Scilab Textbook Companion for Optical Fibers And Fiber Optic Communication Systems by Subir Kumar Sarkar[1]

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Book Description

Title: Optical Fibers And Fiber Optic Communication Systems

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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

Chapter 2

Refractive index and velocity of light

Scilab code Exa 2.1 RIVL1

```
// optical fibers and fiber optic communication
   system
 //Example 2 . 1
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
meu1=1.55;//core
meu2=1.50;//cladding
//to find
delta=(meu1-meu2)/meu1;
NA=meu1*sqrt(2*delta);//numerical aperture
theta0=asind(NA);//acceptance angle
mprintf("Numerical aperture=%.3f",NA);
mprintf("\n Acceptance angle=%.1fdegree",theta0);
```

Scilab code Exa 2.2 2

```
// optical fibers and fiber optic communication system
 //Example 2 . 2
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
meu1=3.6//refractive index of substance at 850nm
meu2=3.4//refractive index of substance at 1300nm
Vvac=3*10^8//velocity of light in free space in m/sec
lamdavac1=850//wavelength 1 in nm
lamdavac2=1300//wavelength 2 in nm
//to find
Vsubstance=Vvac/meu1//velocity of light in substance at 850nm
Vsub=Vvac/meu2//velocity of light in substance at 1300nm
lamda1=lamdavac1/meu1//wavelenfth of light in medium 2 in nm
lamda2=lamdavac2/meu2//wavelenfth of light in medium 2 in nm
mprintf("velocity of light in optically active medium at 850 nm=%.2fx10^7m/sec",Vsubstance/1e7)
mprintf("\n wavelength oflight in optically active medium at 850 nm=%.0fnm",lamda1)
mprintf("\n velocity of light in optically active medium at 1300 nm=%.2fx10^7m/sec",Vsub/1e7);
mprintf("\n wavelength of light in optically active
```

```
medium at 1300 nm=%.0fnm",lamda2)
```

Scilab code Exa 2.3 3

```
// optical fibers and fiber optic communication
   system
 //Example 2 . 3
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
meu1=1.5;//core
meu2=1.45;//cladding
//to find
delta=(meu1-meu2)/meu1;
NA=meu1*sqrt(2*delta);//numerical aperture
theta0=asind(NA);//acceptance angle
thetac=asind(meu2/meu1)//critical angle
mprintf("Numerical aperture=%.3f",NA);
mprintf("\n Acceptance angle=%.2fdegree",theta0);
mprintf("\n crictical angle=%.1fdegree",thetac)
```

Scilab code Exa 2.4 4

```
// optical fibers and fiber optic communication
   system
 //Example 2 . 4
//OS=Windows 10
```

```
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
NA=0.22//numerical aperature
delta=0.012//delta
//to find
meu1=NA/sqrt(2*delta);//meu1=refractive index of
    core
meu2=meu1-delta*meu1// meu 2 refractive index of
    cladding
mprintf("refractive index of core=%.2f",meu1);
mprintf("\n refractive index of cladding=%.2f",meu2)
    ;
```

Scilab code Exa 2.5 5

```
// optical fibers and fiber optic communication
    system
 //Example 2 . 5
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
meu1=1.466//refractive index of core
meu2=1.46//refractive index of cladding
lamda=0.800//operating wavelength in um
V=2.4//cutoff parameter
w_by_a=1.1//w/a at cutoff
distance1=10//distance 1 for spotsize in m
distance2=1000//distance 2 for spotsize in m
//to find
```

```
NA=sqrt(meu1^2-meu2^2)//numerical aperature
a=V*lamda/(2*%pi*NA)//core radius in um
spot_size=a*w_by_a// spot size in um
theta=2*lamda/(%pi*spot_size)//divergence_angle in radian
spot_size_10=lamda*distance1/(%pi*spot_size)//spot size at 10 m
spot_size_1=lamda*distance2/(%pi*spot_size)//spot size at 1km
mprintf("numerical aperature=%.2f",NA);
mprintf("\n core radius =%.2fum",a);
mprintf("\n divergence_angle =%.2fdegree",theta*180/%pi);
mprintf("\n spot size at 10 m =%.2fm",spot_size_10);
mprintf("\n spot size at 1km =%.2fm",spot_size_1);
//The answers given in th textbook donot match
```

Scilab code Exa 2.6 6

```
// optical fibers and fiber optic communication system
 //Example 2 . 6
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
meu1=1.47//refractive index of core
meu2=1.45//refractive index of cladding
A=9800//spot size at a distance of 1 km in cm
D=50//diameter of fiber of core in um
a=D/2//Radius of fiber of core in um
lamda=0.85//operating wavelength in um
```

```
//to find
V=2*%pi*a*sqrt(meu1^2-meu2^2)/(lamda)//cutoff number
Number_of_modes=V^2/2//number ofmodes
mprintf("cutoff number=%.2f",V)
mprintf("\n number of modes=%.0f",Number_of_modes);
//THE TEXTBOOK ASWER DO NOT MATCH
```

Scilab code Exa 2.7 7

```
// optical fibers and fiber optic communication
    system
 //Example 2 . 9
 //OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear all;
//given
meu1=1.47//refractive index of core
meu2=1.46//refractive index of cladding
lamda=1300//wavelength in nm
V=2.405//the condition for single mode
//to find
a=V*lamda*1e6*1e-9/(2*%pi*sqrt(meu1^2-meu2^2))//the
     maximum radius of core in um
d=a*2//maximum diameter in um
mprintf("maximum radius of core=%.2f um",a)
mprintf("\nmaximum diameter  =%.2fum",d)
```

Scilab code Exa 2.8 8

```
// optical fibers and fiber optic communication system
//Example 2 . 8
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear all;
//given
meu1=1.465//refractive index of core
meu2=1.46//refractive index of cladding
lamda=1.250//wavelength in um
V=2.405//the condition for single mode
//to find
delta=(meu1-meu2)/meu1//fractional refractive index
a=V*lamda*1e-6*1e6/(2*%pi*sqrt(meu1^2-meu2^2))//largest core size in um
meueffective=meu1-(sqrt(2*delta)/(2*%pi*a/lamda))//effective refractive index for lowest mode
mprintf("fractional refractive index=%.3fx10^-3 ",delta*1e3)
mprintf("\nlargest core size =%.2fum",a)
mprintf("\neffective refractive index=%.3f",meueffective)
```

