Scilab Manual for
Optical Fiber Communication
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List of Experiments

Experiment: 1

To compute the Thermal noise,Signal to noise ratio and Shot noise power for a PIN photodiode

Scilab code Solution 1.1 Experiment Number 1

```
//AIM:To compute the Thermal noise ,Signal to noise
   ratio and Shot noise power
//for a PIN photodiode

//Software version Scilab 5.5.2
//OS Windows 7
clc;
clear;
//Consider responsivity 0.5 A/W,load resistance=2000
    ohms,system
//bandwidth=50MHz,temperature=40 degrees centigrade
//(a) Thermal noise :
T=40+273;//T=Temperature
disp('K',T,'T=')
delF=50*(10^3);//delF=Bandwidth
```

```
k=1.38*(10^-23);//k=Boltzmann constant
e=1.6*(10^-19);//E=Electron
RL=2000;//RL=Load resistance
//PNT=4*k*T*delF where PNT=Thermal noise
//If shot noise is equal to thermal noise,then PNT=
    PNS
//PNS is the shot noise power
//So, 4*k*T*delF=2*e*iS*delF*RL
//Hence iS=(2*k*T)/(e*RL)
iS=(2*k*T)/(e*RL);//iS=signal photocurrent
disp('Amp',iS,'iS=')
R=0.5;//R=responsivity=0.5
PR=iS/R;
disp('Watts',PR,'Received optic power PR=');
PNT=4*k*T*delF;
disp(PNT,'Thermal noise PNT=')

//(b) Signal to noise ratio:
//Since PNS=PNT;
//Total noise;N=PNS+PNT
//So,N=2*PNS
//But PNS=2*e*iS*delF*RL
S_by_N=(iS)/(4*e*delF);
disp(S_by_N,'Signal to noise ratio (S/N)=')

//(c) Shot noise power:
PNS=2*e*iS*delF*RL;
disp('Watts',PNS,'Shot noise power PNS=')
```

Experiment: 2

To compute the responsivity,received optical power & the number of photons received by a pn photodiode

Scilab code Solution 2.1 Experiment Number 2

```
//AIM:To compute the responsivity ,received optical
   power & the number of
//photons received by a pn photodiode

//Software version Scilab 5.5.2
//OS Windows 7
clc;
clear;
//Let us consider quantum efficiency of 50% at a
   wavelength of 0.9 micrometres
//& mean photocurrent is 10^-6 Amp
n=50/100;//n=Quantum efficiency=50%(given)
lambda=0.9*(10^-6);
//(a): Responsivity
//Responsivity R is related to the quantum
```

```
    efficiency n as R=(n*e*lambda)/(h*e)
e=1.6*(10^-19);
h=6.6*(10^-34);
c=3*(10^8);
R=(n*e*lambda)/(h*c);
disp('AW^-1',R,'R=')

//(b):Received optical power:
//R=Ip/P0
Ip=10^-6;
P0=Ip/R;
disp('Watts',P0,'Received optical power (P0)=')

//No. of received photons :
E=(h*c)/(lambda);
disp('Watts',E,'E=')
//Optical power=No. of photons*Energy of a photon
NOP=P0/E;
disp('photons/sec',NOP,'Number of photons=')
```

Experiment: 3

Compute the resulting output voltage of a photodetector

Scilab code Solution 3.1 Experiment Number 3

```
//AIM:Compute the resulting output voltage of a
    photodetector
//Software version Scilab 5.5.2
//OS Windows 7
clc;
clear;
//Let quantum efficiency=0.9,wavelength=1.3
    micrometre & incident power level
//of −37dBm
//Also we consider load resistance is 50 ohms and
    1000 ohms.
n=0.9;//n=Quantum efficiency
lambda=1.3*(10^(-6));//lambda=wavelength
//Incident optical power Pia=−37dBm
Pia=-37;//Pia=Incident power level
Pi=(10^(-3))*(10^(Pia/10));//Computing the incident
    optical power in Watts
disp('Watts',Pi,'Incident optical power (Pi) in
    Watts=')
```

```
h=(6.625)*(10^(-34));//h=Planck's constant
c=(3)*(10^(8));//c=Speed of light
e=(1.6)*(10^(-19));//Electron
I=(n*e*lambda*Pi)/(h*c);//Computing current I
disp('Amp',I,'Current(I)=')
//Voltage across resistor of 50 ohms
R1=50;
V1=I*R1;//Basic relation:Voltage=Current*Resistance
disp('Volts',V1,'V1=')

//Voltage across resistor of  ohms
R2=1000;
V2=I*R2;//Basic relation:Voltage=Current*Resistance
disp('Volts',V2,'V2=')
```

