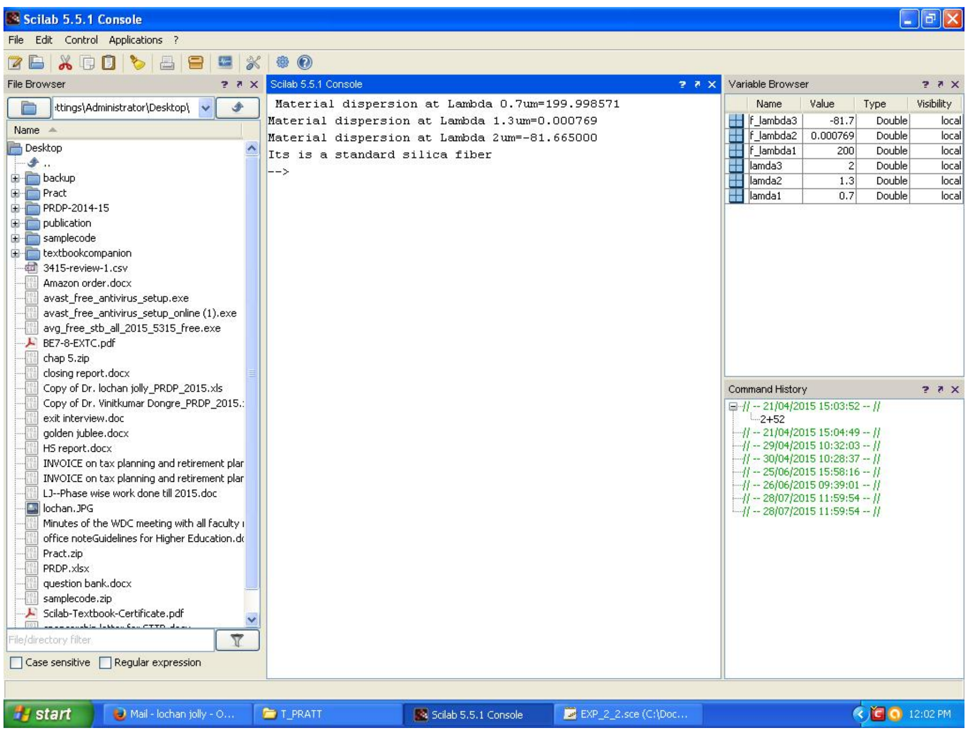
Scilab 5.5.1 Console
File Edit Control Applications ?
File Browser
Scilab 5.5.1 Console
Material dispersion at Lambda 0.7um=199.998571
Material dispersion at Lambda 1.3um=0.000769
Material dispersion at Lambda 2um=-81.665000
Its is a standard silica fiber
-->
Variable Browser
Command History

Figure 2.2: 2

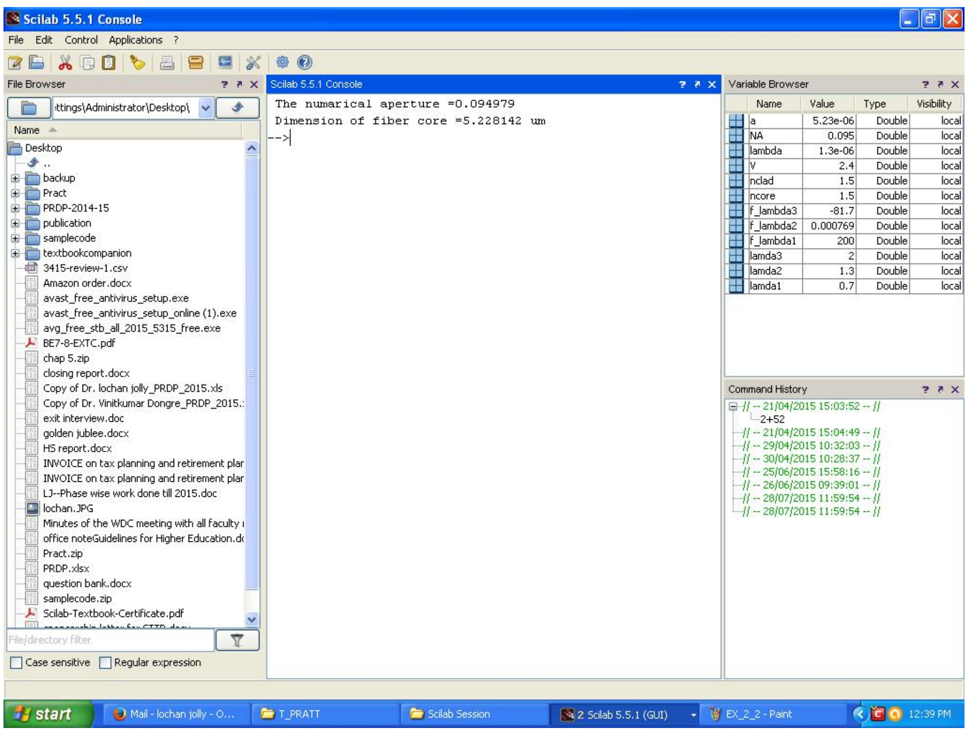
Scilab 5.5.1 Console
The numarical aperture =0.094979
Dimension of fiber core =5.228142 um
Variable Browser
Command History

Figure 2.3: 3

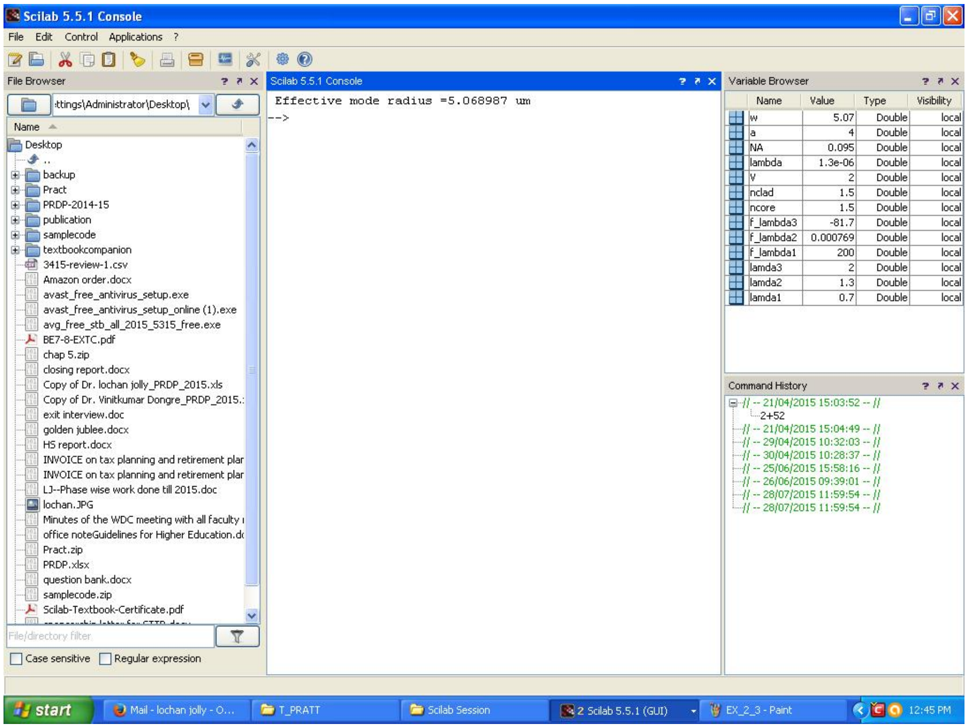

Figure 2.4: 4

```
V=2.4//v no. for single mode
lambda=1300e-9//operating wavelength in m
//to find
NA=sqrt(ncore^2-nclad^2)//numerical aperture
a=V*(lambda)/(2*%pi*NA)//dimension of fiber core in m
//display
mprintf("The numerical aperture =%f",NA);
mprintf("\n Dimension of fiber core =%f um",a*1e6)//multiplication by 1e6 to convert unit from m to um
```

Scilab code Exa 2.4 4

```
//Optical Fiber communication by A selvarajan
//example 2.4
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//given

V=2//v no. for single mode
a=4//radius of fiber in um
//to find
w=a*(0.65+1.619*V^(-3/2)+2.87*V^-6)//effective mode
    radius in um
//display

mprintf("Effective mode radius =%f um",w)
```

Scilab code Exa 2.6 6

```
//Optical Fiber communication by A selvarajan
//example 2.6
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//given
 m=0// for dominant mode
 v=0// for dominant mode
 n1=1.5// refractive index of core
 delta=0.01// core clad index difference
 a=5// fiber radius in um
```

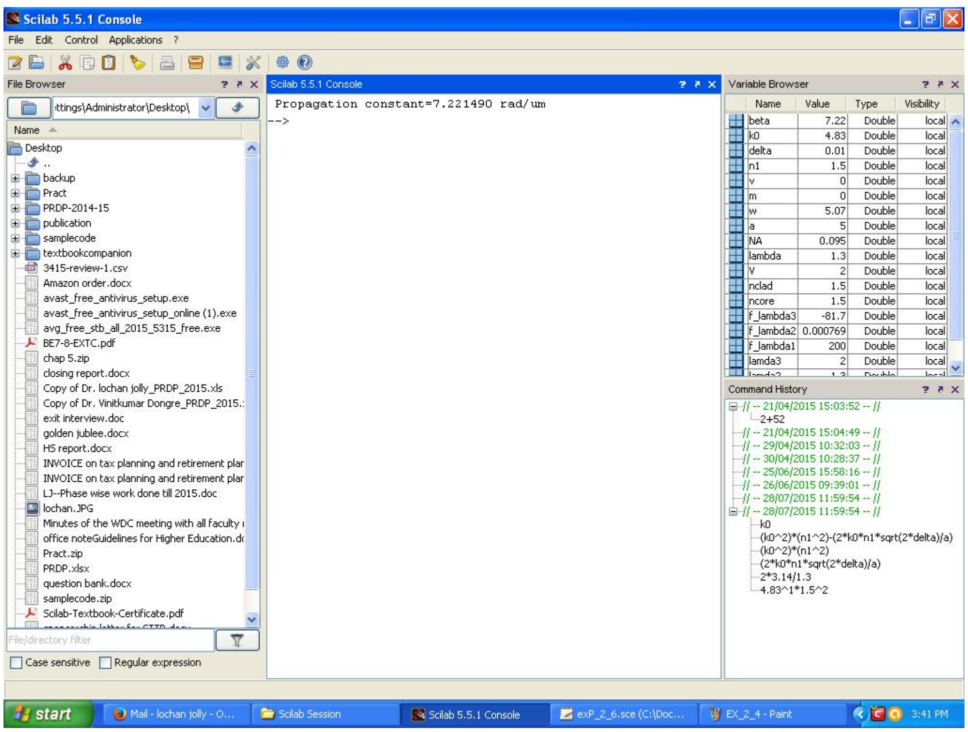
Scilab 5.5.1 Console
File Edit Control Applications ?
File Browser
Scilab 5.5.1 Console
Propagation constant=7.221490 rad/um
-->
Variable Browser
Name Value Type Visibility
beta 7.22 Double local
k0 4.83 Double local
delta 0.01 Double local
n1 1.5 Double local
w 5.07 Double local
a 5 Double local
NA 0.095 Double local
lambda 1.3 Double local
nclad 1.5 Double local
ncore 1.5 Double local
Command History

Figure 2.5: 6

```
 lambda=1.3//wavelength of operation in um
// to find
 k0=(2*%pi/lambda)//constant in /m
beta=sqrt((k0^2)*(n1^2)-(2*k0*n1*sqrt(2*delta)/a))//
   propagation constant in rad/um
 mprintf('Propagation constant=%f rad/um',beta)//The
     answers vary due to round off error
```

Scilab code Exa 2.8 8

```
//Optical Fiber communication by A selvarajan
//example 2.8
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//given
M=1000;//modes supported
lambda=1.3;//operating wavelength in um
n1=1.5;//refractive index of core
n2=1.48;//refractive index of cladding
//to find
V=sqrt(2*M)// normalised frequency V no.
NA=sqrt(n1^2-n2^2)//numerical apperture
R=lambda*V/(2*%pi*NA)//radius of fiber in um
//display
mprintf("Core Radius=%fum",R)//The answer provided
   in the textbook is wrong
```

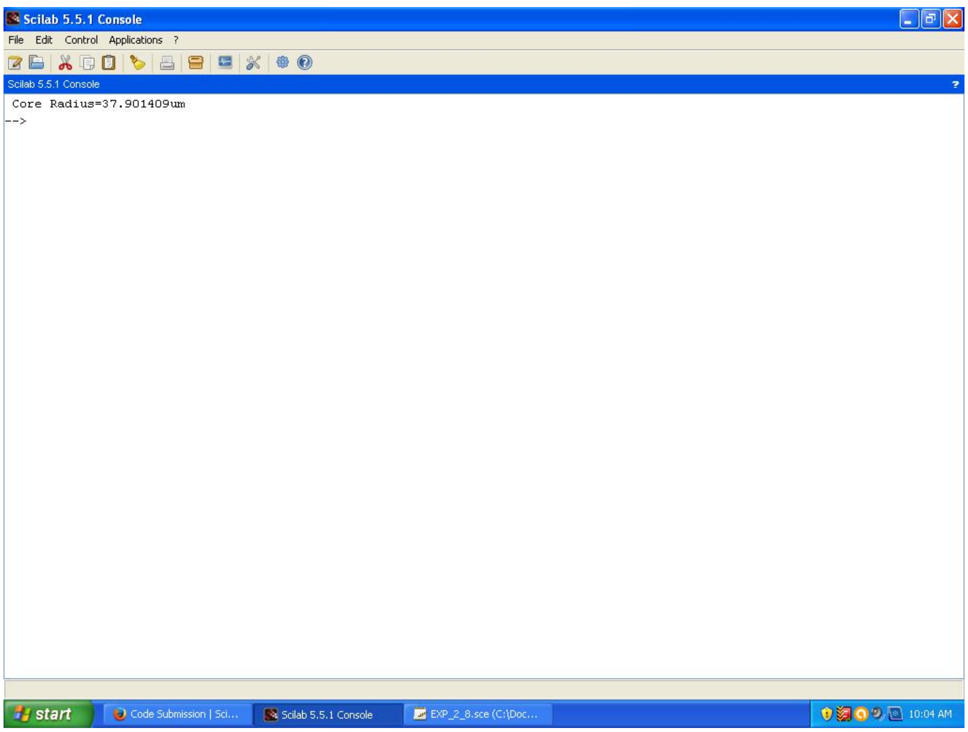
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
Core Radius=37.901409um
-->

Figure 2.6: 8

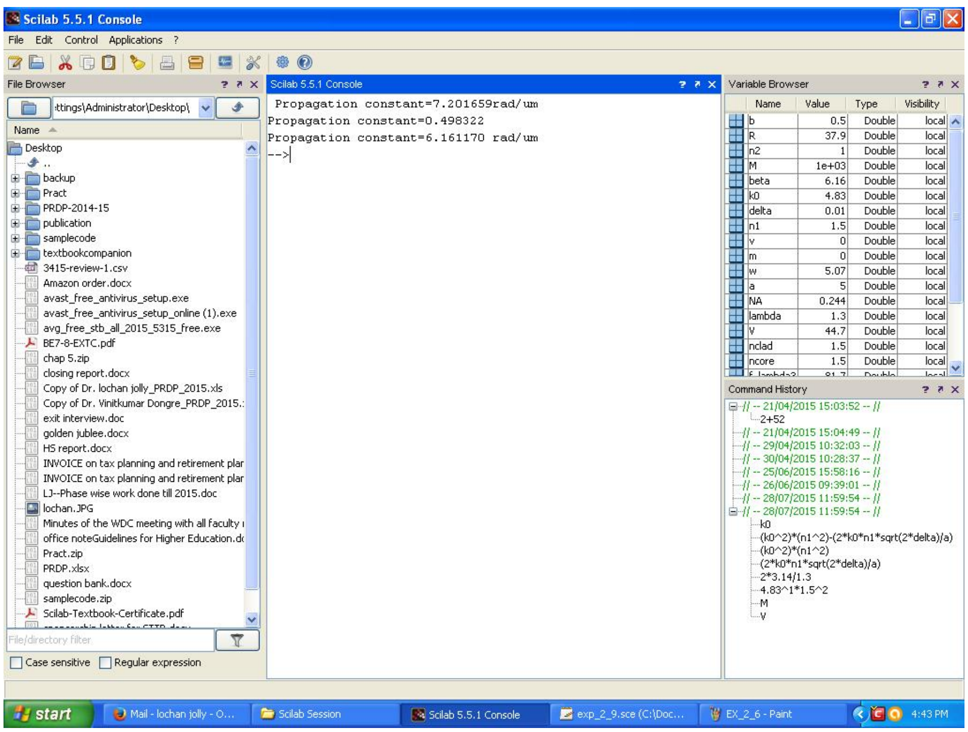
Scilab 5.5.1 Console
File Edit Control Applications ?
File Browser
Name
Desktop
backup
Pract
PRDP-2014-15
publication
samplecode
textbookcompanion
3415-review-1.csv
Amazon order.docx
avast_free_antivirus_setup.exe
avast_free_antivirus_setup_online (1).exe
avg_free_stb_all_2015_5315_free.exe
BE7-8-EXTC.pdf
chap 5.zip
closing report.docx
Copy of Dr. lochan jolly_PRDP_2015.xls
exit interview.doc
golden jublee.docx
HS report.docx
LJ--Phase wise work done till 2015.doc
lochan.JPG
Pract.zip
PRDP.xlsx
question bank.docx
samplecode.zip
Scilab-Textbook-Certificate.pdf
Case sensitive
Regular expression
Scilab 5.5.1 Console
Propagation constant=7.201659rad/um
Propagation constant=0.498322
Propagation constant=6.161170 rad/um
-->
Variable Browser
Name Value Type Visibility
b 0.5 Double local
R 37.9 Double local
n2 1 Double local
M 1e+03 Double local
beta 6.16 Double local
k0 4.83 Double local
delta 0.01 Double local
n1 1.5 Double local
v 0 Double local
m 0 Double local
w 5.07 Double local
a 5 Double local
NA 0.244 Double local
lambda 1.3 Double local
V 44.7 Double local
nclad 1.5 Double local
ncore 1.5 Double local
Command History
// -- 21/04/2015 15:03:52 -- //
2+52
// -- 21/04/2015 15:04:49 -- //
// -- 29/04/2015 10:32:03 -- //
// -- 30/04/2015 10:28:37 -- //
// -- 25/06/2015 15:58:16 -- //
// -- 26/06/2015 09:39:01 -- //
// -- 28/07/2015 11:59:54 -- //
// -- 28/07/2015 11:59:54 -- //
k0
(k0^2)*(n1^2)-(2*k0*n1*sqrt(2*delta)/a)
(k0^2)*(n1^2)
(2*k0*n1*sqrt(2*delta)/a)
2*3.14/1.3
4.83^1*1.5^2
M
V
start
Scilab Session
Scilab 5.5.1 Console
EX_2_6 - Paint
4:43 PM