Scilab code Exa 2.9 9

```
// optical fibers and fiber optic communication system
//Example 2 . 9
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
```

```
//given
meu1=1.54//refractive index of core
meu2=1.5//refractive index of cladding
a=25//radius of fiber of core in um
lamda=1300//operating wavelength in nm
//to find
NA=sqrt(meu1^2-meu2^2)//neumerical aperature
V=2*%pi*a*1e-6*NA/(lamda*1e-9)//cutoff number
Number_of_modes=V^2/2//number ofmodes
mprintf("numerical aperature=%.3f",NA)
mprintf("\ncutoff number=%.2f",V)
mprintf("\n number of modes=%.0f",Number_of_modes);
//THE ANSWER OF V IN TEXTBOOK DO NOT MATCH
```

Scilab code Exa 2.10 10

```
// optical fibers and fiber optic communication
   system
 //Example 2 . 10
 //OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear all;
//given
meu1=1.5//refractive index of core
a=10//diameter of core in um
lamda=1.3//wavelength in um
V=2.405//the condition for single mode
//to find
NA=V*lamda*1e-6/(2*%pi*a*1e-6)//numerical aperature
A=asind(NA)//acceptance angle in degree
delta=(NA/meu1)^2//delta
meu2=meu1-(delta*meu1)//refractive index of cladding
```

```
mprintf("\nrefractive index of cladding=%.3f",meu2)
```

Scilab code Exa 2.11 11

```
// optical fibers and fiber optic communication
   system
 //Example 2 . 11
 //OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear all;
//given
n=600//frequency of light in free space in GHz
c=3*1e8//velocity of light in free space in m/s
//to find
lamda=c*1e6/(n*1e12)//wavelength of light in free
   space in um
mprintf("wavelength of light in free space=%.1f um",
   lamda)
```

Chapter 3

classification of optical fibers

Scilab code Exa 3.1 1

```
// optical fibers and fiber optic communication
   system
 //Example 3.1b
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
meu1=3.41//refractive index of InGaAsP
lamda=1.3// operating wavelength in um
c=3*1e8//velocity of light in m/s
lamdavac=1300//wavelength of light in vacuum
//to find
Vsub=c/meu1//velocity of light in optically active
   medium
lamdasub=lamdavac/meu1//wavelength in medium
mprintf("velocity of light in optically active
   medium=%.2fx10^7m/sec",Vsub/1e7)
mprintf("\n wavelength oflight in optically active
   medium =%.0fnm",lamdasub)
```

Scilab code Exa 3.2 2

```
// optical fibers and fiber optic communication
   system
 //Example 3.2
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
meu1=1.46//refractive index of core
meu2=1.45//refractive index of cladding
//to find
NA=sqrt(meu1^2-meu2^2)//numerical apearture
delta=(meu1-meu2)/meu1//fractional difference in
   refractive index
mprintf("numerical apearture=%.2f",NA)
mprintf("\nfractional difference in wavelength=%.2
   fx10^-3",delta*1e3)
```

Scilab code Exa 3.3 3

```
// optical fibers and fiber optic communication
   system
 //Example 3.3
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
```

```
clear
//given
meu1=1.466//refractive index of core
meu2=1.46//refractive index of cladding
//to find
thetac_core_cladding=asind(meu2/meu1)//criticalangle
    at the core cladding interface in degrees
thetac_cladding_core=asind(1/meu2)//criticalangle at
    the  cladding core interface in degrees
mprintf("criticalangle at the core cladding
   interface =%.2f degrees",thetac_core_cladding)
mprintf("\ncriticalangle at the core cladding
   interface =%.2f degrees",thetac_cladding_core)
```

Scilab code Exa 3.4 4

```
// optical fibers and fiber optic communication
   system
 //Example 3.4
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
meu1=1.5//refractive index of core
meu2=1.49//refractive index of cladding
d=50//diameter of core in um
//to find
thethac=asind(meu2/meu1)//critical angle
x=d*tand(thethac)//length covered in one reflection
n=1000000/x//total no. of reflections per meter
mprintf("critical angle=%.2fdegree",thethac)
mprintf("\nlength covered in one reflection=%.2fum",
```

```
x)
mprintf("\ntotal no. of reflections per meter=%.0f",n)
```

Scilab code Exa 3.5 5

```
// optical fibers and fiber optic communication system
 //Example 3.5
//OS=Windows 10
// // Scilab version 5.5.2(32 bit)
clc ;
clear
//given
d=200//diameter of core in um
a=100*1e-6//radius of core in m
NA=0.29//numerical aperarture
lamda=850*1e-9//operating wavelength in m
//to find
x=2*(a^2)*(%pi^2)*(NA^2)/(lamda^2)//number of modes
mprintf("number of modes=%.0fmodes",x)
//ANSWER GIVEN IN THE TEXTBOOK DOES NOT MATCH
```

Scilab code Exa 3.6 6

```
// optical fibers and fiber optic communication system
 //Example 3.6
//OS=Windows 10
```

```
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
d=50//diameter of core in um
a=25*1e-6//radius of core in m
NA=0.21//numerical aperarture
lamda=1.3*1e-6//operating wavelength in m
p=1.85//index profile
//to find
x=2*(a^2)*(%pi^2)*(NA^2)/(lamda^2)*2*(1/(1+(2/p)))//
   number of modes
mprintf("number of modes=%.0fmodes",x)
```

Scilab code Exa 3.7 7

```
// optical fibers and fiber optic communication
   system
 //Example 3.7
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
meu1=3.5//refractive index of core
meu2=3.45//refractive index of cladding
meu0=1//refractive index of air
//to find
NA=sqrt(meu1^2-meu2^2)//numerical aperarture
alpha0=asind(NA/meu0)//acceptance angle in degree
mprintf("numerical apearture=%.2f",NA)
mprintf("\nacceptance angle=%.2fdegree",alpha0)
```

Scilab code Exa 3.8 8

```
// optical fibers and fiber optic communication
   system
 //Example 3.8
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
meu1=1.54//refractive index of core
meu2=1.50//refractive index of cladding
//to find
NA=sqrt(meu1^2-meu2^2)//numerical aperarture
thetha0=asind(NA)//acceptance angle in degree
mprintf("numerical apearture=%.3f",NA)
mprintf("\nacceptance angle=%.2fdegree",thetha0)
//THE VALUE OF THETHA0 DOES NOT MATCH WITH THE
   TEXTBOOK
```

