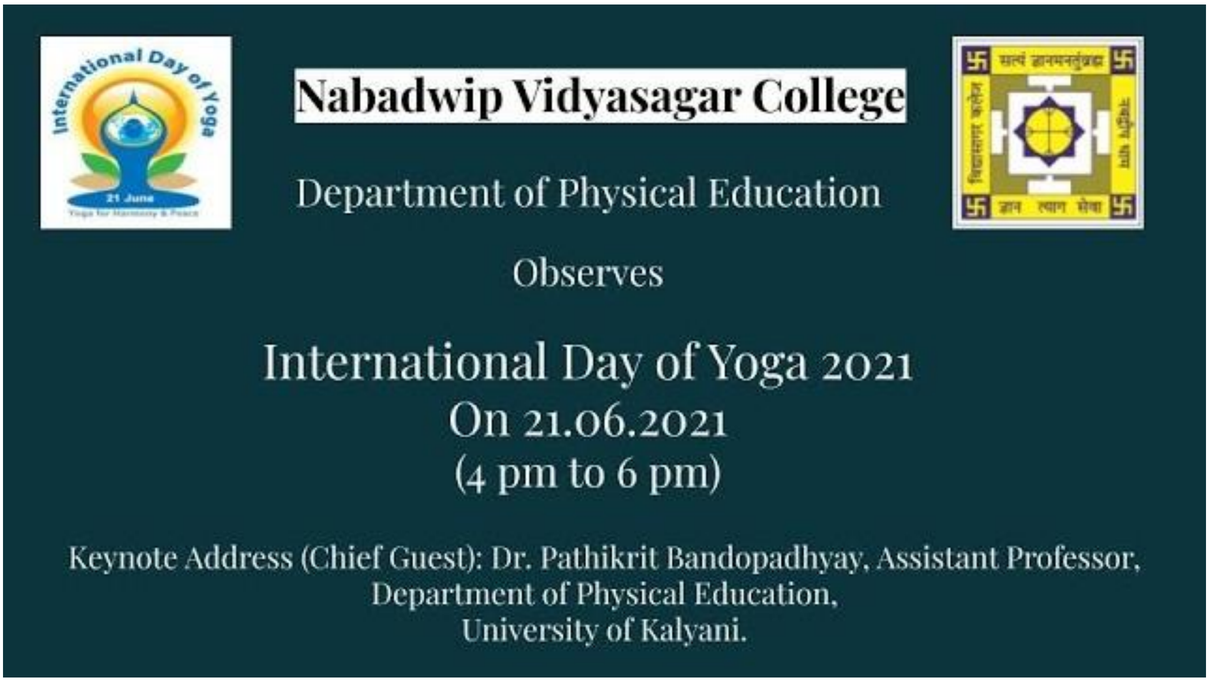
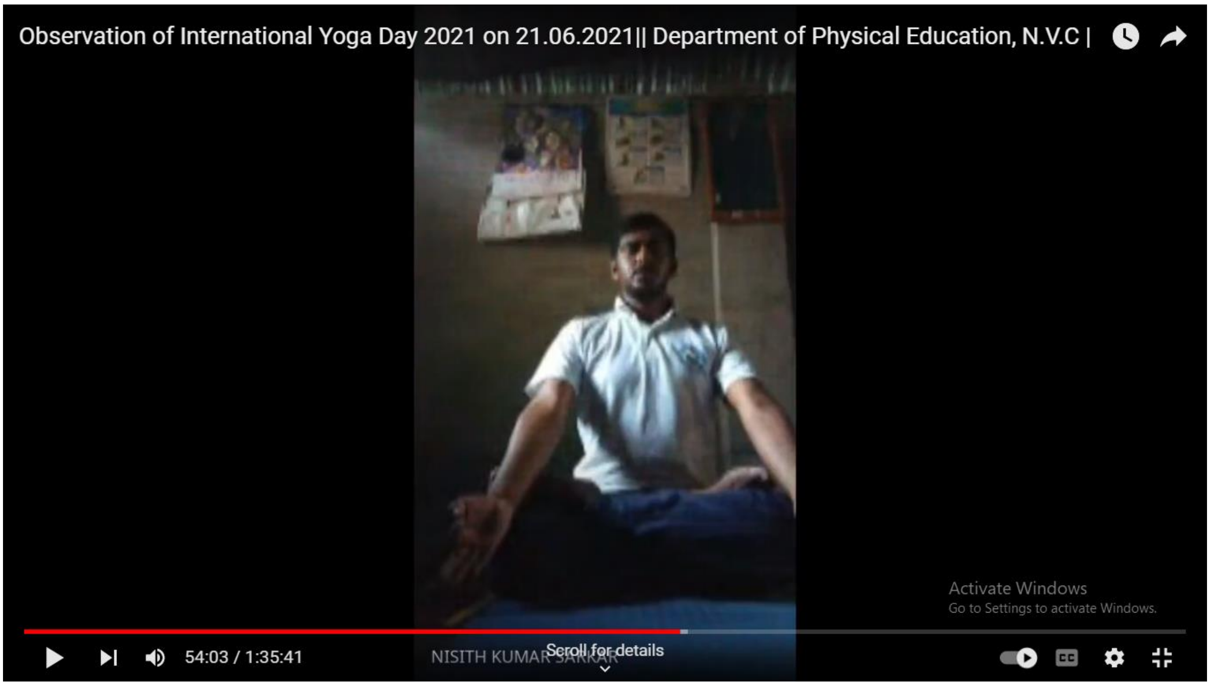
Skill Enhancement Activity (2021-22)

INTERNATIONAL YOGA DAY CELEBRATION (21.06.2021)

The Department of Physical Education in collaboration with I.Q.A.C organized a state level seminar on the observance of International Yoga Day (2021) on 21.06.2021. The welcoming speech by the principal was followed by the session from the honourable speaker Dr. Pathikrit Bandopadhyay, Asst. Professor, Department of Physical Education, University of Kalyani. A live performance was rendered by Mr. Nisith Kumar Sarkar (faculty) and the students of Physical Education Department, Nabadwip Vidyasagar College. Both the sessions garnered numerous views and universal applause. The webinar was concluded with a vote of thanks from Dr Bhaskar Chatterjee (Co-Ordinator of the IQAC, Nabadwip Vidyasagar College).





Youtube Link: https://www.youtube.com/watch?v=wXuXM7ELi8g

Participants List

Sl. No	Name of the Participants	Semester
1.	Suman Saha	1^{st} Sem
2.	Riya Ghosh	1^{st} Sem
3.	Jotish Sarkar	1^{st} Sem
4.	Sanaar Uddin Sk	1^{st} Sem
5.	Amina Khatun	1^{st} Sem
6.	Anindita Das	1^{st} Sem
7.	Banasree Barman	1^{st} Sem
8.	Debasmita Sarkar	1^{st} Sem
9.	Jamuna Das	1^{st} Sem
10.	Marjina Khatun	1^{st} Sem
11.	Mem Barman	1^{st} Sem
12.	Pampa Dhara	1^{st} Sem
13.	Swagata Goswami	1^{st} Sem
14.	Banti Biswas	1^{st} Sem
15.	Dibyendu Das	1^{st} Sem
16.	Gopal Bairagya	1^{st} Sem
17.	Krishnendu Bhowmik	1^{st} Sem
18.	Eisha Mondal	4^{th} Sem
19.	Najiya Molia	4^{th} Sem
20.	Poulami Roy	4^{th} Sem
21.	Rekha Majhi	4^{th} Sem
22.	Saptami Baishnab	4^{th} Sem
23.	Saraswati Bag	4^{th} Sem
24.	Shibani Biswas	4^{th} Sem
25.	Masud Seikh	4^{th} Sem
26.	Raj Sk	4^{th} Sem
27.	Rakesh Roy	4^{th} Sem
28.	Soma Sarkar	4^{th} Sem
29.	Abhijid Das	4^{th} Sem
30.	Akash Das	4^{th} Sem
31.	Priti Mondal	4^{th} Sem
32.	Arpan Pandit	4^{th} Sem
33.	Basudev Bhakta	4^{th} Sem
34.	Jewel Sk	4^{th} Sem
35.	Koushik Santra	4^{th} Sem
36.	Kuntal Mondal	4^{th} Sem
37.	Marej Sk	4^{th} Sem
38.	Raj Sekhar Bala	4^{th} Sem
39.	Rajesh Debnath	4^{th} Sem
40.	Sk Wasim	4^{th} Sem
41.	Sohan Koner	4^{th} Sem
42.	Suman Sarkar	4^{th} Sem
43.	Gita Biswas	4^{th} Sem