Figure 2.7: 9

Scilab code Exa 2.9 9

```
//Optical Fiber communication by A selvarajan
//example 2.9
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//given
lambda=1.3;//wavelength of operation in um
n1=1.5;// refractive index of core
n2=1.48;// refractive index of cladding
k0=2*%pi/lambda;//constant in /m
//case-1
b=0.5//normalized propagation constant
k0=2*%pi/lambda//constant
beta=k0*sqrt(n2^2+b*(n1^2-n2^2))//propagation constant
mprintf("Propagation constant=%frad/um",beta)//The answers vary due to round off error
//case-2
//given
lambda=1.3;//wavelength of operation in um
n1=1.5;// refractive index of core
n2=1.48;// refractive index of cladding
k0=2*%pi/lambda;//constant in /m
b=0.5//normalized propagation constant
k0=2*%pi/lambda//constant
b=(((n1+n2)/2)^2-n2^2)/(n1^2-n2^2)//normalized propagation constant
mprintf("\nPropagation constant=%f ",b)//The answers vary due to round off error

//case-3
//given
lambda=1.3;//wavelength of operation in um
n1=1.5;// refractive index of core
n2=1.0;// refractive index of cladding
```

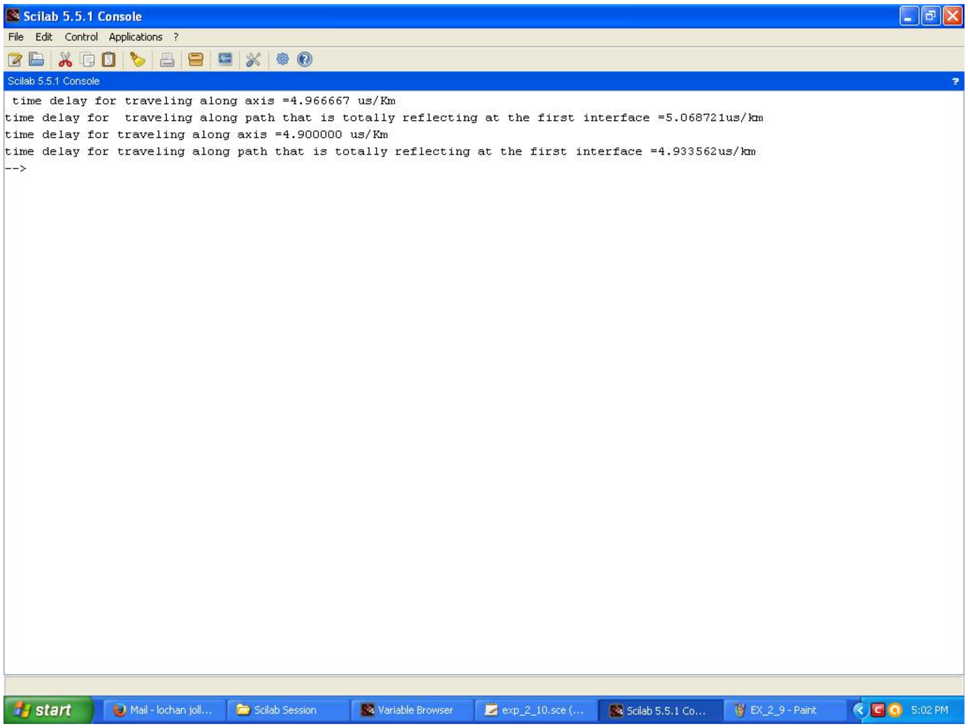

Figure 2.8: 10

```
k0=2*%pi/lambda;//constant in /m
b=0.5//normalized propagation constant
k0=2*%pi/lambda//constant
beta=k0*sqrt(n2^2+b*(n1^2-n2^2))//propagation
    constant
mprintf("\nPropagation constant=%f rad/um",beta)//
    The answers vary due to round off error
```

Scilab code Exa 2.10 10

```
//Optical Fiber communication by A selvarajan
```

```
//example 2.10
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//given
//case-1
n1=1.49;//refractive index of core
n2=1.46//refractive index of cladding
c=3*10^5;//speed of light in Km/s
t1=n1/c;//time delay for one traveling along axis in s/Km
t2=(n1^2/n2)/c//time delay for one traveling along path that is totally reflecting at the first interface in s/km
mprintf("time delay for traveling along axis =%f us/Km",t1*1e6)//multiplication by 1e6 to convert the unit from s/Km to us/Km
mprintf("\ntime delay for  traveling along path that is totally reflecting at the first interface =%fus/km",t2*1e6)//multiplication by 1e6 to convert the unit from s/Km to us/Km
//case-2
n1=1.47;//refractive index of core
n2=1.46//refractive index of cladding
c=3*10^5;//speed of light in Km/s
t1=n1/c;//time delay for one traveling along axis in
t2=(n1^2/n2)/c//time delay for one traveling along path that is totally reflecting at the first interface
mprintf("\ntime delay for traveling along axis =%f us/Km",t1*1e6)//multiplication by 1e6 to convert the unit from s/Km to us/Km
mprintf("\ntime delay for traveling along path that is totally reflecting at the first interface =%fus/km",t2*1e6)//multiplication by 1e6 to convert the unit from s/Km to us/Km

```

```
//The answer provided in the textbook is wrong it
   has got wrong unit
```

Chapter 3

Fiber optic technology

Scilab code Exa 3.1 1

```
//Optical Fiber communication by A selvarajan
//example
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//given
PL=1;//length of preform in m
PD=25e-3;//daimeter of preform in m
OD=125e-6;//outer daimeter of optical fiber in m
V=%pi*((PD/2)^2)*PL;//volume of Preform cylinder in
    m^3
L=V/(%pi*((OD)^2));//Length of optical fiber in m
mprintf("Length of optical fiber=%fKm",L/1e3);//
    division by 1e3 to convert unit from m to Km
```

Scilab code Exa 3.2 2

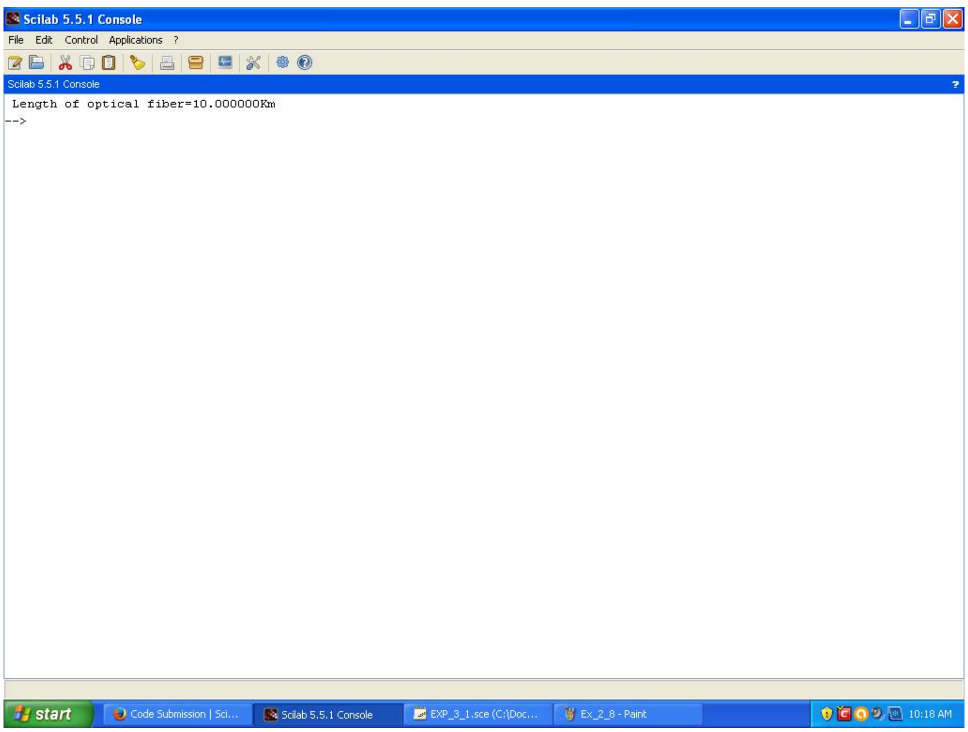
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
Length of optical fiber=10.000000Km
-->
start
Code Submission | Sci...
Scilab 5.5.1 Console
EXP_3_1.sce (C:\Doc...
Ex_2_8 - Paint
10:18 AM

Figure 3.1: 1

```
//Optical Fiber communication by A selvarajan
//example 3.2
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//given
NA1=0.2;//numerical apperture of fiber 1
NA2=0.1;//numerical apperture of fiber 2
D1=12;// core daimeter of fiber 1 in um
D2=6;// core daimeter of fiber 2 in um
Losses=20*log10(NA1/NA2)+20*log10(D1/D2);// total fiber to fiber coupling losses due to NA mismatch and size mismatch
mprintf("total losses=%fdB ",Losses);
```

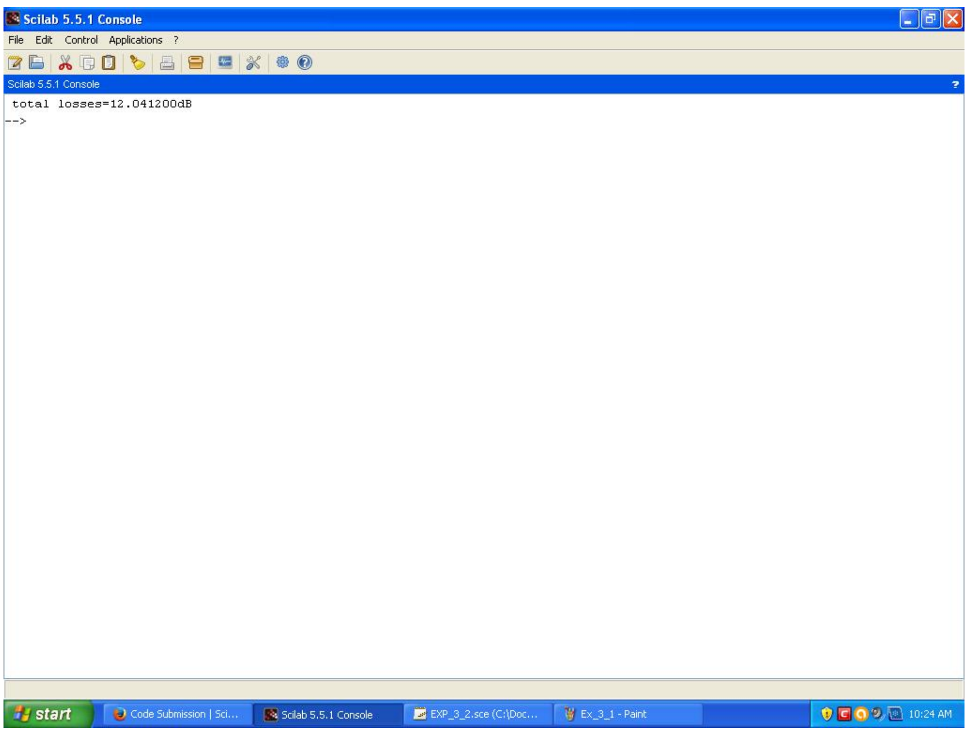
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
total losses=12.041200dB
-->
start
Code Submission | Sci...
Scilab 5.5.1 Console
EXP_3_2.sce (C:\Doc...
Ex_3_1 - Paint
10:24 AM

Figure 3.2: 2

Chapter 4

Optical sources and transmitter circuits

Scilab code Exa 4.1 1

```
//Optical Fiber communication by A selvarajan
//example 4.1
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//given
tau_r=12*10^-9//radiative recombination time in s
tau_nr=35*10^-9//non-radiative recombination time in
    s
n1=3.5//refractive index of semiconductor
n2=1//refractive index of air
d=0.4*10^-6//active later thickness in m
V=8//recombination velocity
eta_int=1/(1+(tau_r/tau_nr))//internal quantum
   efficiency
tau=1/((tau_r^-1)+(tau_nr^-1)+(2*V/d))//total
```

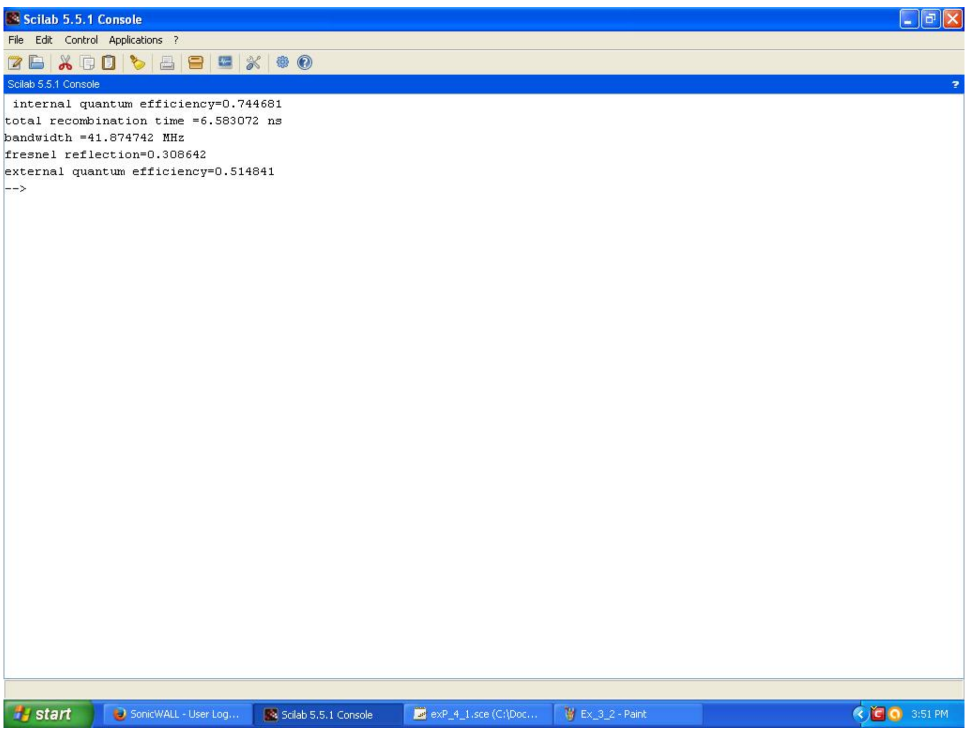
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
internal quantum efficiency=0.744681
total recombination time =6.583072 ns
bandwidth =41.874742 MHz
fresnel reflection=0.308642
external quantum efficiency=0.514841
-->
start
Scilab 5.5.1 Console
Ex_3_2 - Paint
3:51 PM