Scilab code Exa 3.9 9

```
// optical fibers and fiber optic communication
   system
 //Example 3.9
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
```

```
clear
//given
meu1=1.480//refractive index of core
meu2=1.465//refractive index of cladding
alpha=850//operating wavelength in nm
//to find
a=2.405/(2*(%pi)*(sqrt(meu1^2-meu2^2)))*alpha*1e-3//
    radius of core in um
NA=sqrt(meu1^2-meu2^2)//numerical apearture
alpha0=asind(NA)//acceptance angle
mprintf("radius if core=%.4fum",a)
mprintf("\nnumerical apearture=%.5f",NA)
mprintf("\nacceptance angle=%.2fdeg",alpha0)
//THE ANSWER OF RADIUS OF CORE IN THE TEXTBOOK DOES
    NOIT MATCH
```

Chapter 4

Fibre Fabrication

Scilab code Exa 4.1 1

```
// optical fibers and fiber optic communication
    system
 //Example4.1
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
d=100*1e-6//outer diameter in m
a=50*1e-6//outer radius in m
L=1000//length of silica fibre in m
spool_heigt=10*1e-2//height of spool in m
unloaded_diameter=20*1e-2//unloaded diameter in m
number_layer=2//number of layer
//to find
volume=%pi*(a^2)*1e6//volume in cm^3
No_turns_layer=spool_heigt/d//number of turns on a
    layer
increase_diameter=d*number_layer//increase in
    diameter in m
dia_ful_load_spool=(unloaded_diameter+
```

```
    increase_diameter)*1e2//diameter of fully loaded
    spool
mprintf("volume=%.2fcm^3",volume)
mprintf("\nDiameter of fully loaded spool=%.2fcms",
    dia_ful_load_spool)
```

Scilab code Exa 4.2 2

```
// optical fibers and fiber optic communication
    system
 //Example4.2
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
d=100*1e-6//fiber outer diameter in m
dc=1e-3//cable daimeter in m
a=50*1e-6//outer radius in m
length=1000//length of silica fibre in m
spool_heigt=10*1e-2//height of spool in m
fully_loaded_spool_diameter=20.04//unloaded diameter
     in cm

//to find
number_of_turnsperlayer=0.1/d//number of layer
length_in_each_layer=2*%pi*dc/2*1e3//length in each
    layer in m
number_of_layer=number_of_turnsperlayer/
    length_in_each_layer//number of turns on a layer
increase_in_diameter=d*number_of_layer*1e2//increase
     in diameter in cm
diameter_of_fully_loaded_spool=(
```

```
fully_loaded_spool_diameter+increase_in_diameter)
//diameter of fully loaded spool in cm
mprintf("Diameter of fully loaded spool\n=%.2fcms",
diameter_of_fully_loaded_spool)
```

Chapter 5

Fibre cables

Scilab code Exa 5.1 1

```
// optical fibers and fiber optic communication
   system
 //Example 5.1
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
r=125*1e-4//cladding radius of fibre in cm
R=5//radius of curve in cm
//to find
Sp=((R+(2*r))/(r+R)-1)*100//the condition for
   breaking of fibre
mprintf("the condition for breaking of fibre=%.2
   fpercent",Sp)
```

Scilab code Exa 5.2 2

```
// optical fibers and fiber optic communication system
 //Example 5.2
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
W=.035//cable weighing in kg/m
R=.025//radius of curvaturein m
eta=0.19//coefficient of friction between conduit and cable jacket
phi=%pi/4//bend in radians
Si=45.36//pulling tension at entarance in Kg
//to find
SL_exit=W*R*sinh(eta*phi+ asinh(Si/(W*R)))//pulling tension at exit in Kg
mprintf("\npulling tension at exit =%.2f Kg",SL_exit)
```

Chapter 6

Optical Fibre as cylindrical Wave guide

Scilab code Exa 6.1 1

```
// optical fibers and fiber optic communication
   system
 //Example 6.1
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
meu1=2.56//dielectric permittivity of fibre core(
   placed in air)
meu2=1//dielectric permittivity of air
d=1//diameter of core in cm
a=0.5//radius of core in cm
V=2.4048//cutoff number
c=3*1e10//velocity of light in cm/sec
//to find
lamda0=%pi*((2*a)/V)*sqrt(meu1)//free space
   wavelength in cm
Fmax=c/lamda0//maximum frequency
```

```
mprintf("free space wavelength=%.4fcm",lamda0)
mprintf("\nmaximum frequency=%.3fGHz",Fmax/1e9)
//the answer given in textbook is wrong due to wrong
    substitution of meu1 in solution it is taken as
   1.56 instead of 2.56 in question
```

Chapter 7

Fibre Losses

Scilab code Exa 7.1 1

```
// optical fibers and fiber optic communication
   system
 //Example7.1
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
lamda=850*1e-9//wavelength in nm
x=2//index profile parameter
R=2*1e-2//radius of curve in cm
K=2*%pi/lamda//refractive index of core
d=85*1e-6//core daimeter in um
a=d/2//core radius in um
delta=0.0126//relative refractive index
meu1=1.45//core refractive index
X1=(3/(2*K*R*meu1))^(0.67)//constant for ease of
   calculation
Z1=((x+2)/(2*x*delta))*(2*(a/R)+X1)//constant for
   ease of calculation
//to find
```

```
macro_bend_loss=-10*log10(1-Z1)//macro bend loss in dB
mprintf("macro_bend_loss=%.0fdB",macro_bend_loss)
```

Scilab code Exa 7.2 2

```
// optical fibers and fiber optic communication system
 //Example 7.2
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
rc=5*1e-6//radius of core in m
lamdac=1250*1e-9//cutoff wavelength in m
R=1.2*1e-2//radius of curve in m
lamda=1300*1e-9//wavelength in m
meu=1.4469//refractive index at lamda
//to find
dmf=2*rc*(0.65+(0.434*(lamda^1.5/lamdac^1.5))+(0.0149*((lamda^6)/(lamdac^6))))//mode field diameter in um
K=(2*%pi)/lamda//Wave factor
X1=((dmf/2)^6/(8*R^2))//constant for calculation
L=-10*log10(1-((K^4)*(meu^4)*X1))//macrobend loss in dB
mprintf("mode field diameter=%.2fum",dmf*1e6)
mprintf("\npercent loss=%.2f*10^6/m",K/1e6)
mprintf("\nmacrobend loss=%.3fdB",L)
```

