Scilab Textbook Companion for Textbook on Optical Fiber Communication and Its Applications by S. C. Gupta[1]

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July 31, 2019

[1]Funded by a grant from the National Mission on Education through ICT, http://spoken-tutorial.org/NMEICT-Intro. This Textbook Companion and Scilab codes written in it can be downloaded from the "Textbook Companion Project" section at the website http://scilab.in

Book Description

Title: Textbook on Optical Fiber Communication and Its Applications

Author: S. C. Gupta

Publisher: Phi, New Delhi

Edition: 2

Year: 2013

ISBN: 978-81-203-4580-5

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

Optical fibers and fiber cables

Scilab code Exa 2.01 Compuatation of mode parameter

```
// Example 2.1
// Compuatation of mode parameter
// Page no. 479

clc;
clear;
close;

//Given data
n1=1.503; // refractive index of core
n2=1.50; // refractive index of cladding
a=4*10^-6; // core radius
lambda=1*10^-6; // light wavelength

// Mode parameter computation
V=(2*%pi*a*sqrt(n1^2-n2^2))/(lambda);

//Displaying the result in command window
printf("\n Mode parameter is = %0.3f ",V);
```

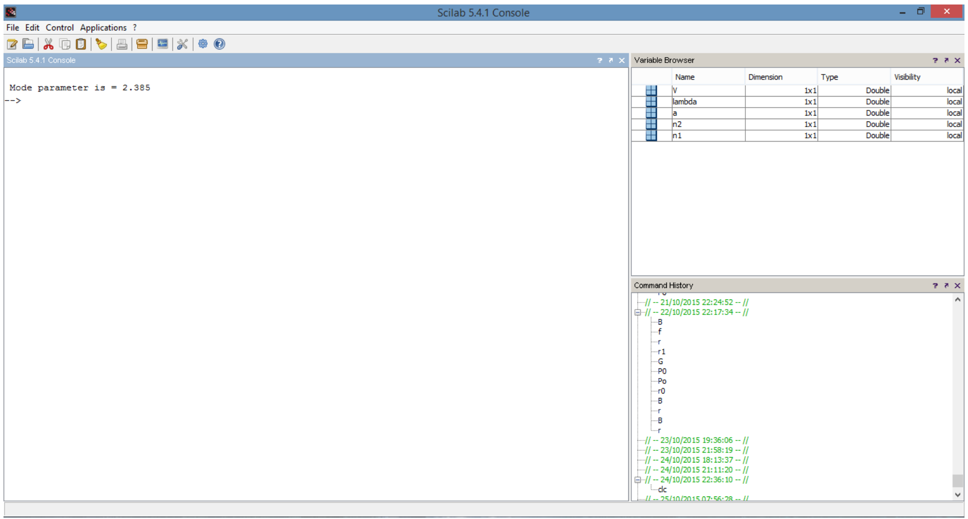

Figure 2.1: Compuatation of mode parameter

```

// The answer vary due to round off error
```

Scilab code Exa 2.1 `Calculation of core diameter`

```
// Example 2.1
// Calculation of core diameter
// Page no 31

clc;
clear;
close;

// Given data
n1=1.5;                     // Refractive index of core
n2=1.48;                    // Refractive index of cladding
```

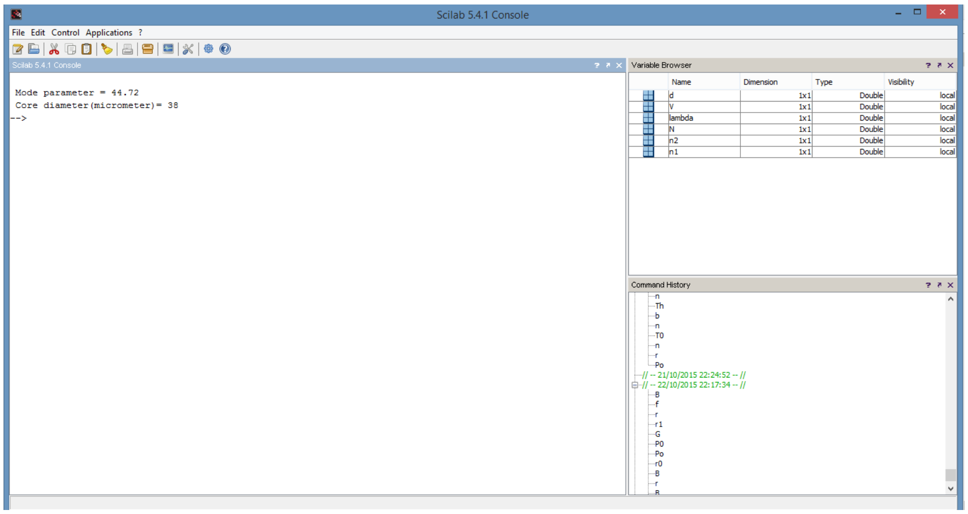

Figure 2.2: Calculation of core diameter

```
N=1000;                    // No of modes
lambda=1.3;                // Light wavelength
V=sqrt(2*N);               // Mode parameter

//core diameter
d=(lambda*V)/(2*%pi*sqrt(n1^2-n2^2));


//Display result on command window
printf("\n Mode parameter = %0.2f  ",V);
printf("\n Core diameter(micrometer)= %0.0f  ",d);

// Answer is wrong in the book.
```

Scilab code Exa 2.02 `Calculation of numerical aperature`

```
// Example 2.2
```

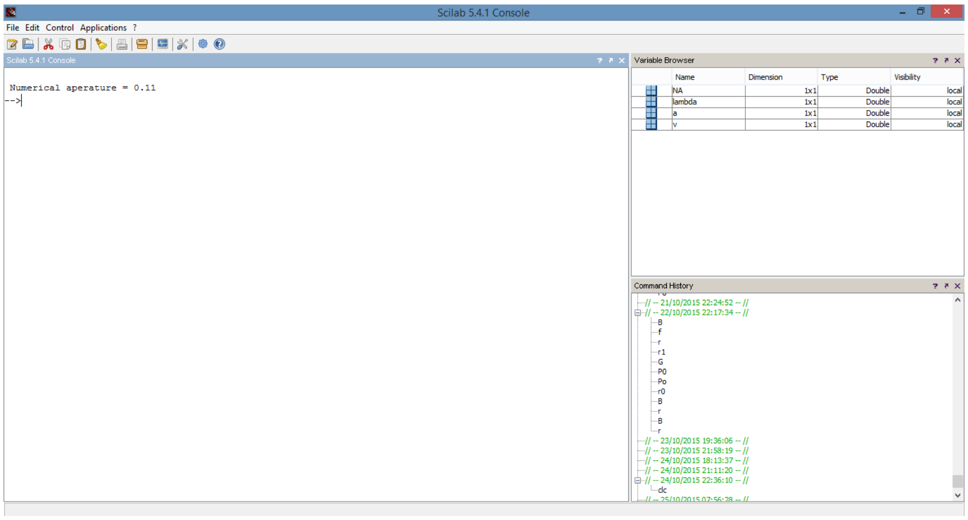

Figure 2.3: Calculation of numerical aperature

```
// Calculation of numerical aperature
// Page no. 479

clc;
clear;
close;

//Given data
v=2.111;                    // Mode parameter
a=4.01*10^-6;               // Core radius in m
lambda=1.3*10^-6;           // Wavelength of laser
   light m

//Numerical aperture computation
NA=(v*lambda)/(2*%pi*a);

//Displaying the result in command window
printf("\n Numerical aperature = %0.2f",NA);
```

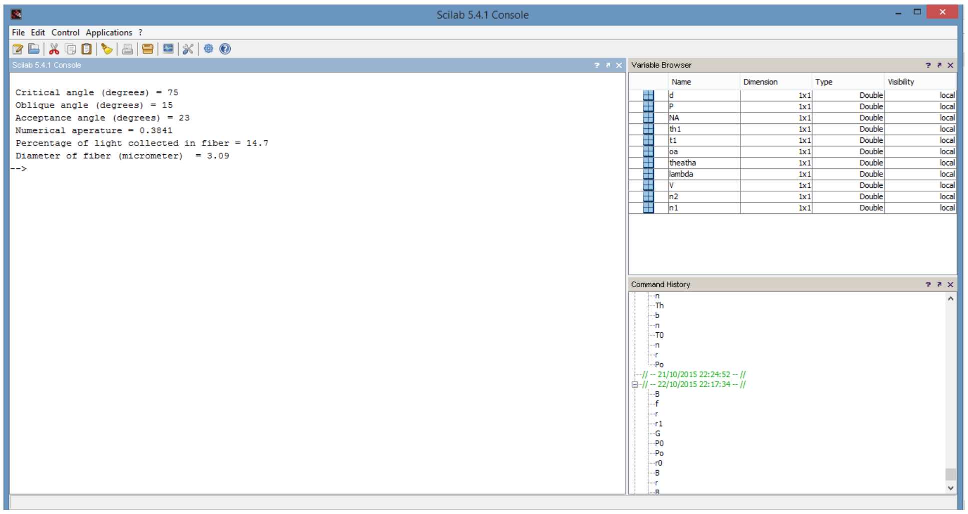

Figure 2.4: Calculation of critical angle and acceptance angle and oblique angle and numerical aperature and percentage of light collected by the fiber and diameter of fiber

Scilab code Exa 2.2 `Calculation of critical angle and acceptance angle and oblique`

```
// Example 2.2
// Calculation of (a) critical angle (b) acceptance
   angle and oblique angle (c) numerical aperature
// (d) percentage of light collected by the fiber
   and (e) diameter of fiber
// Page no 35

clc;
clear;
close;

// Given data
n1=1.5;                          // Refractive
   index of core
```

```
n2=1.45;                          // Refractive index of cladding
V=2.405;                          // Mode parameter
lambda=1.55                       // Wavelength of fiber

// (a) Critical angle of the
theatha=asind(n2/n1);

// (b) Oblique angle
oa=90-theatha;
 //Acceptance angle
t1=n1*sind(oa);
th1=asind(t1);

// (c) Numerical aperature
NA=sqrt(n1^2-n2^2);

// (d) Percentage of light collected in fiber
P=(NA)^2*100;

//(e) Diameter of fiber
d=V*lambda/%pi*(1/sqrt(n1^2-n2^2));

//Display result on command window
printf("\n Critical angle (degrees) = %0.0f  ",theatha);
printf("\n Oblique angle (degrees) = %0.0f  ",oa);
printf("\n Acceptance angle (degrees) = %0.0f  ",th1);
printf("\n Numerical aperature = %0.4f  ",NA);
printf("\n Percentage of light collected in fiber = %0.1f  ",P);
printf("\n Diameter of fiber (micrometer)  = %0.2f  ",d);
```

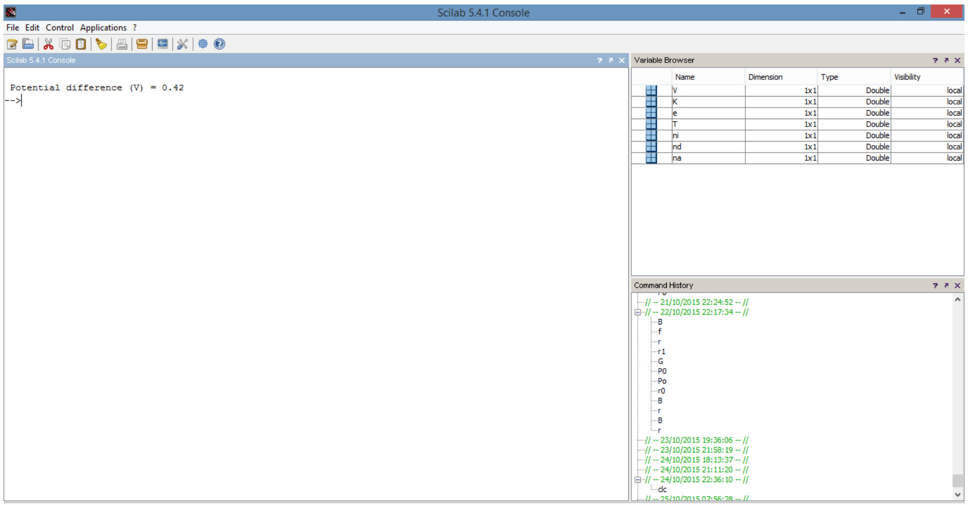

Figure 2.5: Calculation of potential difference

Scilab code Exa 2.03 `Calculation of potential difference`

```
// Example 2.3
// Calculation of potential difference
// page no 480

clc;
clear;
close;

// Given data
na=10^24;                    // Accepter impurity level
nd=10^22;                    // Donor impurity level
ni=2.4*10^19;                // Intrinsic electron
```

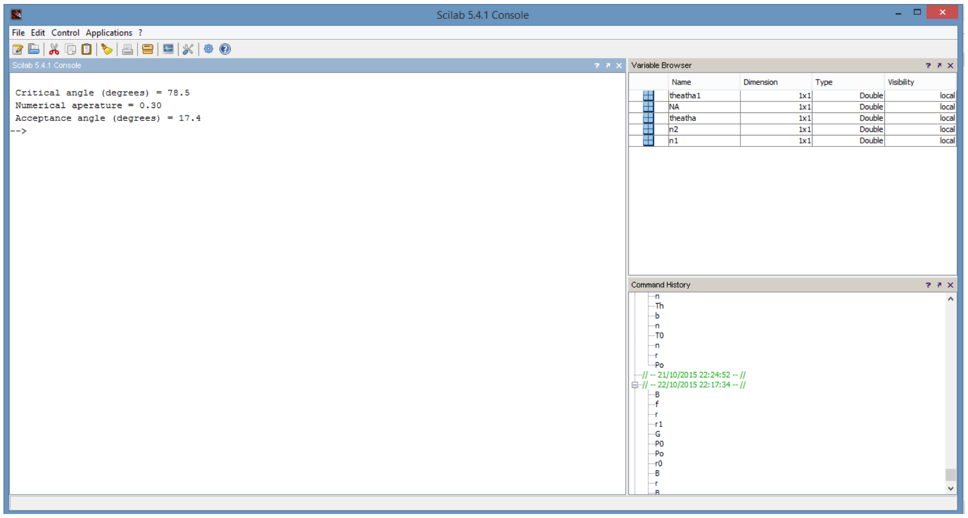

Figure 2.6: Calculation of critical angle and numerical aperature and acceptance angle

```
T=290;                        // Room temperature
e=1.602*10^-19;               // Electric charge
K=1.38*10^-23;                // Boltzmann constant


//Potential difference
V=(K*T)/e*(log(na*nd/(ni)^2));

//Display result on command window
printf("\n Potential difference (V) = %0.2f  ",V);
// The potential difference varies with the
   variation of Na, Nd and ni
```

Scilab code Exa 2.3 Calculation of critical angle and numerical aperature and acce

```
// Example 2.3
```

```
//  Calculation of (a) critical angle (b) numerical aperature and (c) acceptance angle
// Page no 38

clc;
clear;
close;

// Given data
n1=1.5;                                  // Refractive index of core
n2=1.47;                                 // Refractive index of cladding)

// (a) Critical angle
theatha=asind(n2/n1);
// (b) Numerical aperature
NA=sqrt(n1^2-n2^2);
// (c) Acceptance angle
theatha1=asind(NA);

//Display result on command window
printf("\n Critical angle (degrees) = %0.1f  ",theatha);
printf("\n Numerical aperature = %0.2f  ",NA);
printf("\n Acceptance angle (degrees) = %0.1f  ",theatha1);
```

Scilab code Exa 2.04 Calculation of Numerical aperature and critical angle

```
// Example 2.4
// Calculation of (a) Numerical aperature and (b) critical angle
```

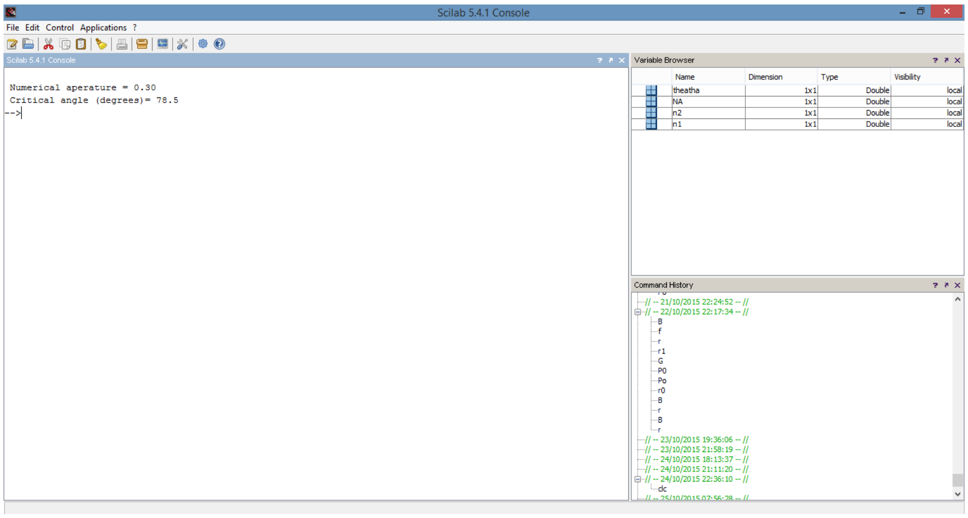

Figure 2.7: Calculation of Numerical aperature and critical angle

```
// Page no 480

clc;
clear;
close;

// Given data
n1=1.5;                          // Refractive index of
    core
n2=1.47;                         // Refractive index of
    cladding

// (a) Numerical aperature
NA= sqrt(n1^2-n2^2);

// (b) Critical angle
theatha=asind(n2/n1);

//Display result on command window
printf("\n Numerical aperature = %0.2f ",NA);
printf("\n Critical angle (degrees)= %0.1f  ",
```