Figure 4.1: 1

```
recombination time in s
f=sqrt(3)/(2*%pi*tau)//bandwidth in Hz
F3=((n1-n2)^2/(n1+n2)^2)//fresnel reflection
eta_ext=eta_int*(1-F3)//external quantum efficiency
mprintf("internal quantum efficiency=%f",eta_int)//The answers vary due to round off error
mprintf("\ntotal recombination time =%f ns",tau*1e9)//multiplication by 1e9 to convert unit from s to ns//The answers vary due to round off error
mprintf("\nbandwidth =%f MHz",f*1e-6)//multiplication by 1e-6 to convert unit from Hz to MHz///The answers vary due to round off error
mprintf("\nfresnel reflection=%f ",F3)//The answers vary due to round off error
mprintf("\nexternal quantum efficiency=%f",eta_ext)//The answers vary due to round off error
```

Scilab code Exa 4.2 2

```
//Optical Fiber communication by A selvarajan
//example 4.2
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//given
lambda=1.3//wavelength of laser in um
w=5//active layer width in um
d=2//active layer thickness in um
n1=3.5//refractive index of core
n2=3.49//refractive index of cladding
//to find
k0=2*%pi/lambda//propagation constant
```

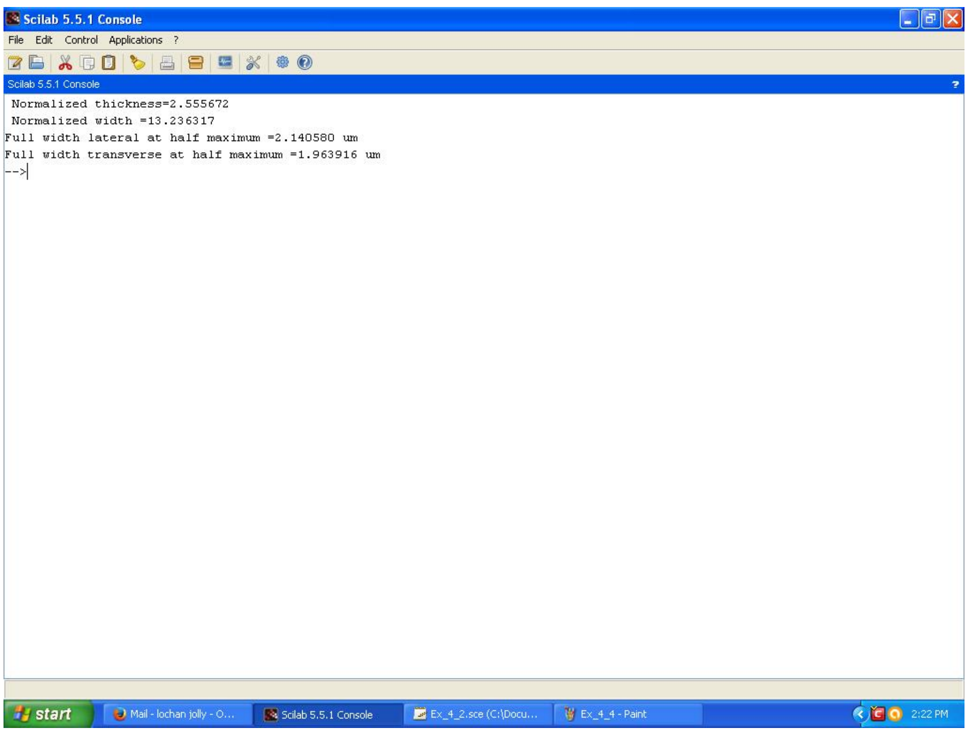
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
Normalized thickness=2.555672
Normalized width =13.236317
Full width lateral at half maximum =2.140580 um
Full width transverse at half maximum =1.963916 um
-->

Figure 4.2: 2

```
row=0.3//confinement factor
neff=sqrt(n2^2+row)//effective refractive index
D=k0*d*(sqrt(n1^2-n2^2))//normalized thickness
W=k0*w*(sqrt(neff^2-n2^2))//normalized width// the
    answer given in textbook is wrong
Wlat=w*(sqrt(2*log(2)))*(0.32+2.1*(W^-1.5))//Full
    width lateral at half maximum in um/ the answer
    given in textbook is wrong
Wtra=d*(sqrt(2*log(2)))*(0.32+2.1*(D^-1.5))//Full
    width transverse at half maximum in um/ the
    answer given in textbook is wrong
mprintf("Normalized thickness=%f",D)//The answers
    vary due to round off error
mprintf("\n Normalized width =%f",W)//multiplication
     by 1e9 to convert unit from s to ns/// the
    answer given in textbook is wrong
mprintf("\nFull width lateral at half maximum =%f um
    ",Wlat)//multiplication by 1e-6 to convert unit
    from Hz to MHz//// the answer given in textbook
    is wrong
mprintf("\nFull width transverse at half maximum =%f
     um",Wtra)//multiplication by 1e-6 to convert
    unit from Hz to MHz//// the answer given in
    textbook is wrong
```

Scilab code Exa 4.3 3

```
//Optical Fiber communication by A selvarajan
//example 4.3
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
```

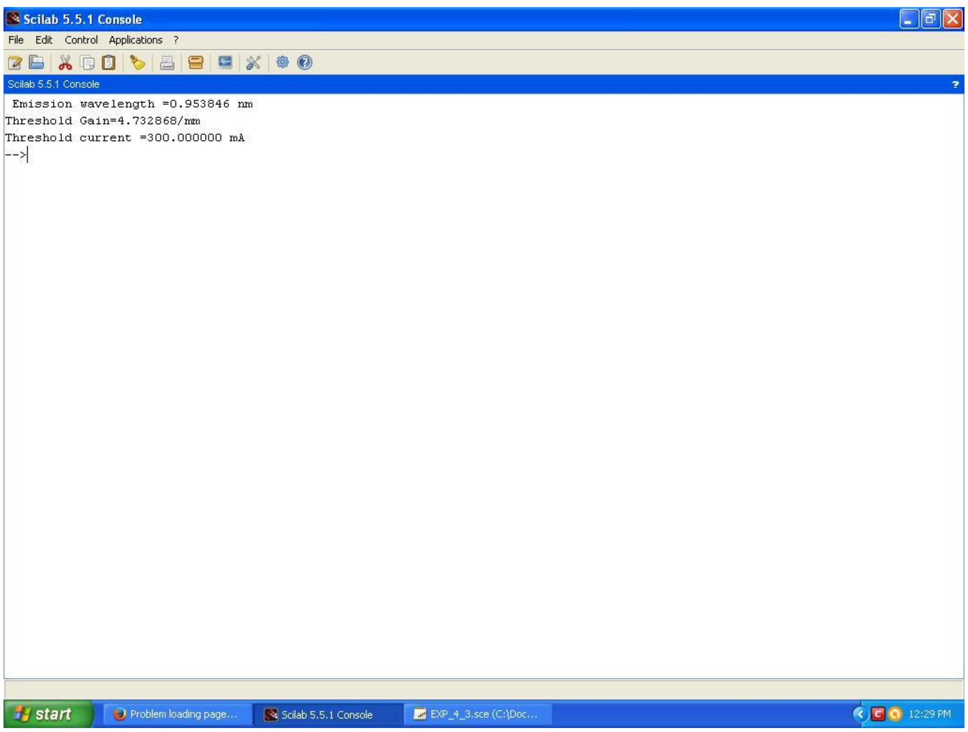
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
Emission wavelength =0.953846 nm
Threshold Gain=4.732868/mm
Threshold current =300.000000 mA
-->
start
Problem loading page...
Scilab 5.5.1 Console
EXP_4_3.sce (C:\Doc...
12:29 PM

Figure 4.3: 3

```
//given
clear all;
Eg=1.3//band gap energy in eV
l=0.4//cavity length in mm
R1=0.5//reflectivities on ends
R2=0.5//reflectivities on ends
alpha=3//loss coefficient in /mm
current_density=30*10^5//current density in amp/m^2
area=0.2*0.5*10^-6//laser active area in m^2

lambda=1.24/Eg//emission wavelength in um
gth=alpha+(1/(2*l))*log(1/(R1*R2))// Threshold Gain
threshold_current=current_density*area//threshold current in A
mprintf("Emission wavelength =%f nm",lambda)//multiplication by 1e3 to convert unit from um to nm
mprintf("\nThreshold Gain=%f/mm",gth)
mprintf("\nThreshold current =%f mA",threshold_current*1e3)//for converting unit from A to mA
```

Scilab code Exa 4.4 4

```
 //Optical Fiber communication by A selvarajan
//example 4.4
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//given
clear all;
lamda=0.85*10^-6//wavelength of operation in m
```

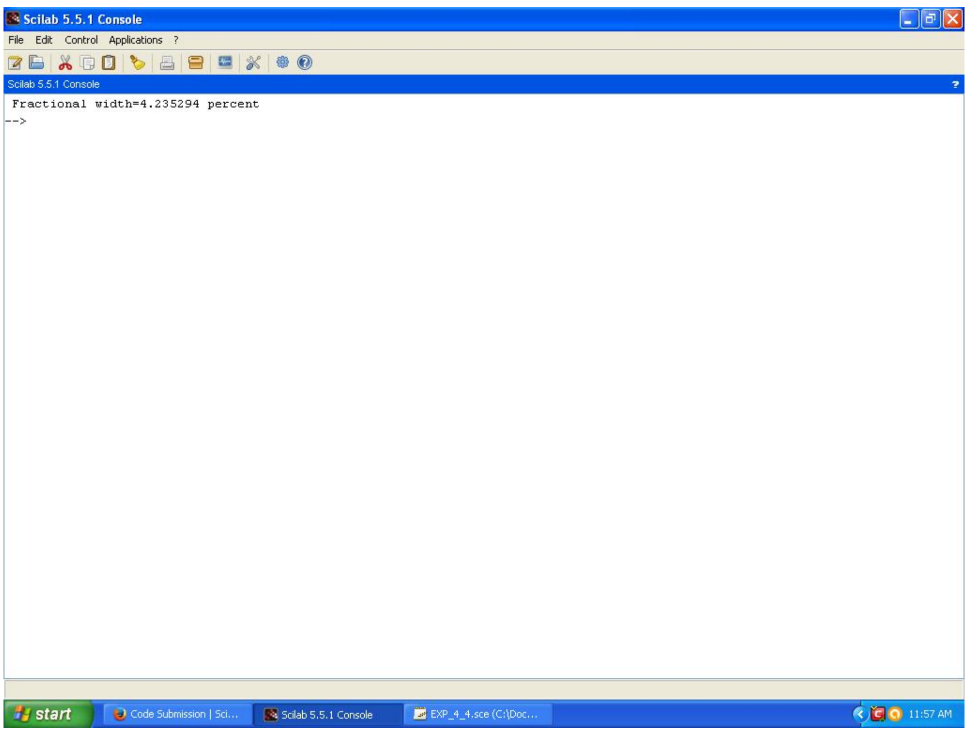
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
Fractional width=4.235294 percent
-->

Figure 4.4: 4

```
delta_lamda=36*10^-9//spectral width in m
fractional_width=delta_lamda/lamda//fractional width
mprintf("Fractional width=%f percent",fractional_width*100)//multiplication by 100 to represent information in percentage
```

Chapter 5

Optical Detectors and Receivers

Scilab code Exa 5.1 1

```
//Optical Fiber communication by A selvarajan
//example 5.1
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//given

optical_power=10*10^-6//optical power in W
R=0.5//Responsivity in A/W
Is=optical_power*R//shot noise current in A
Id=2*10^-9//dark current in A
Rl=1e6//Load resistance in ohm
B=1e6//bandwidth in Hz
T=300//Temperature in K
K=1.38*10^-20//Boltzman constant in m2 g s-2 K-1
q=1.609*10^-19//charge of a electron in Coulombs
```

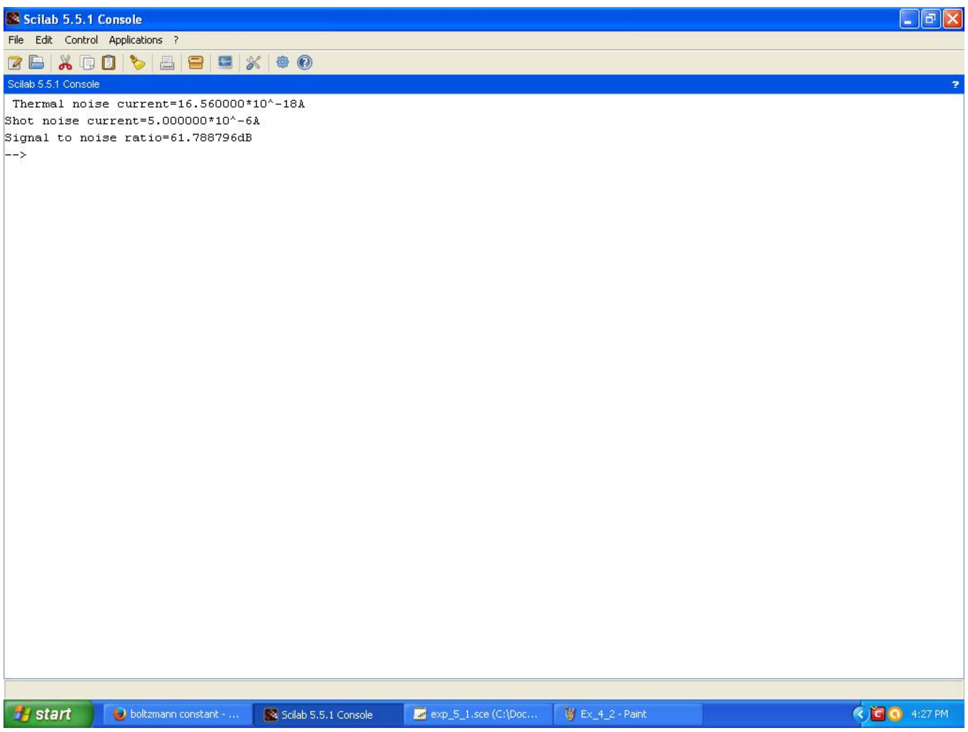
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
Thermal noise current=16.560000*10^-18A
Shot noise current=5.000000*10^-6A
Signal to noise ratio=61.788796dB
-->
start
boltzmann constant - ...
Scilab 5.5.1 Console
exp_5_1.sce (C:\Doc...
Ex_4_2 - Paint
4:27 PM

Figure 5.1: 1

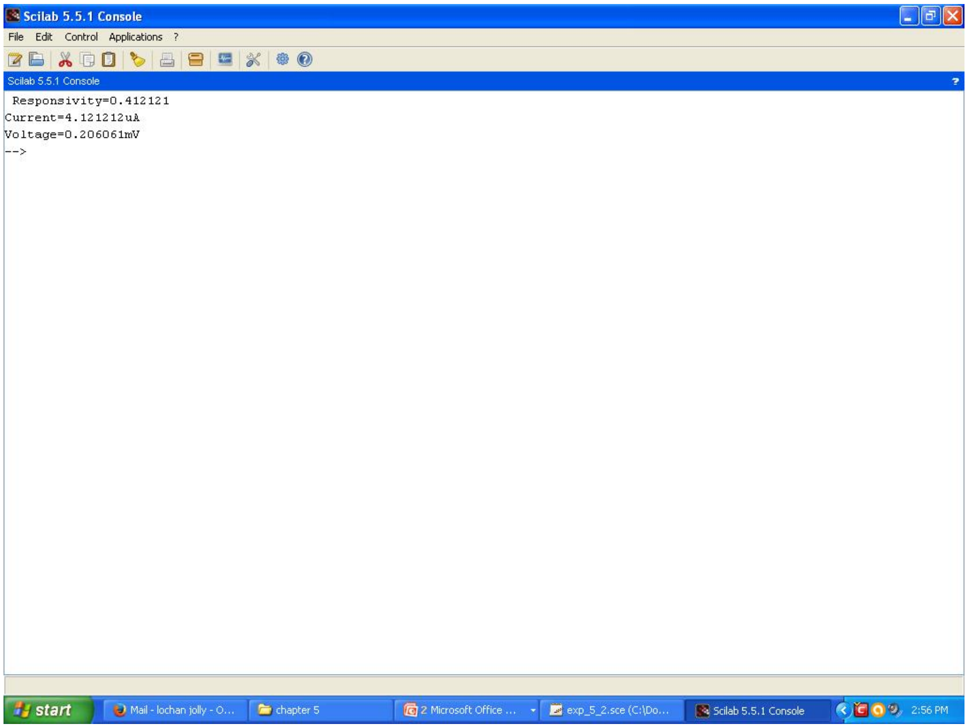

Figure 5.2: 2

```
Ith=4*K*T*B/Rl//Mean Square Thermal noise current in
    A
SNR=(Is^2)/(2*q*(Is+Id)+Ith)//Signal to noise ratio
mprintf("Thermal noise current=%f*10^-18A",Ith
    *10^18)
mprintf("\nShot noise current=%f*10^-6A",Is*10^6)
mprintf("\nSignal to noise ratio=%fdB",10*log10(SNR)
    )//The answers vary due to round off error
```