Scilab code Exa 7.3 3

```
// optical fibers and fiber optic communication
   system
 //Example7.3
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
L=0.450//length of fibre in km
reduction_in_power=30/100//reduction in power
//to find
Loss=(10*log10(reduction_in_power))/L//loss in dB/km
mprintf("Loss =%.2fdB/km",Loss)
// the answer in textbook donot match because the
   minus sign is missing in textbook. as it is log
   ratio of Pour/ Pin which is a negative value so
   the answer is negative.
```

Scilab code Exa 7.4 4

```
// optical fibers and fiber optic communication
   system
 //Example7.4
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
```

```
clear
//given
meu1=4/3//refractive index of water
meu2=1//refractive index of air
angle_of_incidence=0//angle of incidence in degree
//to find
Percent_power_loss=(((meu1-meu2)/(meu1+meu2))^2)*100
   //percent power loss
mprintf("percent power loss=%.2fpercent",
   Percent_power_loss)
```

Scilab code Exa 7.5 5

```
// optical fibers and fiber optic communication
   system
 //Example7.5
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
power_absorb=0.04// power absorbed
L=0.01//length of fibre in km
//to find
Poutbypin=10*log10(1-power_absorb)//loss in 10m
   length of fiber in dB
Loss_for_1km=Poutbypin/.01//loss for 1km of length
   of fibre
mprintf("loss for 1 km of length of fibre=%.0fdB/km"
   ,Loss_for_1km)
// the answer in textbook donot match because the
   minus sign is missing in textbook. as it is log
   ratio of Pour/ Pin which is a negative value so
```

```
the answer is negative and the value of Pout/Pin
in the question itself is negativeas shown above.
```

Scilab code Exa 7.6 6

```
// optical fibers and fiber optic communication
   system
 //Example7.6
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
L=0.15//length of fibre in km
Pin=10*1e-6//input power in watts
Pout=8*1e-6//output poer in watts
//to find
Loss=(10*log10(Pout/Pin))/L//loss in dB/km
mprintf("Loss =%.2fdB/km",Loss)
```

Scilab code Exa 7.7 7

```
// optical fibers and fiber optic communication
   system
 //Example7.7
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
```

```
//given
Pin=500// input power in uW
L=100//length of fibre in km
alpha=3//fiber loss in dB/km
//to find
total_loss=-alpha*L//total fiber loss in 100km fiber
    in dB
Pout=10^(total_loss/10)*Pin//output power in uW
mprintf("output power =%.0fx10^-28 uWatt",Pout*1e28)
```

Chapter 8

Dispersion in Optical Fibres

Scilab code Exa 8.1 1

```
// optical fibers and fiber optic communication
   system
 //Example 8.1
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
NA=0.28//numerical apearture
meu1=1.5//refractive index
L=5//length of fibre in km
C=3*1e5//velocity of light in km/sec
//to find
taurms=(NA)^2/(4*(3^0.5)*meu1*C)//rms intermodal
   pulse broadcasting in ns/Km
total_pulse_broadcasting=taurms*L//total pulse
   broadcasting in ns
bandwidth=0.187/total_pulse_broadcasting//bandwidth
   for 5km fibre in Hz
mprintf("rms intermodal pulse broadcasting=%.3fns/km
   ",taurms*1e9)
```

```
mprintf("\ntotal pulse broadcasting=%.0f nsecond",total_pulse_broadcasting*1e9)
mprintf("\nbandwidth for 5 km fiber=%.1fMHz",bandwidth*1e-6)
//the textbook answer donot match
```

Scilab code Exa 8.2 2

```
// optical fibers and fiber optic communication system
 //Example 8.2
//OS=Windows 10
// // Scilab version 5.5.2(32 bit)
clc ;
clear
//given
d=50//core daimeter in um
BLP=500//bandwidth length product in MHz.Km
L=5//length of fibre in km
lamda=820//wavelength in nm
delta_lamda=40//half power spectral width in nm
M=85//material dispersion in ps/nm.km
//to find
tau_r_modal=0.32*1e3/BLP//intermodal pulse broadening in ns/km
tau_m=M*delta_lamda*1e-3//Pulse Broadening due to material dispersion in ns/km
tau_c=sqrt(tau_r_modal^2+tau_m^2)*1e-3//combined pulse broadening in ns/km
actual_BLP=0.32/tau_c//actual bandwidth length product in MHz.Km
mprintf("intermodal pulse broadening =%.2f ns/km",tau_r_modal)
```

```
mprintf("\nPulse Broadening due to material
   dispersion =%.1f ns/km",tau_m)
mprintf("\ncombined pulse broadening =%.2fns/km",
   tau_c*1e-3)
mprintf("\nactual bandwidth length product =%.1fMHz.
   Km",actual_BLP)
//the textbook answer donot match for actual
   bandwidth length product
```

Scilab code Exa 8.3 3

```
// optical fibers and fiber optic communication
   system
 //Example 8.3
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc;
meu1=1.5//refractive index at the center of the core
L=1000//in m
delta=0.0260//bandwidth
c=3*10^(8)//speed of light in m/s
deltat=meu1*L*(delta^2)/(8*c)*10^(9)//maximum
   dispersion in ns/Km
mprintf("Maximum dispersion=%0.2fns/Km",deltat);
```

Scilab code Exa 8.4 4

```
// optical fibers and fiber optic communication
   system
```

```
 //Example 8.4
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
N=6.5//material dispersion in ps/(nm*km)
deltalamda=6//spectral width in nm
L=25//length in km
//to find
tau=N*deltalamda*L//chromatic material dispersion
mprintf("chromatic material dispersion=%.3fns",tau*1e-3)
//the unit in textbook is wrong
```

Scilab code Exa 8.5 5

```
// optical fibers and fiber optic communication system
 //Example 8.5
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
lamda=1.3//Operating wavelength in um
delta_tau_wg=0.5//Waveguide Dispersion in ns
delta_tau_md=2.8//material dispersion in ns
width_transmitted_pulse=0.6//width of transmitted pulse in ns
//to find
delta_tau=sqrt(delta_tau_md^2+delta_tau_wg^2)//Total dispersion in ns
```

```
received_pulse_width=width_transmitted_pulse+delta_tau//received pulse width in ns
maximum_bit_rate=1*1e3/(5*received_pulse_width)//maximum bit rate in Mb/sec
mprintf("Total dispersion =%.2f ns",delta_tau)
mprintf("\nreceived pulse width =%.2f ns",received_pulse_width)
mprintf("\nmaximum bit rate=%.2f Mb/sec ",maximum_bit_rate)

//the textbook answer donot match in last place of decimal
```