Principal
Nabadwip Vidyasagar College
Nabadwip, Nadia-741302

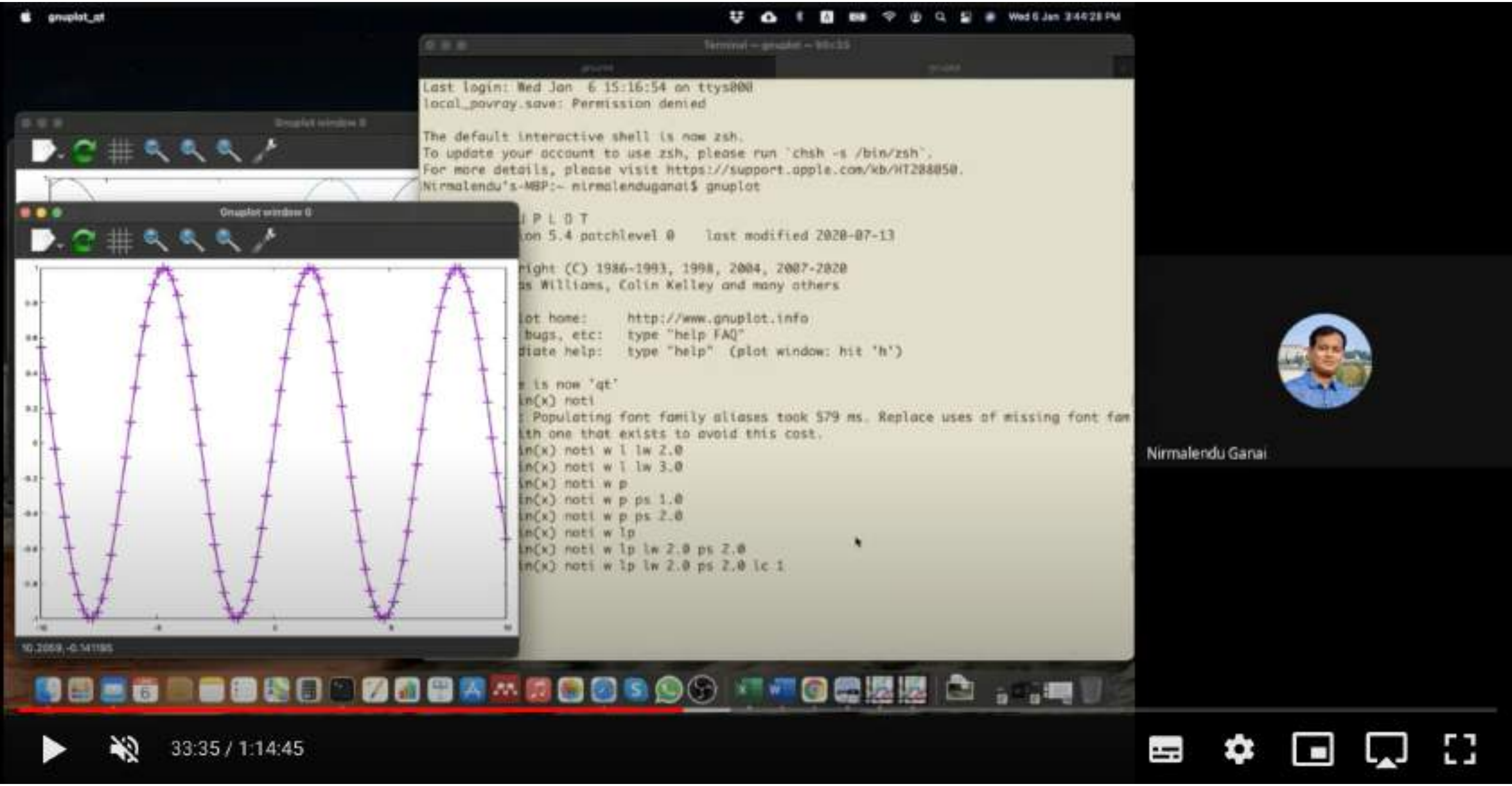
Teaching different Computational Techniques to Students

After the implementation of CBCS in the UG Courses, Department of Physics started to teach different computation skills to the students to solve different problems using computer as mentioned in the syllabus. Some of the computational techniques are gnuplot, Fortran, LaTex and scilab. Using gnuplot and scilab, students learn how to plot different functions whereas they can solve different problems like 1^{st} & 2^{nd} order differential equations, integrations, Dirac delta function, Bessel function, sum of an infinite series, least square fitting method, Schrodinger equation for the ground state and the first excited state of the Hydrogen atom for different potentials etc. using Fortran and scilab. LaTex has also been taught to the students so that they can learn how to prepare documents. Approximately forty students per year are benefitted from these computational techniques.

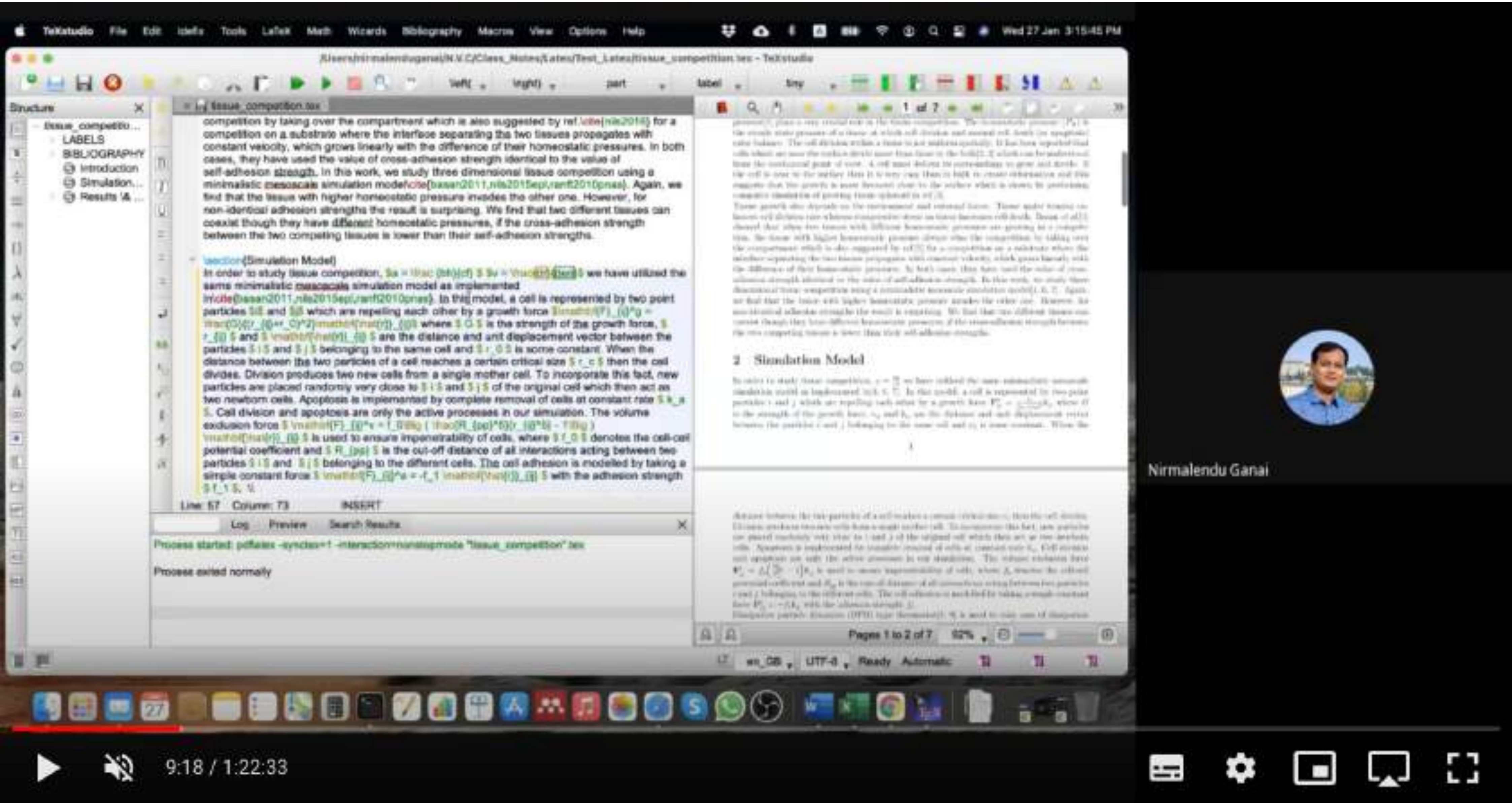
Screenshots of the programs are provided underneath.