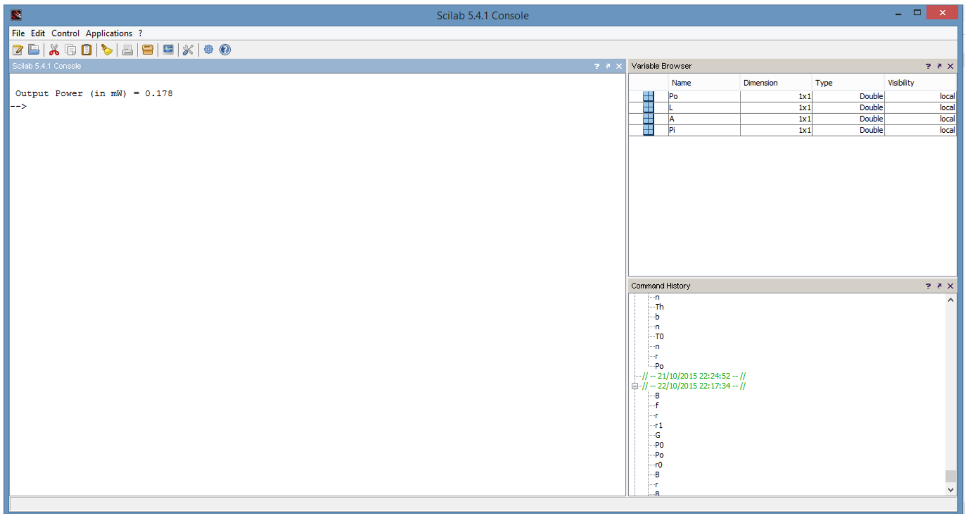

Figure 2.8: Calculation of output power

```
theatha);
```

Scilab code Exa 2.4 `Calculation of output power`

```
// Example 2.4
// Calculation of output power
// Page no 46

clc;
clear;
close;

// Given data
Pi=1;                                    // Input
   power
A=0.5;                                  //
   Atteuation
```

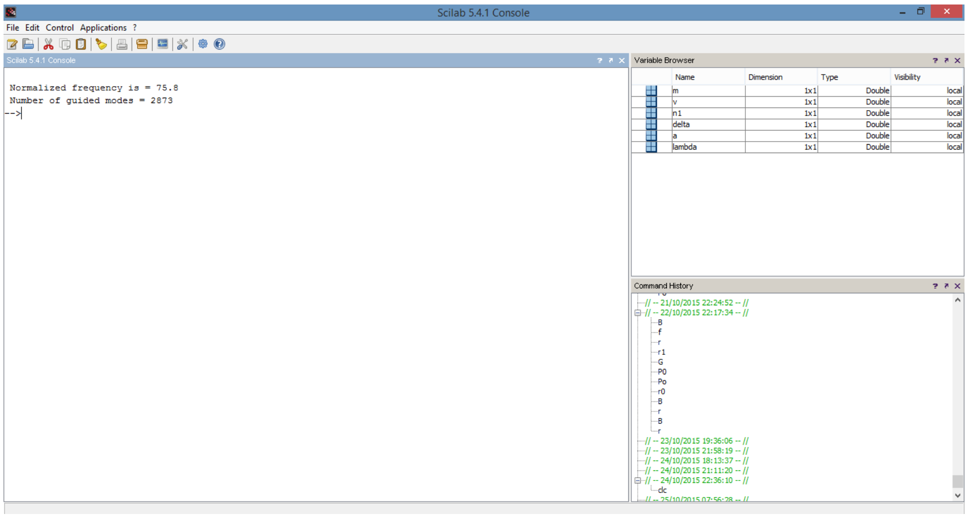

Figure 2.9: Computation of normalized frequency and no of guided modes

```
L=15;                                            // Fiber link length

// Output Power
Po=Pi*10^((-A*L)/10);

//Display result on command window
printf("\n Output Power (in mW) = %0.3f  ",Po);
```

Scilab code Exa 2.05 Computation of normalized frequency and no of guided modes

```
// Example 2.5
// Computation of (a) normalized frequency and (b) no. of guided modes
// Page no 480

clc;
```

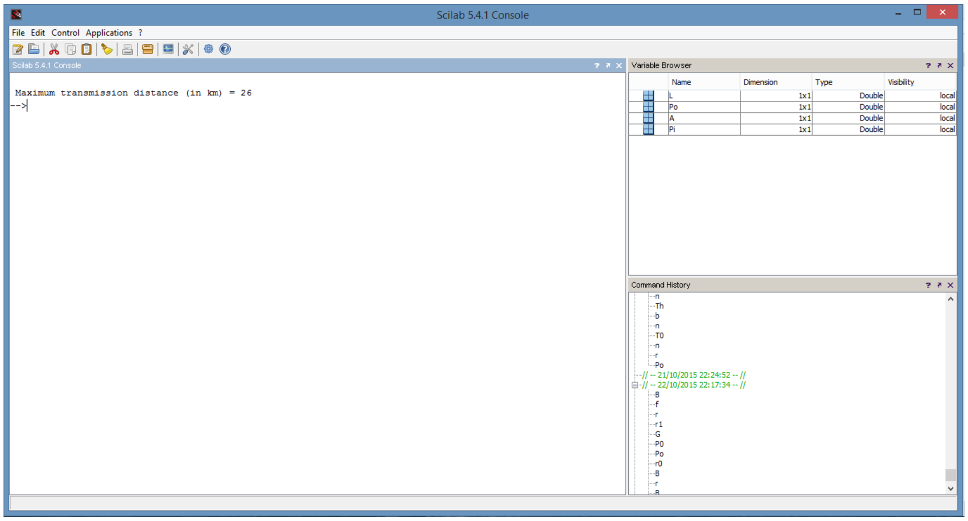

Figure 2.10: Calculation of maximum transmission distance

```
clear;
close;

//Given data
lambda=0.85*10^-6;          // wavelength of fiber
a=40*10^-6;                 // core diameter of fiber
delta=0.015;                // relative refractive index
n1=1.48;                    // refractive index of core

// (a) Normalized frequency
v=(2*%pi*a*n1*(2*delta)^(1/2))/lambda;
//(b) Number of guided modes
m=v^2/2;
m=ceil(m);
//Displaying results in the command window
printf("\n Normalized frequency is = %0.1f  ",v);
printf("\n Number of guided modes = %0.0f  ",m);
```

Scilab code Exa 2.5 `Calculation of maximum transmission distance`

```
// Example 2.5
// Calculation of maximum transmission distance
// Page no 47
clc;
clear;
close;

// Given data
Pi=1*10^-3;                              // Input power
A=0.5;                                   // Atteuation
Po=50*10^-6;                             // Output Power

// Maximum transmission distance
L=(10/A)*log10(Pi/Po);

//Display result on command window
printf("\n Maximum transmission distance (in km) =
    %0.0f  ",L);
```

Scilab code Exa 2.06 `Computation of normalized frequency and no of guided modes`

```
// Example 2.6
// Computation of normalized frequency and no of
   guided modes
// Page no 480
clc;
clear;
close;
```

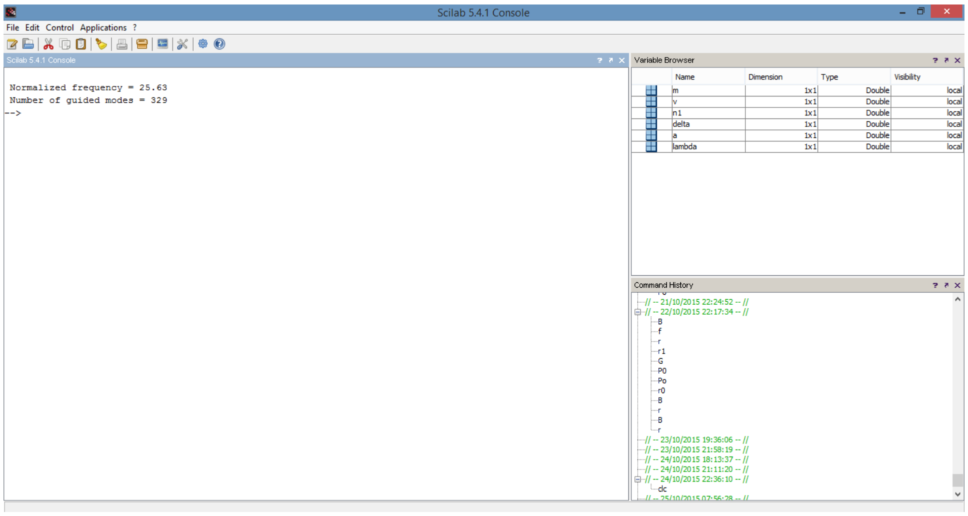

Figure 2.11: Computation of normalized frequency and no of guided modes

```

//Given data
lambda=1.30*10^-6;          // Wavelength of fiber
a=25*10^-6;                 // Core diameter of fiber
delta=0.01;                 // Relative refractive index
n1=1.50;                    // Refractive index of core

// (a) Normalized frequency
v=((2*%pi*a*n1)/(lambda))*((2*delta)^(1/2));
//(b) Number of guided modes
m=v^2/2;
//m=ceil(m);

//Displaying results in the command window
printf("\n Normalized frequency = %0.2f  ",v);
printf("\n Number of guided modes = %0.0f  ",m);

//Answer varies due to round off error
```

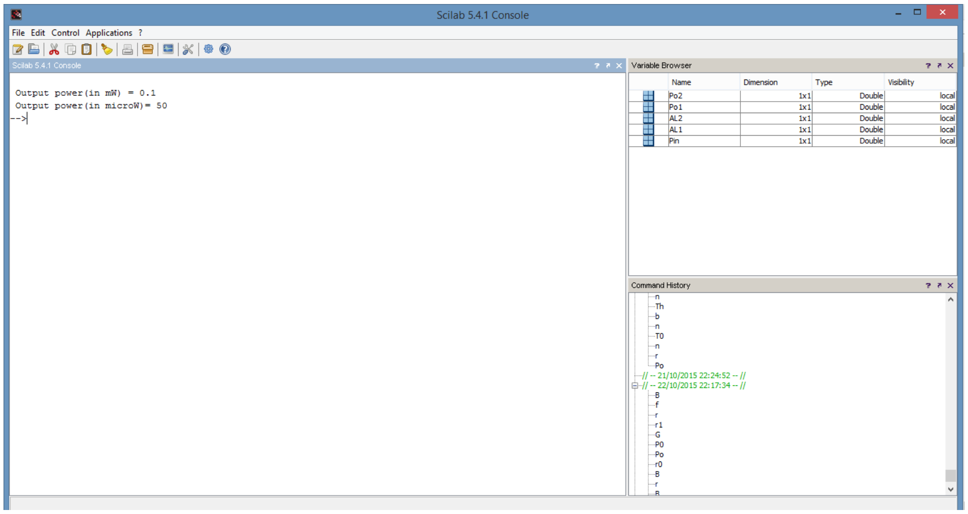

Figure 2.12: Calculation of output power

Scilab code Exa 2.6 `Calculation of output power`

```
// Example 2.6
// Calculation of output power
// Page no 48

clc;
clear;
close;

// Given data
Pin=1*10^-3;                    // Input power
AL1=10;                         // Attenuation 1
AL2=20;                         // Attenuation 2
//Output power 1 and 2
Po1=Pin/10;
```

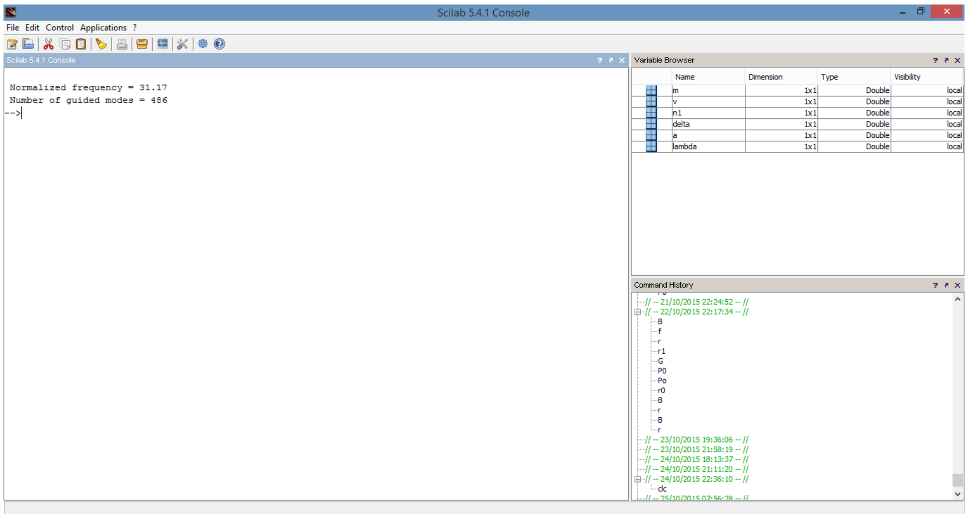

Figure 2.13: Calculation of normalized frequency and no of guided modes

```
Po2=Pin/20;
Po1=Po1*10^3;
Po2=Po2*10^6;
//Display result on command window
printf("\n Output power(in mW) = %0.1f ",Po1);
printf("\n Output power(in microW)= %0.0f",Po2);
```

Scilab code Exa 2.07 `Calculation of normalized frequency and no of guided modes`

```
// Example 2.7
// Calculation of normalized frequency and no of
   guided modes
// Page no 481

clc;
clear;
close;
```

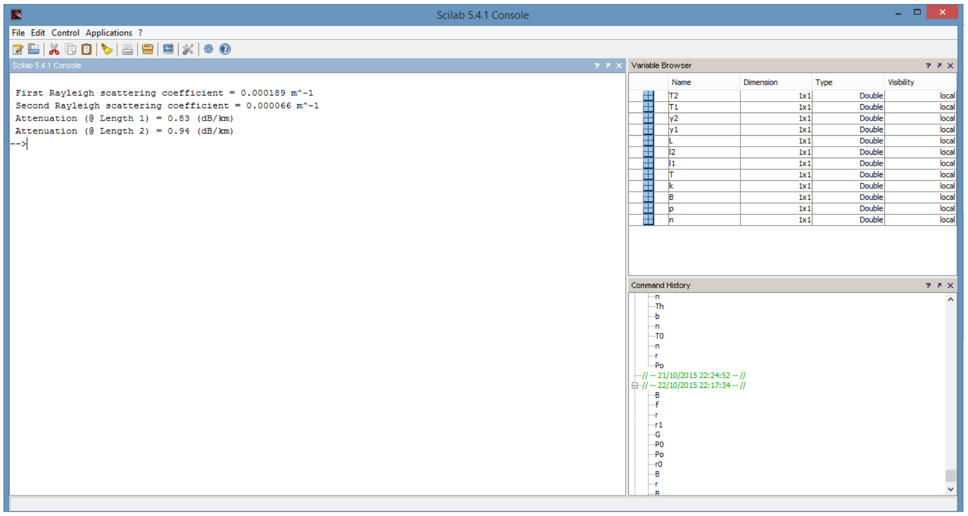

Figure 2.14: Calculation of attenuation and Rayleigh scattering coefficient for fiber

```

//Given data
lambda=1.55*10^-6;        // Wavelength of fiber
a=30*10^-6;               // Core diameter of fiber
delta=0.015;              // Relative refractive index
n1=1.48;                  // Refractive index of core

// (a) Normalized frequency
v=(2*%pi*a*n1*(2*delta)^(1/2))/lambda;
//(b) Number of guided modes
m=v^2/2;

//Displaying results in the command window
printf("\n Normalized frequency = %0.2f  ",v);
printf("\n Number of guided modes = %0.0f  ",m);
// The answers vary due to round off error
```

Scilab code Exa 2.7 `Calculation of attenuation and Rayleigh scattering coefficient`

```
// Example 2.7
// Calculation of attenuation and Rayleigh
   scattering coefficient for fiber
// Page no 50
clc;
clear;
close;

// Given data
n=1.46;                                          //
   Refractive index
p=0.286;                                         //
   Average photoelastic coefficient
B=7.25*10^-11;                                   //
   Isothermal compressibility
k=1.38*10^-23;                                   //
   Boltzmann's constant
T=1350;                                          //
   Fictive temperature
l1=1*10^-6;                                      //
   Wavelength 1
l2=1.3*10^-6;                                    //
   Wavelength 2
L=10^3;                                          //
   Length

// Rayleigh scattering coefficient for length 1
y1=8*(%pi)^3*(n)^8*(p)^2*B*k*T/(3*(l1)^4);
// Rayleigh scattering coefficient for length 2
y2=8*(%pi)^3*(n)^8*(p)^2*B*k*T/(3*(l2)^4);
y1=y1;
```

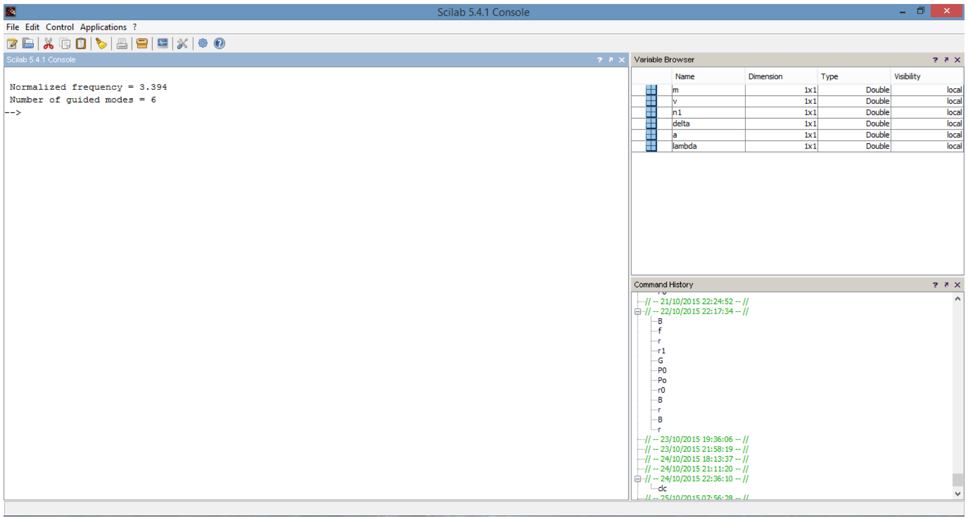

Figure 2.15: Calculation of normalized frequency and no of guided modes

```
y2=y2;
//Attenuation 1
T1=exp(-(y1*L));
//Attenuation 2
T2=exp(-(y2*L));

//Display result on command window
printf("\n First Rayleigh scattering coefficient = %0.6f m^-1 ",y1);
printf("\n Second Rayleigh scattering coefficient = %0.6f m^-1 ",y2);

printf("\n Attenuation (@ Length 1) = %0.2f (dB/km) ",T1);
printf("\n Attenuation (@ Length 2) = %0.2f (dB/km) ",T2);
```

Scilab code Exa 2.08 Calculation of normalized frequency and no of guided modes

```
// Example 2.8
// Calculation of normalized frequency and no of guided modes
// Page no 481
clc;
clear;
close;

//Given data
lambda=1.55*10^-6;          // Wavelength of fiber
a=4*10^-6;                  // Core diameter of fiber
delta=0.01;                 // Relative refractive index
n1=1.48;                    // Refractive index of core
// (a) Normalized frequency
v=(2*%pi*a*n1*(2*delta)^(1/2))/lambda;
//(b) Number of guided modes
m=v^2/2;

//Displaying results in the command window
printf("\n Normalized frequency = %0.3f ",v);
printf("\n Number of guided modes = %0.0f ",m);
// The answers vary due to round off error
```