Scilab code Exa 8.6 6

```
// optical fibers and fiber optic communication system
 //Example8.6
//OS=Windows 10
// // Scilab version 5.5.2(32 bit)
clc ;
clear
//given
meu1=1.55//refractive index of core
delta=0.026//delta
c=3*1e8//speed of light in m/sec
//to find
Maximum_dispersion=(meu1/c)*(delta/(1-delta))*1e9*1e3//maximum dispersion in ns for 10 km
mprintf("maximum dispersion for 10 km =%.0fns",Maximum_dispersion)
```

Scilab code Exa 8.7 7

```
// optical fibers and fiber optic communication system
 //Example8.7
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
meu_core=1.44//refractive index of core
mue_clad=1.40////refractive index of cladding
delta=(meu_core^2-mue_clad^2)/(2*meu_core)//delta
c=3*1e8//speed of light in m/sec
L=300//length of fibre in m
//to find
delta_t=(L*meu_core/c)*delta//DIspersion of pulse in s
dispersion_per_km=delta_t/(L*1e-3)//dispersion in ns/Km
mprintf("dispersion for 300m =%.1fns/km",dispersion_per_km*1e9)
//the textbook answer donot match
```

Scilab code Exa 8.8 8

```
// optical fibers and fiber optic communication
   system
 //Example8.8
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
meucore=1.4//refractive index of core
NA=0.22//numerical aperture
L=500//length of fibre in m
C=3*1e8//speed of lkight in m/sec
//to find
delta=((NA/meucore)^2)/2//delta
deltat=((L*meucore*delta)/C)*1e9//intermodal
   dispersion in ns
mprintf("delta=%.4f",delta)
mprintf("\nIntermodal dispersion=%.1fns",deltat)
```

Scilab code Exa 8.9 9

```
// optical fibers and fiber optic communication
   system
 //Example 8.9
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc;
L=1//length in km
intermodal_dispersion=5//in ns/km
intramodal_dispersion=80//in ps/(km*nm)
deltatimd=intermodal_dispersion*L//in ns//total
   intermodal dispersion
mprintf("total intermodal dispersion=%.2f ns",
   deltatimd);
line_width=50//in nm
```

```
deltatintramd=line_width*intramodal_dispersion*L*10^(-3)// intramodal dispersion in ns
mprintf("\ntotal intramodal dispersion=%.2f ns",deltatintramd);
total_dispersion=sqrt(deltatimd^2+deltatintramd^2);//total dispersion in ns
mprintf("\nTotal Dispersion=%.2f ns",total_dispersion);
//the textbook answer donot match
```

Scilab code Exa 8.10 10

```
// optical fibers and fiber optic communication system
 //Example 8.10
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc;
meucore=1.42//refractive index of core
meuclad=1.38//refractive index of cladding
delta=((meucore^2)-(meuclad^2))/(2*meucore);//relative refractive index
L=5000//length of link in m
mprintf("delta=%0.2f",delta);
c=3*10^(8)//speed of light in m/s
deltat=((meucore*delta*L)/c)*10^(9)//intramodal dispersion in ns
mprintf("\nIntramodal dispersion=%0.2f ns",deltat);
//the textbook answer donot match
```

Scilab code Exa 8.11 11

```
// optical fibers and fiber optic communication
   system
 //Example8.11
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
meu=1.5//refractive index of fibre
delta=2/100//delta
c=3*1e8//speed of light in m/sec
//to find
Intermodal_dispersion=((meu*delta)/c)*1e9*1000//
   intermodel dispersion in ns/km
mprintf("intermodel dispersion=%.0fns/km",
   Intermodal_dispersion)
```

Scilab code Exa 8.12 12

```
// optical fibers and fiber optic communication
   system
 //Example 8.12
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
```

```
//given
L=500//length of fibre in m
meu_core=1.41//refractive index of core
meu_clad=1.37//refractive index of cladding
R1=1e7//rate of pulse per second in bits/sec
R2=2*R1//case II rate of pulse per second in bits/
    sec
c=3*1e8//velocity of light in m/sec
//to find
NA=(meu_core-meu_clad)/meu_core//numerical aperture
delta=(meu_core^2-meu_clad^2)/(2*meu_core^2)//
    relative refractive index
delta_t=L*meu_core*delta**1e9/c//dispersion per km
    in ns
mprintf("numerical aperture=%.5f ns",NA)
mprintf("\nrelative refractive index=%.3f ns",delta)
mprintf("\ndispersion per km =%.1f ns ",delta_t)

//the textbook answer donot match in last place of
    decimal
```

Chapter 9

Light Sources for optical fibres

Scilab code Exa 9.1 1

```
// optical fibers and fiber optic communication
   system
 //Example 9.1
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
Or=1.5*1e-2//overall efficiency
I=60*1e-2//injection efficiency
E=50*1e-2//extraction efficiency
taunr=1e-8//non radiated lifetime
//to find
etar=Or/(I*E)//radiative recombination efficiency
taur=19*taunr*1e7//radiated lifetime
mprintf("radiative recombination efficiency=%.2
   fpercent",etar)
mprintf("\nradiated lifetime=%.1f1e-7sec",taur)
```

Scilab code Exa 9.2 2

```
// optical fibers and fiber optic communication
    system
 //Example 9.2
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
lamda=633*1e-3//operating wavelength in um
w=25//beam diameter in um
//to find
thetha0=(2*lamda)/(%pi*w)//divergance angle in
    radian
thetha=(thetha0*180)/%pi//divergance angle in degree
mprintf("divergance angle=%.3fradians",thetha0)
mprintf("\ndivergance angle=%.2fdegree",thetha)
```

Scilab code Exa 9.3 2

```
// optical fibers and fiber optic communication
    system
 //Example9.3
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
```

```
//given
Po=2*1e-3//output power in watts
Pe=100*2*1e-3//input power in watts
//to find
eta=(Po/Pe)*100//conversion efficiency
mprintf("conversion efficiency=%.0fpercent",eta)
```

Chapter 10

Photo Detectors

Scilab code Exa 10.1 1

```
// optical fibers and fiber optic communication system
 //Example10.1
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
Responsivity=0.58//responsivity in A/W
h=6.63*1e-34//plank constant in J.s
c=3*1e8//speed of light in m/s
lamda=850*1e-9//wavelength of light in m
e=1.6*1e-19//charge on conductor
//to find
eta=((Responsivity*h*c)/(e*lamda))*100//efficiency in percent
mprintf("efficiency of a PIN silicon photo detector =%.0fpercent",eta)
```