Principal
Nabadwip Vidyasagar College
Nabadwip, Nadia-741302

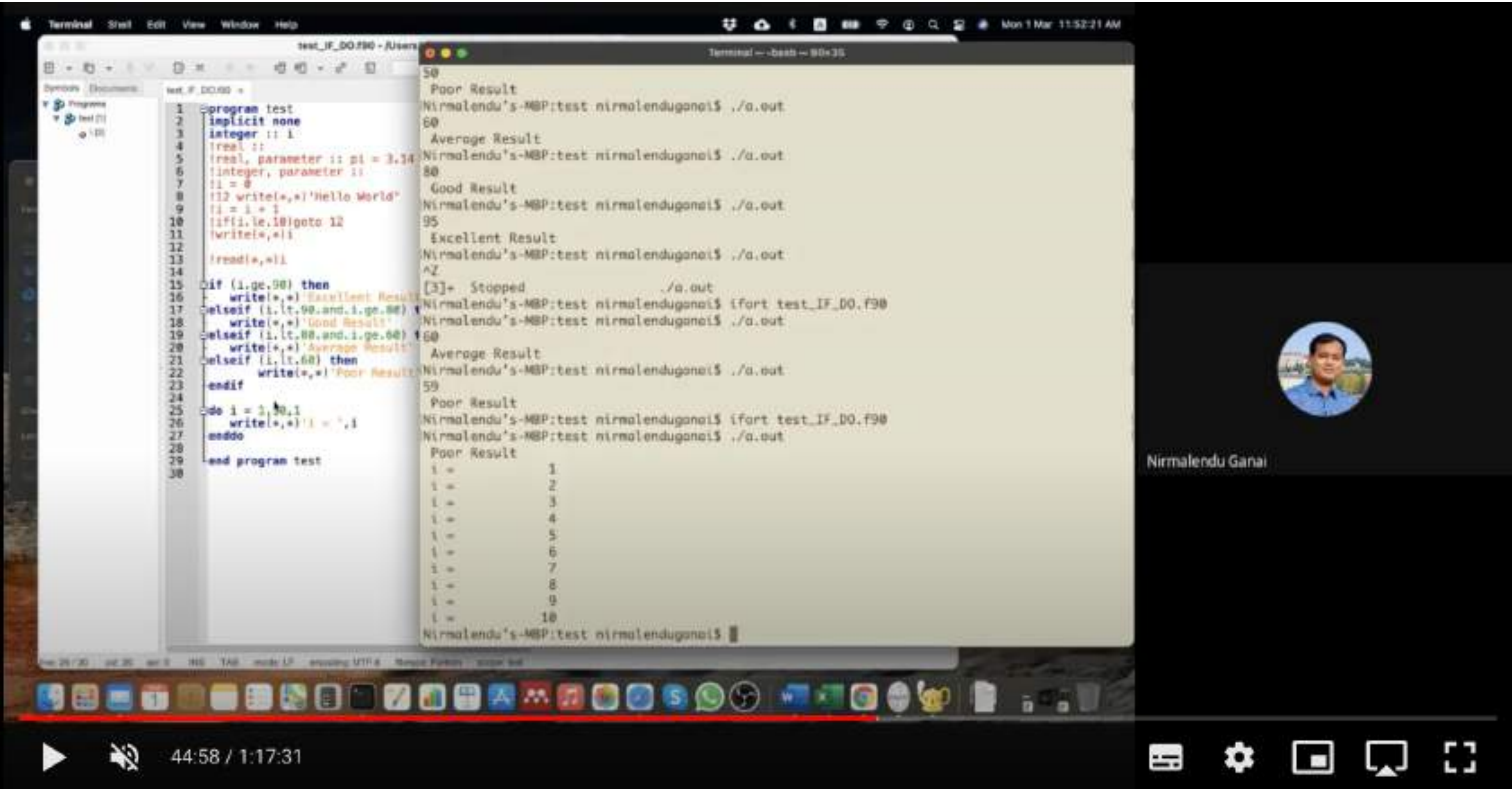
gnuplot


Last login: Wed Jan 6 15:16:54 on ttys000
local_povray.save: Permission denied
The default interactive shell is now zsh.
To update your account to use zsh, please run `chsh -s /bin/zsh`.
For more details, please visit https://support.apple.com/kb/HT208050.
Nirmalendu's-MBP:~ nirmalenduganai$ gnuplot
ion 5.4 patchlevel 0 last modified 2020-07-13
right (C) 1986-1993, 1998, 2004, 2007-2020
s Williams, Colin Kelley and many others
lot home: http://www.gnuplot.info
bugs, etc: type "help FAQ"
diate help: type "help" (plot window: hit 'h')
e is now 'qt'
in(x) noti
: Populating font family aliases took 579 ms. Replace uses of missing font fam
ith one that exists to avoid this cost.
in(x) noti w l lw 2.0
in(x) noti w l lw 3.0
in(x) noti w p
in(x) noti w p ps 1.0
in(x) noti w p ps 2.0
in(x) noti w lp
in(x) noti w lp lw 2.0 ps 2.0
in(x) noti w lp lw 2.0 ps 2.0 lc 1
Nirmalendu Ganai
33:35 / 1:14:45

LATEX

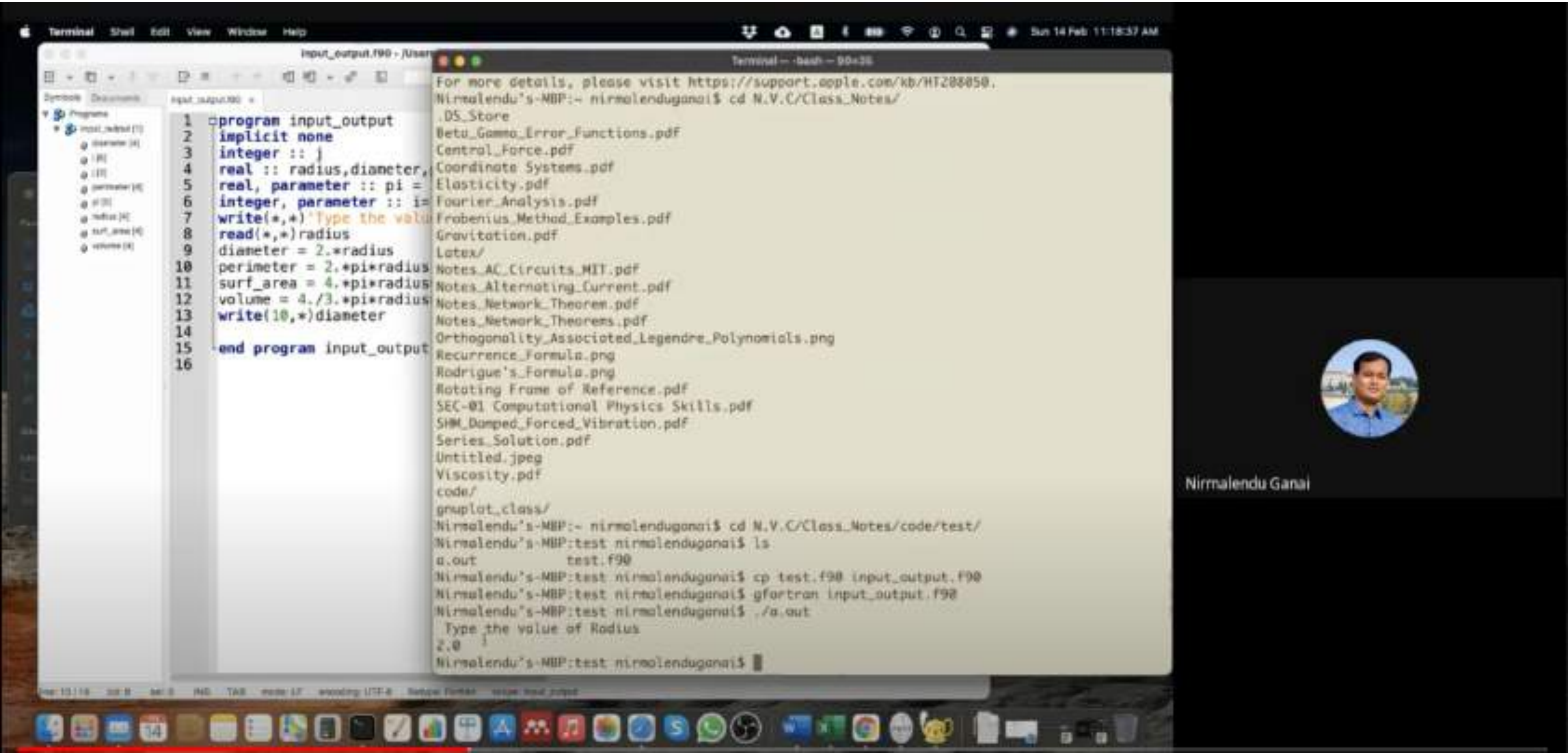

TeXstudio
2 Simulation Model
Process exited normally
Nirmalendu Ganai
9:18 / 1:22:33