Scilab code Exa 5.2 2

```
//Optical Fiber communication by A selvarajan
//example 5.2
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//given
eta=0.6//quantum efficiency
Po=10*10^-6//optical power in W
q=1.6*10^-19//charge of an elctron in columb
lambda=0.85*10^-6//wavelength in m
h=6.6*10^-34//planck's constant
c=3*10^8//velocity of light in m/s
Rl=50//load Resistance in ohm
R=(q*eta*lambda)/(h*c)//responsivity in A/W
I=R*Po//current in A
V=Rl*I//Voltage in V
mprintf("Responsivity=%f",R)
mprintf("\nCurrent=%fuA",I*10^6)//multiplication by
   1e6 to convert unit from A to uA
mprintf("\nVoltage=%fmV",V*10^3)//multiplication by
   1e6 to convert unit from V to mV
```

Scilab code Exa 5.3 3

```
//Optical Fiber communication by A selvarajan
//example 5.3
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//given
tau_tr=2*1e-9//transit time in sec
```

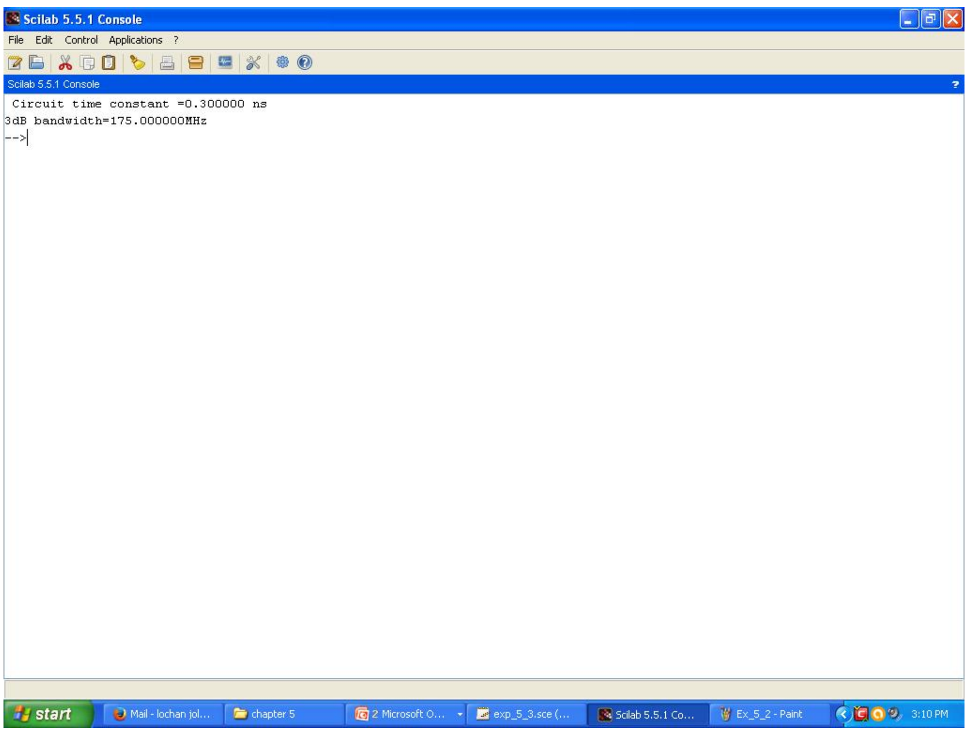
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
Circuit time constant =0.300000 ns
3dB bandwidth=175.000000MHz
-->

Figure 5.3: 3

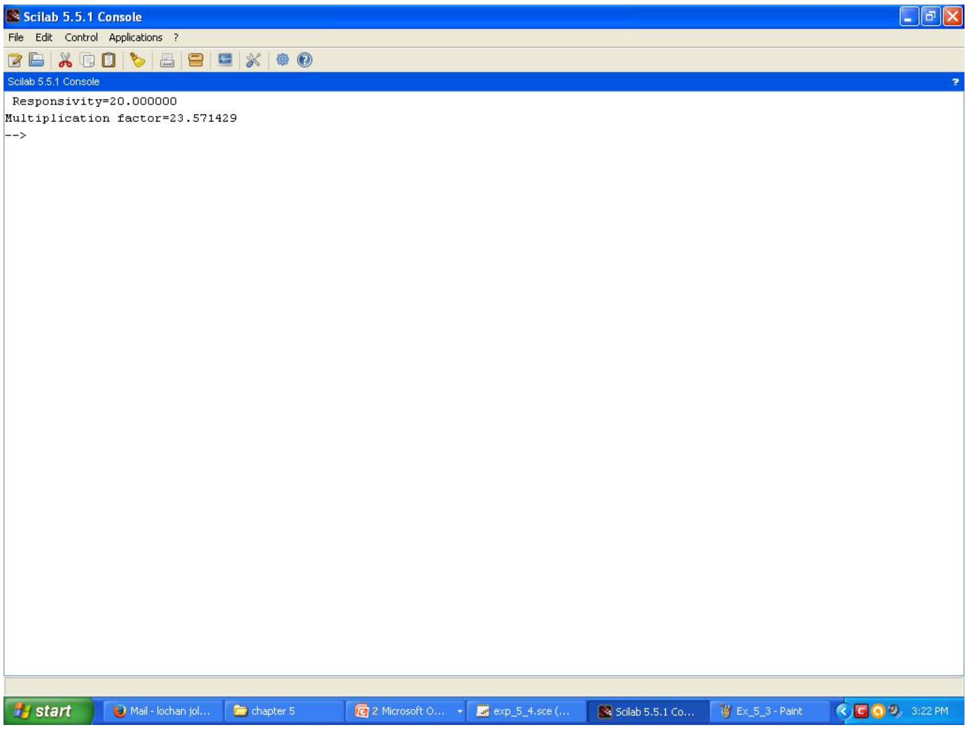

Figure 5.4: 4

```
Rl=50//load resistance in ohm
Cd=3*1e-12//Junction capacitance in farad
tau=2*Rl*Cd//Circuit time constant in sec
f3dB=(0.35/tau_tr)//3dB bandwidth in Hz
mprintf("Circuit time constant =%f ns",tau*1e9)//multiplication by 1e9 to convert unit from s to ns
mprintf("\n3dB bandwidth=%fMHz",f3dB*1e-6)//multiplication by 1e-6 to convert unit from Hz to MHz
```

Scilab code Exa 5.4 4

```
//Optical Fiber communication by A selvarajan
//example 5.4
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//given
I=100*1e-9//current in A
P=5*1e-9//Incident power in W
h=6.6*10^-34//planck's constant
c=3*10^8//velocity of light in m/s
q=1.6*10^-19//charge of an elctron in columb
eta=0.7//quantum efficiency
lambda=1.5*10^-6//wavelength in m
R=I/P;//APD responsivity in A/W
M= (R*h*c)/(q*eta*lambda);//Multiplication factor
mprintf("Responsivity=%f",R)
mprintf("\nMultiplication factor=%f",M)
```

Scilab code Exa 5.5 5

```
//Optical Fiber communication by A selvarajan
//example 5.5
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//given
h=6.6*10^-34//planck's constant
c=3*10^8//velocity of light in m/s
q=1.6*10^-19//charge of an elctron in columb
```

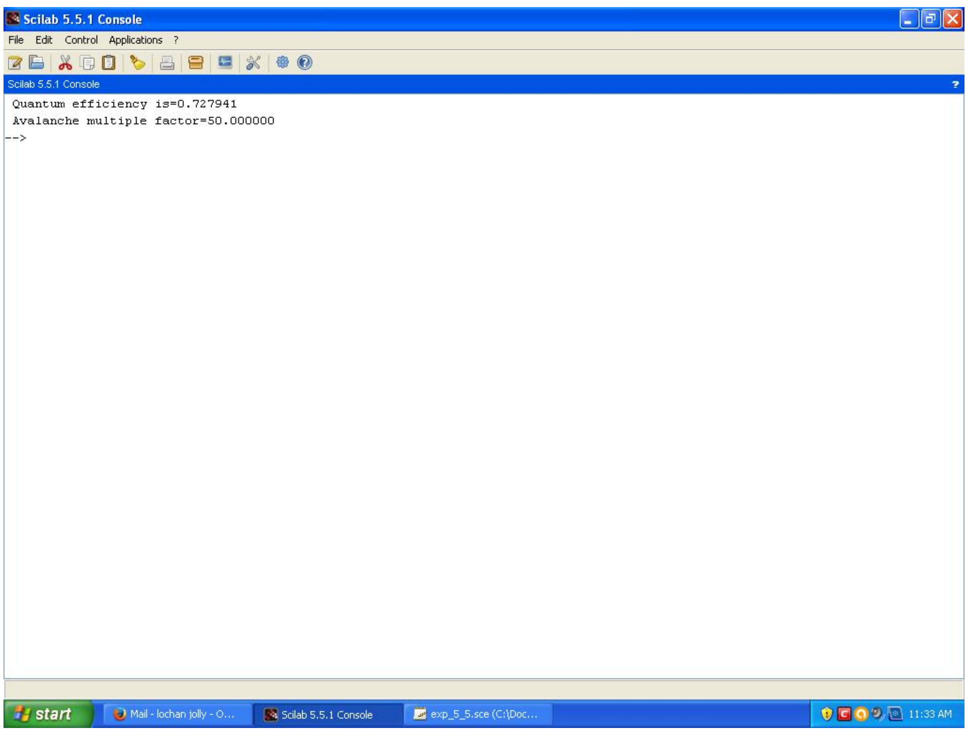
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
Quantum efficiency is=0.727941
Avalanche multiple factor=50.000000
-->
start
Mail - lochan jolly - O...
Scilab 5.5.1 Console
exp_5_5.sce (C:\Doc...
11:33 AM

Figure 5.5: 5

```
lambda=0.85*10^-6//wavelength in m
I=0.1//incident light intensity in mW/mm2
Iph1=10*1e-6//photocurrent in pin in A
Iph2=500*1e-6//photocurrent in APD in A
A=0.2//detector area in mm2
P=I*A//Power seen by detector in mW
photons_generated=P*1e-3/(h*c/lambda)//photons
    Generated
Rate=Iph1/q//rate of carrier generation for pin
eta=Rate/photons_generated;//Quantum efficiency for
    pin
M=Iph2/Iph1//Multiplication factor
mprintf('Quantum efficiency is=%f',eta);//The
    answers vary due to round off error
mprintf('\n Avalanche multiple factor=%f',M);
```

Chapter 6

Integrated Optics and Photonic Circuits

Scilab code Exa 6.1 1

```
//Optical Fiber communication by A selvarajan
//example 6.1
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//given
lamda=1.55;//wavelength in um
n1=1.51;//Film refractive index
n2=1.5;//substrate refractive index
t=(lamda)/(2*%pi*sqrt(n1*n1-n2*n2));//Thickness of
   film in um
mprintf('Film thickness=%fum',t);
```

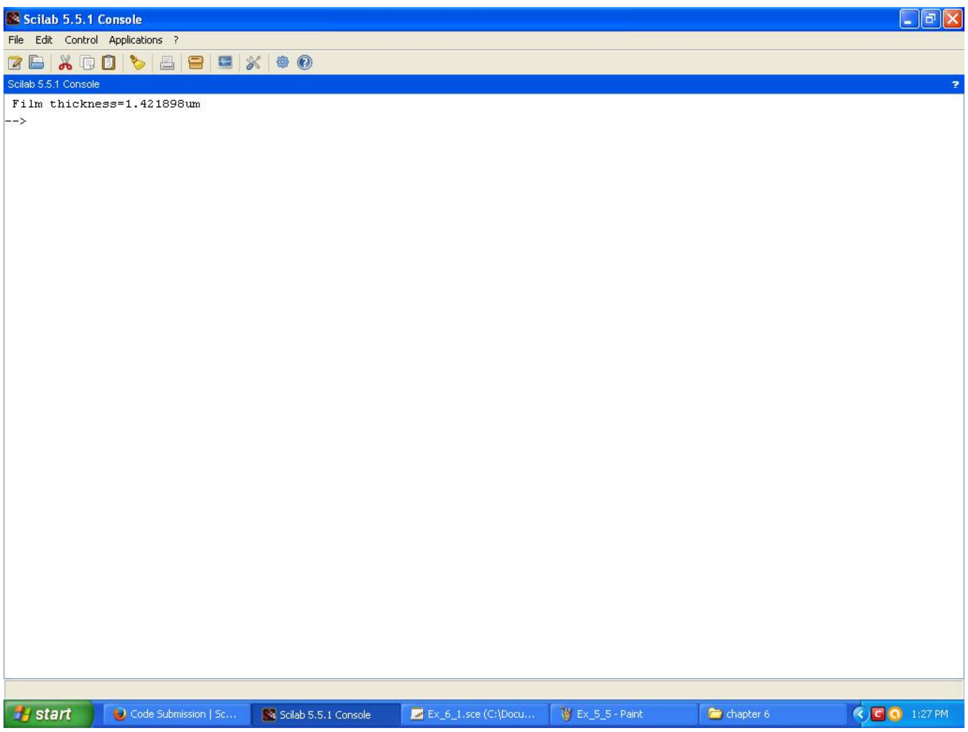
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
Film thickness=1.421898um
-->
start
Code Submission | Sc...
Scilab 5.5.1 Console
Ex_6_1.sce (C:\Docu...
Ex_5_5 - Paint
chapter 6
1:27 PM

Figure 6.1: 1

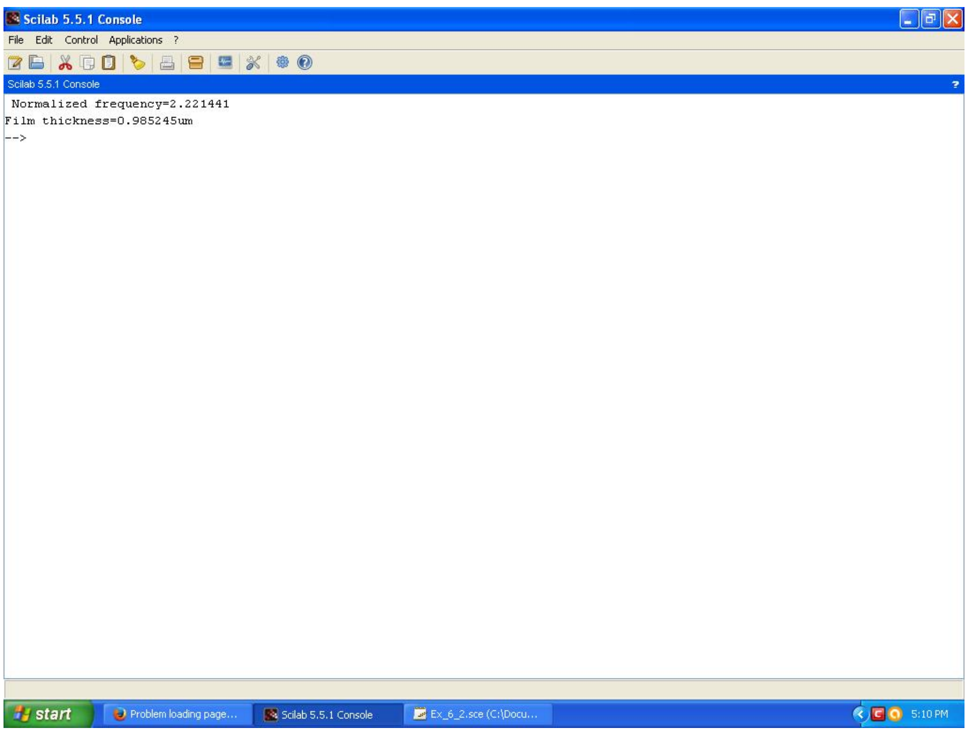
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
Normalized frequency=2.221441
Film thickness=0.985245um
-->
start
Problem loading page...
Scilab 5.5.1 Console
Ex_6_2.sce (C:\Docu...
5:10 PM

Figure 6.2: 2

Scilab code Exa 6.2 2

```
//Optical Fiber communication by A selvarajan
//example 6.2
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//given
b=0.5//normalized propoagation constant
V=(2*atan(b/(1-b))/(sqrt(1-b)))//normalized
    frequency
mprintf('Normalized frequency=%f',V)
lamda=1.3;//wavelength in um
n1=2.21;//Film refractive index
n2=2.2;//substrate refractive index
t=(lamda)/(2*%pi*sqrt(n1*n1-n2*n2));//Thickness of
    film in um
mprintf('\nFilm thickness=%fum',t);
```