Scilab code Exa 10.2 2

```
// optical fibers and fiber optic communication
   system
 //Example10.2
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc;
k=1.38*10^(-23);//boltman's constant
lamda=1300//wavelength in nm
dark_current=5//in nA
responsivity=0.86//in A/W
optical_point=-27//in dBm
bias_resistor=4//in Kohm
delta=1//bandwidth in Hz
ith=sqrt(4*k*300/(bias_resistor*1000))//thermal
   noise in A/sqrt(Hz)
mprintf("thermal noise =%.2fx1e-12 A/sqrt(Hz)",ith
   *10^(12));//in pm
//the textbook answer donot match for  for last
   place of decimal
```

Scilab code Exa 10.3 3

```
// optical fibers and fiber optic communication
   system
 //Example10.3
//OS=Windows 10
```

```
// // Scilab version 5.5.2(32 bit)
clc;
Pd=2//in meuW detected optical supply
k=1.38*10^(-23);//boltman's constant
lamda=1300//wavelength in nm
dark_current=5//in nA
Ra=0.86//in A/W
optical_point=-27//in dBm
bias_resistor=4//in Kohm
delta=1//bandwidth in Hz
e=1.6*10^(-19)//charge on an electron
LNsh=sqrt(2*e*(Ra*Pd*10^(-6)+5*10^(-9)))//quantum shot noise
mprintf("quantum shot noise current=%.2fx1e-13 A*sqrt(Hz)",LNsh*1e13)

NEP=LNsh/Ra//in PW/sqrt(Hz)
mprintf("\nNEP=%.3f PW/sqrt(Hz)",NEP*1e12)
```

Scilab code Exa 10.4 4

```
// optical fibers and fiber optic communication system
 //Example10.4
//OS=Windows 10
// // Scilab version 5.5.2(32 bit)
clc ;
clear
//given
work_function=1.8//work function in eV
//to find
lamda=(1.24/work_function)*1e3//wavelength in nm
mprintf("cutoff wavelength =%.0fnm",lamda)
```

Scilab code Exa 10.5 5

```
// optical fibers and fiber optic communication
   system
 //Example10.5
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
efficiency=15/100//quantum efficiency
wavelength=0.8*1e-6//wavelength in m
h=6.63*1e-34//plank constant
c=3*1e8//speed of light in m/s
e=1.6*1e-19//charge
//to find
Responsivity=(efficiency*e*wavelength)/(h*c)//
   responsivity in A/w
mprintf("responsivity=%.1fx10^-3A/w",Responsivity*1
   e3)
//the answer in the textbook does not match because
   efficiency is wrongly substituted
```

Scilab code Exa 10.6 6

```
// optical fibers and fiber optic communication
   system
```

```
 //Example10.6
//OS=Windows 10
// // Scilab version 5.5.2(32 bit)
clc ;
clear
//given
power=1*1e-6//power absorbed in watts
resistance=50//load resistance in ohms
efficiency=1/100//efficiency
wavelength=800*1e-9//operating wavelength
//to find
id=(6.4*1e-3)*power*1e9//detector current in na
Vl=id*resistance//voltage across the load in nV
mprintf("detector current =%.1fnA",id)
mprintf("\nvoltage across the load =%.0fnV",Vl)
```

Scilab code Exa 10.7 7

```
// optical fibers and fiber optic communication
   system
 //Example10.7
//OS=Windows 10
// // Scilab version 5.5.2(32 bit)
clc
EG1=1.12//bandgap in eV
EG2=0.667//bandgap in eV
EG=1.24//bandgap in eV
lamdaSi=EG/EG1//wavelength of Si in um
mprintf("wavelength of Si =%.2f um",lamdaSi)//in um
lamdaGe=EG/EG2//wavelength of Ge in um
mprintf("\nwavelength of Ge =%.2f um",lamdaGe)//in
   um
```

Scilab code Exa 10.8 8

```
// optical fibers and fiber optic communication
   system
 //Example 10.8
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
Cd=5//capacitance in pf
tr=2*1e-9//transit time limited rise time in s
c=3*1e8//velocity of light in m/sec
//to find
f3_dB=0.35*1e-6/tr//3-dB bandwidth in MHz
RL_max=0.5*1e3/(2.19*Cd)//largest resistance in ohm
mprintf("f3-dB bandwidth =%.0fMHz",f3_dB)
mprintf("\nlargest resistance=%.0f ohm",RL_max)


//the textbook answer donot match in last place of
   decimal
```

Chapter 11

Noise control in Optical Fibres

Scilab code Exa 11.1 1

```
// optical fibers and fiber optic communication
   system
 //Example 11.1
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
emitting_power=12//in mW of an led
lamda1=850//wavelength in nm
loss1=20//in dB
Responsivity=0.45//in A/W
dark_current=2//in nA
Rl=70//load resistance in ohm
deltaf=10//in MHz
temperature=27+273//in kelvin
loss2=14//in dB
loss3=10//in dB
Total_system_loss=loss1+loss2+loss3;
mprintf("\nTotal_system_loss =%.1fdB",
   Total_system_loss);//in dB
```

```
transmission_efficiency=10^(-Total_system_loss/10)
mprintf("\nThe transmission efficiency =%.1fx1e-5", transmission_efficiency*1e5);

Pr=transmission_efficiency*emitting_power//optical power reaching the receiver in W
mprintf("\noptical power reaching the receiver =%.1fx1e-4mW",Pr*1e4);


Ip=Responsivity*Pr*1e-3//Photocurrent in A
mprintf("\nPhotocurrent =%0.0f x1e-0A",Ip*1e9);
//the textbook answer donot match for  last place of decimal due to rounding
Electrical_signal_power=(Ip)^(2)*Rl;//in W
mprintf("\nElectrical_signal_power =%0.2f x1e-12W", Electrical_signal_power*1e12);//in W
//the textbook answer donot match for  last place of decimal due to rounding
k=1.38*10^(-23)//boltman's constant
PTh=4*k*temperature*deltaf*10^(6);//Thermal noise in W
mprintf("\nThermal noise=%0.2f x1e-13W",PTh*1e13);//in W

e=1.6*10^(-19)//charge on an electron in columb
PSN=2*e*Ip*deltaf*Rl*10^(6)//shot noise in W
mprintf("\nshot noise=%0.1f x1e-17W",PSN*1e17);//in W

SNR=Electrical_signal_power/PTh//signal to noise ratio
mprintf("\nsignal to noise ratio=%0.2f ",SNR);
//the textbook answer only donot match for  last place of decimal due to rounding
```