Fortran



Terminal Shell Edit View Window Help
Mon 1 Mar 11:52:21 AM
program test
implicit none
integer :: i
!real ::
!real, parameter :: pi = 3.14
!integer, parameter ::
!i = 0
!12 write(*,*)'Hello World'
!i = i + 1
!if(i.le.10)goto 12
!write(*,*)i
!read(*,*)i
if (i.ge.90) then
write(*,*)'Excellent Result'
elseif (i.lt.90.and.i.ge.80)
write(*,*)'Good Result'
elseif (i.lt.80.and.i.ge.60)
write(*,*)'Average Result'
elseif (i.lt.60) then
write(*,*)'Poor Result'
endif
do i = 1,10,1
write(*,*)'i = ',i
enddo
end program test
50
Poor Result
Nirmalendu's-MBP:test nirmalenduganai$ ./a.out
60
Average Result
Nirmalendu's-MBP:test nirmalenduganai$ ./a.out
80
Good Result
Nirmalendu's-MBP:test nirmalenduganai$ ./a.out
95
Excellent Result
Nirmalendu's-MBP:test nirmalenduganai$ ./a.out
^Z
[3]+ Stopped ./a.out
Nirmalendu's-MBP:test nirmalenduganai$ ifort test_IF_DO.f90
Nirmalendu's-MBP:test nirmalenduganai$ ./a.out
60
Average Result
Nirmalendu's-MBP:test nirmalenduganai$ ./a.out
59
Poor Result
Nirmalendu's-MBP:test nirmalenduganai$ ifort test_IF_DO.f90
Nirmalendu's-MBP:test nirmalenduganai$ ./a.out
Poor Result
i = 1
i = 2
i = 3
i = 4
i = 5
i = 6
i = 7
i = 8
i = 9
i = 10
Nirmalendu's-MBP:test nirmalenduganai$
Nirmalendu Ganai
44:58 / 1:17:31

Fortran


Terminal Shell Edit View Window Help
Sun 14 Feb 11:18:37 AM
input_output.f90
Terminal — -bash — 90×35
program input_output
implicit none
integer :: j
real :: radius,diameter,
real, parameter :: pi =
integer, parameter :: i=
write(*,*)'Type the valu
read(*,*)radius
diameter = 2.*radius
perimeter = 2.*pi*radius
surf_area = 4.*pi*radius
volume = 4./3.*pi*radius
write(10,*)diameter
end program input_output
For more details, please visit https://support.apple.com/kb/HT208050.
Nirmalendu's-MBP:~ nirmalenduganai$ cd N.V.C/Class_Notes/
.DS_Store
Beta_Gamma_Error_Functions.pdf
Central_Force.pdf
Coordinate Systems.pdf
Elasticity.pdf
Fourier_Analysis.pdf
Frobenius_Method_Examples.pdf
Gravitation.pdf
Latex/
Notes_AC_Circuits_MIT.pdf
Notes_Alternating_Current.pdf
Notes_Network_Theorem.pdf
Notes_Network_Theorems.pdf
Orthogonality_Associated_Legendre_Polynomials.png
Recurrence_Formula.png
Rodrigue's_Formula.png
Rotating Frame of Reference.pdf
SEC-01 Computational Physics Skills.pdf
SHM_Damped_Forced_Vibration.pdf
Series_Solution.pdf
Untitled.jpeg
Viscosity.pdf
code/
gnuplot_class/
Nirmalendu's-MBP:~ nirmalenduganai$ cd N.V.C/Class_Notes/code/test/
Nirmalendu's-MBP:test nirmalenduganai$ ls
a.out test.f90
Nirmalendu's-MBP:test nirmalenduganai$ cp test.f90 input_output.f90
Nirmalendu's-MBP:test nirmalenduganai$ gfortran input_output.f90
Nirmalendu's-MBP:test nirmalenduganai$ ./a.out
Type the value of Radius
2.0
Nirmalendu's-MBP:test nirmalenduganai$
Nirmalendu Ganai

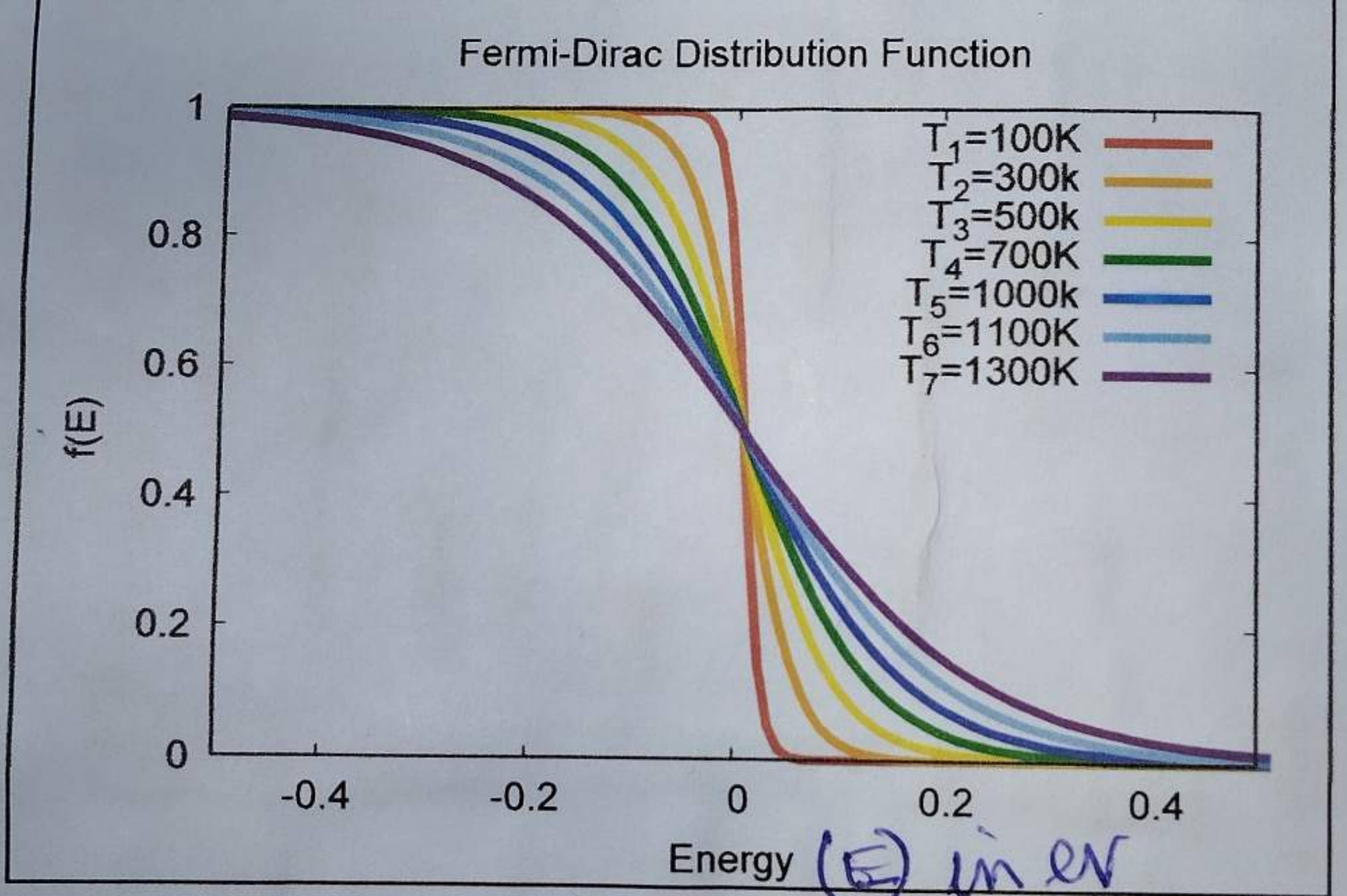
gnuplot

Page 7 1.
Date 4/3/22

```
#plot Fermi-Dirac distribution function vs temperature
set title "Fermi-Dirac Distribution Function"
set xrange[-0.5:0.5]
set yrange[0:1]
set xlabel "Energy"
set ylabel "f(E)"
e=1.6e-19
k=1.38e-23
u=0
a=1
T1=100
T2=300
T3=500
T4=700
T5=1000
T6=1100
T7=1300
f1(x)=1/(exp(((x-u)*e)/(k*T1))+a)
f2(x)=1/(exp(((x-u)*e)/(k*T2))+a)
f3(x)=1/(exp(((x-u)*e)/(k*T3))+a)
f4(x)=1/(exp(((x-u)*e)/(k*T4))+a)
f5(x)=1/(exp(((x-u)*e)/(k*T5))+a)
f6(x)=1/(exp(((x-u)*e)/(k*T6))+a)
f7(x)=1/(exp(((x-u)*e)/(k*T7))+a)
plot f1(x) title "T_1=100K" lw 5 lc rgb "red", f2(x) title "T_2=300k" lw 5 lc rgb "orange", f3(x) title "T_3=500k" lw 5 lc rgb "yellow", f4(x) title "T_4=700K" lw 5 lc rgb "green", f5(x) title "T_5=1000k" lw 5 lc rgb "blue", f6(x) title "T_6=1100K" lw 5 lc rgb "skyblue", f7(x) title "T_7=1300K" lw 5 lc rgb "dark-violet"
set term post solid color eps enhanced "Helvetica" 22 lw 2.0
set output "FD.eps"
rep
```