Scilab code Exa 2.8 Calculation of threshold power of stimulated Brillouin scatter

```
// Example 2.8
// Calculation of threshold power of stimulated Brillouin scattering and Raman Scattering
// Page no 52
```

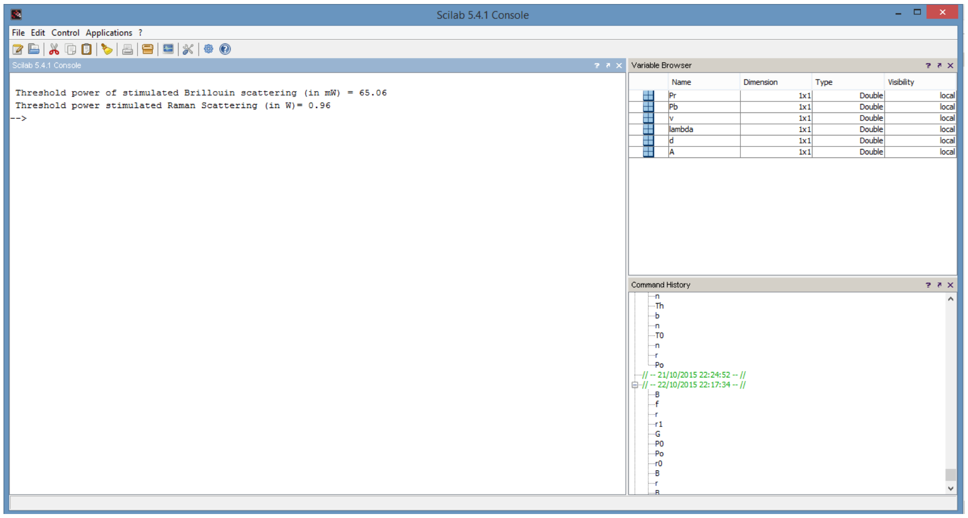

Figure 2.16: Calculation of threshold power of stimulated Brillouin scattering and Raman Scattering

```

clc;
clear;
close;

// Given data
A=0.5;                    // Attenuation
d=5;                      // Core diameter
lambda=1.3;               // Operating wavelength
v=0.7;                    // Bandwith of laser
   diode

// Threshold power of stimulated Brillouin
   scattering
Pb=4.4*10^-3*d^2*lambda^2*A*v;
Pb=Pb*10^3;

//Threshold power stimulated Raman Scattering
Pr=5.9*10^-2*d^2*lambda*A;

```

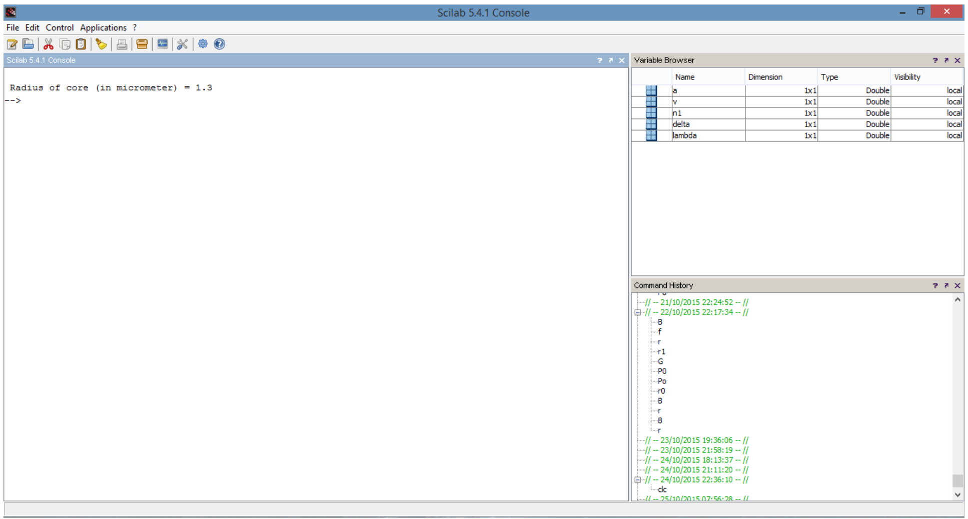

Figure 2.17: Calculation of Core radius

```
//Display result on command window
printf("\n Threshold power of stimulated Brillouin
    scattering (in mW) = %0.2f ",Pb);
printf("\n Threshold power stimulated Raman
    Scattering (in W)= %0.2f",Pr);
```

Scilab code Exa 2.09 `Calculation of Core radius`

```
// Example 2.9
// Calculation of Core radius
// Page no 481

clc;
clear;

//Given data
lambda=0.85*10^-6;              // Wavelength of fiber
```

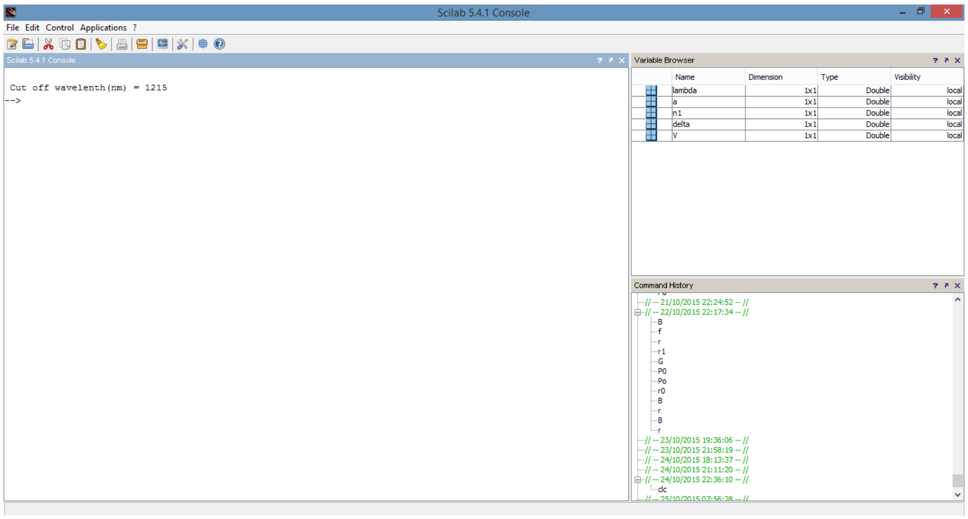

Figure 2.18: Calculation of Cut off wavelength

```
delta=0.015;                    // Relative refractive index
n1=1.48;                        // Refractive index of core
v=2.403;                        // Normalized frequency for single mode fiber
// Computation of core radius
a=v*lambda/(2*%pi*n1*sqrt(2*delta));
a=a*10^6;

//Displaying result in the command window
printf("\n Radius of core (in micrometer) = %0.1f  ",a);
```

Scilab code Exa 2.010 `Calculation of Cut off wavelength`

```
// Example 2.10
```

```
// Calculation of Cut off wavelength
// Page no 482

clc;
clear;
close;

// Given data
V=2.403;                // Normalized frequency
delta=0.25;             // Refractive index of core
n1=1.46;                // Relative refractive index
a=4.5*10^-6;            // Radius of core

// Cut off wavelenth
lambda=(2*%pi*a*n1*(sqrt(2*delta)))/V;

//Display result on command window
printf("\n Cut off wavelenth(nm) = %0.0f  ",lambda
    *10^8);

// The answers vary due to round off error
```

Scilab code Exa 2.011 Calculation of reflection and loss of light signal at joint

```
// Example 2.11
//Calculation of (a) reflection and (b) loss of
    light signal at joint areas.
// Page no 482

clc;
clear;
close;

```

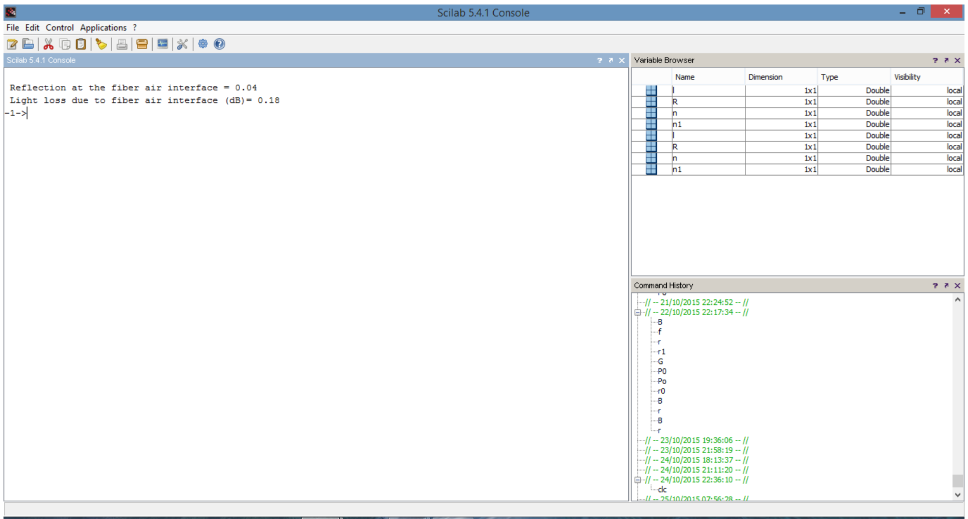

Figure 2.19: Calculation of reflection and loss of light signal at joint areas

```
// Given data
n1=1.5;                    // Refractive index of core
n=1;                       // Refractive index of air

// (a) Reflection at the fiber air interface
R=((n1-n)/(n1+n))^2;

// (b) Light loss due to fiber air interface
l= -10*log10(1-R);

//Display result on command window
printf("\n Reflection at the fiber air interface = %0.2f ",R);
printf("\n Light loss due to fiber air interface (dB)= %0.2f ",l);
```

Scilab code Exa 2.012 Computation of numerical aperature and maximum angle of entr

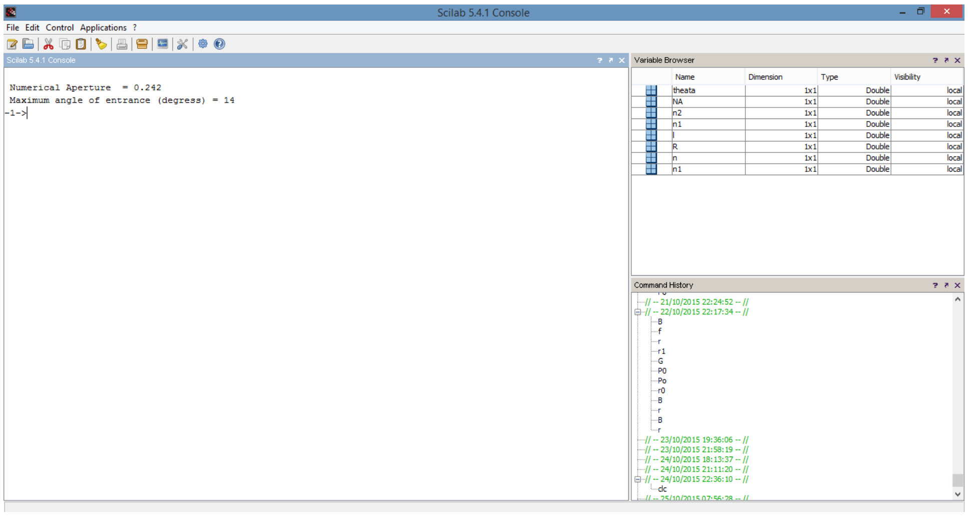

Figure 2.20: Computation of numerical aperature and maximum angle of entrance

```
// Example 2.12
// Computation of (a) numerical aperature and (b) maximum angle of entrance
// Page no 482

clc;
clear;
close;

//Given data
n1=1.48;                 // Refractive index of core
n2=1.46;                 // Refractive index of cladding

// (a) Numerical Aperture
NA=sqrt(n1^2-n2^2);

//(b) Maximum angle of entrance
theata=asind(NA);

//Displaying result in the command window
```

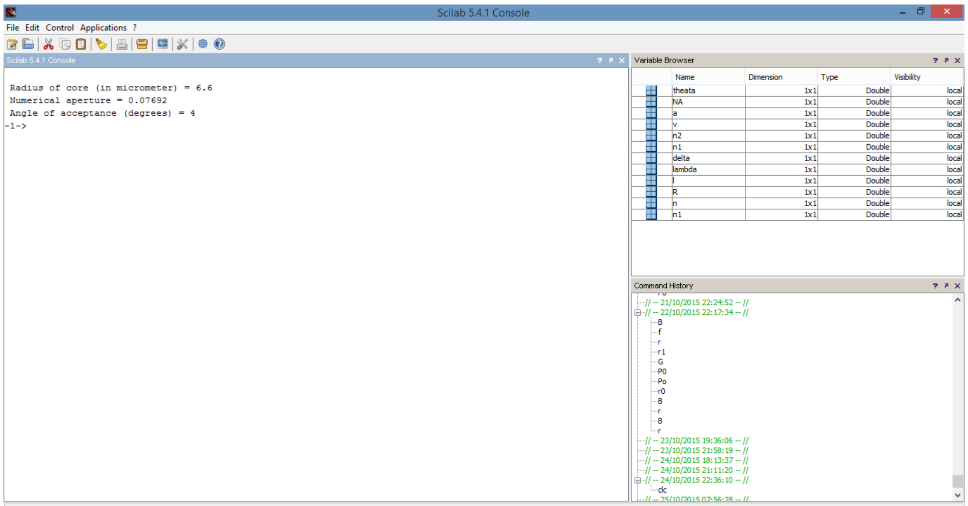

Figure 2.21: Calculation of core radius and maximum value of angle of acceptance of the fiber

```
printf("\n Numerical Aperture   = %0.3f  ",NA);
printf("\n Maximum angle of entrance (degress) = %0
    .0f  ",theata);

// Final answer in the book is wrong. Please refer
    example 2.11 of
// Fiber Optic Communication by Gerd Keiser book.
```

Scilab code Exa 2.013 `Calculation of core radius and maximum value of angle of acc`

```
// Example 2.13
// Calculation of (a) core radius and (b) maximum
    value of angle of acceptance of the fiber
// Page no 483

clc;
```

```
clear;
close;

//Given data
lambda=1320*10^-9;          // Wavelength of fiber
delta=0.077;                // Relative refractive index
n1=1.48;                    // Refractive index of core
n2=1.478;                   // Refractive index of cladding
v=2.403;                    // Normalized frequency

// (a) Core radius
a=v*lambda/(2*%pi*delta);
a=a*10^6;

//Numerical Aperture
NA=sqrt(n1^2-n2^2);

// (b) Angle of acceptance
theata = asind(NA);

//Display result on command window
printf("\n Radius of core (in micrometer) = %0.1f  ",a);
printf("\n Numerical aperture = %0.5f  ",NA);
printf("\n Angle of acceptance (degrees) = %0.0f  ",theata);

// The answers vary due to round off error
```

Scilab code Exa 2.014 Calculation of critical wavelength

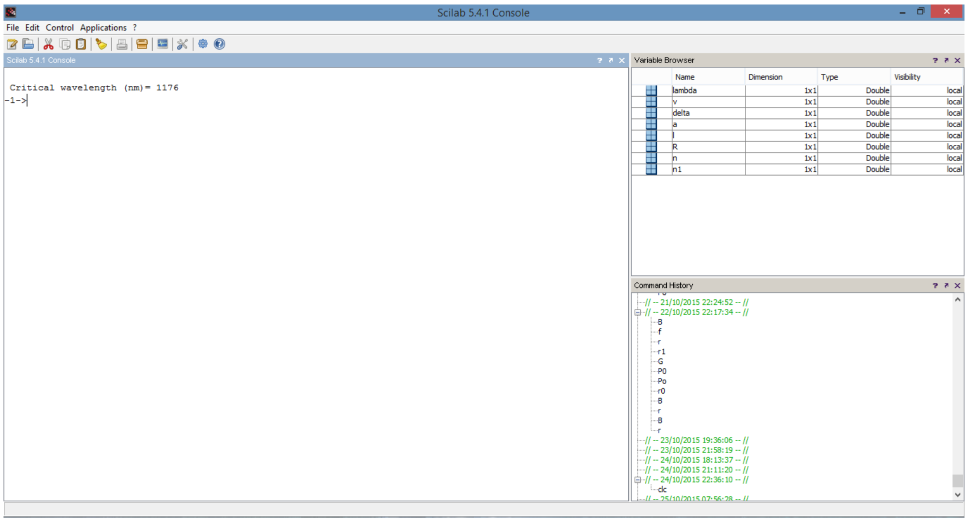

Figure 2.22: Calculation of critical wavelength

```
// Example 2.14
// Calculation of critical wavelength
// Page no 483

clc;
clear;
close;

//Given data
a=3*10^-6;                // Core diameter of fiber
delta=0.15;               // Relative refractive index
v=2.405;                  // Normalized frequency

// Critical wavelength
lambda=(2*%pi*a*delta)/v;
lambda=lambda*10^9;

//Displaying The Results in Command Window
printf("\n Critical wavelength (nm)= %0.0f ",lambda
    );

```

```
// The answers vary due to round off error
```

Chapter 3

Electroluminescent sources

Scilab code Exa 3.1 Calculation of barrier potential

```
//Calculation of barrier potential
// Example 3.1
// Page no 80
clc;
clear all;
close;


//Given data
p=5;                           // Resistivity of p-
   region
n=2;                           // Resistivity of n-
   region
mu=3900;
k=0.026;                       //Boltzmann constant
ni=2.5*10^13;                 //Density of the electron
    hole pair
e=1.6*10^-19;                 //charge of electron

```

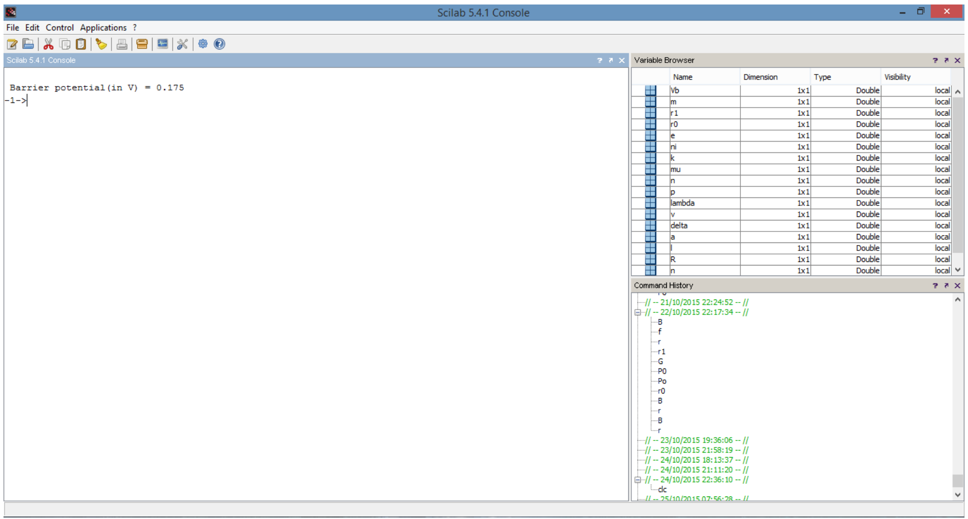

Figure 3.1: Calculation of barrier potential

```
//Barrier potential calculation
r0=(1/p);            // Reflection at the fiber air interface
r1=(1/n);
m=r1/(mu*e);
p=6.5*10^14;         //Density of hole in p -region
Vb=k*log(p*m/ni^2);

//Displaying the result in command window
printf("\n Barrier potential(in V) = %0.3f",Vb);

// The answers vary due to round off error
```