Scilab code Exa 11.2 2

```
// optical fibers and fiber optic communication
   system
 //Example 11.1
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )clc;
//given
clc
clear all
lamda1=0.850//wavelength in um
Responsivity=0.5//in A/W
Id=2e-9//dark_currentin A
Rl=100//load resistance in ohm
deltaf=1//in MHz
T=27+273//temperaturein kelvin
e=1.6*10^(-19)//charge on an electron in columb
k=1.38*10^(-23)//boltman's constant
//to find
PTh_2=4*k*T*deltaf*10^(6)/Rl;//Thermal noise in W
//mprintf("\nThermal noise=%0.2f W",PTh_2);//in W

PSN_2=2*e*Id*deltaf*10^(6)//shot noise in W
//mprintf("\nshot noise=%0.2f W",PSN_2);//in W
NEP=sqrt(PTh_2+PSN_2)//Noise equivalent power
Pmin=NEP*sqrt(deltaf)//minimum power in W
mprintf("\nminimum power =%0.2f nW ",Pmin*1e9);
//the textbook answer donot match for for last
   place of decimal
```

Scilab code Exa 11.3 3

```
// optical fibers and fiber optic communication
   system
 //Example 11.3
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc;
dark_current=5*10^(-9)//dark current in A
responsivity=0.80//in A/W
lamda=1300//wavelength in nm
deltaf=1//bandwidth in Hz
received_optical_power=-27//in dBm
R=4*10^(3)//bias resistance in ohm
e=1.6*10^(-19)//charge on an electron
Isnc=sqrt(2*e*dark_current)/deltaf//shot noise
mprintf("shot noise=%.2fx1e-14 A/sqrt(Hz)",Isnc*1e14
   );//in A/sqrt(Hz)
```

Scilab code Exa 11.4 4

```
// optical fibers and fiber optic communication
   system
 //Example 11.1
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )clc;
//given
clc;
```

```
k=6.63*10^(-34)//plank's constant
lamda=820//wave;ength in nm
c=3*10^(8)//velocity of light in m/s
photons_per_pulse=10.5//photons_per_pulse or per bit
    for a 1Hz bandwidth
Pav=photons_per_pulse*k*c/(lamda*10^(-9))//average
    photon power in W
mprintf("average photon power =%.2f x1e-18 W/sqrt(Hz
    )",Pav*1e18);//in W/sqrt(Hz)
mprintf("\naverage photon power =%.2f dBm/sqrt(Hz)"
    ,10*log10(Pav/1e-3));//in dBm/sqrt(Hz)
```

Scilab code Exa 11.5 5

```
// optical fibers and fiber optic communication
    system
 //Example 11.5
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )clc;
//given
clc;
//given
Idark=5*1e-9//dark current in A
A=25//avalanche gain
R=0.86*25//responsivity in A/W
Ip=42.9*1e-6//avalanche photocurrent in A
Id=Ip/A//photo current in uA without gain
Rd=4000//detector resistor
NF=1.41//noise figure in normal scale
R=45//receiver operating rate in Mb/s
k=1.38*1e-23//Boltzman constant
T=300//room temperature in K
e=1.6*1e-19//charge of an electron in Columb
```

```
//to find
ith_2=4*k*T*R*NF/Rd//thermal noise in A^2
is_2=2*e*(Id+Idark)*R//Quantum shot noise current in
    A^2
F_25=0.4*A+(1-0.4)*(2-1/Rd)//Excess noise factor
Ex_shot_noise_cur_2=2*e*(Ip+Idark)*A^2*F_25*R//
   excess shot noise current in A^2
SNR=10*log10(A^2*Id^2/(7.2*10.15))//signal to noise
   ratio in dB
mprintf("signal to noise ratio =%.2fdB ",SNR);
//the data given is also incomplete
//the answer given in textbook donot match
```

Chapter 12

optical coupler

Scilab code Exa 12.1 1

```
// optical fibers and fiber optic communication
   system
 //Example 12.1
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
d=50//core daimeter in um
NA=0.21//numerical aperture
Long_disp=5//Longitudinal_displacement in percent
//to find
eta_SI=(d/2*1e-6)/(d/2*1e-6+Long_disp/100*50*1e-6*
   tand(asind(NA)))
mprintf("coupling efficiency =%.2f",eta_SI)
```

Scilab code Exa 12.2 2

```
// optical fibers and fiber optic communication
   system
 //Example 12.2
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
input_power=200//input power to the star coupler in
   u watts
power_at_each_coupler=50//in u watts
n=4//number of couplers
//to find
power_division=-10*log(1/n)//power division
mprintf("the power divsion=%.2fdB",power_division)
```

Scilab code Exa 12.3 3

```
// optical fibers and fiber optic communication
   system
 //Example 12.3
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
P2byP3=4//splitting ratio

//to find
P3byP1=1/(P2byP3+1)//in normal scale
P2byP1=P2byP3/(P2byP3+1)//in normal scale
P4byP1=0//therefore directionality is infinity

```

```
throughput_loss=-10*log10(P2byP1)//throughput loss in dB
tap_loss=-10*log10(P3byP1)//tap loss in dB
excess_loss=-10*log10(P3byP1+P2byP1)//loss due to radiation scattering in dB
mprintf("P4byP1=%.4f",P4byP1)
mprintf("\nP3byP1 =%.3f",P3byP1)
mprintf("\nP2byP1=%.3f",P2byP1)
mprintf("\nthroughput loss=%.2fdB",throughput_loss)
mprintf("\ntap loss=%.2fdB",tap_loss)
mprintf("\nRadiation scattering =%.0fdB",excess_loss)
mprintf("\ndirectionality= infinity")
```

Scilab code Exa 12.4 4

```
// optical fibers and fiber optic communication system
 //Example 12.4
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
P2byP3=2//splitting ratio
excess_loss=1//complex directionality in dB
//to find
P3byP1=10^(-excess_loss/10)/(P2byP3+1)//in normal scale
P2byP1=P2byP3*P3byP1//in normal scale

mprintf("\nP3byP1 =%.2f",P3byP1)
mprintf("\nP2byP1=%.2f",P2byP1)
```

```
//the textbook answer donot match for p2by p1 for
   last place
```

