```
%Definition constants
h = 6.626e-34;
kb = 1.381e-23;
c=299792458;
q = 1.602e-19;
format short
```

```
%Exercise 1
%*****************************************************************
d=100e-6;%diameter in m
nco = 1.475;
ncl = 1.455;
lambda = 850e-9;%Wavelength in m
V = 2*pi*d/2*sqrt(nco^2-ncl^2)/lambda;
fprintf('Exercise 1\n a) V-number: %f', V)
```

```
Exercise 1
 a) V-number: 89.470477
```

```
M = round(V^2/2);
fprintf('a) number of modes: %i', M)
```

```
a) number of modes: 4002
```

```
disp("Single mode condition V<2.405")
```

```
Single mode condition V<2.405
```

```
Vs = 2.405;
lambdac = 2*pi*d/2*sqrt(nco^2-ncl^2)/Vs;
fprintf('b) Cut-off wavelength: %f um',lambdac*1e6)
```

```
b) Cut-off wavelength: 31.621582 um
```

```
NA = sqrt(nco^2-ncl^2);
fprintf('c) Numerical Aperture: %f ',NA)
```

```
c) Numerical Aperture: 0.242074
```

```
fprintf('d) Acceptance angle: %f rad or %f°',2*asin(NA),2*asin(NA)*180/pi)
```

```
d) Acceptance angle: 0.489006 rad or 28.018007°
```

```
Dt = (nco-ncl)/c;
fprintf('time dispersion: %d ns/km',Dt*1e3*1e9)
```

```
time dispersion: 6.671282e+01 ns/km
```

```
BL = 0.59/(Dt*1e3*1e9);
fprintf('BL produt : %f GHz\n',BL)
```

```
BL produt : 0.008844 GHz
```

```
%Exercise 2
%*****************************************************************
Df = 15;%ps.nm-1km-1
Dc = -110;
Lf = 900;%km
Lc = 100;
Ttot = Df*Lf+Dc*Lc;
De = Ttot/(Lf+Lc);
fprintf('Exercise2 \n effective dispersion : %f ps.nm^-1.km^-1 \n',De)
```

```
Exercise2
 effective dispersion : 2.500000 ps.nm^-1.km^-1
```

```
%Exercise 3
%*****************************************************************
B = 2.5e9;
lambda= 1550e-9;
Dlambda = 0.5;
fprintf('Exercise 3 \n 1-SNR: %f or %f dB',10e-6/20e-9, 10 *log10(10e-6/20e-9))
```

```
Exercise 3
 1-SNR: 500.000000 or 26.989700 dB
```

```
Loss=0.2; %Loss in db/km
Pi = 1e-3;
Pf = 10e-6;
Lt = 10*log10(Pi/Pf);
Length = Lt/Loss;
fprintf('2- Length: %f km\n',Length)
```

```
2- Length: 100.000000 km
```

```
Df = -18;
Dt = Df*Length*Dlambda;
fprintf('3- total dispersion: %f ps\n',Dt)
```

```
3- total dispersion: -900.000000 ps
```

```
fprintf('max allowed is: %f ps\n',1e12/B)
```

```
max allowed is: 400.000000 ps
```

```
fprintf(' The system cannot work properly\n')
```

```
 The system cannot work properly
```

```
fprintf('4 - Either by reducing the linewidth of laser or using a compensating fiber')
```

```
4 - Either by reducing the linewidth of laser or using a compensating fiber
```

```
Dc = 100;
Lmin=(1e12/(B*Dlambda)-Df*Length)/Dc;
fprintf('5- Minimum Length: %f km\n',Lmin)
```

```
5- Minimum Length: 26.000000 km
```

```
Dlambda = 0.025;
B = 10e9;
Dt = Df*Length*Dlambda;
fprintf('6- total dispersion: %f ps\n',Dt)
```

```
6- total dispersion: -45.000000 ps
```

```
fprintf('max allowed is: %f ps\n therefore ok \n',1e12/B)
```

```
max allowed is: 100.000000 ps
 therefore ok
```

```
%Exercise 4
%*****************************************************************
fprintf('Exercise 4 \n')
```

Exercise 4

```
L = 0.6;
R1 = 0.99;
R2 = R1;
lambda = 633e-9;