Scilab code Exa 3.15 `Calculation of external efficiency`

```
// Example 3.15
// Calculation of external efficiency
```

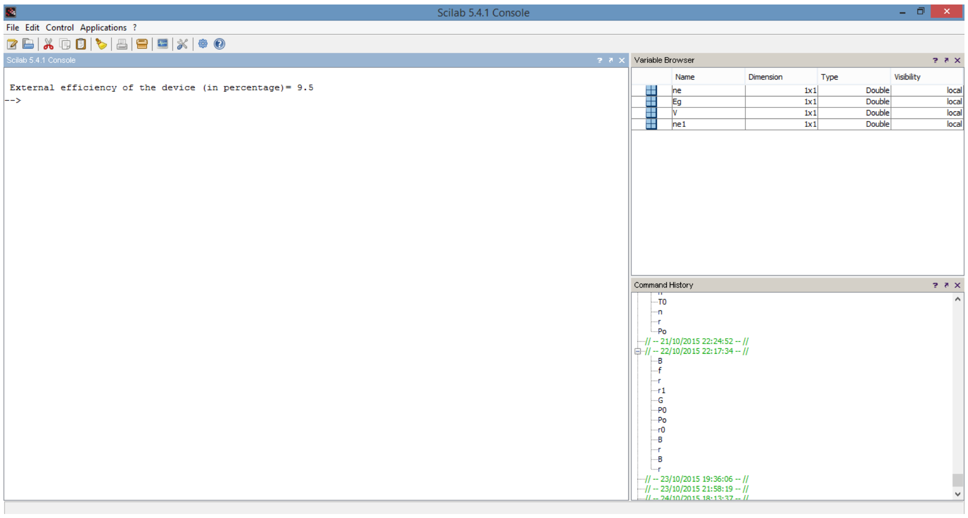

Figure 3.2: Calculation of external efficiency

```
// Page no 484

clc;
clear;
close;

//Given data
ne1=0.20;          //Total efficiency
V=3;               // Voltage applied
Eg=1.43;           // Bandgap energy

// External efficiency
ne=(ne1*Eg/V)*100;

//Display result on command window
printf("\n External efficiency of the device (in
   percentage)= %0.1f  ",ne);
```

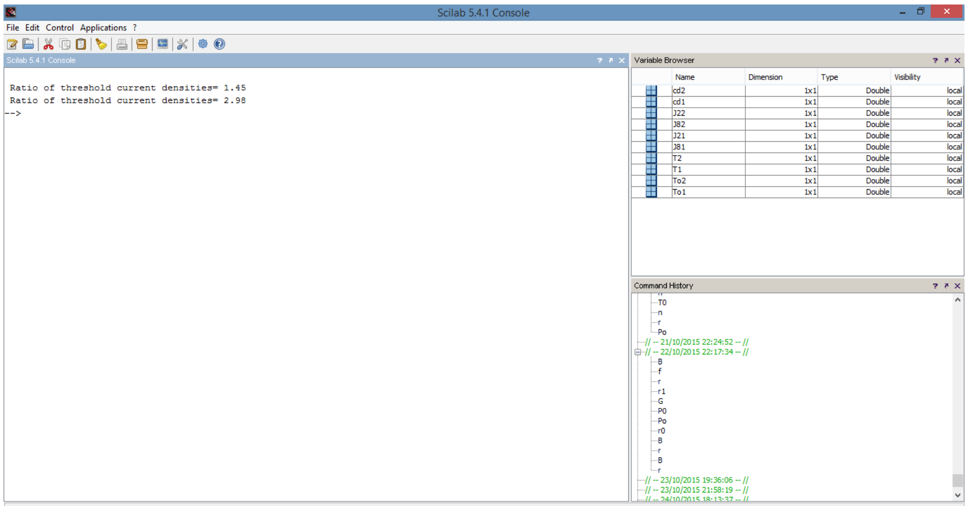

Figure 3.3: Calculation of ratio of threshold current densities

Scilab code Exa 3.16 `Calculation of ratio of threshold current densities`

```
// Example 3.16
//  Calculation of ratio of threshold current densities
// Page no 484

clc;
clear;
close;

// Given data
To1=160;                          // Device temperature
To2=55;                           // Device temperature
T1=293;
T2=353;
J81=exp(T1/To1);                 // Threshold current density
```

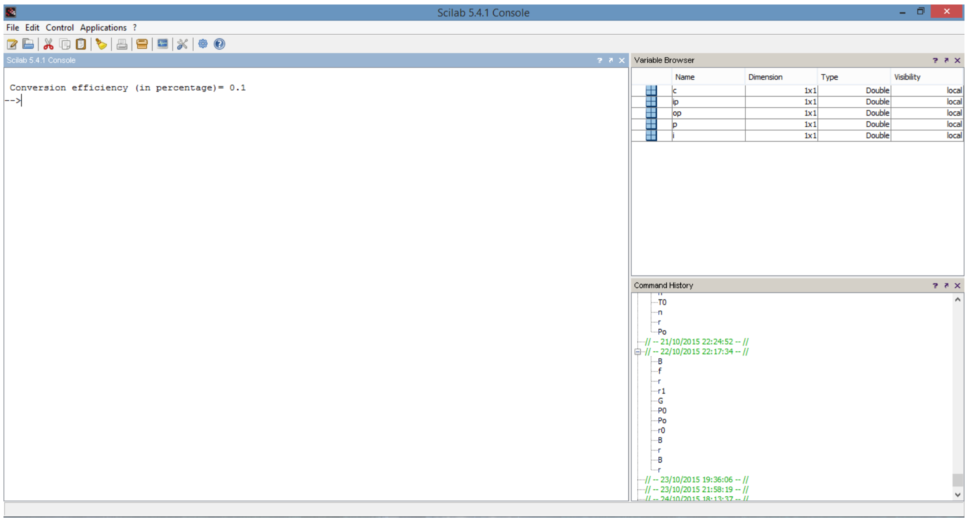

Figure 3.4: Computation of conversion efficiency

```
J21=exp(T2/To1);
J82=exp(T1/To2);;
J22=exp(T2/To2);;
cd1=J21/J81;                    // Ratio of threshold current densities
cd2=J22/J82;

//Display result on command window
printf("\n Ratio of threshold current densities= %0.2f  ",cd1);
printf("\n Ratio of threshold current densities= %0.2f  ",cd2);
```

Scilab code Exa 3.17 `Computation of conversion efficiency`

```
// Example 3.17
//Computation of conversion efficiency
```

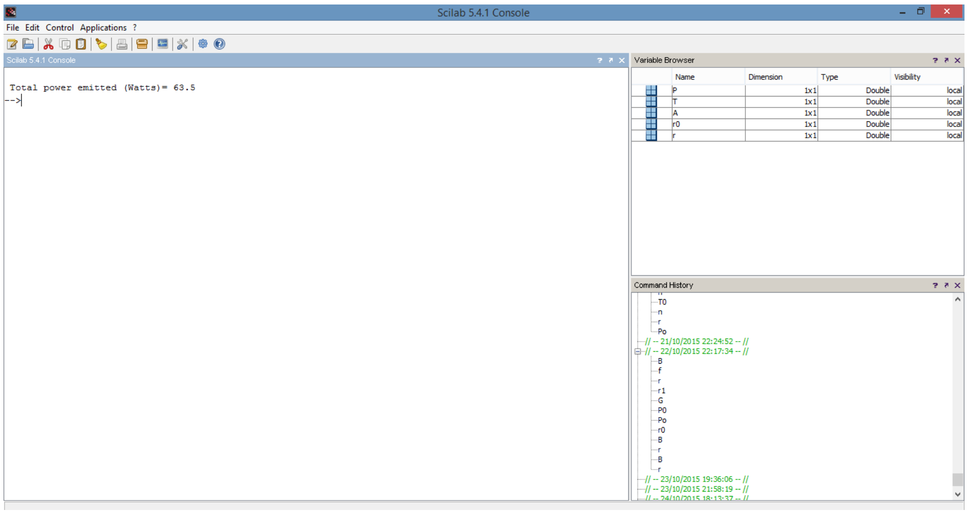

Figure 3.5: Calculation of total power emitted

```
// Page no 484

clc;
clear;

//Given data
i=10*10^-6;                    // Device current
p=5;                          // Electrical power
op=50 *10^-6;                 // Optical power
ip=5*10*10^-3;                // Input power

//Conversion efficiency
c=op/ip*100;
//Display result on command window
printf("\n Conversion efficiency (in percentage)= %0
    .1f ",c);
```

Scilab code Exa 3.18 `Calculation of total power emitted`

```
// Example 3.18
// Calculation of total power emitted
// Page no 485

clc;
clear;
close;

//Given data
r=0.7;                // Emissivity
r0=5.67*10^-8;        // Stephen's constant
A=10^-4;              // Surface area
T=2000;               // Temperature

// Total power emitted
P=r*r0*A*T^4;

//Display result on command window
printf("\n Total power emitted (Watts)= %0.1f  ",P);
```

Scilab code Exa 3.19 `Computation of total energy`

```
// Example 3.19
// Computation of total energy
// Page no 485

clc;
clear;
close;

//Given data
```

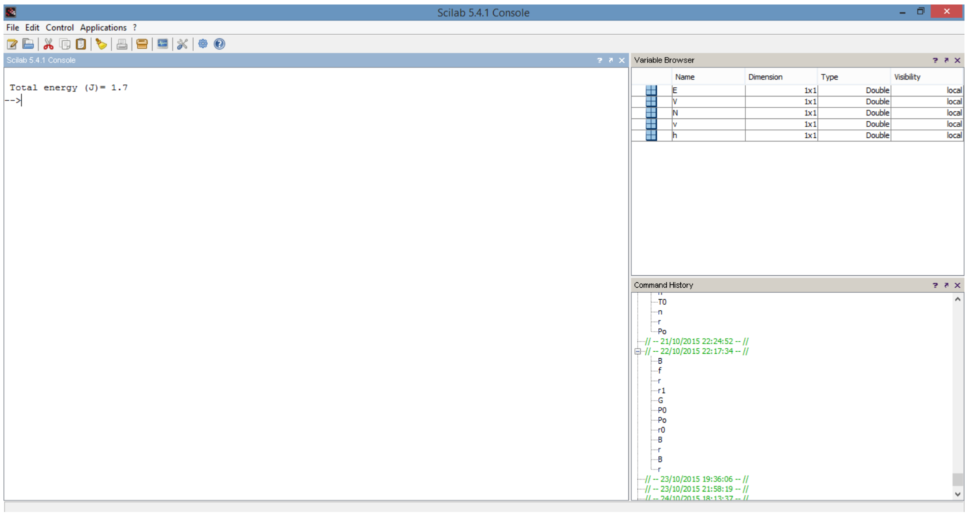

Figure 3.6: Computation of total energy

```
h=6.63*10^-34;          // Planck constant
v=5*10^14;              // Bandgap frequency of laser
N=10^24;                // Population inversion
    density
V=10^-5;                // Volume of laser medium

// Total energy
E=(1/2)*h*v*(N)*V;

//Display result on command window
printf("\n Total energy (J)= %0.1f  ",E);
```

Scilab code Exa 3.20 Computation of pulse power

```
// Example 3.20
// Computation of pulse power
// Page no 485
```

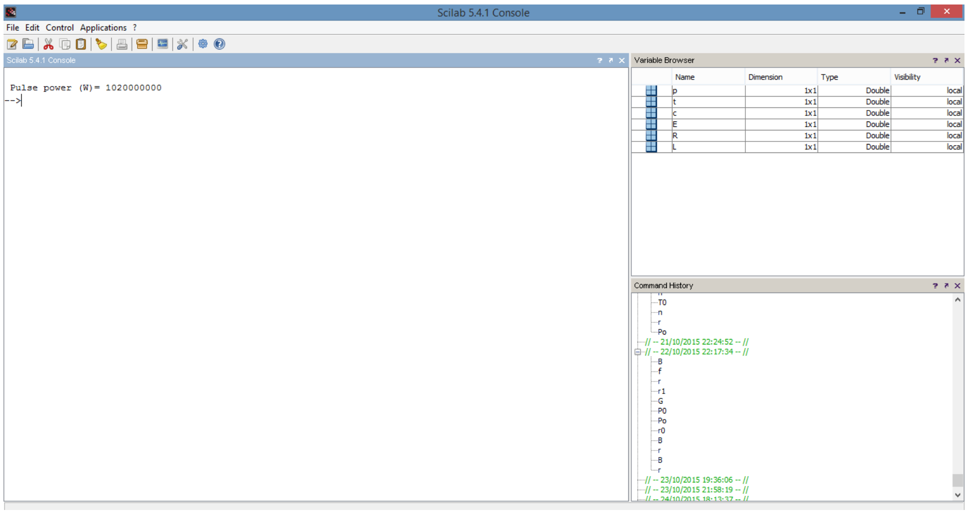

Figure 3.7: Computation of pulse power

```

clc;
clear;
close;

// Given data
L=0.1;                    // Length of laser
R=0.8;                    // Mirror reflectance of end
   mirror
E=1.7;                    // Laser pulse energy
c=3*10^8;                 // Velocity of light
t=L/((1-R)*c);              // Cavity life time

// Pulse power
p=E/t;

//Display result on command window
printf("\n Pulse power (W)= %0.0f  ",p);
```

Chapter 4

Optical fiber transmitter

Scilab code Exa 4.21 `Calculation of wavelength seperation between longitudinal mod`

```
// Example 4.21
// Calculation of wavelength seperation between longitudinal modes.
// Page no 486

clc;
clear;
close;

//Given data
lambda=0.85;                    // Wavelength
n1=3.6;                         // Refractive index of GaAs
L=200*10^-6;                    // Length of cavity

// Wavelength seperation between longitudinal modes.
lambda1=((lambda)^2)*(10^-12)/(2*n1*L);
lambda1=lambda1*10^9;

```

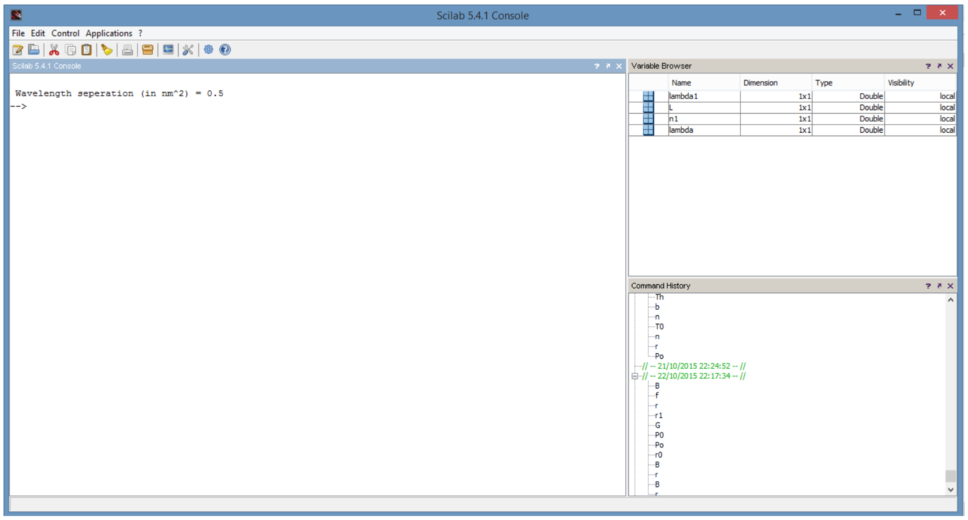

Figure 4.1: Calculation of wavelength seperation between longitudinal modes

```
//Displaying results in the command window
printf("\n Wavelength seperation (in nm^2) = %0.1f "
    ,lambda1);
```

Scilab code Exa 4.22 `Computation of overall external efficiency`

```
// Example 4.22
// Computation of overall external efficiency
// Page no 486

clc;
clear;
close;

//Given data
eg=1.43;                    // Bandgap energy
v=2.5;                      // Electrical supply Voltage
```

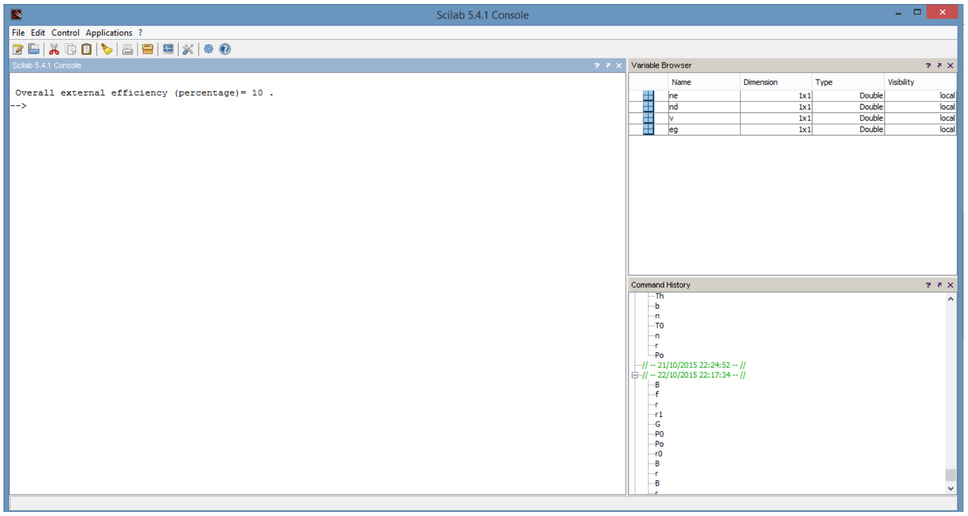

Figure 4.2: Computation of overall external efficiency

```
nd=0.18;                 // Optical efficiency of laser
    diode

// Computation of overall external efficiency
ne=(nd*eg/v)*100;

//Display result in the command window
printf("\n Overall external efficiency (percentage)=
     %0.0f .",ne);
```