08/04/2022

```
gnuplot> load 'Fermi-dirac.gnu'
```



Fermi-Dirac Distribution Function
1
0.8
0.6
0.4
0.2
0
f(E)
T1=100K
T2=300k
T3=500k
T4=700K
T5=1000k
T6=1100K
T7=1300K
-0.4
-0.2
0
0.2
0.4
Energy (E) in eV

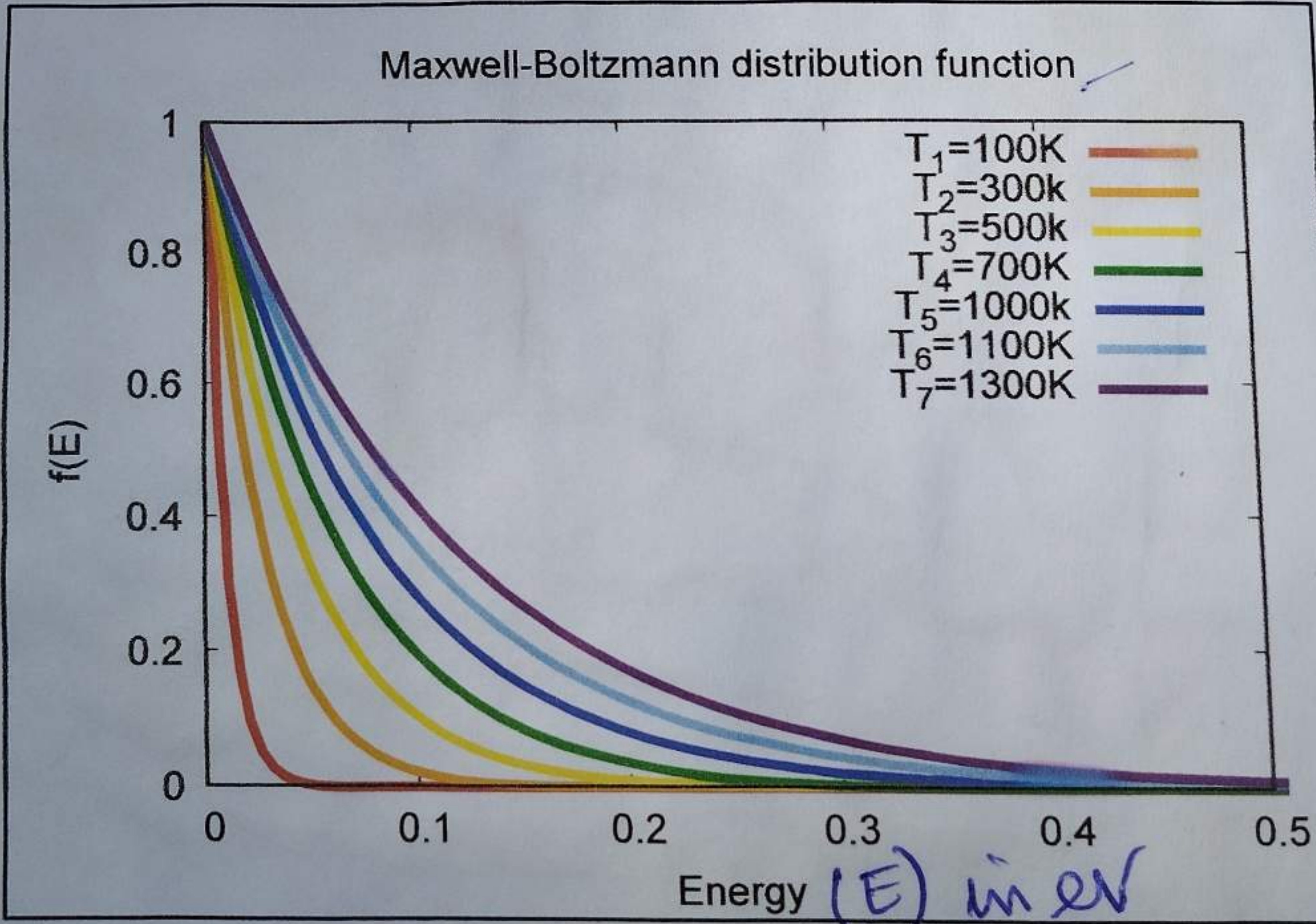
gnuplot

Page-2
Date-15/3/22

```
#plot Maxwell-Boltzmann distribution function vs temperature
set title " Maxwell-Boltzmann distribution function"
set xrange[0:0.5]
set yrange[0:1]
set xlabel "Energy"
set ylabel "f(E)"
e=1.6e-19
k=1.38e-23
u=0
a=0
T1=100
T2=300
T3=500
T4=700
T5=1000
T6=1100
T7=1300
f1(x)=1/(exp(((x-u)*e)/(k*T1))+a)
f2(x)=1/(exp(((x-u)*e)/(k*T2))+a)
f3(x)=1/(exp(((x-u)*e)/(k*T3))+a)
f4(x)=1/(exp(((x-u)*e)/(k*T4))+a)
f5(x)=1/(exp(((x-u)*e)/(k*T5))+a)
f6(x)=1/(exp(((x-u)*e)/(k*T6))+a)
f7(x)=1/(exp(((x-u)*e)/(k*T7))+a)
plot f1(x) title "T_1=100K" lw 5 lc rgb "red", f2(x) title "T_2=300k" lw 5 lc rgb "orange", f3(x) title "T_3=500k" lw 5 lc rgb "yellow", f4(x) title "T_4=700K" lw 5 lc rgb "green", f5(x) title "T_5=1000k" lw 5 lc rgb "blue", f6(x) title "T_6=1100K" lw 5 lc rgb "skyblue", f7(x) title "T_7=1300K" lw 5 lc rgb "dark-violet"
set term post solid color eps enhanced "Helvetica" 22 lw 2.0
set output "MB.eps"
rep
```

```
gnuplot> load 'Maxwell-Boltzmann.gnu'
```

Nanai
08/04/2022



Maxwell-Boltzmann distribution function
f(E)
1
0.8
0.6
0.4
0.2
0
0
0.1
0.2
0.3
0.4
0.5
T1=100K
T2=300k
T3=500k
T4=700K
T5=1000k
T6=1100K
T7=1300K
Energy (E) in eV