Experiment: 4

Compute the acceptance angle for the optical fiber in water

Scilab code Solution 4.1 Experiment Number 4

```
//AIM:Compute the acceptance angle for the optical
   fiber in water
//Software version Scilab 5.5.2
//OS Windows 7
clc;
clear;
//Let refractive index be 1.33,numerical aperture be
    0.20 and cladding
//refractive index be 1.59.
na=1.33;
n2=1.59;
NA=0.20;
//The refractive index of the core n1 is not given.
   So is has to be calculated.
//NA=sqrt((n1^2)-(n2^2))
n1=sqrt((NA^2)+(n2^2));
disp(n1,'n1=')
fiy_c = asin(n2/n1);
fiy_c_degrees=(fiy_c)*(180/%pi);
```

```
disp('degrees',fiy_c_degrees,'Critical angle at the
   core-cladding interface: fiy_c=')
//Computing the acceptance angle
theta_a=asin(NA/na);
theta_a_degrees=(theta_a)*(180/%pi);
disp('degrees',theta_a_degrees,'Acceptance angle :
   theta_a=')
```

Experiment: 5

Compute the numerical aperture and the critical angle at the core cladding interface for the step index fiber

Scilab code Solution 5.1 Experiment Number 5

```
//AIM:Compute the numerical aperture and the
    critical angle at the core
//cladding interface for the step index fiber

//Software version Scilab 5.5.2
//OS Windows 7
clc;
clear;
//Let the acceptance angle in air be 22 degrees and
    a relative refractive index
//difference of 3%
theta_a_degrees=22;
theta_a_radians=(theta_a_degrees)*(%pi/180);
del=0.03;
NA=sin(theta_a_radians);
```

```
disp(NA,'NA=')
n1=(NA)/(sqrt(2*del));
disp(n1,'n1=')
//Computing n2:
n2=n1-(del*n1);
disp(n2,'n2=')
//Computing the critical angle
fiy_c=asin(n2/n1);
fiy_c_degrees=(fiy_c)*(180/%pi);
disp('degrees',fiy_c_degrees,'Critical angle=')
```

Experiment: 6

Computation of maximum bit rate for RZ & NRZ encoding for the pulse spreading constants certain cable lengths

Scilab code Solution 6.1 Experiment Number 6

```
//AIM:Computation of maximum bit rate for RZ & NRZ encoding for the pulse
//spreading constants & certain cable lengths

//Software version Scilab 5.5.2
//OS Windows 7
clc;
clear;
//Consider pulse spreading constants & cable lengths as follows:
//(i): T =10ns/mm,L=100m;(ii): T =20ns/m,L=1000m ;(iii): T =2000ns/m,L=2km

//To find maximum bit rate for RZ & NRZ encoding
//(i):Since delT1=10ns/mm and 1mm=10^-6 km
```

```
delT1=10*(10^(-9))*(10^(6));
disp('sec/km',delT1,'delT1=')
tao1=0.1*delT1;//Computing total dispersion for 100 m
disp('sec',tao1,'Total dispersion for 100 m=')
//Maximum possible optical bandwidth=maximum possible bit rate for RZ
Bopt1=1/(2*tao1)
disp('bits/sec',Bopt1,'Maximum possible bit rate for RZ=')
NRZ1=Bopt1/2;
disp('bits/sec',NRZ1,'Maximum possible bit rate for NRZ=')
//(ii):Since delT2=20ns/m and 1m=10^-3km
delT2=20*(10^(-9))/(10^(-3));
disp('sec',delT2,'Total dispersion for 1000 m or 1 km =')
tao2=delT2;
Bopt2=1/(2*tao2)
disp('bits/sec',Bopt2,'Maximum possible bit rate for RZ=')
NRZ2=Bopt2/2;
disp('bits/sec',NRZ2,'Maximum possible bit rate for NRZ=')
//(iii):Since delT3=2000ns/m and 1m=10^-3km
delT3=2000*(10^(-9))/(10^(-3));
disp('sec/km',delT3,'delT3=')
tao3=delT3*2;
disp('sec',tao3,'Total dispersion over a length of 2 km =')
Bopt3=1/(2*tao3)
disp('bits/sec',Bopt3,'Maximum possible bit rate for RZ=')
NRZ3=Bopt3/2;
disp('bits/sec',NRZ3,'Maximum possible bit rate for NRZ=')
```

Experiment: 7

Computing overall signal attenuation,signal attenuation/km,overall signal attenuation for 20km link with splices at 2km interval

Scilab code Solution 7.1 Experiment Number 7

```
//AIM:Computing overall signal attenuation,signal
    attenuation/km,overall
//signal attenuation for 20km link with splices at 2
    km interval

//Software version Scilab 5.5.2
//OS Windows 7
clc;
clear;
//Let us consider that each splice gives attenuation
    of 1.5dB for 10km long
//optical fiber having output optical power of 4  W
//and  input optical power of 100 W
```

```
Pin=100*(10^(-6));//Pin=Input optical power
Pout=4*(10^(-6));//Pout=Output optical power
alphaT=10*log10(Pin/Pout);//alphaT=Overall attenuation
disp('dB',alphaT,'Overall attenuation (alphaT)=')
//The length of the optical fiber is 10km
L1=10*(10^(3));
//Computing Signal attenuaion per km
alpha=alphaT/10;
disp('dB/km',alpha,'The signal attenuation per kilometer (alpha) =')
//Computation for 20kms length:
L2=20*(10^(3));
TSA=alpha/(10^(3))*L2;//TSA=Total signal attenuation
disp('dB',TSA,'Total signal attenuation=')
//A splice is connected at each 2km distance.Thus total 9 splices are used.
//Now each splice gives 1.5dB attenuation.
S=9;//S=Total No. of splices used
A=1.5;//A=Attenuation by each splice
TAFS=S*A;//TAFS=Total attenuation from splices
disp('dB',TAFS,'Total attenuation from splices=')
//Computing overall signal attenuation including attenuation due to splices
a=TAFS+TSA;
disp('dB',a,'Overall signal attenuation including attenuation due to splices=')
```