Scilab code Exa 4.23 `Calculation of overall external efficiency of a Laser diode`

```
// Example 4.23
// Calculation of overall external efficiency of a
    Laser diode
// Page no 486

```

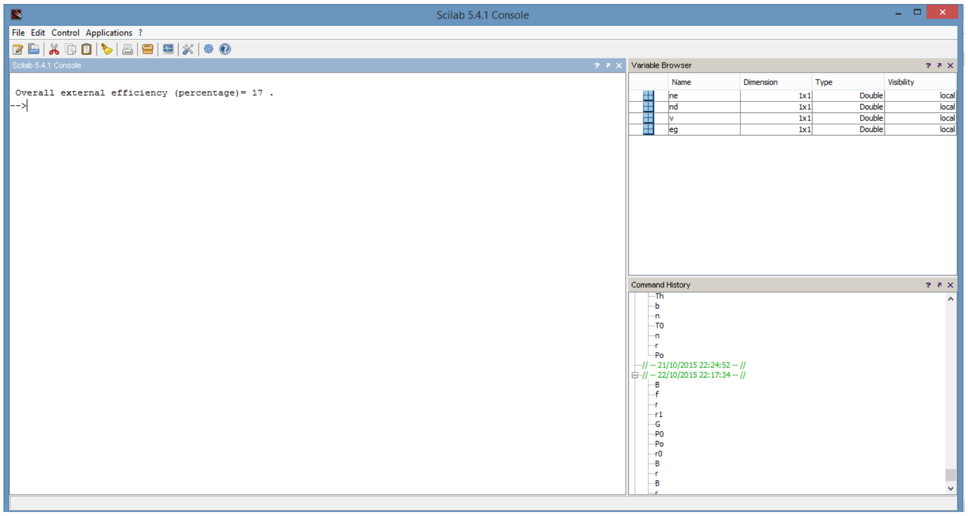

Figure 4.3: Calculation of overall external efficiency of a Laser diode

```
clc;
clear;
close;

//Given data
eg=1.43;                    // Bandgap energy
v=2.5;                      // Voltage applied
nd=0.30;                    // Optical efficiency of laser
    diode

//// Overall external efficiency
ne=(nd*eg/v)*100;

//Display result in the command window
printf("\n Overall external efficiency (percentage)=
    %0.0f .",ne);
```

Chapter 5

Optical detector

Scilab code Exa 5.24 Calculation of wavelength and resposivity and incident power

```
// Example 5.24
// Calculation of (a) wavelength (b) resposivity and
    (c) incident power
// Page no 487

clc;
clear;
close;

//Given data
e=0.7;                           // Efficiency
c=3*10^8;                        // Speed  of light
h=6.62*10^-34                    // Planck constant
E=2.2*10^-19;                    // Energy of photons
e1=1.6*10^-19;                   // Electron charge
// (a) Wavelength computation
lambda=h*c/E                     // Wavelength of laser
   source
f=c/lambda;
```

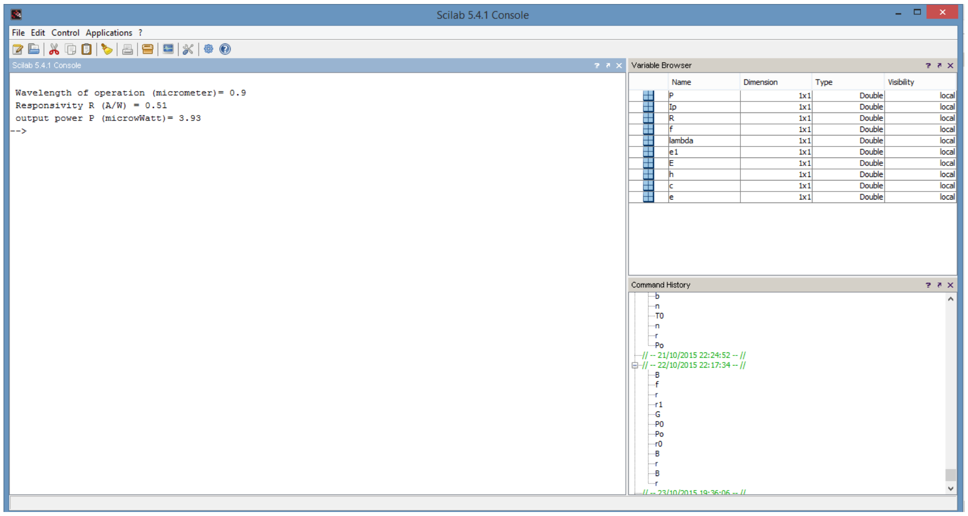

Figure 5.1: Calculation of wavelength and resposivity and incident power

```

// (b) Responsivity
R=e*(lambda*e1)/(h*c);

// (c) Incident power
Ip=2*10^-6;                         // Photocurrent
P=Ip/R;

//Display result on command window
printf("\n Wavelength of operation (micrometer)= %0.1f ",lambda*10^6);
printf("\n Responsivity R (A/W) = %0.2f ",R);
printf("\n output power P (microwWatt)= %0.2f ",P*10^6);
```

Scilab code Exa 5.25 `Computation of quantum efficiency and resposivity`

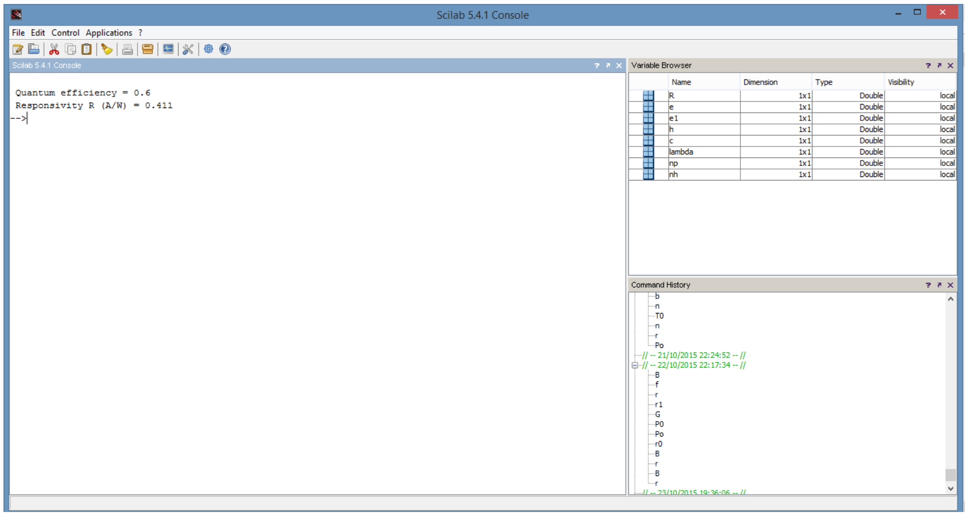

Figure 5.2: Computation of quantum efficiency and resposivity

```
// Example 5.25
// Computation of (a) quantum efficiency and (b) resposivity
// page no 487

clc;
clear;
close;

//Given data
nh=1.5*10^12;                 // No. of hole pairs generated
np=2.5*10^12;                 // No. of incident photons
lambda=0.85*10^-6;            // Wavelength of laser source
c=3*10^8;                     // Speed of light
h=6.62*10^-34                 // Planck constant
e1=1.6*10^-19;                // Electronic charge

// (a)  Quantum efficiency
```

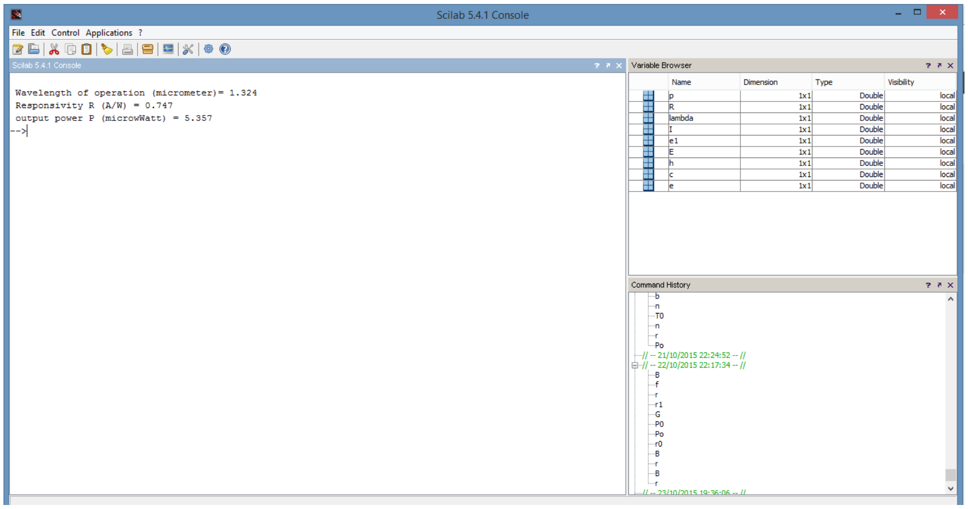

Figure 5.3: Computation of wavelength and power and resposivity

```
e=nh/np;

// (b) Responsivity
R=e*(lambda*e1)/(h*c);                          //

//Display result on command window
printf("\n Quantum efficiency = %0.1f  ",e);
printf("\n Responsivity R (A/W) = %0.3f  ",R);
```

Scilab code Exa 5.26 Computation of wavelength and power and resposivity

```
// Example 5.26
// Computation of (a) wavelength (b) power and (c)
   resposivity
// page no 488

clc;
```

```
clear;
close;

//Given data
e=0.7;                          // Quantum efficiency
c=3*10^8;                       // Speed of light
h=6.62*10^-34                   // Planck constant
E=1.5*10^-19;                   // Energy of photons
e1=1.6*10^-19;                  // Electronic charge
I=4*10^-6;                      // Diode photocurrent
// (a) Wavelength of operation
lambda=h*c/E;

// (b) Responsivity
R=e*(lambda*e1)/(h*c);                              //

// (c) Incident optical power
p=I/R;                                    //power

//Display result on command window
printf("\n Wavelength of operation (micrometer)= %0
   .3f ",lambda*10^6);
printf("\n Responsivity R (A/W) = %0.3f ",R);
printf("\n output power P (microwWatt) = %0.3f ",p
   *10^6);
```

Scilab code Exa 5.27 `Computation of multiplication factor`

```
// Example 5.27
// Computation of (a)resposivity (b)output current
   and (c)multiplication factor
// Page no 488

```

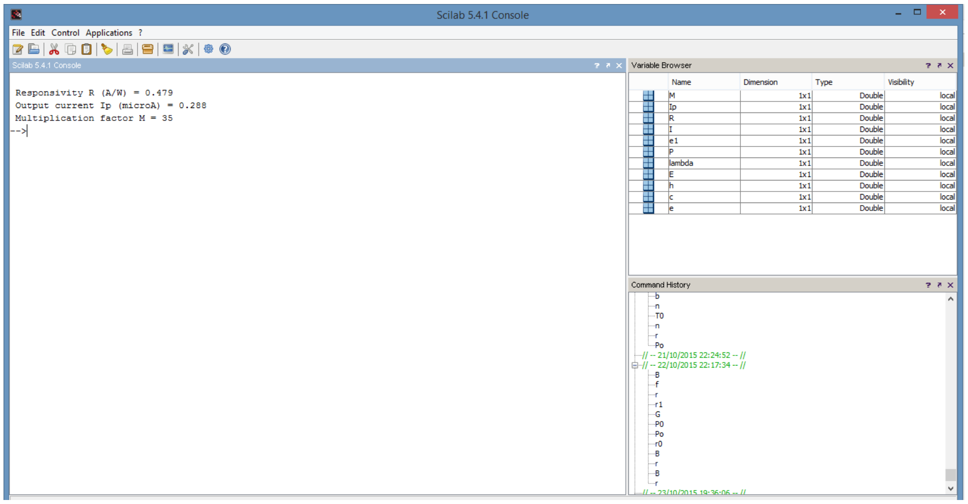

Figure 5.4: Computation of multiplication factor

```
clc;
clear;
close;

//Given data
e=0.7;                      // Quantum efficiency
c=3*10^8;                   // Speed of light
h=6.62*10^-34               // Planck constant
E=1.5*10^-19;               // Energy of photons
lambda=0.85*10^-6           // Wavelength of laser source
P=0.6*10^-6;                // Incident light power
e1=1.6*10^-19;              // Electronic charge
I=10*10^-6;                 // Output current of the device

// (a) Responsivity
R=e*(lambda*e1)/(h*c);

// (b) Photocurrent
Ip=R*P;
```

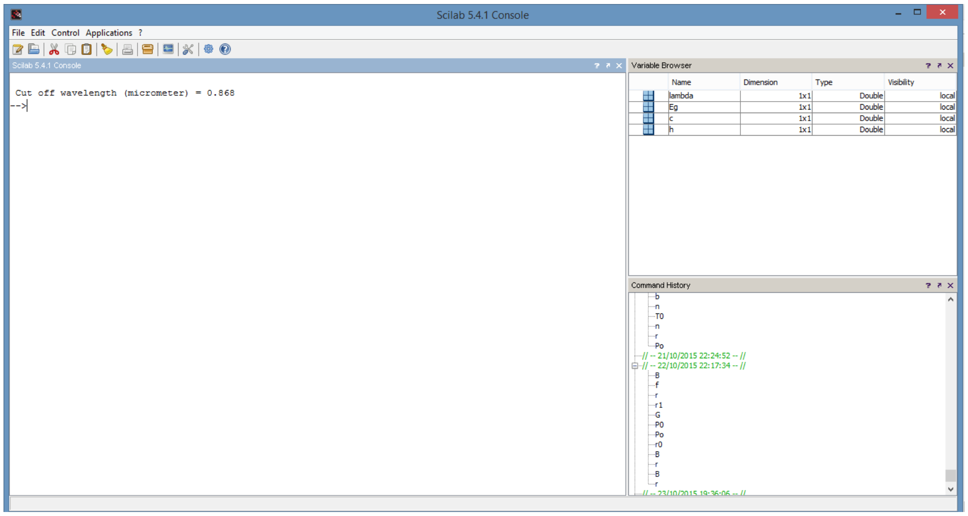

Figure 5.5: Computation of cut off wavelength

```

// (c) Multiplication factor
M=I/Ip

//Display result on command window
printf("\n Responsivity R (A/W) = %0.3f ",R);
printf("\n Output current Ip (microA) = %0.3f ",Ip
    *10^6);
printf("\n Multiplication factor M = %0.0f ",M);

//Calculation mistake in (b)Phtocurrent in the book
```

Scilab code Exa 5.28 `Computation of cut off wavelength`

```
// Example 5.28
// Computation of  cut off wavelength
// Page no 488
```

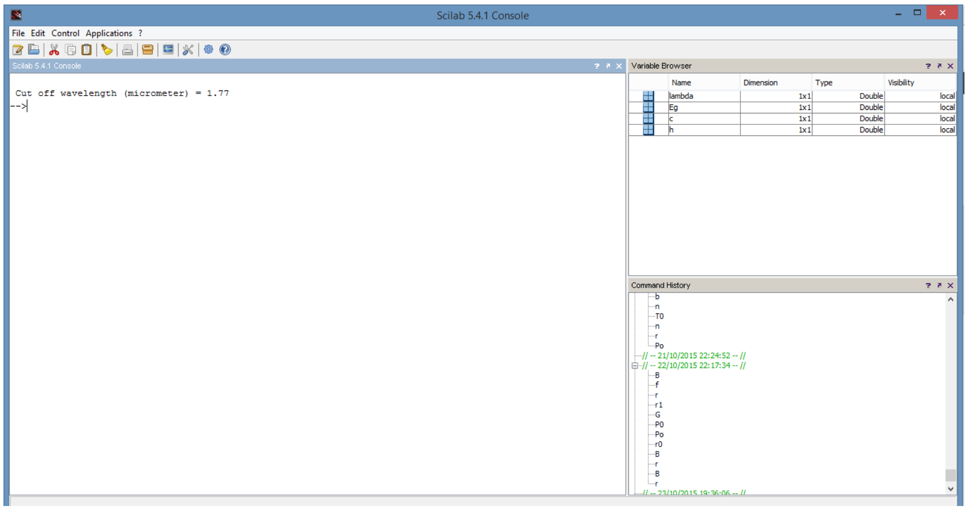

Figure 5.6: Computation of cut off wavelength

```

clc;
clear;
close;

// Given data
h=6.626*10^-34;             // Planck constant.
c=3*10^8;                   // Speed of light
Eg= 1.43*1.602*10^-19;      // Bandgap energy

// Cut off wavelength
lambda= h*c/Eg;

//Display result on command window
printf("\n Cut off wavelength (micrometer) = %0.3f
   ",lambda*10^6);
```

Scilab code Exa 5.29 `Computation of cut off wavelength`

```
// Example 5.29
// Computation of cut off wavelength
// Page no 489

clc;
clear;
close;

// Given data
h=6.626*10^-34;                // Planck constant
c=3*10^8;                      // Speed of light
Eg= 0.7*1.602*10^-19;          // Bandgap energy

// Cut off wavelength
lambda= h*c/Eg;
//Display result on command window
printf("\n Cut off wavelength (micrometer) = %0.2f
   ",lambda*10^6);
```

Scilab code Exa 5.30 `Computation of value of reflectance`

```
// Example 5.30
// Computation of value of reflectance
// Page no 489

clc;
clear;
close;

// Given data
n1=3.5;                      // Refractive index of
```

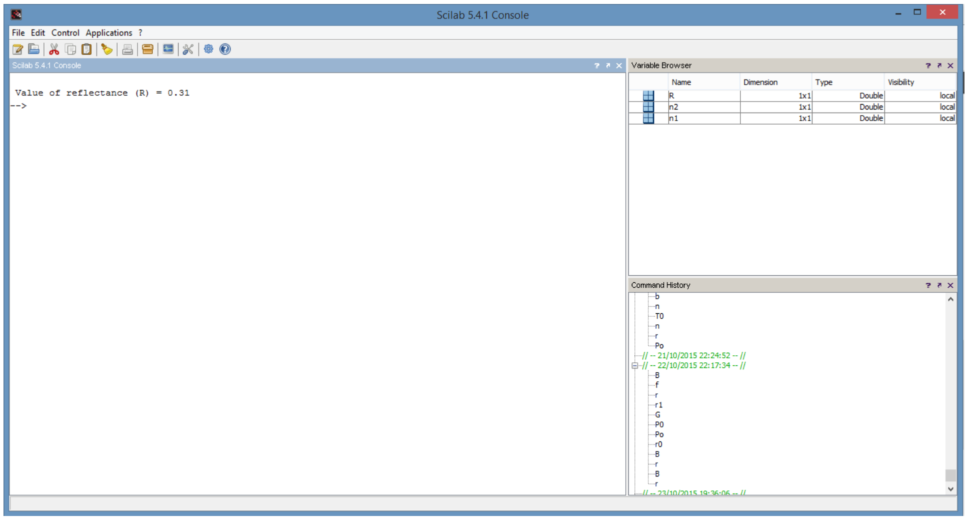

Figure 5.7: Computation of value of reflectance

```
silicon
n2=1;                        // Refractive index of photodiode

//Value of reflectance
R=((n1-n2)/(n1+n2))^2;

//Display result on command window
printf("\n Value of reflectance (R) = %0.2f  ",R);
```