Scilab code Exa 6.3 3

```
//Optical Fiber communication by A selvarajan
//example 6.3
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//given
lamda=1.3;//wavelength in um
```

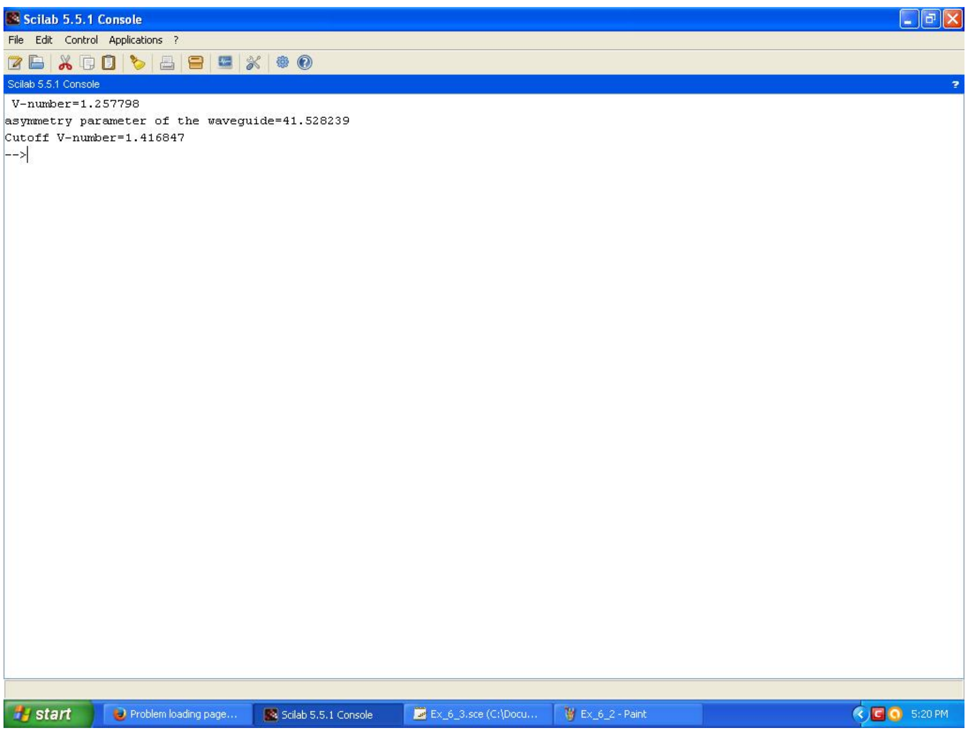
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
V-number=1.257798
asymmetry parameter of the waveguide=41.528239
Cutoff V-number=1.416847
-->
start
Problem loading page...
Scilab 5.5.1 Console
Ex_6_3.sce (C:\Docu...
Ex_6_2 - Paint
5:20 PM

Figure 6.3: 3

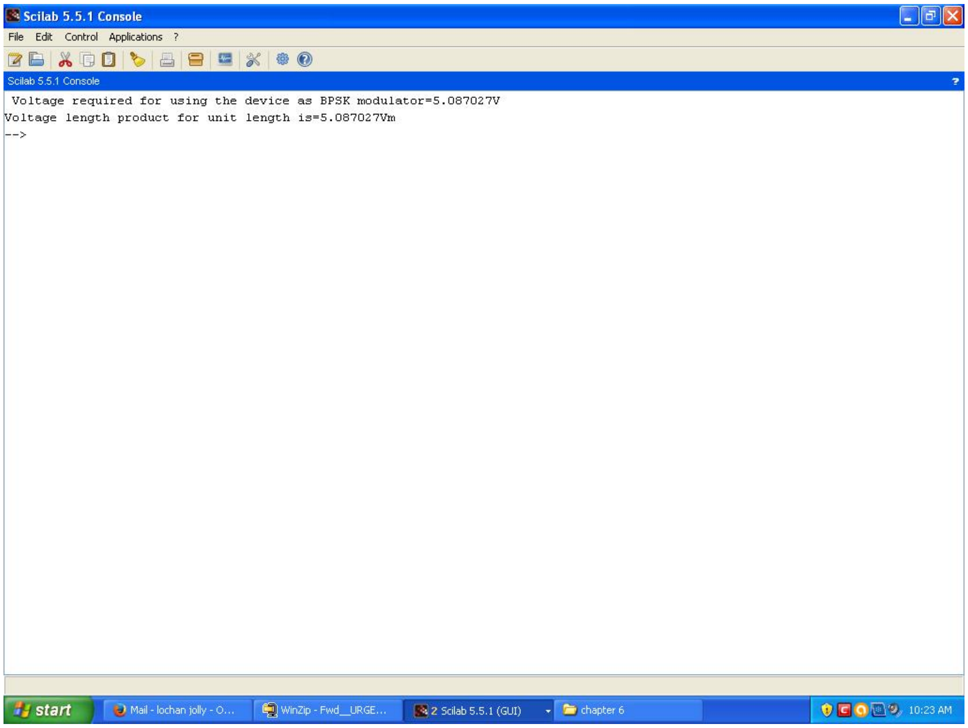

Figure 6.4: 4

```
nf=1.51;//Film refractive index
t=1.5;//Film thickness in um
ns=1.5//Waveguide refractive index
na=1//refractive index of air
V=(2*%pi*t/lamda)*sqrt(nf^2-ns^2)//V-number
a=(ns^2-na^2)/(nf^2-ns^2)//asymmetry parameter of
    the waveguide
Vc=atan(a^0.5)//cutoff V-number
mprintf("V-number=%f",V)
mprintf("\nasymmetry parameter of the waveguide=%f",
    a)
mprintf("\nCutoff V-number=%f",Vc)
```

Scilab code Exa 6.4 4

```
//Optical Fiber communication by A selvarajan
//example 6.4
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//given
delta_phi=%pi
d=4*10^-6//seperation between electrodes
n=2.2// approximate inder in absence of voltage
r13=30*10^-12//poper electro optic coefficient
row=0.4//overlap factor
lambda=1300*1e-9//wavelength in m
L=8*10^-3//length of electrode in m
delta_n=delta_phi*lambda/(2*%pi*L)//change in
    refractive index
V_pi=2*d*delta_n/(n^3*row*r13)//Voltahe required for
     using the device as BPSK modulator
mprintf("Voltage required for using the device as
   BPSK modulator=%fV",V_pi)
mprintf("\nVoltage length product for unit length is
   =%fVm",V_pi)
```

Scilab code Exa 6.5 5

```
//Optical Fiber communication by A selvarajan
//example 6.5
//OS=Windows XP sp3
```

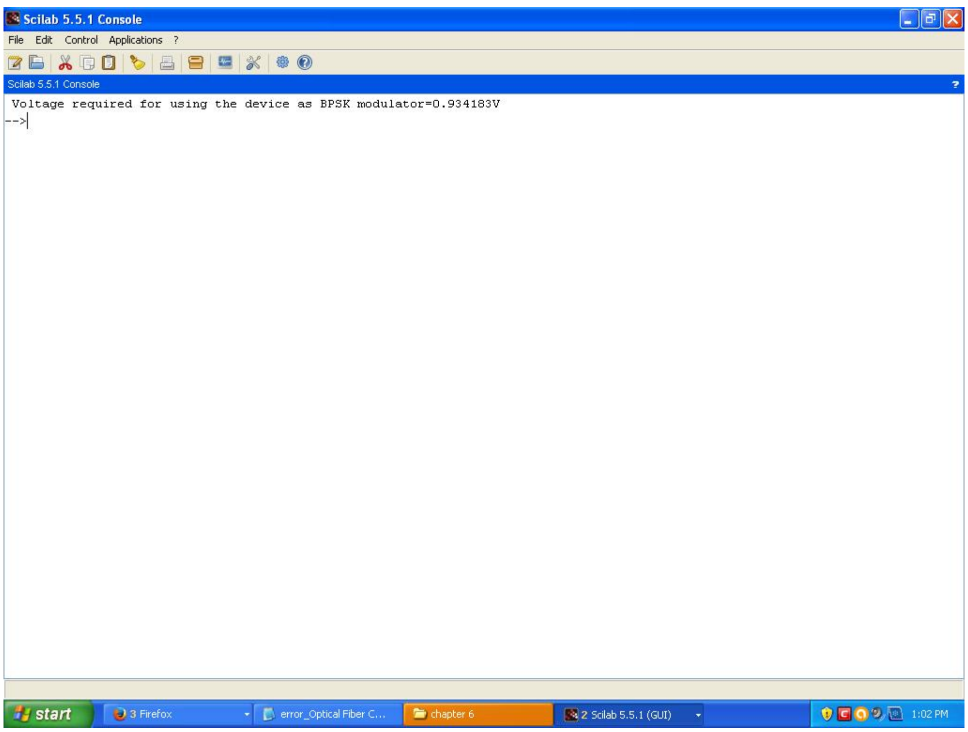
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
Voltage required for using the device as BPSK modulator=0.934183V
-->
start
3 Firefox
error_Optical Fiber C...
chapter 6
2 Scilab 5.5.1 (GUI)
1:02 PM

Figure 6.5: 5

```
//Scilab version 5.5.1
clc;
clear all;
//given
d=10*10^-6//seperation between electrodes
ne=2.2// approximate inder in absence of voltage
r33=32*10^-12//poper electro optic coefficient
lambda=1*1e-6//wavelength in m
L=5*10^-3//length of electrode in m
V=d*lambda/(2*%pi*ne^3*r33*L)//Voltahe required for using the device as BPSK modulator
mprintf("Voltage required for using the device as BPSK modulator=%fV",V)//the answer is different because of rounding off error
```

Scilab code Exa 6.6 6

```
//Optical Fiber communication by A selvarajan
//example 6.6
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//given
delta_L=1/100//error in effective interaction length
P=(%pi/2*delta_L)^2//cross talk power output in W
mprintf("cross talk power output=%fx10^-4W",P*10^4);//multiplication by 10^4 to convert unit from W to 10^-4 W
PdB=10*log10(P)//power in dB
mprintf("\ncross talk power output=%fdB",PdB)
```

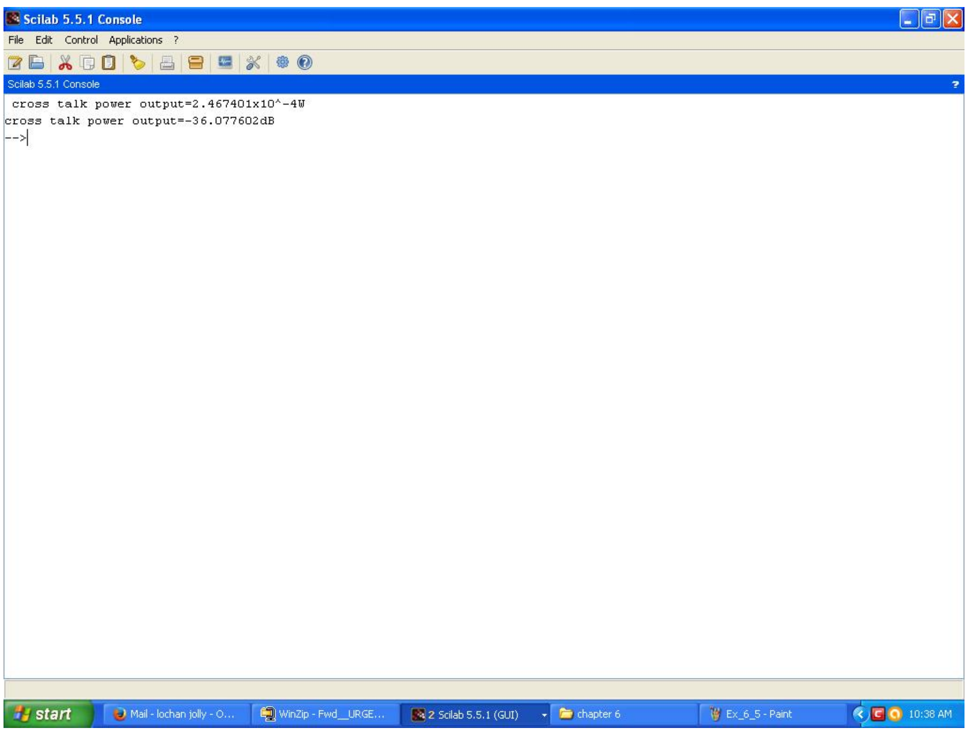
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
cross talk power output=2.467401x10^-4W
cross talk power output=-36.077602dB
-->
start
Mail - lochan jolly - O...
WinZip - Fwd__URGE...
2 Scilab 5.5.1 (GUI)
chapter 6
Ex_6_5 - Paint
10:38 AM

Figure 6.6: 6

Chapter 7

Wavelength Division Multiplexing

Scilab code Exa 7.1 1

```
//Optical Fiber communication by A selvarajan
//example 7.1
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
//given
delta_lambda=60e-9;//delta lambda in m
lambda=1550e-9;//wavelength in m
c=3e8//velocity of light in m/s
CS=75*1e9//Channel spacing in Hz
Power_margin=30//power margin in dB
Fiber_loss=0.25//fiber loss in dB/Km
channel_capacity=2.5*1e9//channel capacity STM-16 in
    bps
delta_f=(c*delta_lambda)/lambda^2;//frequency
    bandwidth in Hz
```

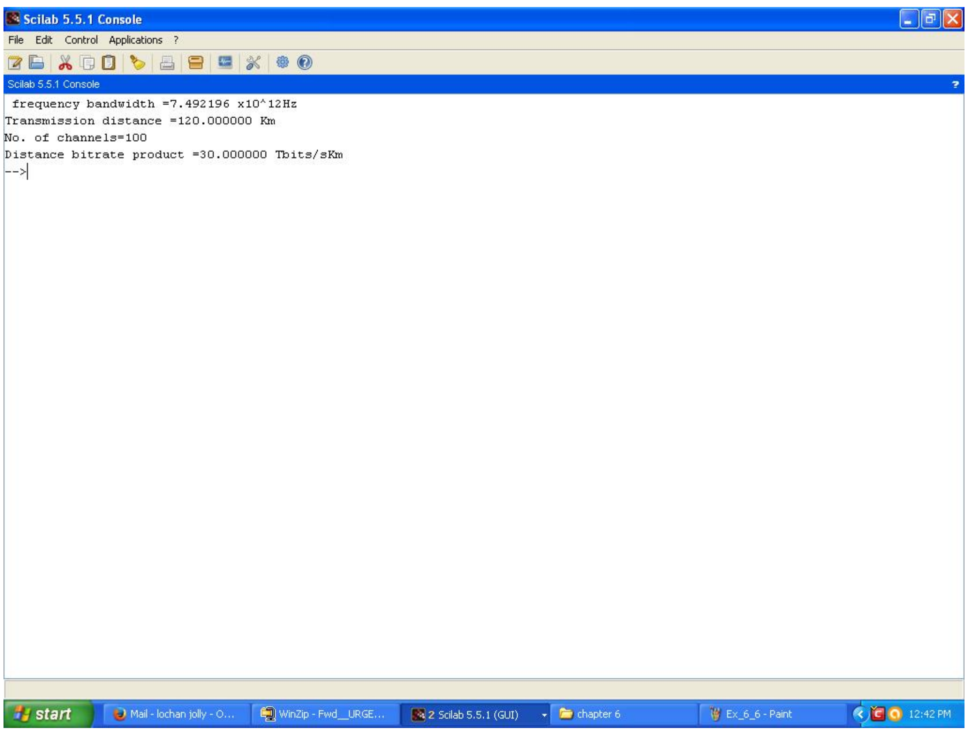
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
frequency bandwidth =7.492196 x10^12Hz
Transmission distance =120.000000 Km
No. of channels=100
Distance bitrate product =30.000000 Tbits/sKm
-->

Figure 7.1: 1

```
transmission_distance=Power_margin/Fiber_loss//Transmission distance in Km
No_channels=round(delta_f/CS);//No. of channels
distance_bitrate_product=No_channels*channel_capacity*transmission_distance//distance bitrate product in bpsKm
mprintf("frequency bandwidth =%f x10^12Hz",delta_f/1e12)////division by  1e12 to convert unit from Hz to 10^12 Hz
mprintf("\nTransmission distance =%f Km",transmission_distance)
mprintf("\nNo. of channels=%i",No_channels)
mprintf("\nDistance bitrate product =%f Tbits/sKm",distance_bitrate_product/1e12)////division by  1e12 to convert unit from bits/sKm to Tbits/sKm
```

Chapter 8

Coherent Optical Communication

Scilab code Exa 8.1 1

```
//Optical Fiber communication by A selvarajan
//example 8.1
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
eta=0.8;//quantum efficiency of detection
Ps=2e-9;//received optical power in W
h=6.62*1e-34;//plancks constant
lambda=1500*1e-9//wavelength in m
c=3*1e8//velocity of light in m/s
new=c/lambda;//frequency in Hz
B=1e6;//Signal Bandwidth in Hz
SNR=(eta*Ps)/(2*h*new*B);//signal to noise ratio
SNRdB=10*log10(SNR)//signal to noise ratio in dB)
mprintf("signal to noise ratio=%f",SNR)//the answer
   in textbook is wrong
```