Experiment: 8

To compute the maximum link span for 4,8,16 channel; 2.5Gb/s channel optical link.

Scilab code Solution 8.1 Experiment Number 8

```
//AIM:To compute the maximum link span for 4,8,16
    channel; 2.5Gb/s channel
// optical link.

//Software version Scilab 5.5.2
//OS Windows 7
clc;
clear;
//(i):Computing maximum link span for 4-channel,2.5
    Gb/s per channel
//optical link

fb1=4*2.5;
Lmax1=(6.1*(10^3))/((fb1)^2);
disp('km',Lmax1,'Maximum link span for 4-channel,2.5
    Gb/s per channel optical link (i.e. Lmax1) =')

```

```
//(ii):Computing maximum link span for 8-channel,2.5
    Gb/s per channel
//optical link

fb2=8*2.5;
Lmax2=(6.1*(10^3))/((fb2)^2);
disp('km',Lmax2,'Maximum link span for 8-channel,2.5
    Gb/s per channel optical link (i.e.Lmax2) =')

//(iii):Computing maximum link span for 16-channel
    ,2.5Gb/s per channel
//optical link

fb3=16*2.5;
Lmax3=(6.1*(10^3))/((fb3)^2);
disp('km',Lmax3,'Maximum link span for 16-channel
    ,2.5Gb/s per channel optical link (i.e. Lmax3) ='
    )
```

Experiment: 9

Compute the numerical aperture & the acceptance angle for the fiber in air

Scilab code Solution 9.1 Experiment Number 9

```
//AIM:Compute the numerical aperture & the acceptance angle for the fiber in air
//Software version Scilab 5.5.2
//OS Windows 7
clc;
clear;
//Let the velocity of light in vacuum be 2.998*10^8 m/sec, critical angle at the
// core-cladding interface be 80 degrees & velocity of light in the core
//of a step index fiber be 2.01*10^8 m/sec

c=2.998*10^8;//c=velocity of light in vacuum
v1=2.01*10^8;//v1=velocity of light in the core
theta_c=80*(%pi/180);//Expressing theta_c in radians
n1=c/v1;
disp(n1,'n1=')
```

```
//Since sin(theta_c)=n2/n1
n2=sin(theta_c)*n1;
disp(n2,'n2=')
NA=sqrt((n1^2)-(n2^2))
disp(NA,'Numerical aperture (NA)=')
//Computing the acceptance angle
theta_a=asin(NA)
theta_a_degrees=(theta_a)*(180/%pi);
disp('degrees',theta_a_degrees,'Acceptance angle (theta_a)=')
```

Experiment: 10

Compute the absorption loss taking place in an optical fiber

Scilab code Solution 10.1 Experiment Number 10

```
//AIM:Compute the absorption loss taking place in an optical fiber
//Software version Scilab 5.5.2
//OS Windows 7
clc;
clear;
//Let the length of the optical fiber be 3.5cm in an interference sphere, while
//the total length of the fiber be 1km.
//Also consider that it gives 5.1nV & 165 micro Volts corresponding to
//scattered & unscattered light respectively while for the cutback method,
//it gives 5.20V & 22V for original & cutback optical fibers respectively.

l=3.5*(10^(-5));//l=Length of optical in integrating sphere
Vsc=5.1*(10^(-9));//Vsc=Voltage level corresponding
```

```
to scattered light
Vop=165*(10^(-6));//Vop=Voltage level corresponding to unscattered light
//Computing the scattering loss :
alpha_sc=(4.343/l)*(Vsc/Vop);
disp('dB/km',alpha_sc,'Scattering loss (alpha_sc)=')
//Computation of total attenuation:
L1=1;//L1=Length of the original fiber
L2=0.002;//L2=Length of cutback optical fiber
V2=22;//V2=Voltage level for cutback optical fiber
V1=5.20;//V1=Voltage level for original optical fiber
alpha_T=(1/(L1-L2))*(10*log10(V2/V1));//alpha_T=total attenuation
disp('dB/km',alpha_T,'Total attenuation (alpha_T) =')
//Computing the absorption loss :
AL=alpha_T-alpha_sc;//AL=Absorption loss
disp('dB/km',AL,'Absorption loss=')
```