Chapter 6

Optical receiver systems

Scilab code Exa 6.31 Calculation of peak photocurrent and shot noise and mean squa

```
// Example 6.31
// Calculation of a)peak photocurrent , b)shot noise
    and c)mean square shot noise current
// Page no 489

clc;
clear;
close;

//Given data
n=0.7;                                    // Efficiency
lambda=0.9*10^-6;                         // Wavelength
R=5*10^3;                                // Load
    resistance
I=2*10^-9;                               // Dark current
P=300*10^-6;                             // Incident
    power
B=15*10^6;                               // Bandwidth
T=298;                                  // Room
```

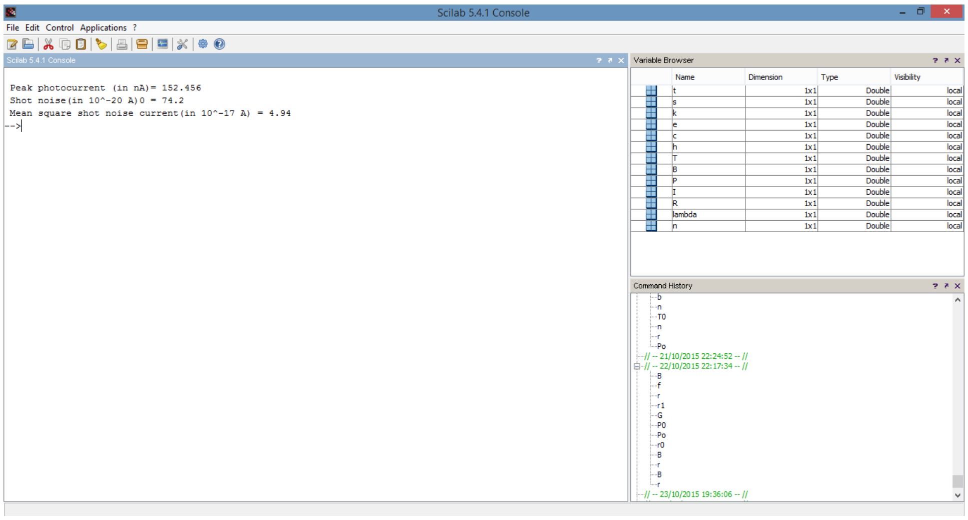

Figure 6.1: Calculation of peak photocurrent and shot noise and mean square shot noise current

```
    temperature
h=6.62*10^-34;
c=3*10^8;
e=1.602*10^-19;                    // Charge of an
    electron
k=1.381*10^-23;                    // Boltzman
    constant

// a)Peak photocurrent
I=(n*P*e*lambda)/(h*c);
I=I*10^6;

//b) Shot noise and mean square shot noise current
s=2*e*B*(2+I);
s=s*10^11;

//c) mean square shot noise current
t=(4*k*T*B)/R;
t=t*10^17;

```

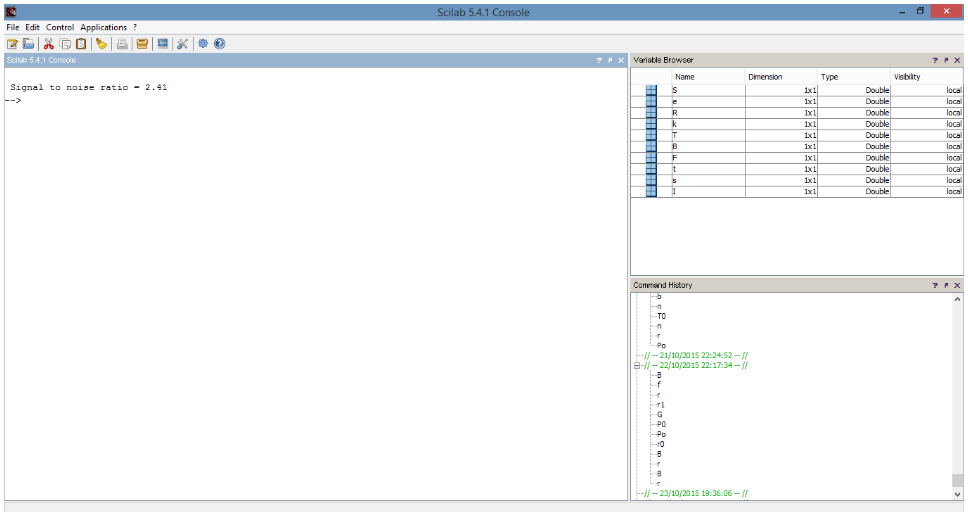

Figure 6.2: Calculation of signal to noise ratio

```



//Displaying results in the command window
printf("\n Peak photocurrent (in nA)= %0.3f ",I);
printf("\n Shot noise(in 10^-20 A)0 = %0.1f ",s);
printf("\n Mean square shot noise current(in 10^-17 A) = %0.2f ",t);



// The answers vary due to round off error
```

Scilab code Exa 6.32 Calculation of signal to noise ratio

```
// Example 6.32
// Calculation of signal to noise ratio
```

```
// Page no 495

clc;
clear;
close;

//Given data
I=152.3*10^-9;                          // Peak photocurrent
s=74.15*10^-20;                         // Shot noise
t=4.94*10^-17;                         // Mean square shot noise current
F=10*log10(3);                         // Noise figure
B=15*10^6;                             // Bandwidth
T=298;                                 // Room temperature
k=1.381*10^-23;                        // Boltzman constant
R=5*10^3;                              // Load resistance
e=1.602*10^-19;                       // Charge of an electron


// Signal to noise ratio
S=(I^2)/((2*e*B*(2+I))+(4*k*T*B*F)/R);
S=S*10^3;




//Displaying results in the command window
printf("\n Signal to noise ratio = %0.2f  ",S);


// The answers vary due to round off error
```

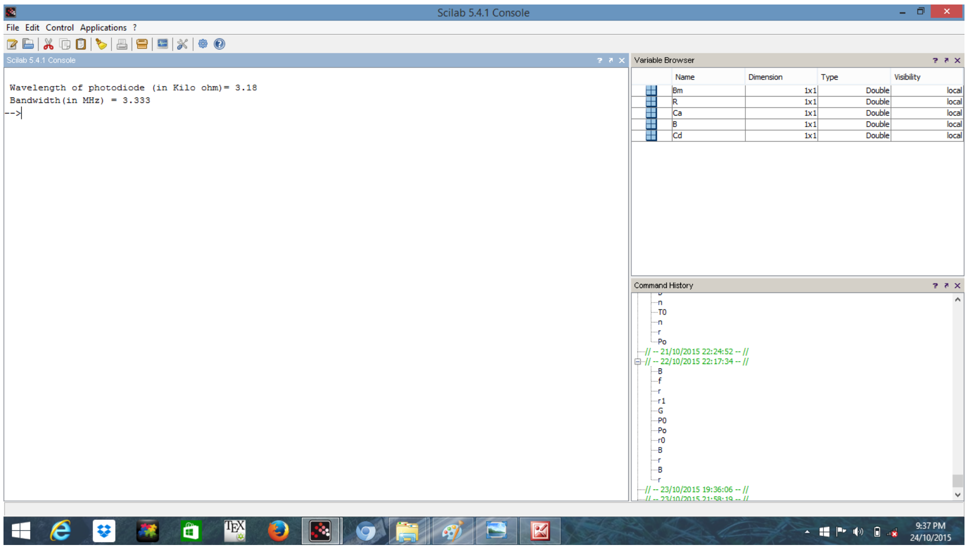

Figure 6.3: Calculation of load resistance and bandwidth

Scilab code Exa 6.33 `Calculation of load resistance and bandwidth`

```
// Example 6.33
// Calculation of a)load resistance and b)bandwidth
// Page no 495

clc;
clear;
close;

//Given data
Cd=5*10^-12                              // Capacitance
    of pin photodiode
B=10*10^6;                              // Bandwidth
Ca=10*10^-12;                           // Input
```

```
   capacitance


// a)Load resistance
R=1/(2*%pi*B*Cd);
R=R*10^-3;
// b)Bandwidth
Bm=1/(2*%pi*(Cd+Ca)*R);
Bm=Bm*10^-9;



//Displaying results in the command window
printf("\n Wavelength of photodiode (in Kilo ohm)=
   %0.2f ",R);
printf("\n Bandwidth(in MHz) = %0.3f ",Bm);

// The answers vary due to round off error
```

Scilab code Exa 6.34 Calculation of signal to noise ratio

```
// Example 8.34
// Calculation of signal to noise ratio.
// Page no 491

clc;
clear;
close;

//Given data

h=6.62*10^-34;                          // Planck
   constant
```

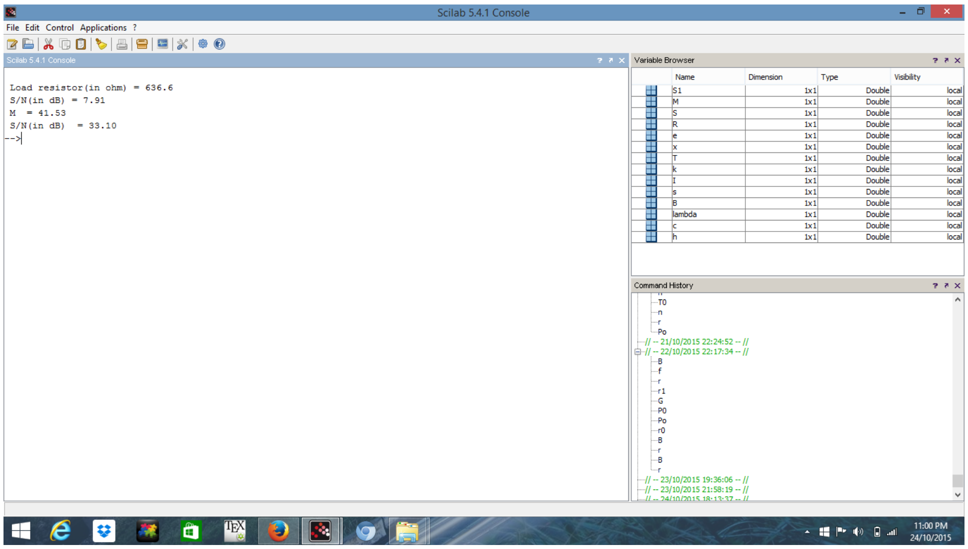

Figure 6.4: Calculation of signal to noise ratio

```
c=5*10^-12;                              // capacitor
lambda=1.55*10^-6;                       // Wavelength
B=50*10^6;                               // Speed of communication
s=2*10^-9;
I=10^-7;
k=1.381*10^-23;
T=291;
x=0.3;
e=1.602*10^-19;

// Maximum load resistance is
R=1/(2*%pi*c*B);

S=I^2/((2*e*B*I)+(4*k*T*B/R));
M=((4*k*T)/(e*x*R*I))^(0.435);
S1=((((M^2)*(I^2))/(2*e*B*I*M^2.3))+((4*k*T*B)/R));
S1=10*log10(S1);
//Displaying results in the command window
printf("\n Load resistor(in ohm) = %0.1f  ",R);
```

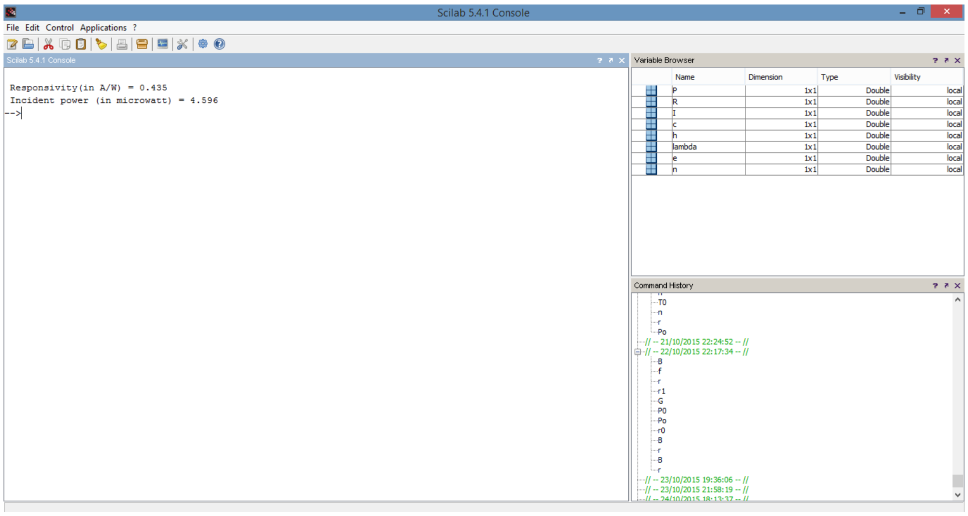

Figure 6.5: Calculation of responsivity and incident optical power

```
printf("\n S/N(in dB) = %0.2f ",S);
printf("\n M = %0.2f ",M);
printf("\n S/N(in dB) = %0.2f ",S1);

// The answers vary due to round off error
```

Scilab code Exa 6.35 `Calculation of responsivity and incident optical power`

```
// Example 6.35
// Calculation of a) responsivity b)incident optical
    power
// Page no 493

clc;
clear;
close;

```

```
//Given data
n=0.6;                              // Quantum efficiency
e=1.602*10^-19;                     // Charge of electron
lambda=0.9*10^-6;                   // Wavelength
h=6.626*10^-34;                     // Planck constant
c=3*10^8;                           // Velocity of light
I=2*10^-6;                          // Photocurrent

// a)Responsivity
R= (n*e*lambda)/(h*c);

// b)Incident power
P=I/R;
P=P*10^6;


//Displaying results in the command window
printf("\n Responsivity(in A/W) = %0.3f  ",R);
printf("\n Incident power (in microwatt) = %0.3f  ",
   P);

// The answers vary due to round off error
```

Scilab code Exa 6.36 Calculation of responsivity and Multiplication factor

```
// Example 6.36
// Calculation of a) responsivity b)Multiplication
   factor
// Page no 493

clc;
clear;
close;
```

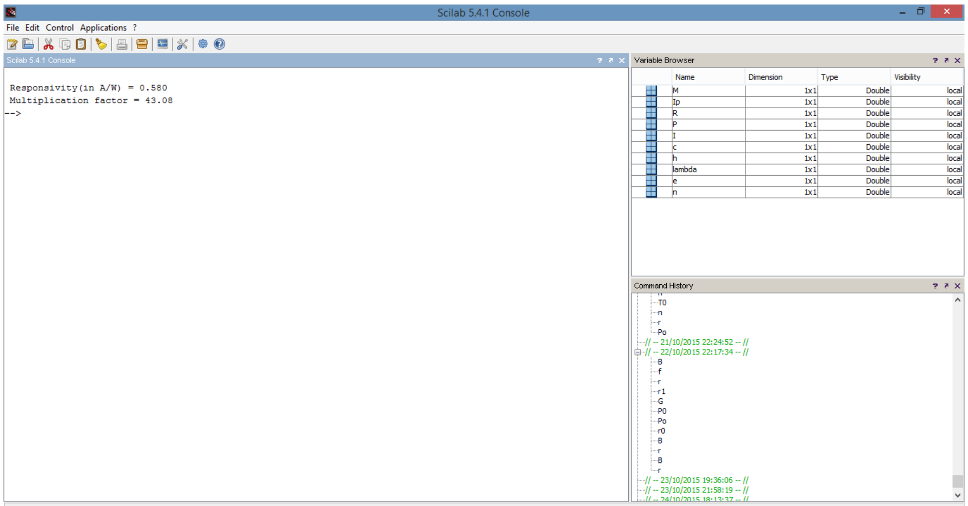

Figure 6.6: Calculation of responsivity and Multiplication factor

```

//Given data
n=0.8;                                          // Quantum
    efficiency
e=1.602*10^-19;                                 // Charge of an
    electron
lambda=0.9*10^-6;                               // Wavelength
h=6.626*10^-34;                                 // Planck constant
c=3*10^8;                                      // Velocity of
    light
I=15*10^-6;                                    // Photocurrent
P=0.6*10^-6;

// a)Responsivity
R= (n*e*lambda)/(h*c);
// b)Multiplication factor
Ip=P*R;
M=I/Ip;


//Displaying results in the command window
```

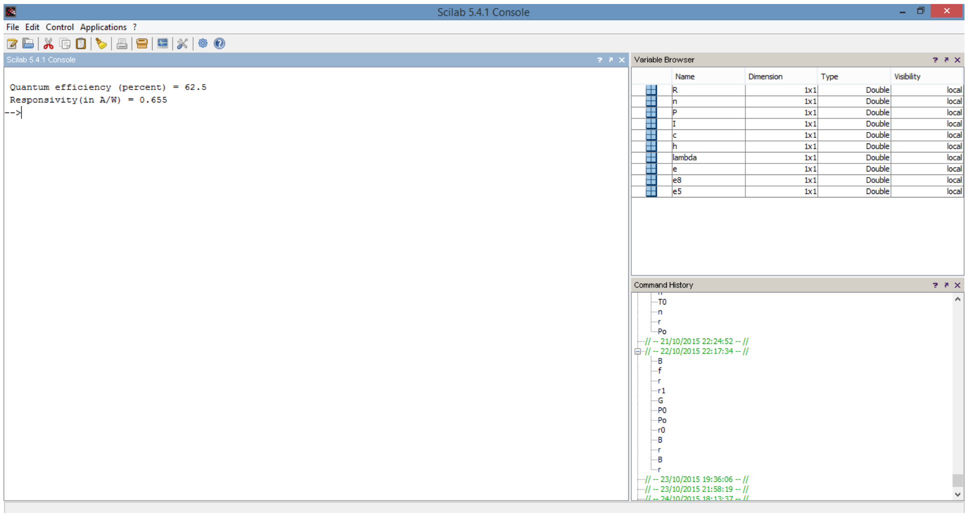

Figure 6.7: Calculation on quantum efficiency and responsivity

```
printf("\n Responsivity(in A/W) = %0.3f  ",R);
printf("\n Multiplication factor = %0.2f  ",M);

// The answers vary due to round off error
```