gnuplot

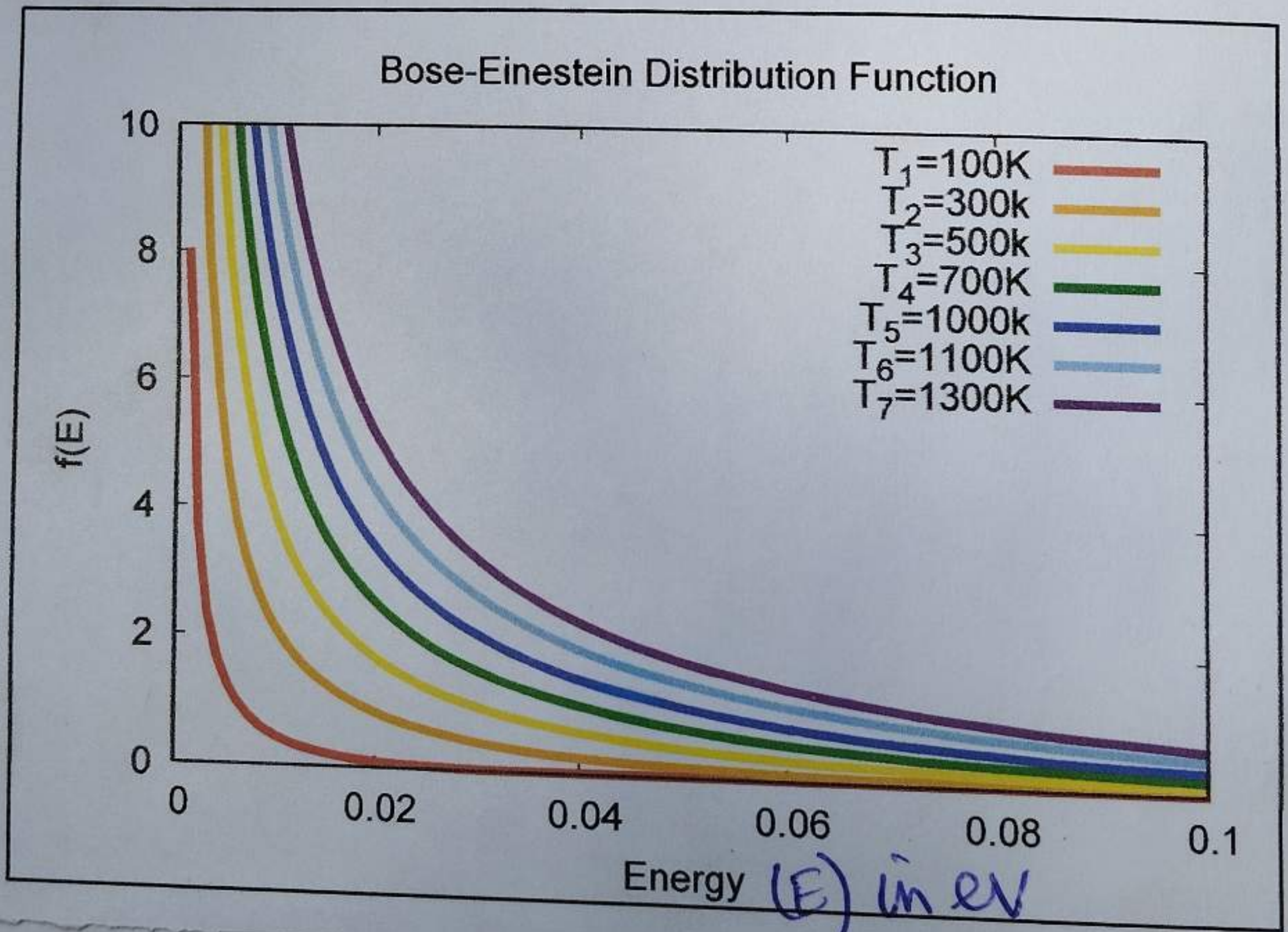
page → 3
Date → 21/3/22

Plot Bose-Einestein Distribution Function vs temperature

```
set title " Bose-Einestein Distribution Function "
set xrange[0:0.1]
set yrange[0:10]
set xlabel "Energy"(E) in eV
set ylabel "f(E)"
e=1.6e-19
k=1.38e-23
u=0
a=-1
T1=100
T2=300
T3=500
T4=700
T5=1000
T6=1100
T7=1300
f1(x)=1/(exp(((x-u)*e)/(k*T1))+a)
f2(x)=1/(exp(((x-u)*e)/(k*T2))+a)
f3(x)=1/(exp(((x-u)*e)/(k*T3))+a)
f4(x)=1/(exp(((x-u)*e)/(k*T4))+a)
f5(x)=1/(exp(((x-u)*e)/(k*T5))+a)
f6(x)=1/(exp(((x-u)*e)/(k*T6))+a)
f7(x)=1/(exp(((x-u)*e)/(k*T7))+a)
plot f1(x) title "T_1=100K" lw 5 lc rgb "red", f2(x) title "T_2=300k" lw 5 lc rgb "orange", f3(x) title "T_3=500k" lw 5 lc rgb "yellow", f4(x) title "T_4=700K" lw 5 lc rgb "green", f5(x) title "T_5=1000k" lw 5 lc rgb "blue", f6(x) title "T_6=1100K" lw 5 lc rgb "skyblue", f7(x) title "T_7=1300K" lw 5 lc rgb "dark-violet"
set term post solid color eps enhanced "Helvetica" 22 lw 2.0
set output "BE.eps"
rep
```

```
gnuplot> load ' Bose-Einestein.gnu'
```

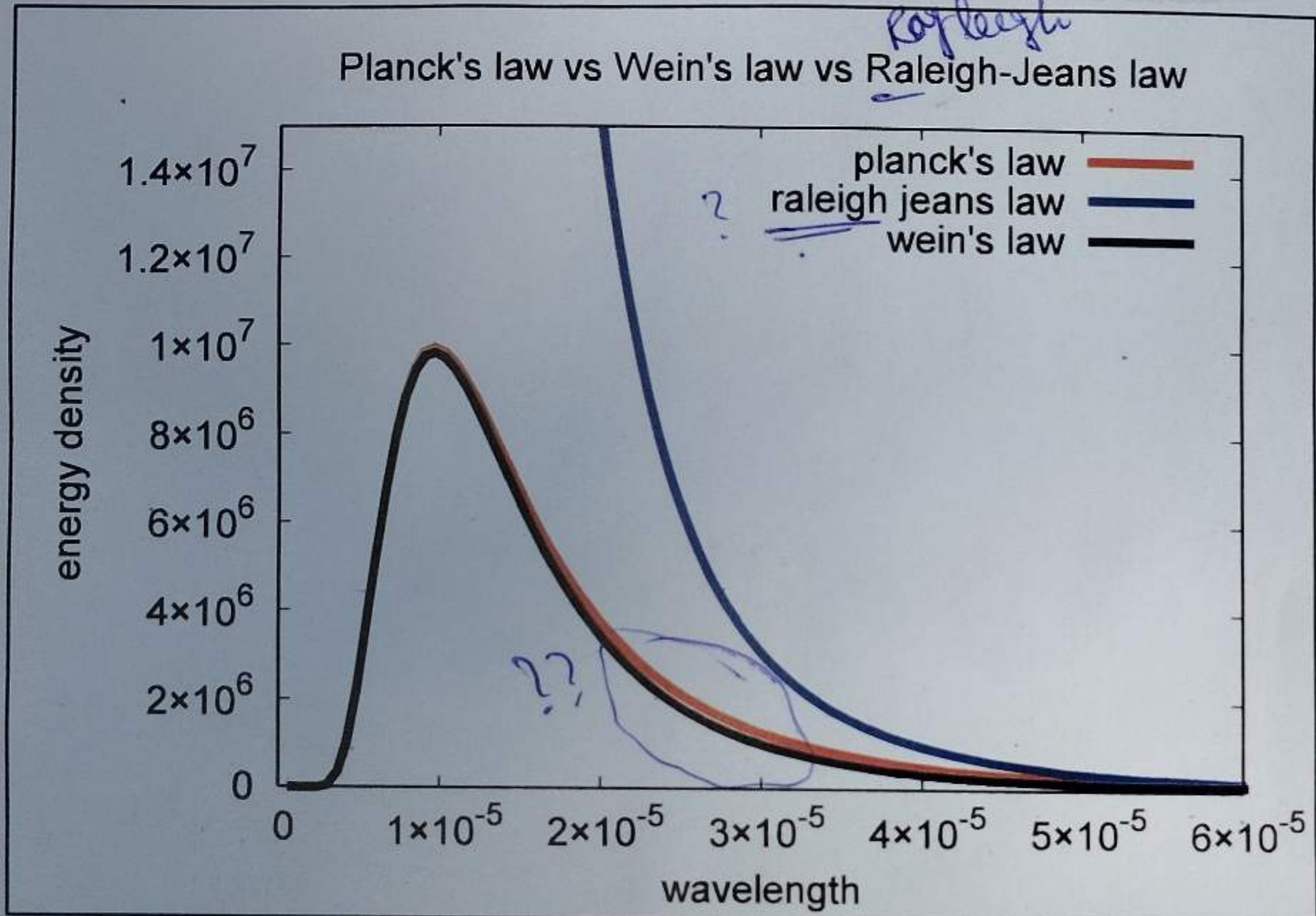
Sanai
09/04/2022



Bose-Einestein Distribution Function
f(E)
10
8
6
4
2
0
0
0.02
0.04
0.06
0.08
0.1
Energy (E) in eV
T1=100K
T2=300k
T3=500k
T4=700K
T5=1000k
T6=1100K
T7=1300K

gnuplot

```
#plot planck's law  for black body radiation and compare it with
wein's law and rayleigh-jeans law at room temperature
set title "Planck's law vs Wein's law vs Raleigh-Jeans law"
set xlabel "wavelength"
set ylabel "energy density"
set xrange[0:6e-5]
set yrange[0:1.5e7]
h=6.626e-34
c=3e8
k=1.38e-23
T=300
p(x)=(2*h*c**2/x**5)*(1/(exp(h*c/(x*k*T))-1))
r(x)=2*c*k*T/x**4
w(x)=(2*h*c**2/x**5)*(exp(-(h*c/(x*k*T))))
plot p(x) title "planck's law" lw 5 lc rgb "red", r(x) title "raleigh jeans law" lw 5 lc rgb "blue", w(x) title "wein's law" lw 5 lc rgb "black"
set term post solid color eps enhanced "Helvetica" 22 lw 2.0
set output "graph_pwr.eps"
rep
```


Planck's law vs Wein's law vs Raleigh-Jeans law
Rayleigh
planck's law
raleigh jeans law
wein's law
?
??
energy density
1.4×10^7
1.2×10^7
1×10^7
8×10^6
6×10^6
4×10^6
2×10^6
0
0
1×10^-5
2×10^-5
3×10^-5
4×10^-5
5×10^-5
6×10^-5
wavelength