Scilab code Exa 12.5 5

```
// optical fibers and fiber optic communication
   system
 //Example 12.5
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
Laser_Power=3//power of laser in dB
no_of_fibers=8//no. of fibers
excess_loss=2//complex directionality in dB
//to find
Power_division=-10*log10(1/no_of_fibers)//Power
   division in decibels
Power_in_each_fiber=Laser_Power-Power_division-
   excess_loss//in dB
Power_in_each_fiber_W=10^(Power_in_each_fiber/10)//
   in Watt
mprintf("\nPower in each fiber =%.2fdB",
   Power_in_each_fiber)
mprintf("\nPower in each fiber=%.2fmW",
   Power_in_each_fiber_W*1e3)
//the textbook answer donot match for  for last
   place of decimal
```

Scilab code Exa 12.6 6

```
// optical fibers and fiber optic communication system
 //Example 12.6
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
excess_loss=2//excess loss in dB
P2byP3=4//splitting ratio
directionality=40//complex directionality in dB
//to find
P4byP1dB=-directionality/10//in dB
P4byP1=10^(P4byP1dB)//in normal scale
P3byP1=(10^(-excess_loss/10))/5//in normal scale
P2byP1=P3byP1*4//in normal scale
throughput_loss=-10*log10(P2byP1)//throughput loss in dB
tap_loss=-10*log10(P3byP1)//tap loss in dB
loss=excess_loss//loss due to radiation scattering in dB
mprintf("P4byP1=%.4f",P4byP1)
mprintf("\nP3byP1 =%.3f",P3byP1)
mprintf("\nP2byP1=%.3f",P2byP1)
mprintf("\nthroughput loss=%.2fdB",throughput_loss)
mprintf("\ntap loss=%.2fdB",tap_loss)
mprintf("\nRadiation scattering =%.0fdB",loss)
```

Scilab code Exa 12.7 7

```
// optical fibers and fiber optic communication
   system
 //Example 12.7
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
d=50//core daimeter in um
NA=0.21//numerical aperture
a=2/2//beam diameter in mm
lateral_loss=1//lateral offset loss in dB
beam_divergence_angle=12.12//beam divergence angle
   in degrees
//to find
F=a/tand(beam_divergence_angle)//Focal length of
   lense in m
la=10^(-lateral_loss/10)*2*a/10//allowable lateral
   offset  in mm
mprintf("Focal length of lense =%.2fm",F)
mprintf("\nAllowable lateral offset=%.2fmm",la)
```

Chapter 13

Splicing

Scilab code Exa 13.1 1

```
// optical fibers and fiber optic communication system
 //Example 13.1
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
NA=0.24//numerical aperture
a=50//radius of core in um
loss_dB=0.25//error in loss in dB
meu0=1//refractive index of air
d=0.45//seperation between the axis of the two fibers in um
//to find
loss=10^(-loss_dB/10)//loss in normal scale
lateral_offset=d/(2*a)//lateral offset in mm
angular_misalignment=(1-loss)*(%pi*NA/meu0)//angular misalignment in degrees
end_seperation=a*loss//end seperation in um
//Loss=-10*log10(1-(meu0*theta)/(%pi*NA))
```

```
mprintf("lateral offset=%.1f um",lateral_offset*1e3)


mprintf("\nangular misalignment=%.2f degrees",
    angular_misalignment)
//the answer given in the book for angular
    misalignment donot match because as per the
    formula given and the values the calculation are
    done wrongly in textbook

mprintf("\nend seperation =%.0f um",end_seperation)
```

Scilab code Exa 13.2 2

```
// optical fibers and fiber optic communication
    system
 //Example13.2
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
NA=0.2//numerical aperture
loss=0.5//loss in dB
r=1//radius of fibre in mm
a=1//radius in mm
//to find
thetha=asind(NA)//beam divergance angle
f=1/tand(thetha)//distance from the fibre to the  in
     mmm
d=(2*a)*0.09*1e3//distance
mprintf("beam divergance angle=%.1fdegree",thetha)
mprintf("\ndistance from the fibre to the um=%.1fmm"
```

```
,f)
mprintf("\ndistance=%.0fum",d)
```

Scilab code Exa 13.3 3

```
// optical fibers and fiber optic communication system
 //Example 13.3
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear
//given
meu1=1.45//refractive index of glass
meu2=1//refractive index of air
//to find
fresnel_loss=10*log10((meu1+meu2)/(4*meu1*meu2))//fresnel loss
mprintf("total fresnel loss=%.2fdB",2*fresnel_loss)
//THE ANSWER IT TEXBOOK IS WRONG
```

Scilab code Exa 13.4 4

```
// optical fibers and fiber optic communication system
 //Example 13.4
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
```

```
clear
//given
diameter=200//diameter of fibre pigtail in um
graded_index_core=50//graded index core in um
//to find
loss=20*log10(diameter/graded_index_core)//coupling loss
mprintf("coupling loss=%.0fdB",loss)
```

Scilab code Exa 13.5 5

```
// optical fibers and fiber optic communication system
//Example 13.5
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc ;
clear all;
//given
NA1=0.39//numerical aperture for fibre 1
NA2=0.20//numerical aperture for fibre 2
//to find
NA_mismatch_coupling_loss=20*log10(NA1/NA2)//NA mismatch coupling loss in dB
mprintf("NA mismatch coupling loss=%.1fdB",NA_mismatch_coupling_loss)
```

Chapter 20

Measurements on Optic Fibres

Scilab code Exa 20.1 1

```
// optical fibers and fiber optic communication system
 //Example 20.1
//OS=Windows 10
// // Scilab version 5.5.2(32 b i t )
clc;
D=15//diameter in inch
R=(D/2)*0.0254//radius in m
L=4//length in km
N=L*1000/(2*%pi*R)//no of turns
mprintf("no of turns=%0.0f",N);

lamdac=1250//cutoff wavelength in nm
delta=0.004//delta
A=60*%pi*(N/(L))*((delta)^(1/4))*sqrt(R*1e6*((lamdac)^(3/2)))//overlaped mode area in dB*um^(2)*km^(-1)
mprintf("\noverlaped mode area =%0.2fx1e6 dB*um^(2)*km^(-1)",A*1e-6);
//the textbook answer  for A  donot match although same values as given in textbook are substitites
```

```
so there is calculation mistake in book
m1=-0.705*delta^(3/2)*R*1e6;//in um
mprintf("\nm1=%0.2f  um",m1);
//the textbook answer  for m1 donot match although same values as given in textbook are substitites so there is calculation mistake in book

m2=0.996/lamdac*1e-3//in (um)^(-1)
mprintf("\nm2=%0.4f(um)^(-1)",m2*1e6);
```