Scilab code Exa 6.37 Calculation on quantum efficiency and responsivity

```
// Example 6.37
// Calculation of a) quantum efficiency b)
   responsivity
// Page no 494

clc;
clear;
close;

//Given data
```

```
e5=500;                                 // No of incident
    photons
e8=800;                                 // No of incident
    electrons
e=1.602*10^-19;                         // Charge of an
    electron
lambda=1.3*10^-6;                       // Wavelength
h=6.626*10^-34;                         // Planck
    constant
c=3*10^8;                               // Velocity of
    light
I=15*10^-6;                             // Photocurrent
P=0.6*10^-6;

// a)Quantum efficiency
n=e5/e8;
// b)Responsivity
R=(n*e*lambda)/(h*c);


//Displaying results in the command window
printf("\n Quantum efficiency (percent) = %0.1f ",n
    *100);
printf("\n Responsivity(in A/W) = %0.3f ",R);

// The answers vary due to round off error
```

Scilab code Exa 6.38 Calculation of quantum efficiency and responsivity

```
// Example 6.38
// Calculation of a) quantum efficiency b)
    responsivity
// Page no 494
```

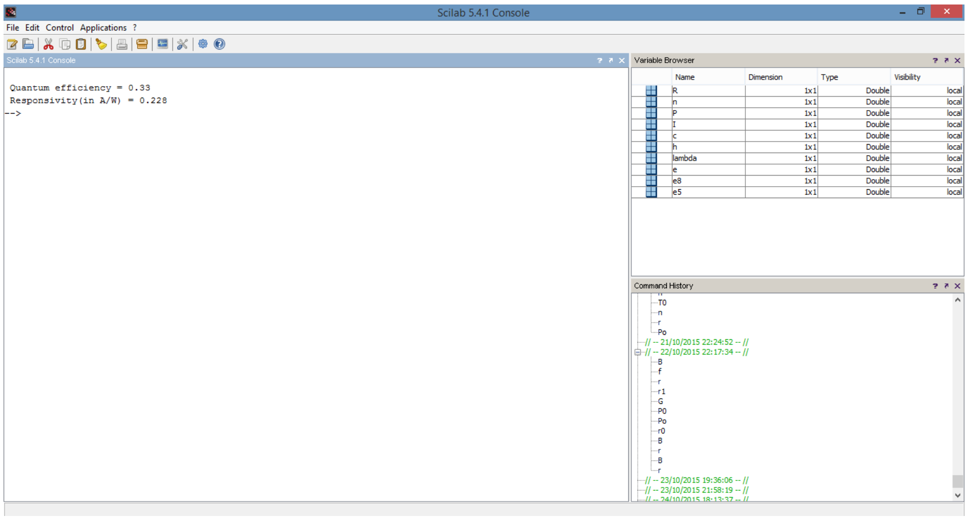

Figure 6.8: Calculation of quantum efficiency and responsivity

```

clc;
clear;
close;

//Given data
e5=1.2*10^11;                    // No of electrons collected
e8=3.6*10^11;                    // No of incident photon
e=1.602*10^-19;                  // Charge of an electron
lambda=0.85*10^-6;               // Wavelength
h=6.626*10^-34;                  // Planck constant
c=3*10^8;                        // Velocity of light
I=15*10^-6;                      // Photocurrent
P=0.6*10^-6;
```

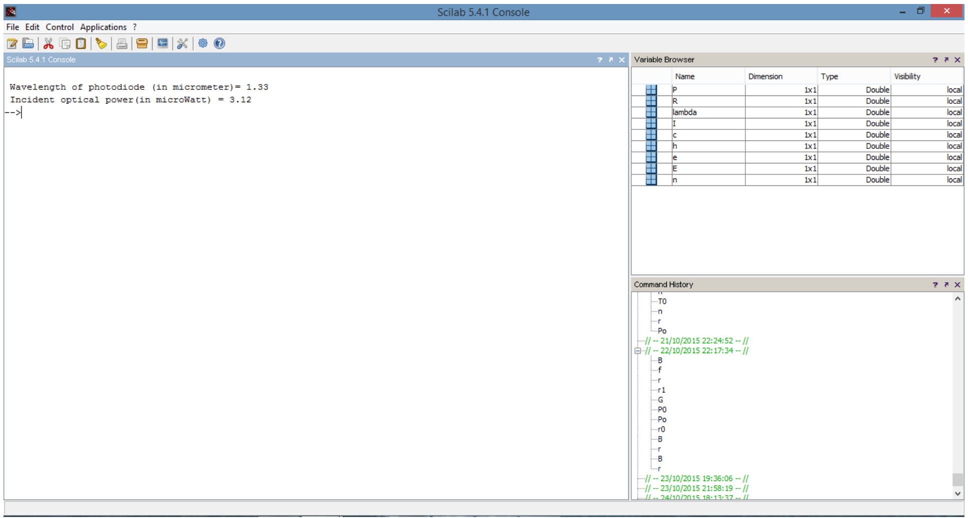

Figure 6.9: Calculation of operating wavelength and incidence optical power

```

// a)Quantum efficiency
n=e5/e8;
// b)Responsivity
R=(n*e*lambda)/(h*c);


//Displaying results in the command window
printf("\n Quantum efficiency = %0.2f ",n);
printf("\n Responsivity(in A/W) = %0.3f ",R);

// The answers vary due to round off error
```

Scilab code Exa 6.39 `Calculation of operating wavelength and incidence optical pow`

```
// Example 6.39
```

```
// Calculation of a) operating wavelength b) incidence optical power
// Page no 495

clc;
clear;
close;

//Given data
n=0.60                                  // Quantum efficiency
E=1.5*10^-19;                           // Photons of energy
e=1.602*10^-19;                         // Charge of an electron
h=6.626*10^-34;                         // Planck constant
c=3*10^8;                               // Velocity of light
I=2*10^-6;                              // Photocurrent


// a)Operating wavelength
lambda=(h*c)/E;
lambda=lambda*10^6;

// b)Incident optical power
R=(n*e)/E;
P=I/R;
P=P*10^6;


//Displaying results in the command window
printf("\n Wavelength of photodiode (in micrometer)= %0.2f ",lambda);
printf("\n Incident optical power(in microWatt) = %0.2f ",P);

// The answers vary due to round off error
```

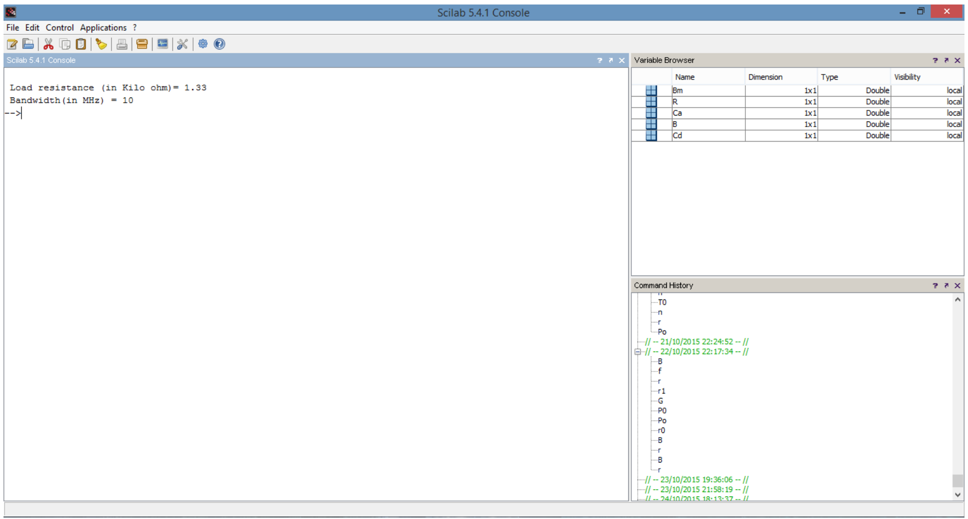

Figure 6.10: Calculation of load resistance and bandwidth

Scilab code Exa 6.40 `Calculation of load resistance and bandwidth`

```
// Example 6.40
// Calculation of load resistance and bandwidth
// Page no 495

clc;
clear;
close;

//Given data
Cd=6*10^-12                          // Capacitance of pin photodiode
B=20*10^6;                           // Bandwidth
Ca=6*10^-12;                         // Input
```

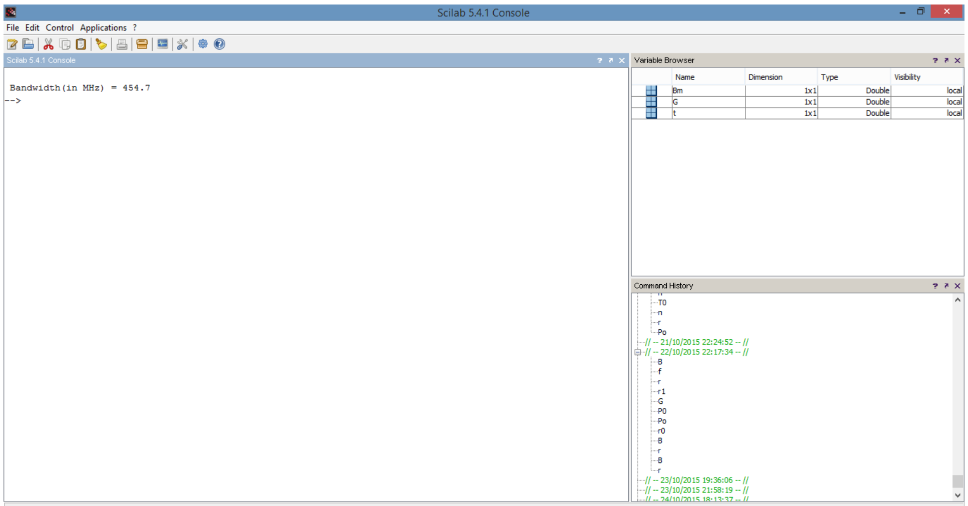

Figure 6.11: Calculation of maximum bandwidth

```
    capacitance


// a)Load resistance
R=1/(2*%pi*B*Cd);
R=R*10^-3;
// b)Bandwidth
Bm=1/(2*%pi*(Ca+Ca)*R);
Bm=Bm*10^-9;



//Displaying results in the command window
printf("\n Load resistance (in Kilo ohm)= %0.2f  ",R
    );
printf("\n Bandwidth(in MHz) = %0.0f  ",Bm);

// The answers vary due to round off error
```

Scilab code Exa 6.41 Calculation of maximum bandwidth

```
// Example 6.41
// Calculation of maximum bandwidth
// Page no 496

clc;
clear;
close;

//Given data
t=5*10^-12                              // Electron
    transit time
G=70;                                   // Gain of the
    device



// Maximum bandwidth
Bm=1/(2*%pi*t*G);
Bm=Bm*10^-6;



//Displaying results in the command window
printf("\n Bandwidth(in MHz) = %0.1f  ",Bm);

// The answers vary due to round off error
```

Chapter 7

Optical fiber connectors and optical amplification

Scilab code Exa 7.42 Calculation of excess loss and insertion loss and crosstalk a

```
// Example 7.42
// Calculation of a)excess loss,b)insertion loss,c) crosstalk and d)split ratio for the device.
// Page no 496

clc;
clear;
close;

//Given data
P1=60*10^-6;                    // Power launched in port 1
P2=0.004*10^-6;                 // Power launched in port 2
P3=26*10^-6;                    // Power launched in port 3
P4=27.5*10^-6;                  // Power launched in
```

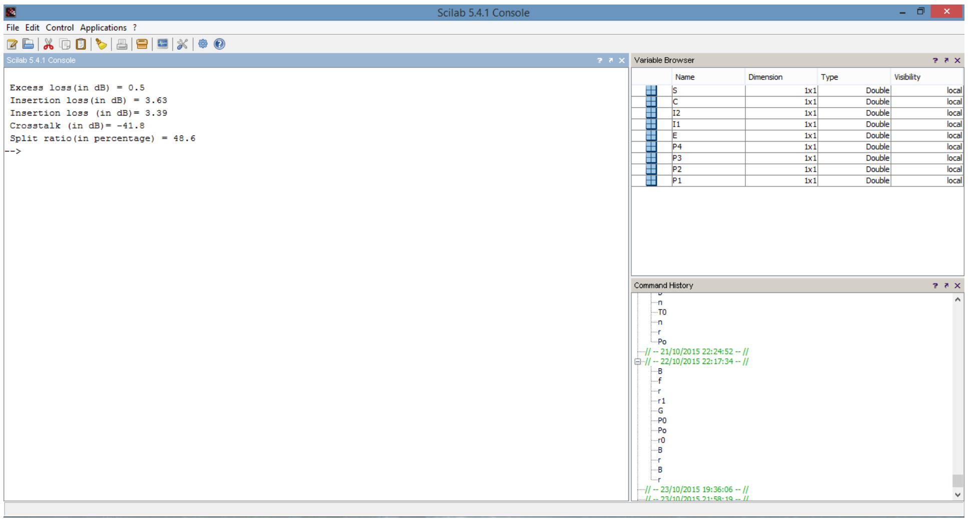

Figure 7.1: Calculation of excess loss and insertion loss and crosstalk and split ratio for the device

```
    port 4

// a)Excess loss
E=10*log10(P1/(P3+P4));

//b)Insertion loss
I1=10*log10(P1/P3);
I2=10*log10(P1/P4);

//c)Crosstalk
C=10*log10(P2/P1);

//d)Split ratio
S=(P3/(P3+P4))*100;


//Displaying results in the command window
printf("\n Excess loss(in dB) = %0.1f  ",E);
printf("\n Insertion loss(in dB) = %0.2f  ",I1);
printf("\n Insertion loss (in dB)= %0.2f  ",I2);
```

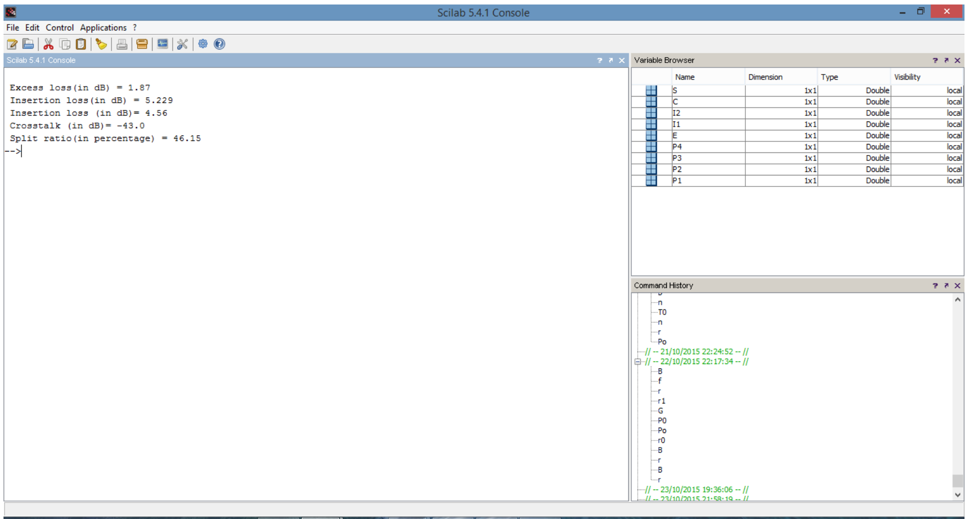

Figure 7.2: Calculation of excess loss and insertion loss and crosstalk and split ratio for the device

```
printf("\n Crosstalk (in dB)= %0.1f  ",C);
printf("\n Split ratio(in percentage) = %0.1f  ",S);
```

Scilab code Exa 7.43 Calculation of excess loss and insertion loss and crosstalk a

```
// Example 7.42
// Calculation of a)excess loss,b)insertion loss,c)
   crosstalk and d)split ratio for the device.
// Page no 497

clc;
clear;
close;

//Given data
```

```
P1=100*10^-6;                          // Power launched in port 1
P2=0.005*10^-6;                        // Power launched in port 2
P3=30*10^-6;                           // Power launched in port 3
P4=35*10^-6;                           // Power launched in port 4

// a)Excess loss
E=10*log10(P1/(P3+P4));
// b)Insertion loss
I1=10*log10(P1/P3);
I2=10*log10(P1/P4);

//c)Crosstalk
C=10*log10(P2/P1);

//d)Split ratio
S=(P3/(P3+P4))*100;


//Displaying results in the command window
printf("\n Excess loss(in dB) = %0.2f  ",E);
printf("\n Insertion loss(in dB) = %0.3f  ",I1);
printf("\n Insertion loss (in dB)= %0.2f  ",I2);
printf("\n Crosstalk (in dB)= %0.1f  ",C);
printf("\n Split ratio(in percentage) = %0.2f  ",S);
// The cross talk answer computation is wrong in the book
```

Scilab code Exa 7.44 Calculation of excess loss and insertion loss and crosstalk a

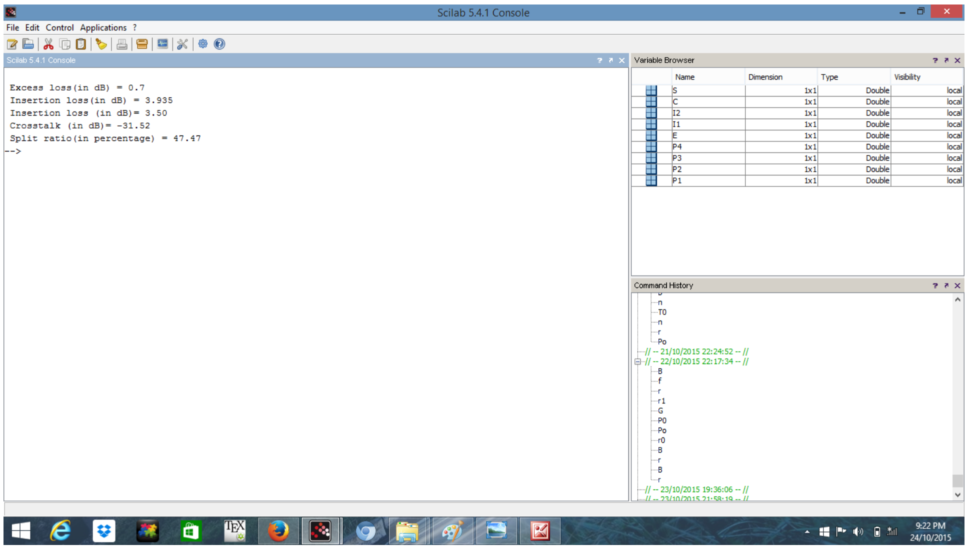

Figure 7.3: Calculation of excess loss and insertion loss and crosstalk and split ratio for the device

```
// Example 7.42
// Calculation of a)excess loss,b)insertion loss,c)
    crosstalk and d)split ratio for the device.
// Page no 498

clc;
clear;
close;

//Given data
P1=116.3*10^-6;                    // Power launched in
    port 1
P2=0.082*10^-6;                  // Power launched in
    port 2
P3=47*10^-6;                     // Power launched in
    port 3
P4=52*10^-6;                   // Power launched in port
    4