Dfreq = c/(2*L);
F = pi*sqrt(R1)/(1-R1);
freq = c/lambda;
Dlambda = 633e-9^2/(2*L);
fprintf('An He-Ne has a wavelength output of 633 nm \n a) \x0394\x03bb : %d nm\n',Dlambda*1e9)
```

```
An He-Ne has a wavelength output of 633 nm
 a) Δλ : 3.339075e-04 nm
```

```
fprintf('a) \x03b4\x03bb : %d nm\n',Dlambda*1e9/F)
```

```
a) δλ : 1.068215e-06 nm
```

```

w0 = 0.1e-3/2;
theta = lambda/(pi*w0);
fprintf('b) Divergence angle theta: %.3d  or %.3f°\n',theta,theta*180/pi)
```

```
b) Divergence angle theta: 4.030e-03  or 0.231°
```

```

z0 = pi*w0^2/lambda;
z=1;
w = w0*sqrt(1+(z/z0)^2)
```

```
w = 0.0040
```

```
fprintf('c) spot diameter after 1 m = %f mm',2*w*1e3)
```

```
c) spot diameter after 1 m = 8.060227 mm
```

```
z=10;
w = w0*sqrt(1+(z/z0)^2)
```

```
w = 0.0403
```

```
fprintf('c) spot diameter after 10 m = %f mm\n',2*w*1e3)
```

```
c) spot diameter after 10 m = 80.596125 mm
```

```
%Exercise 5
%*****************************************************************
fprintf('Exercise 5 \n')
```

```
Exercise 5
```

```
Lcav = 250e-6;
lambda = 1540e-9;
freq = c/lambda;
n=3.7;
Line = 2;
m = 2*n*Lcav*freq/(c);
fprintf('a) mode integer %.0f', round(m))
```

```
a) mode integer 1201
```

```
fprintf('b) Separation between modes %.0f GHz\n',c/(1e9*2*n*Lcav))
```

```
b) Separation between modes 162 GHz
```

```
fprintf('Separation between modes %.2d nm\n',1e9*lambda^2/(2*n*Lcav))
```

```
Separation between modes 1.28e+00 nm
```

```
fprintf('c) number of modes around %.0f',2)
```

```
c) number of modes around 2
```

```
fprintf('d) Reflectance is Fresnel Reflection, R: %f', (n-1)^2/(n+1)^2)
```

```
d) Reflectance is Fresnel Reflection, R: 0.330014
```

```
fprintf('e) Period should be around %.1f nm',1e9*lambda/(2*n))
```

```
e) Period should be around 208.1 nm
```

```
R1 = 0.9;
F1 = pi*sqrt(R1)/(1-R1);
R2 = 0.95;
F2 = pi*sqrt(R2)/(1-R2);
fprintf('f) linewidth with R = 0.9 is : %.1d nm',1e9*lambda^2/(2*n*Lcav)/F1)
```

```
f) linewidth with R = 0.9 is : 4.3e-02 nm
```

```
fprintf('f) linewidth with R = 0.9 is : %.1f THz',1e-12*(c/lambda)/F1)
```

```
f) linewidth with R = 0.9 is : 6.5 THz
```

```
fprintf('f) linewidth with R = 0.95 is : %.1d nm\n',1e9*lambda^2/(2*n*Lcav)/F2)
```

```
f) linewidth with R = 0.95 is : 2.1e-02 nm
```

```
%Exercise 6
%*****************************************************************
fprintf('Exercise 6 \n')
```

```
Exercise 6
```

```
lambda = 600e-9;
freq = c/lambda;
En = h*freq/q;
fprintf('a) Maximum Eg: %.2f eV\n',En)
```

```
a) Maximum Eg: 2.07 eV
```

```
A = 4e-2;
I = 5e-3;
P = A*I;
nbphoton = P/(En*q);

fprintf('b) Number of EHP per second: %.2d\n',nbphoton)
```

```
b) Number of EHP per second: 6.04e+14
```

```
Eg=1.42;
freq = Eg*q/h;
lambda=c/freq;
fprintf('Wavelength: %.0f nm which is not visible', lambda*1e9)
```

```
Wavelength: 873 nm which is not visible
```

```

fprintf('d) yes because the bandgap of Silicon is around 1.1eV which is below 1.42eV')
```

```
d) yes because the bandgap of Silicon is around 1.1eV which is below 1.42eV
```