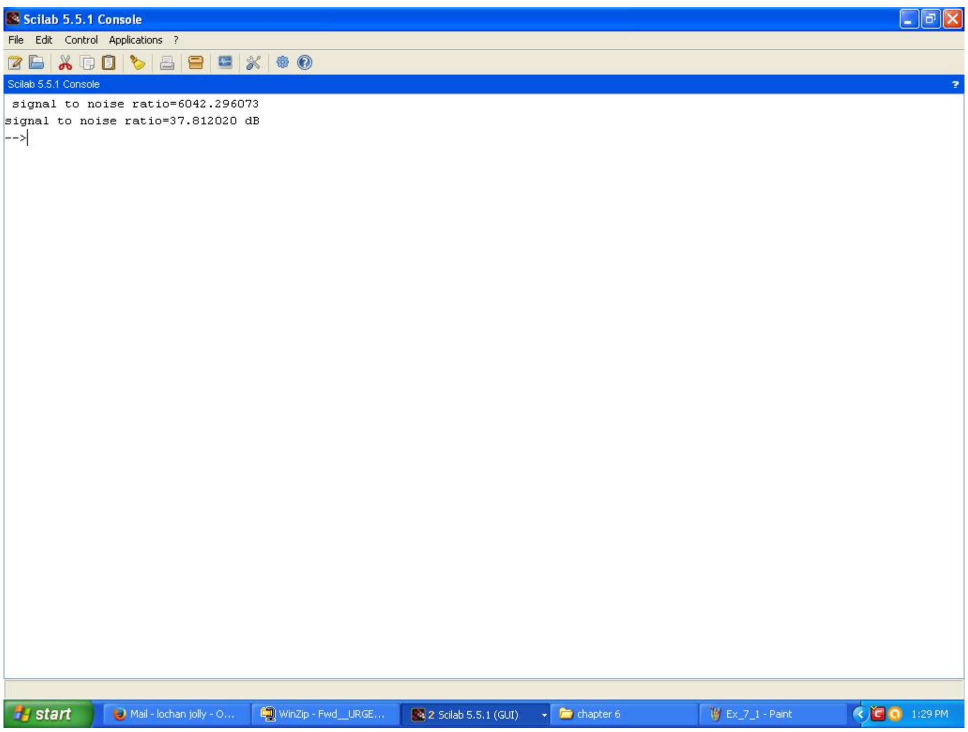
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
signal to noise ratio=6042.296073
signal to noise ratio=37.812020 dB
-->

Figure 8.1: 1

```
mprintf("\nsignal to noise ratio=%f dB",SNRdB)//the
   answer in textbook is wrong
```

Chapter 9

Optical Amplifiers

Scilab code Exa 9.1 1

```
//Optical Fiber communication by A selvarajan
//example 9.1
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
lambda=1.3*1e-6//wavelength in m
c=3*1e8//velocity of light in m/s
SNRoutdB=30//signal to noise ratio at outputin dB
SNRout=10^(SNRoutdB/10);//signal to noise ratio at
    output normal scale
new=c/lambda;//frequency in Hz
h=6.6e-34;//plancks constant
P=0.5e-3;//Input power in W
NFdB=4//noise figure in dB
NF=10^(NFdB/10);//noise figure in normal scale
SNRin=NF*SNRout//signal to noise ratio at input
    normal scale
delta_Be=P/(2*h*new*SNRin);//receiver bandwidth in
```

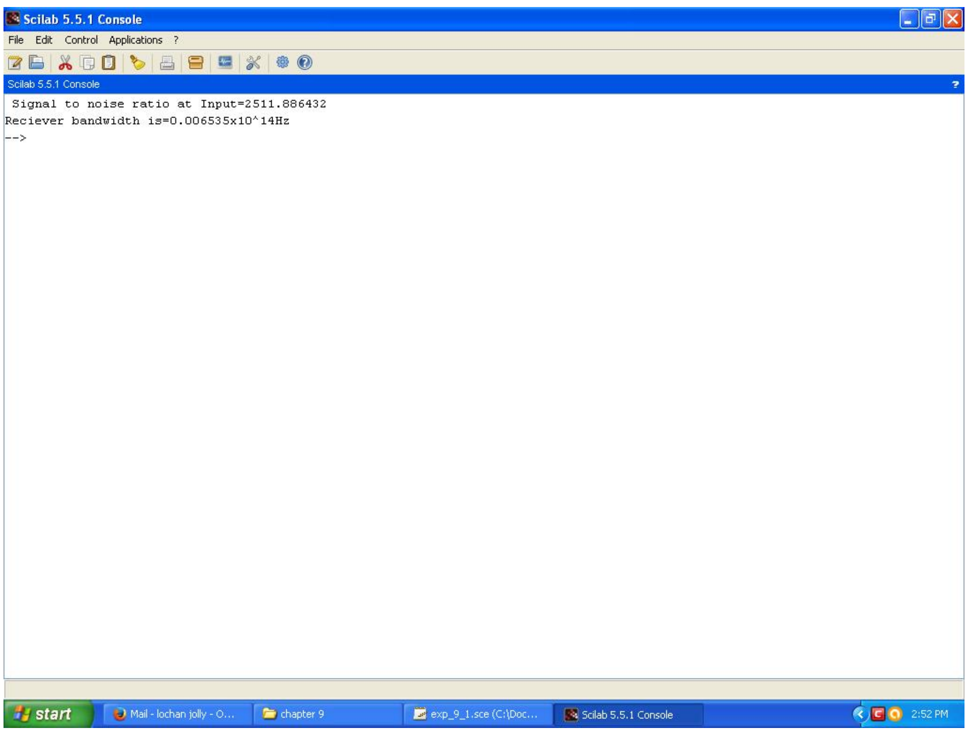
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
Signal to noise ratio at Input=2511.886432
Reciever bandwidth is=0.006535x10^14Hz
-->
start
Mail - lochan jolly - O...
chapter 9
exp_9_1.sce (C:\Doc...
Scilab 5.5.1 Console
2:52 PM

Figure 9.1: 1

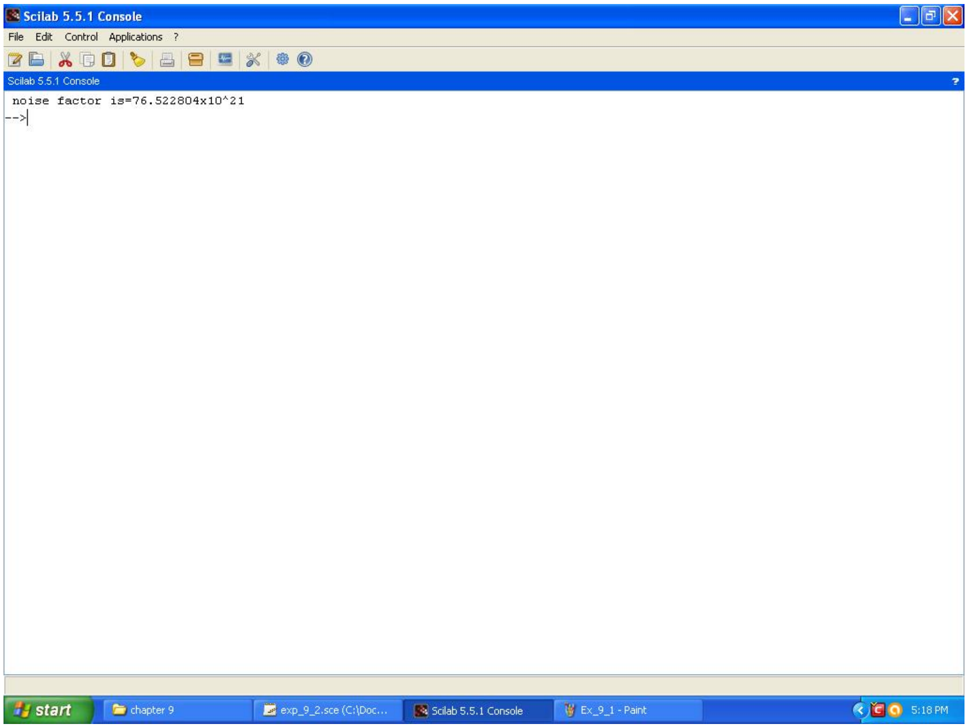

Figure 9.2: 2

```
    Hz
mprintf('Signal to noise ratio at Input=%f',SNRin)
mprintf('\nReciever bandwidth is=%fx10^14Hz',
    delta_Be/1e14);// division by 1e14 to convert the
     unit from Hz to 10^14 Hz
// The answer given in textbook is wrong
```

Scilab code Exa 9.2 2

```
//Optical Fiber communication by A selvarajan
//example 9.2
```

```
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
PASE=1e-3;//amplified spontaneous emission power in W
Gdb=20;//optical amplifier gain in dB
G=10^(Gdb/10);//optical amplifier gain in normal scale
delta_newbynew=5e-6;//fractional bandwidth
h=6.6e-34;//planck's constant
ns=PASE/((G-1)*h/delta_newbynew);//noise factor
mprintf('noise factor is=%fx10^21',ns/1e21);//division by 1e21 to convert the unit from Hz to 10^21 Hz
// The answer given in textbook is wrong
```

Scilab code Exa 9.3 3

```
//Optical Fiber communication by A selvarajan
//example 9.3
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
L=50//link length in Km
Fiber_loss=0.2//fiber loss in dB/Km
Req_Gain=Fiber_loss*L//required Gain
Fn1db=5//Noise figure in dB
Fn2db=5//Noise figure in dB
Fn3db=5//Noise figure in dB
Fn1=10^(Fn1db/10);//Noise figure in normal scale for all amplifiers
```

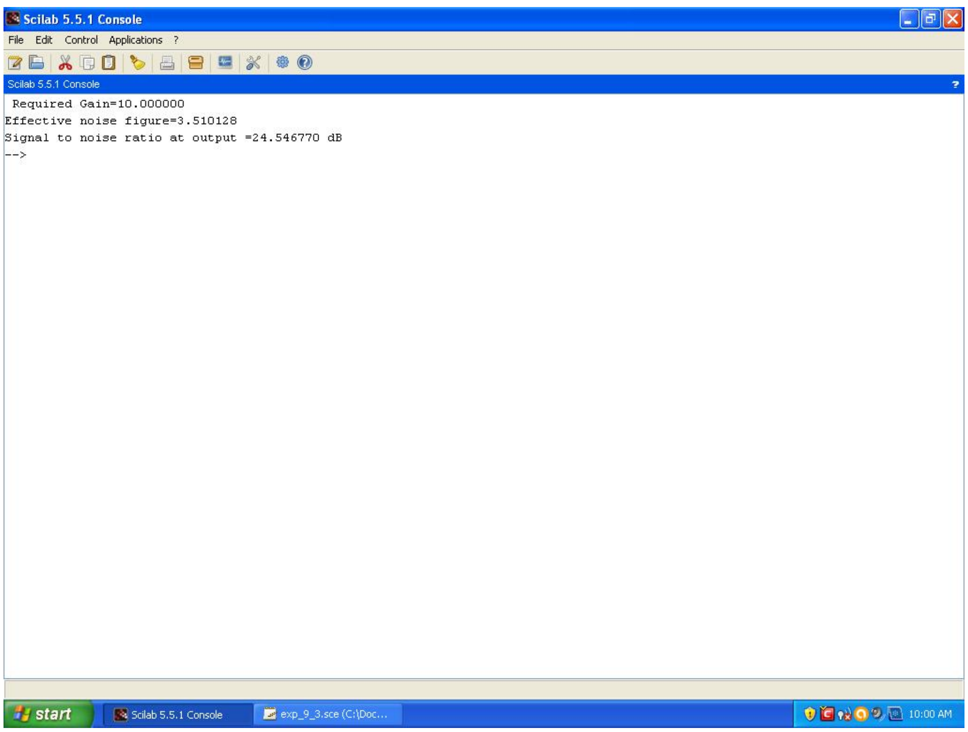
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
Required Gain=10.000000
Effective noise figure=3.510128
Signal to noise ratio at output =24.546770 dB
-->
start
Scilab 5.5.1 Console
exp_9_3.sce (C:\Doc...
10:00 AM

Figure 9.3: 3

```
Fn2=10^(Fn2db/10);//Noise figure in normal scale for
    all amplifiers
Fn3=10^(Fn3db/10);//Noise figure in normal scale for
    all amplifiers
G1=10^(Req_Gain/10)//gain in normal scale
G2=10^(Req_Gain/10)//gain in normal scale
Fneff=Fn1+(Fn2/G1)+(Fn3/(G1*G2));//Effective noise
   figure
SNRindb=30;//Signal to noise ratio at input in dB
SNRout=10^(SNRindb/10)/Fneff;//Signal to noise ratio
    at output in dB
SNRoutdb=10*log10(SNRout);
mprintf("Required Gain=%f",Req_Gain)
mprintf("\nEffective noise figure=%f",Fneff)
mprintf("\nSignal to noise ratio at output =%f dB",
   SNRoutdb)
```

Chapter 10

Photonic Switching

Scilab code Exa 10.1 1

```
//Optical Fiber communication by A selvarajan
//example 10.1
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
Xx=-30//crosstalk in dB
L=0.3//typical value
N=5//no. of switches Nb+Nc
SXR=Xx-L*(N)-10*log10(5*(10^(-L*N/10))/N)//Signal
   power to noise power in dB
mprintf('Minimum and maximum SXR values=%fdB',SXR)
```

Scilab code Exa 10.2 2

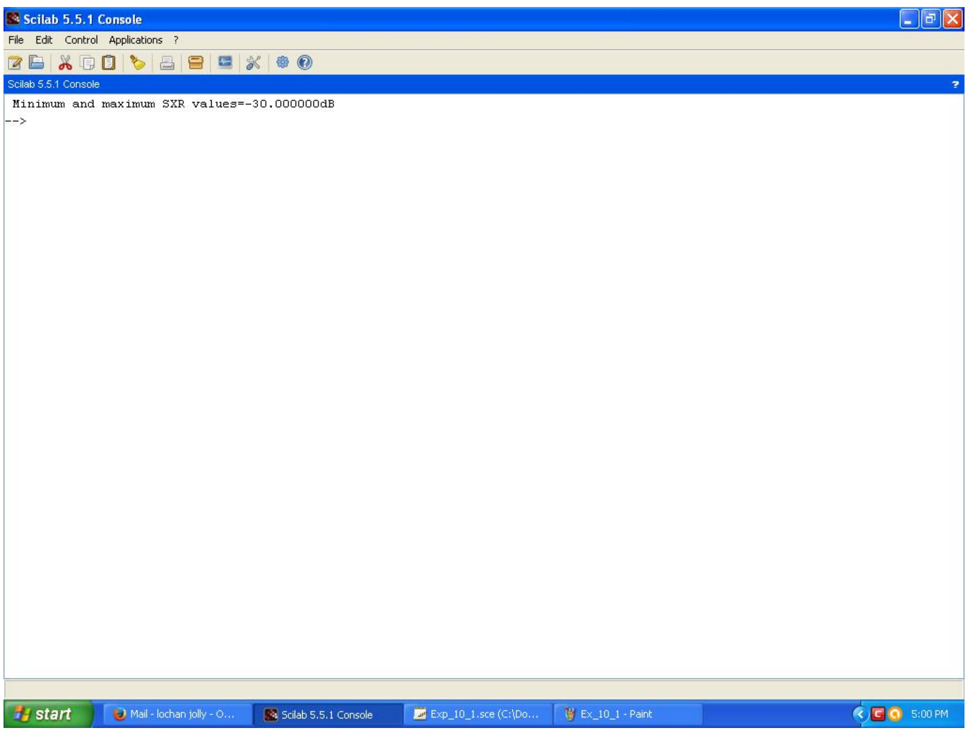
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
Minimum and maximum SXR values=-30.000000dB
-->
start
Mail - lochan jolly - O...
Scilab 5.5.1 Console
Exp_10_1.sce (C:\Do...
Ex_10_1 - Paint
5:00 PM