Experiment No. 1 Name:

DOMS Page No. 1
Date 23 | 05 | 22

Scilab

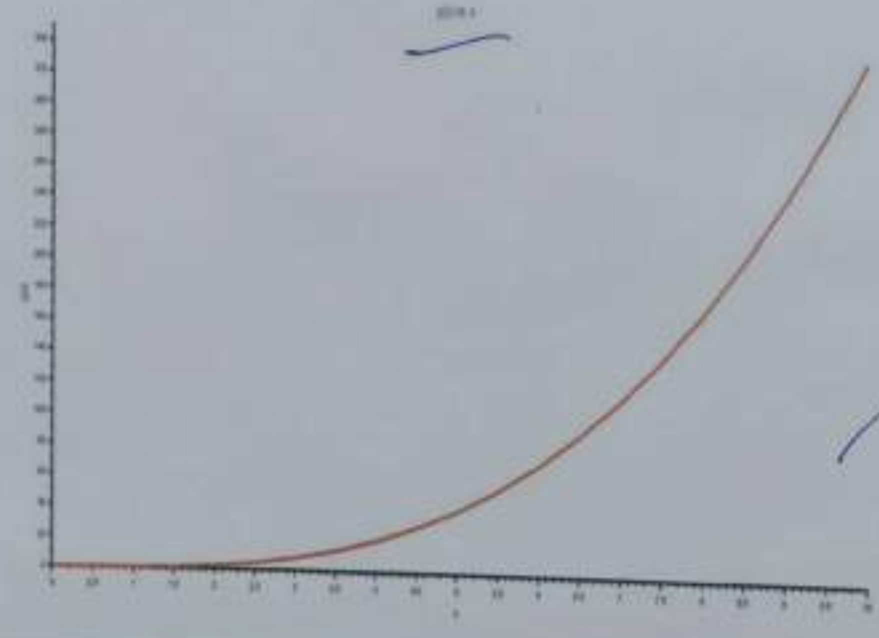
- SOLVE DIFFERENTIAL EQUATION :

```
clf;
function a=f(x, y)
a=x^2-exp(-x)*y
endfunction
y0=0
x0=0
x=[0:0.5:10]
sol=ode(y0,x0,x,f)
//disp(x,sol)
xset("thickness",3)
plot2d(x,sol,5)
xlabel('x')
ylabel('y(x)')
title('y(x) vs. x')
//xgrid(0)
```

14/05/22

Teacher's Signature:

- **OUTPUT :**



Experiment No. 2 Name ______

DOMS Page No. 2
Date 23 | 05 | 22

Scilab

• DIRAC DELTA FUNCTION :

```
function y=f(x)
y=(1/sqrt(2*(%pi)*(sigma^2)))*exp(-(x-2)^2/(2*(sigma^2)))*(x+3)
endfunction
sigma=0.01
I=integrate('f(x)','x',-4,4)
disp(I)
```

• OUTPUT :

= 5.0000000

14/06/22

Teacher's Signature: ______

Scilab

- FOURIER SERIES : PROGRAM TO SUM

```
sum=0
term=1
n=30
for i=1:1:n
term=term*0.2
sum=sum+term
end
disp(sum)
```

$\sum (0.2)^n$

- OUTPUT :

= 0.2500000

14/06/22

Experiment No. 4 Name: DOMS Page No. 4 Date 27 | 05 | 22

Scilab

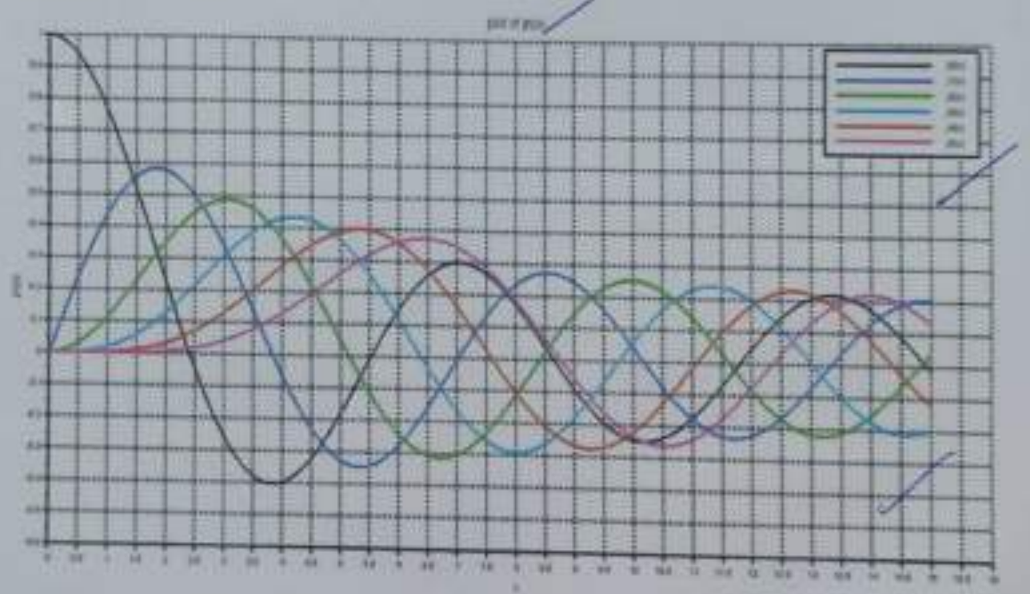
- BESSEL FUNCTION :

```
funcprot(0)
function jn=j(n, x)
sum=0.0
for m=0:30
den=factorial(m)*factorial(m+n)
sum=sum+((-1)^m)*((x/2)^(2*m+n))/den
end
jn=sum
endfunction
clf;
x=0:0.1:15
for n=0:5
xset("thickness",3)
plot2d(x,j(n,x),n+1)
xgrid(0)
xtitle('plot of jn(x)','x','jn(x)');
hl=legend(['j0(x)';'j1(x)';'j2(x)';'j3(x)';'j4(x)';'j5(x)']);
end
```

14/06/22

Teacher's Signature: ___

- **OUTPUT :**



Experiment No. 5 Name

20M15 Page No. 5
Date 25 | 05 | 22

Scilab

- 2ND ORDER DIFFERENTIAL EQUATION :

```
clf
function dy=f(t, y)
dy(1)=y(2)
dy(2)=-3*y(2)+10*y(1)
endfunction
t0=0
y0=1
dy0=3
t=3:0.01:5
y=ode([y0;dy0],t0,t,f)
plot(t,y(1,:),"b",'linewidth',5)
plot(t,y(2,:),"r",'linewidth',5)
xtitle("$\frac{d^2 y}{dt^2}=-3*\frac{dy}{dt}+10*y $","t","f(t,y)")
hl=legend(['y(t)';"$\frac{dy}{dt}$"],[2])
xgrid(0)
```

14/06/22

Teacher's Signature

- **OUTPUT :**

Experiment No. 6 Name:

DOMS Page No. 6
Date: 25 | 05 | 22

Scilab

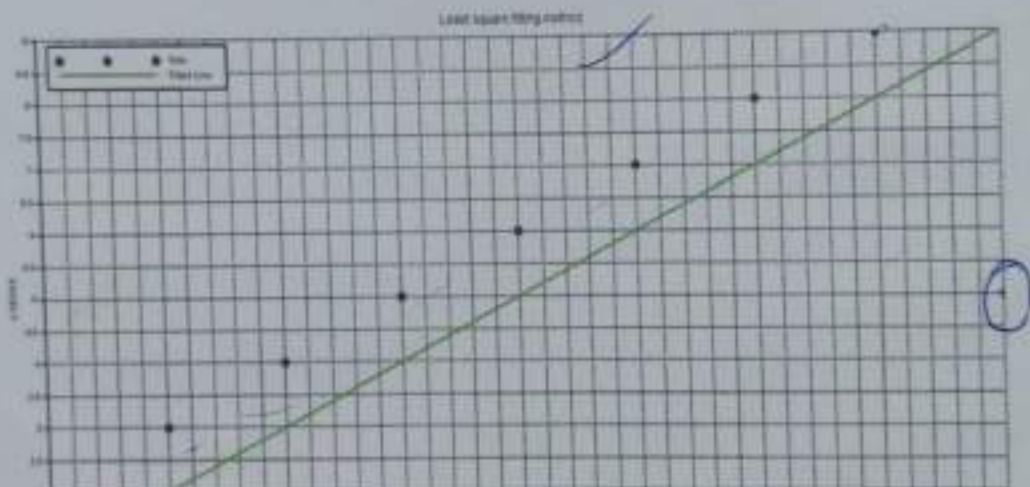
- CALCULATION OF LEAST SQUARE FITTING :

```
clf;
x=[1,2,3,4,5,6,7,8,9]
y=[2,3,4,5,6,7,8,9,5]
n=length(x)
sx=sum(x)
sy=sum(y)
sx2=sum(x.*x)
sxy=sum(x.*y)
A=[sxn;sx2sx]
B=[sx;sxy]
sol=inv(A)*B
m=(sol(1))
c=(sol(2))
disp("The slop of the best fitted line is",m)
disp("And the constant is",c)
xset("thickness",2)
plot2d(x,y,-3)
plot2d(x,m*x+c,3)
xtitle('Least square fitting method','x values','y values');
hl=legend(['Data';'Fitted Line'],[2]);
xgrid(0)
```