```

```
// a)Excess loss
E=10*log10(P1/(P3+P4));
//b)Insertion loss
I1=10*log10(P1/P3);
I2=10*log10(P1/P4);

//c)Crosstalk
C=10*log10(P2/P1);

//d)Split ratio
S=(P3/(P3+P4))*100;


//Displaying results in the command window
printf("\n Excess loss(in dB) = %0.1f  ",E);
printf("\n Insertion loss(in dB) = %0.3f  ",I1);
printf("\n Insertion loss (in dB)= %0.2f  ",I2);
printf("\n Crosstalk (in dB)= %0.2f  ",C);
printf("\n Split ratio(in percentage) = %0.2f  ",S);
// The answers vary due to round off error
```

Chapter 8

Telecommunication applicationt

Scilab code Exa 8.45 Calculation of incident optical power

```
// Example 8.45
// Calculation of incident optical power.
// Page no 499

clc;
clear;
close;

//Given data
lambda=1.3*10^-6;                              // Wavelength
B=6*10^6;                                      // Bandwidth
S=10^5;                                        // Total
    system margin
n=1;                                           // Efficiency
v=3*10^14;
h=6.62*10^-34;                                 // Planck
    constant


```

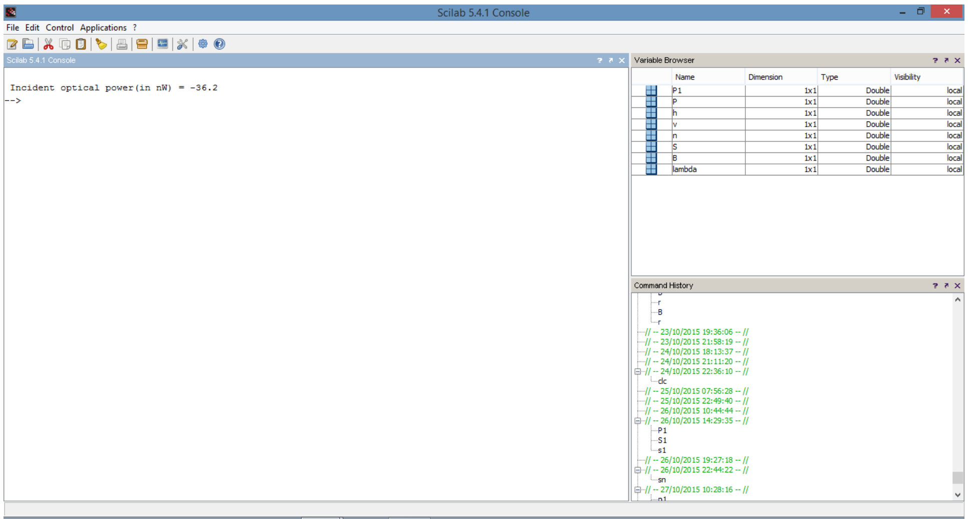

Figure 8.1: Calculation of incident optical power

```

// Incident optical power
P=(2*S*v*h*B)/n;

P1=10*log10(P/10^-3);

//Displaying results in the command window
printf("\n Incident optical power(in nW) = %0.1f  ",
   P1);


// The answers vary due to round off error
```

Scilab code Exa 8.46 Calculation of maximum repeater spacing of ASK hetrodyne and

```
// Example 8.46
```

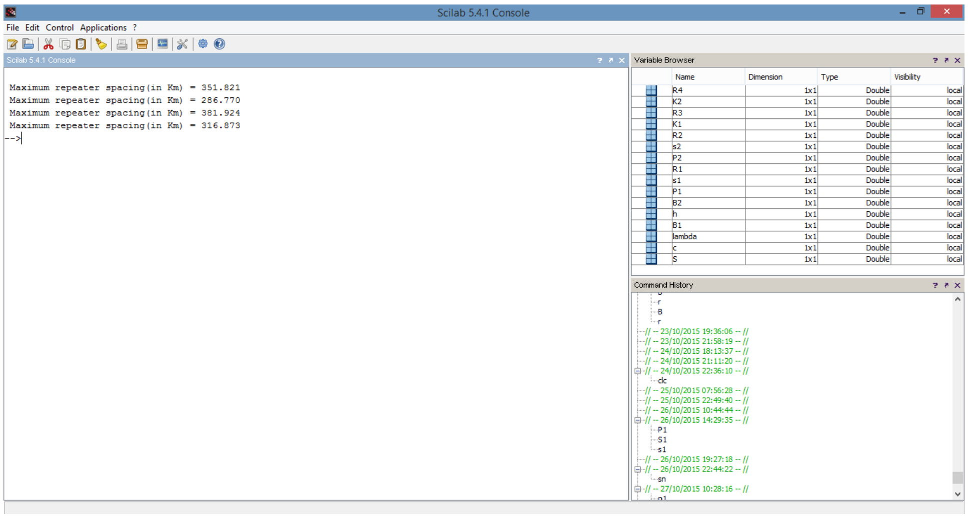

Figure 8.2: Calculation of maximum repeater spacing of ASK hetrodyne and PSK homodyne

```
// Calculation of maximum repeater spacing of a)ASK hetrodyne b)PSK homodyne
// Page no 500

clc;
clear;
close;

//Given data

S=0.2;                              // Split loss
c=3*10^8;                           // velocity of light
lambda=1.55*10^-6;                  // Wavelength
B1=50*10^6;                         // Speed of communication
h=6.63*10^-34                       // Planck constant
B2=1*10^9;                          // Speed of communication
```

```
// a)Maximum repeater spacing for ASK hetrodyne
P1=(36*h*c*B1)/lambda;
P1=10*log10(P1/10^-3);
s1=4-P1;
R1=s1/S;
P2= (36*h*c*B2)/lambda;
P2=10*log10(P2/10^-3);
s2=4-P2;
R2=s2/S;
//b)Maximum repeater spacing for PSK homodyne
K1= (9*h*c*B1)/lambda;
K1=10*log10(K1/10^-3);
K1=4-K1;
R3=K1/S;
K2= (9*h*c*B2)/lambda;
K2=10*log10(K2/10^-3);
K2=4-K2;
R4=K2/S;

//Displaying results in the command window
printf("\n Maximum repeater spacing(in Km) = %0.3f
    ",R1);
printf("\n Maximum repeater spacing(in Km) = %0.3f
    ",R2);
printf("\n Maximum repeater spacing(in Km) = %0.3f
    ",R3);
printf("\n Maximum repeater spacing(in Km) = %0.3f
    ",R4);
// The answers vary due to round off error
```

Scilab code Exa 8.47 Calculation of incident optical power

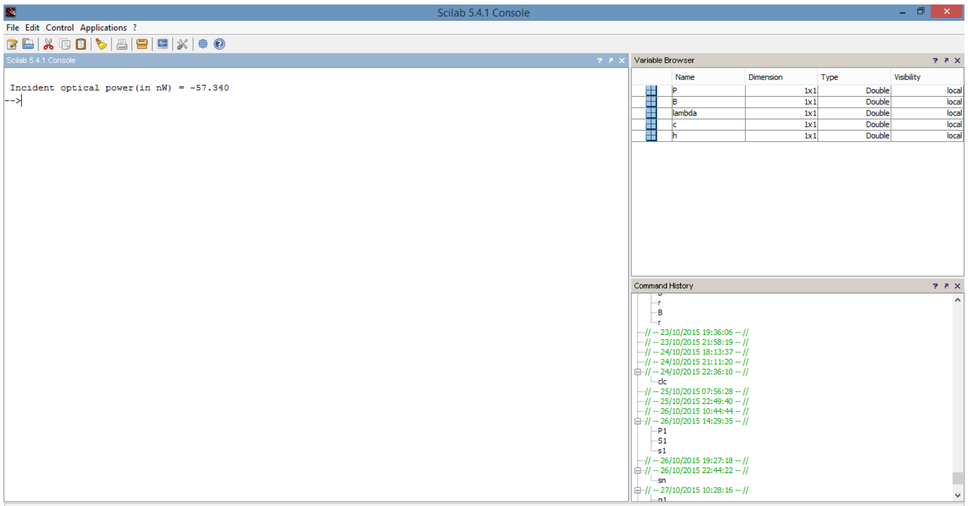

Figure 8.3: Calculation of incident optical power

```
// Example 8.47
// Calculation of incident optical power.
// Page no 499

clc;
clear;
close;

//Given data

h=6.62*10^-34;                          // Planck
    constant
c=3*10^8;                              // velocity of
    light
lambda=1.55*10^-6;                     // Wavelength
B=400*10^6;                            // Speed of
    communication

// Maximum repeater spacing
P=(36*h*c*B)/lambda;
P=10*log10(P/10^-3);
```

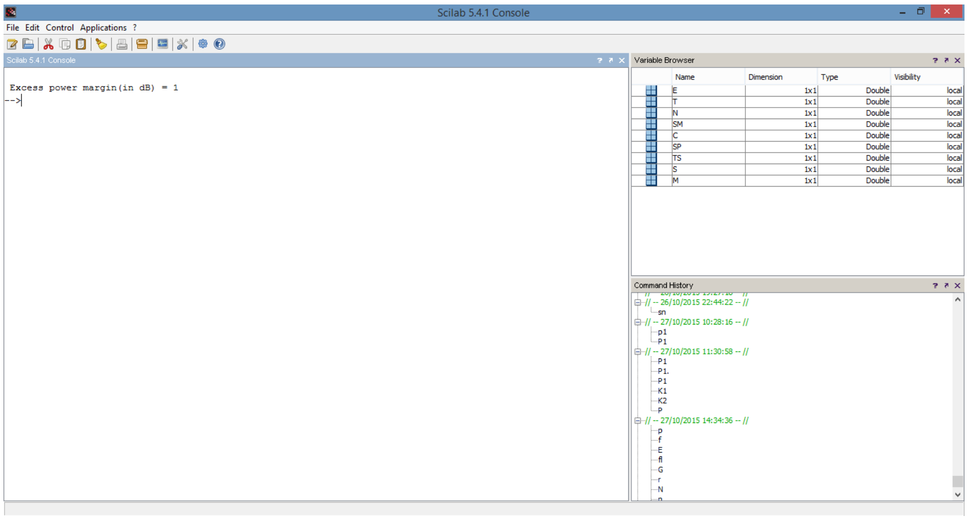

Figure 8.4: Calculation of optical power budget

```


//Displaying results in the command window
printf("\n Incident optical power(in nW) = %0.3f  ",
   P);


// The answers vary due to round off error
```

Scilab code Exa 8.48 `Calculation of optical power budget`

```
// Example 8.48
// Calculation of optical power budget.
// Page no 502

clc;
clear;
```

```
close;

//Given data
M=-10;                           // Mean optical power
S=-25;                           // Split loss
TS=7;                            // Total system margin
SP=1.4;                          // Split loss
C=1.6;                          // Connector loss
SM=4;                           // Safety margin


// Net margin between LED and receiver
N=M-S;

// Total system loss
T=TS+SP+C+SM;
// Excess power margin
E=N-T;




//Displaying results in the command window
printf("\n Excess power margin(in dB) = %0.0f  ",E);


// The answers vary due to round off error
```

Scilab code Exa 8.49 Calculation of viability of digital link

```
// Example 8.49
// Calculation of viability of digital link.
// Page no 503
```

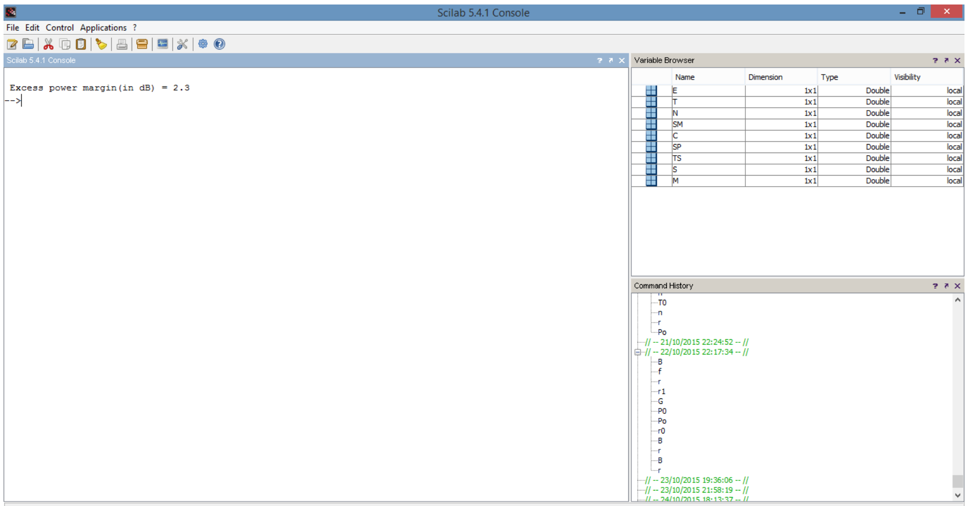

Figure 8.5: Calculation of viability of digital link

```

clc;
clear;
close;

//Given data
M=-10;                          // Mean optical power
S=-41;                          // Receiver sensitivity
TS=18.2;                        // Total system margin
SP=3;                           // Split loss
C=1.5;                         // Connector loss
SM=6;                           // Safety margin


// Net margin between LED and receiver
N=M-S;

// Total system loss
T=TS+SP+C+SM;
// Excess power margin
E=N-T;
```

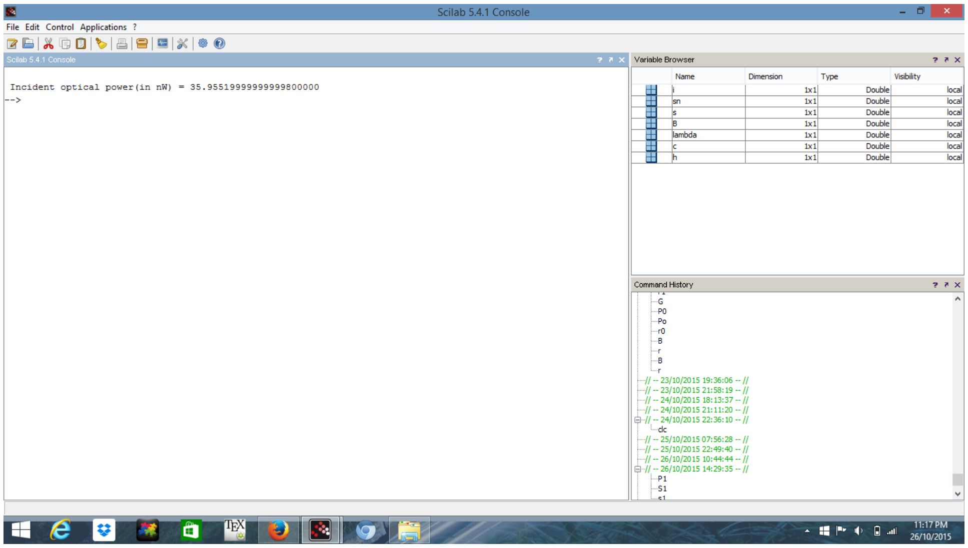

Figure 8.6: Calculation of signal to noise ratio

```
//Displaying results in the command window
printf("\n Excess power margin(in dB) = %0.1f  ",E);


// The answers vary due to round off error
```

Scilab code Exa 8.50 `Calculation of signal to noise ratio`

```
// Example 8.50
// Calculation of signal to noise ratio.
// Page no 499

```

```
clc;
clear;
close;

//Given data

h=6.62*10^-34;                                   // Planck constant
c=3*10^8;                                        // velocity of light
lambda=1.55*10^-6;                               // Wavelength
B=400*10^6;                                      // Speed of communication
s=2;
// S/N ratio

sn=(s*4.24)/(2^(1/2));
i=(sn)^2;

//Displaying results in the command window
printf("\n Incident optical power(in nW) = %0.20f  ",i);


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

Scilab code Exa 8.51 `Calculation of Bit rate of communication system Bit duration`

```
// Example 7.42
// Calculation of a)Bit rate of communication system b)Bit duration c)Time period
// Page no 504

```

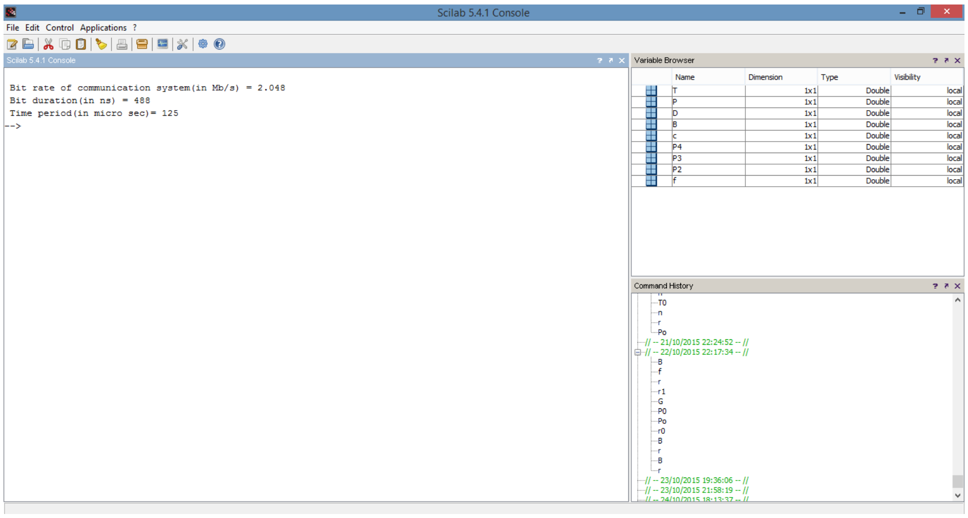

Figure 8.7: Calculation of Bit rate of communication system Bit duration and Time period

```
clc;
clear;
close;

//Given data
f=8*10^3;                    // Power launched in
    port 1
P2=0.082*10^-6;              // Power launched in
    port 2
P3=47*10^-6;                // Power launched in
    port 3
P4=52*10^-6;                // Power launched in
    port 4

// a)Bit rate of communication system
c=32*8;
B=f*c;
B=B*10^-6;
// b)Bit duration
D=1/B;
```

```
D=D*10*10^2;
P=8*D;


// c)Time period
T=32*P;
T=T*10^-3;


//Displaying results in the command window
printf("\n Bit rate of communication system(in Mb/s)
    = %0.3f  ",B);
printf("\n Bit duration(in ns) = %0.0f  ",D);
printf("\n Time period(in micro sec)= %0.0f  ",T);

// The answers vary due to round off error
```