Figure 10.1: 1

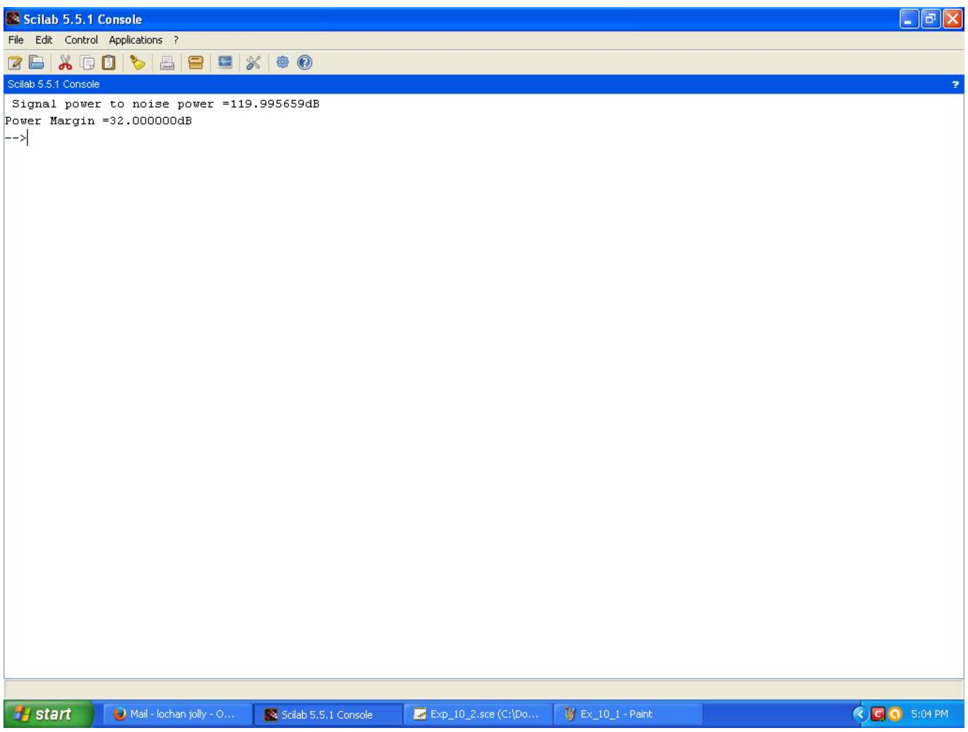
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
Signal power to noise power =119.995659dB
Power Margin =32.000000dB
-->
start
Mail - lochan jolly - O...
Scilab 5.5.1 Console
Exp_10_2.sce (C:\Do...
Ex_10_1 - Paint
5:04 PM

Figure 10.2: 2

```
//Optical Fiber communication by A selvarajan
//example 10.2
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
PB=40//power budget in dB
x=-30//crosstalk in dB assumed
N=4//no. of switches
Lin=1//insertion loss of in dB
Linw=Lin*N//worst case insertion loss of in dB
Lc=2//worst case connector loss in dB
L=Linw+2*Lc//total power lost in the worst case signal path in dB
Power_margin=PB-L//power margin in dB
K=0;
for i=1:N
K=K+(((-1)^(i+1))*(10^(-x/10))^i);
end
SbyN=10*log10(K)//Signal power to noise power in dB
mprintf('Signal power to noise power =%fdB',SbyN)
mprintf('\nPower Margin =%fdB',Power_margin)//The Textbook answer is wrong
```

Chapter 11

Fiber Optic Communication System Design

Scilab code Exa 11.1 1

```
//Optical Fiber communication by A selvarajan
//example 11.1
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
BW=7//bandwidth in MHz
SNR=60//signal to noise ratio in dB
Pin=0//Launched power in dBm
Trise_source=20//risetime at source LED in ns
delta_lambda=20//spectra width in nm
lambda=850;//operating wavelength in nm
c=2.998*10^5;//velocity of light in Km/sec
R=0.3//Detector PIN FET responsivity in A/W
Cdiode=3//diode capacitance in pf
trise_detector=1//risetime at detector in ns
S=-30//sensitivity in dbm
```

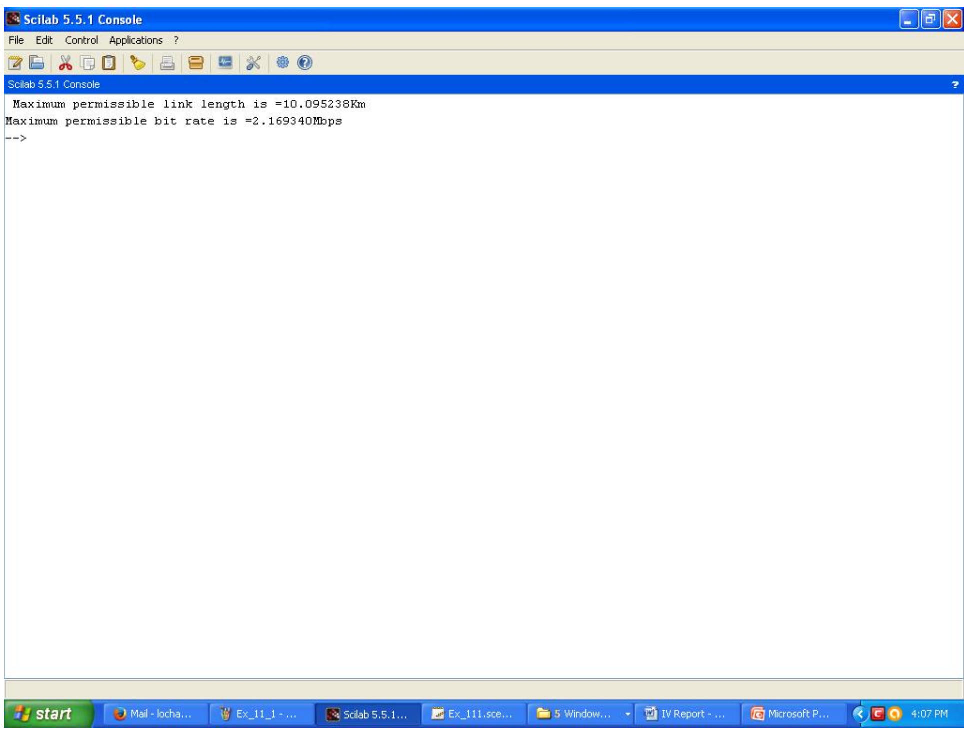
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
Maximum permissible link length is =10.095238Km
Maximum permissible bit rate is =2.169340Mbps
-->
start
4:07 PM

Figure 11.1: 1

```
Lsplice=0.2//splice loss in dB/connector
NA=0.2//numerical aperture for GI/MM
n1=1.46//refractive index of core
A=2//attenuation in dB/Km
Ls=3//loss due to source in dB
Ld=1//loss due to detector in dB
Psm=5//system margin in dB
c=3*10^8//velocity of light in m/s

//solution

Available_power=Pin-S;//available power in dB
Total_loss=Ls+Ld+Psm;
Power_left=Available_power-Total_loss;//power left in dB
L=(Power_left+Lsplice)/(Lsplice/2+2);
tmod=L*10^3*(NA^2)/(2*c*n1);//modal dispersion in s
Bit_rate=1/tmod;//bit rate in bps
mprintf('Maximum permissible link length is =%fKm',L);

mprintf('\nMaximum permissible bit rate is =%fMbps',Bit_rate/10^6);//division by 10^6 to convert the unit from bps to Mbps//the answer is different because of rounding off
```

Scilab code Exa 11.2 2

```
//Optical Fiber communication by A selvarajan
//example 11.2
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
```

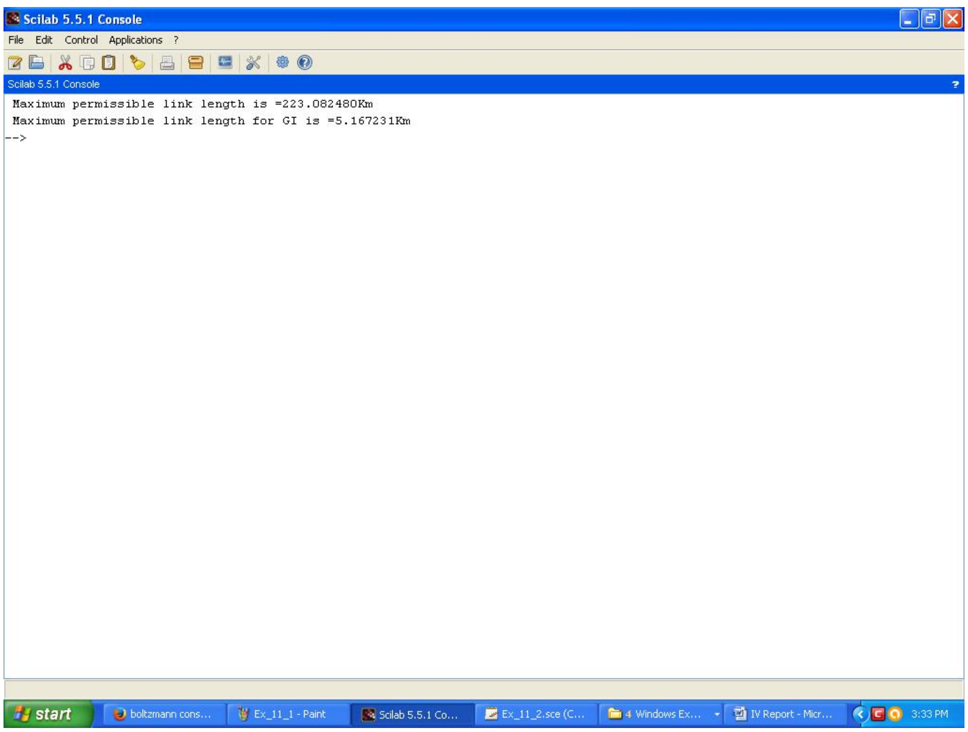
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
Maximum permissible link length is =223.082480Km
Maximum permissible link length for GI is =5.167231Km
-->

Figure 11.2: 2

```
clear all;
BW=7//bandwidth in MHz
SNR=60//signal to noise ratio in dB
Pin=0//Launched power in dBm
Trise_source=4//risetime at source LED in ns
delta_lambda=1//spectra width in nm
lambda=1300;//operating wavelength in nm
c=2.998*10^5;//velocity of light in Km/sec
R=0.3//Detector PIN FET responsivity in A/W
Cdiode=3//diode capacitance in pf
trise_detector=5//risetime at detector in ns
F=2.1//amplifier noise figure in dB
Camp=2//amplifier capacitance in pf
L=2//minimum link length in Km
Lsplice=0.5//splice loss in dB/connector
NA=0.22//numerical aperture for GI/MM
BWGI=600//GI/MM fiber bandwidth in MHz F3dB_optical
Te=630//temperate in Kelvin
K=1.38064852 *10-23//boltzman constant in m2 kg s-2 K-1
//solution
Rload=1/(2*%pi*(Cdiode+Camp)*BW)*10^6//maximum load resistance in ohm Actual value
Rload=4300//approximated value in ohm
BWRx=1/(2*%pi*(Cdiode+Camp)*Rload)//receiver BW in Hz
SbyN=10^(SNR/10)//SNR in normal scale
Pmin=10*log10(sqrt(SbyN*4*K*Te*BW/(0.5*Rload*R^2)))//input power in W
L1=Pmin/0.2//power budget limited link length in Km
mprintf('Maximum permissible link length is =%fKm',L1);

Trise_required=(0.35/BW)*10^3//Bandwith budgetting rise time required is rise time required in ns//multiplication by 10^3 to convert msec to ns
Trise_receiver=2.19*Rload*(Cdiode+Camp)*10^-3//rise time of receiver in ns//multiplication by 10^3 to
```

```
    convert msec to ns
Trise_fiber=sqrt(Trise_required^2-Trise_receiver^2-
    Trise_source^2)//fiber dispersion in ns
//for GI
f3dB_electrical=0.71*BWGI;//3dB elctrical BW in
    MHzKm
t_intra_modal=1//intra modal dispersion in ns/Km
t_inter_modal=3//intermodal dispersion in ns/Km
t_fiber_GI=sqrt(t_intra_modal^2+t_inter_modal^2);//
    rise time of fiber in ns/Km
L2=Trise_fiber/t_fiber_GI//link length in Km
mprintf('\n Maximum permissible link length for GI
    is =%fKm',L2);
```

Chapter 13

Video Transmission

Scilab code Exa 13.1 1

```
//Optical Fiber communication by A selvarajan
//example 13.1
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
Sigma_s=0.1//source dispersion inns
Sigma_D=0.1//detector dispersion in ns
Sigma_F=0.05//fiber dispersion in ns
bitrate=622//bitrate in Mbps
STM_rate=250//4 channel VSB PCM
Power_margin=30//power margin in dB
system_margin=6//system margin in dB
Average_loss=0.6//average loss in dB/Km

//solution
Sigma_max=STM_rate/bitrate//max dispersion allowed
L2=sqrt((Sigma_max-Sigma_s^2-Sigma_D^2)/(Sigma_F^2))
    //dispersion limited maximum length in Km
```

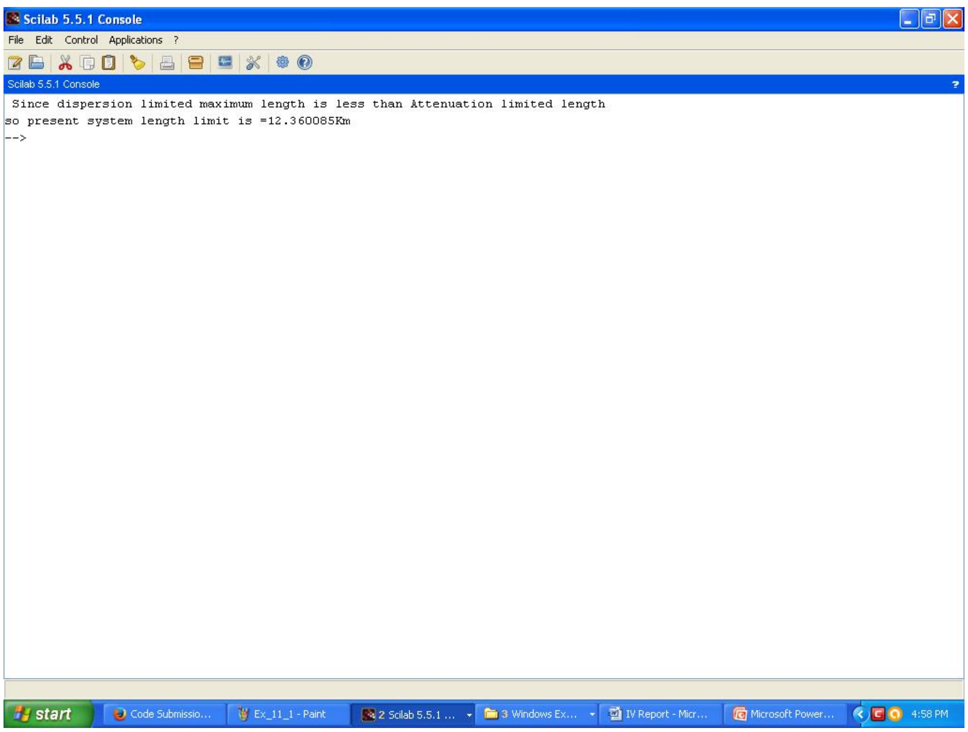
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
Since dispersion limited maximum length is less than Attenuation limited length
so present system length limit is =12.360085Km
-->

Figure 13.1: 1

```
L1=(Power_margin-system_margin)/Average_loss//
    Attenuation limited length in km
mprintf("Since dispersion limited maximum length is
    less than Attenuation limited length \nso present
     system length limit is =%fKm ",L2)
```

Chapter 14

Data Communication and LAN

Scilab code Exa 14.1 1

```
//Optical Fiber communication by A selvarajan
//example 14.1
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
N=256//no. of nodes
Lc=0.25//loss per coup;er in dB
Power_margin=30//power margin in dB
system_margin=6//system margin in dB
Average_loss=0.6//average loss in dB/Km
TxRX_powergain=32//transmitter to receiver power gain in dB
Avg_Tr_loss=0.5//average transmitter loss in dB/Km

//solution
Nc=log2(N)//since 2x2 couplers are used
Ns=N/2//each stage coupler
T_Nc=Nc*Ns//total no. of couplers
```

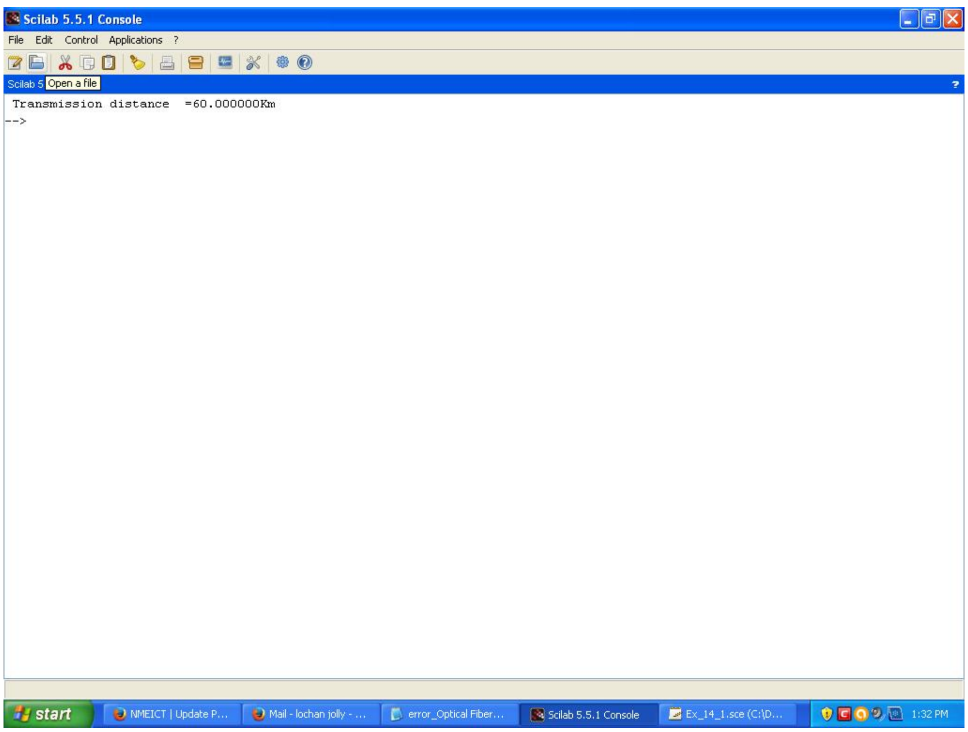
Scilab 5.5.1 Console
File Edit Control Applications ?
Open a file
Transmission distance =60.000000Km
-->

Figure 14.1: 1

```
Total_Lc=Nc*Lc//total coupler loss in dB
Permissible_loss=TxRX_powergain-Total_Lc//
    permissible cable loss in dB
L=Permissible_loss/Avg_Tr_loss//Transmission
    distance in Km
mprintf("Transmission distance =%fKm ",L)
```

Chapter 16

Soliton Communication Systems

Scilab code Exa 16.1 1

```
//Optical Fiber communication by A selvarajan
//example 16.1
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
lambda=850;//operating wavelength in nm
Beta2=-1//dispersion regime ps^2/Km
Gama=2//nonlinearity in /W-Km
TFWHM=10//fundamental soliton width in ps
To=TFWHM/1.763//pulse width in ps
Ppeak=1/(Gama*(To^2))//peak power in W
mprintf("Peak power required to maintain fundamental
    soliton=%fmW",Ppeak*10^3)//multiplication by
    10^3 is to convert the unit from w to mW
```

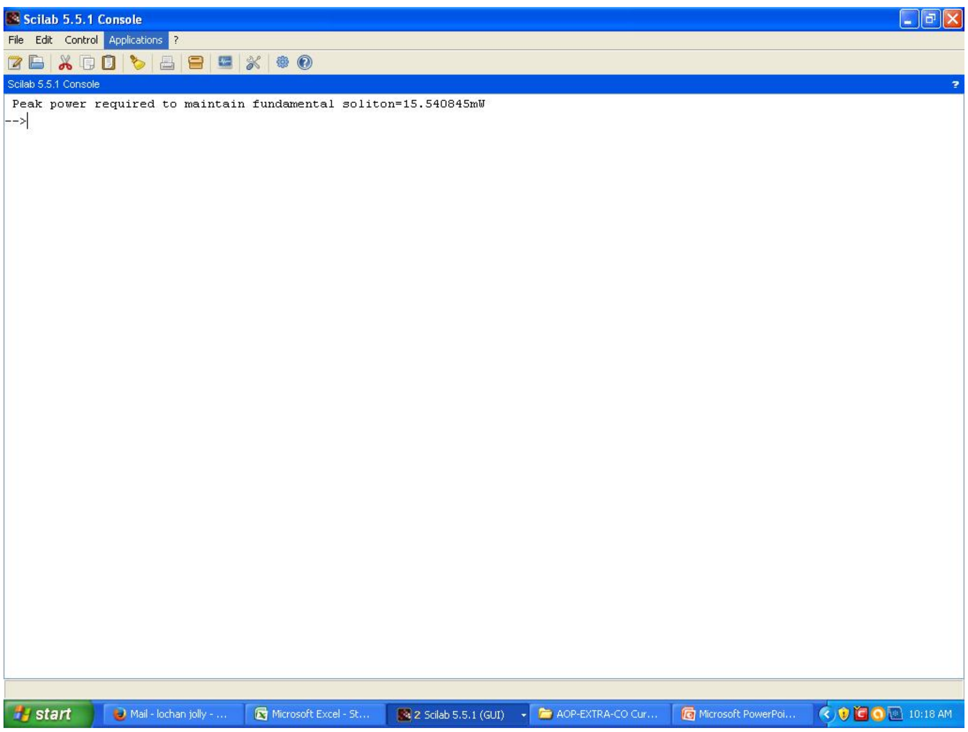
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
Peak power required to maintain fundamental soliton=15.540845mW
-->

Figure 16.1: 1

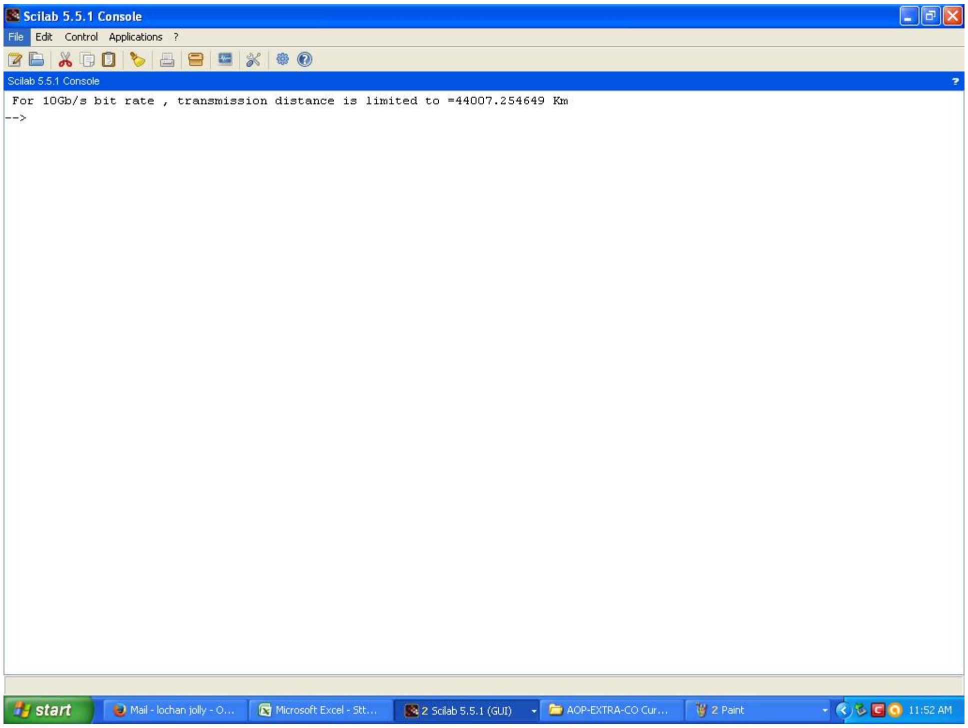

Figure 16.2: 2

Scilab code Exa 16.2 2

```
//Optical Fiber communication by A selvarajan
//example 16.2
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
lambda=1.55;//operating wavelength in um
Beta2=-1//dispersion regime ps^2/Km
```

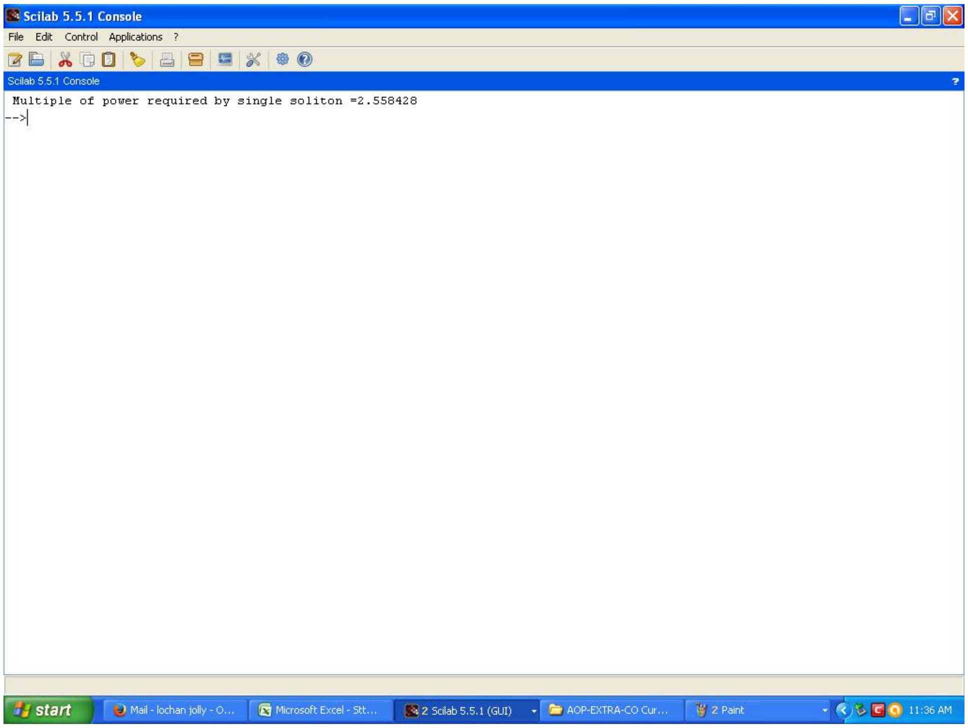

Figure 16.3: 3

```
B=10//bitrate in Gb/s
two_qo=12//separation between two neighbouring
    solitons in normalized units
LT=%pi*exp(two_qo/2)/(8*(two_qo/2)^2*abs(Beta2)
    *10^-24)/(B^2*(10^18))//distance transmission
    limit in Km
mprintf('For 10Gb/s bit rate , transmission distance
     is limited to =%f Km',LT)//the answer is
    different because of rounding off
```

Scilab code Exa 16.3 3

```
//Optical Fiber communication by A selvarajan
//example 16.3
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
alpha=0.2//fiber loss in dB/Km
LA=50//Amplifier spacing in Km
G=(alpha*LA)//gain in fiber
PbyPo=G*log(G)/(G-1)//Multiple of power required by
    single soliton
mprintf('Multiple of power required by single
    soliton =%f ',PbyPo)// the answer is slightly
    varing due to rounding error
```

Scilab code Exa 16.4 4

```
//Optical Fiber communication by A selvarajan
//example 16.4
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
lambda=1.55;//operating wavelength in um
LA=50//Amplifier spacing in Km
qo=6//Half of separation between two neighbouring
    solitons in normalized units
Beta2=-1//dispersion regime ps^2/Km
B=1/(4*(qo)^2*abs(Beta2))//bandwidth in THz
mprintf('Communication Link bitrate is limited to =
    %f GHz',B*10^3)// Multiplication by 10^3 to
    convert unit fron THz to GHz
//the answer is wrong
```

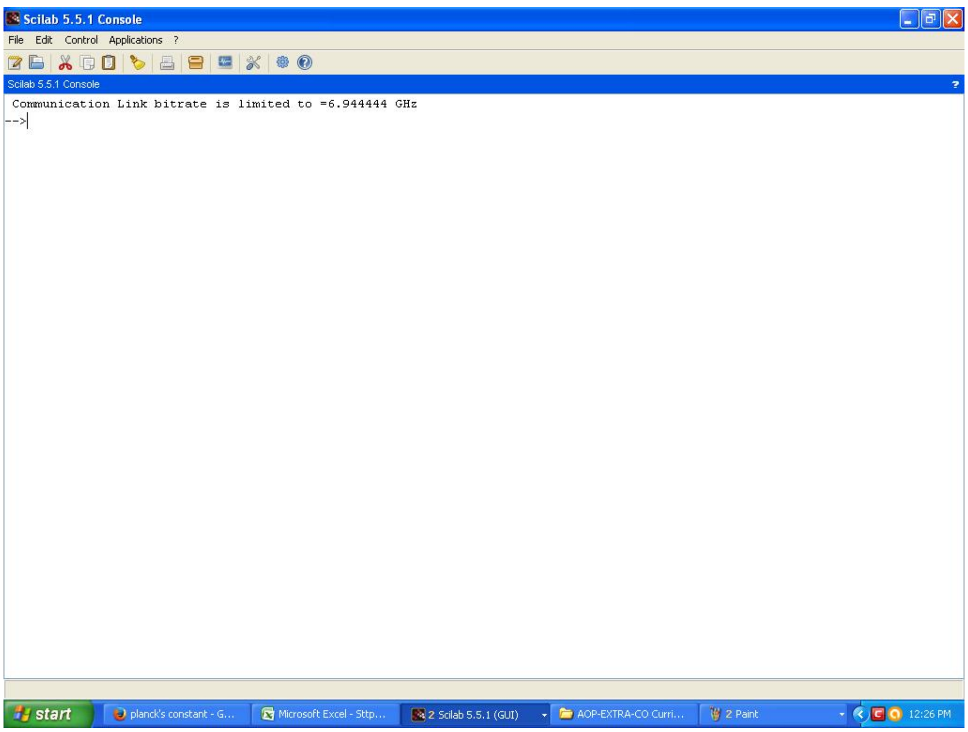
Scilab 5.5.1 Console
File Edit Control Applications ?
Scilab 5.5.1 Console
Communication Link bitrate is limited to =6.944444 GHz
-->

Figure 16.4: 4

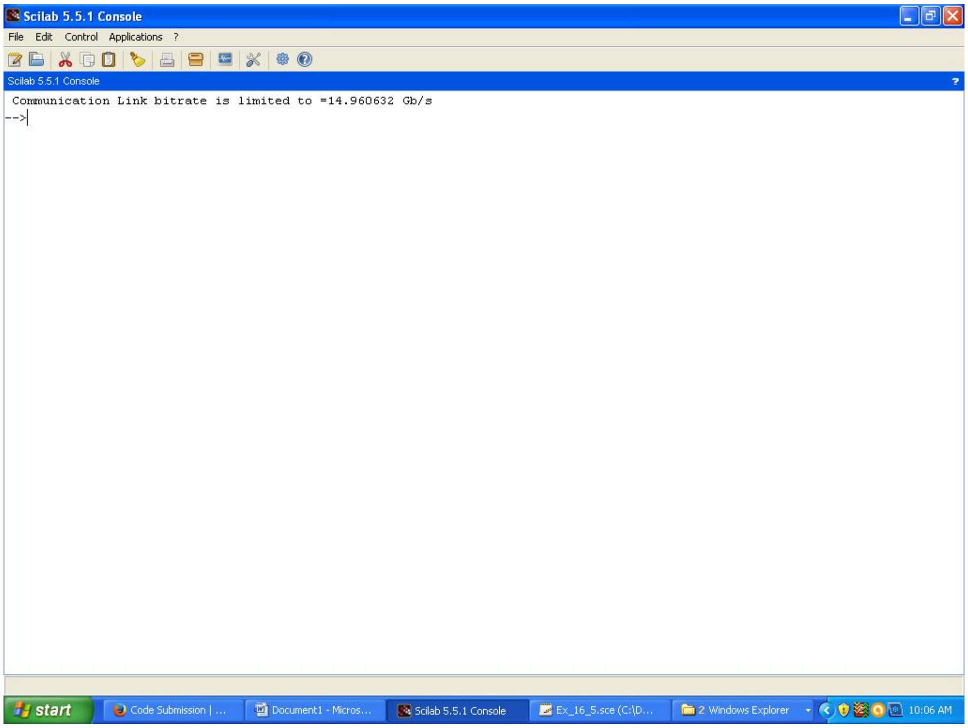

Figure 16.5: 5

Scilab code Exa 16.5 5

```
//Optical Fiber communication by A selvarajan
//example 16.5
//OS=Windows XP sp3
//Scilab version 5.5.1
clc;
clear all;
LT=10000//Transmission distance in Km
alpha=0.2//fiber loss in dB/Km
```

```
lambda=1.55*10^-6;//operating wavelength in m
Gama=2//nonlinearity in /W-Km
LA=50//Amplifier spacing in Km
D=1//dispersion parameter ps/(Km-nm)
FG=3.518//Fiber gain factor
fj=0.1//timing jitter factor
h=6.62607004 * 10-34 //planck's constant in m2 kg / s
nsp=2//spontaneous emission factor
qo=6//Half of separation between two neighbouring solitons in normalized units
B1=((9*%pi*fj^2*LA)/(nsp*FG*qo*lambda*h*Gama*D*10^-3))//variable converting la
B2=B1^(1/3)//variable
B=B2/LT//bandwidth in THz
mprintf('Communication Link bitrate is limited to = %f Gb/s',B*10^3)// Multiplication by 10^3 to convert unit fron THz to GHz
//the answer is wrong
```