14/06/22

Teacher's Signature:

- **OUTPUT :**



Expt NO-1 Date - 26/11/22

Scilab

1. SOLVE THE S-WAVE SCHRODINGER EQUATION FOR THE GROUND STATE AND THE FIRST EXCITED STATE OF THE HYDROGEN ATOM [PROVIDED V(r)=-(e^2/r)] :

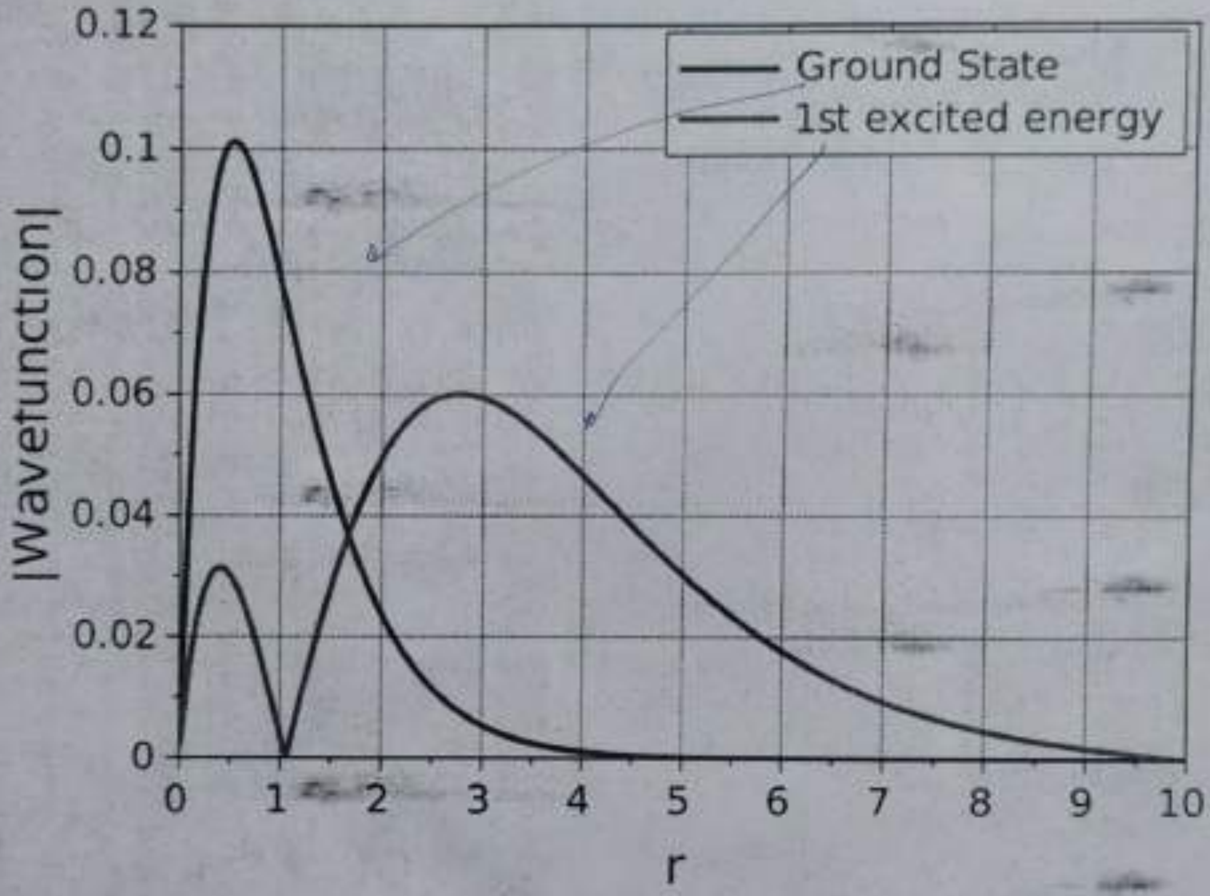
```
clf;clear;clc;
m=0.511*10^6;e=3.795;h=1973;
rmin=0.01;rmax=10;n=1000;
r=linspace(rmin,rmax,n);
d=r(2)-r(1)
V=zeros(n,n)
for i=1:n
    V(i,i)=(-(e^2)/r(i))
end
K=eye(n,n)*(-2)
for i=1:(n-1)
    K(i,i+1)=1;
    K(i+1,i)=1;
end
H=(-(h^2)/(2*m*d^2))*K+V;
[U,EV]=spec(H)
E=diag(EV)
disp('Ground state energy:'+string(E(1))+'eV','1st excited state
energy:'+string(E(2))+'eV');
plot(r',[abs(U(:,1)),abs(U(:,2))],'linewidth',3)
xlabel('r','fontsize',5);
ylabel('|Wavefunction|','fontsize',5);
l=legend('Ground State','1st excited energy',1);
xset('font size',4);
l.font_size=4;
xgrid();
//pdf export
filename='wavefunction_Coulomb_Potential'
xs2pdf(0,'Schrodinger_eqn');
xs2pdf(gcf(),'Schrodinger_eqn');
```

03/12/22

RESULT :

"Ground state energy:-13.612724eV"

"1st excited state energy:-3.4026108eV"



2.SOLVE THE S-WAVE RADIAL SCHRODINGER EQUATION FOR AN ATOM WHERE 'm' IS THE REDUCED MASS OF THE SYSTEM,FOR SCREENED COULOMB POTENTIAL [PROVIDED V(r)=-(e^2)*(exp(-r/a))/r] AND [a=3A,5A,7A] :

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```
clf;clear;clc;
m=0.511*10^6;e=3.795;h=1973;a1=3;a2=5;a3=7;
rmin=0.01;rmax=10.0;n=1000;
r=linspace(rmin,rmax,n);
d=r(2)-r(1); r
V1=zeros(n,n);
for i=1:n
    V1(i,i)=-((e^2)*(exp(-r(i)/a1)))/r(i);
end
V2=zeros(n,n);
for i=1:n;
    V2(i,i)=-((e^2)*(exp(-r(i)/a2)))/r(i);
end
V3=zeros(n,n);
for i=1:n;
    V3(i,i)=-((e^2)*(exp(-r(i)/a3)))/r(i);
end
K=eye(n,n)*(-2)
for i=1:(n-1)
    K(i,i+1)=1;
    K(i+1,i)=1;
end
H1=(-(h^2)/(2*m*d^2))*K+V1;
H2=(-(h^2)/(2*m*d^2))*K+V2;
H3=(-(h^2)/(2*m*d^2))*K+V3;
[U1,EV1]=spec(H1);[U2,EV2]=spec(H2);[U3,EV3]=spec(H3);
E1=diag(EV1);E2=diag(EV2);E3=diag(EV3);
disp('Ground state energy (eV) for a=3A,5A and 7A')
disp([E1(1),E2(1),E3(1)]);
disp('1st excited state energy (eV) for a=3A,5A and 7A');
disp([E1(2),E2(2),E3(2)]);
subplot(3,1,1)
plot(r',[abs(U1(:,1)),abs(U1(:,2))],'linewidth',5);
xlabel('r','fontsize',3);ylabel('|Wavefunction|','fontsize',3);
l=legend('Ground State','1st excited state',1);
xset('font size',2);
l.font_size=2;
xgrid();
title('a=3A','position',[4,0.08])
subplot(3,1,2)
plot(r',[abs(U2(:,1)),abs(U2(:,2))],'linewidth',5);
xlabel('r','fontsize',3);ylabel('|Wavefunction|','fontsize',3);
l=legend('Ground State','1st excited state',1);
xset('font size',2);
l.font_size=2;
xgrid();
title('a=5A','position',[4,0.095])
subplot(3,1,3)
plot(r',[abs(U3(:,1)),abs(U3(:,2))],'linewidth',5);
xlabel('r','fontsize',3);ylabel('|Wavefunction|','fontsize',3);
l=legend('Ground State','1st excited state',1);
xset('font size',2);
l.font_size=2;
xgrid();
title('a=7A','position',[4,0.095])
filename='Screened_Coulomb_Potential'
xs2pdf(0,'Schrodinger_eqn2');
xs2pdf(gcf(),'Schrodinger_eqn2');
```

@Nanai
10/12/2022

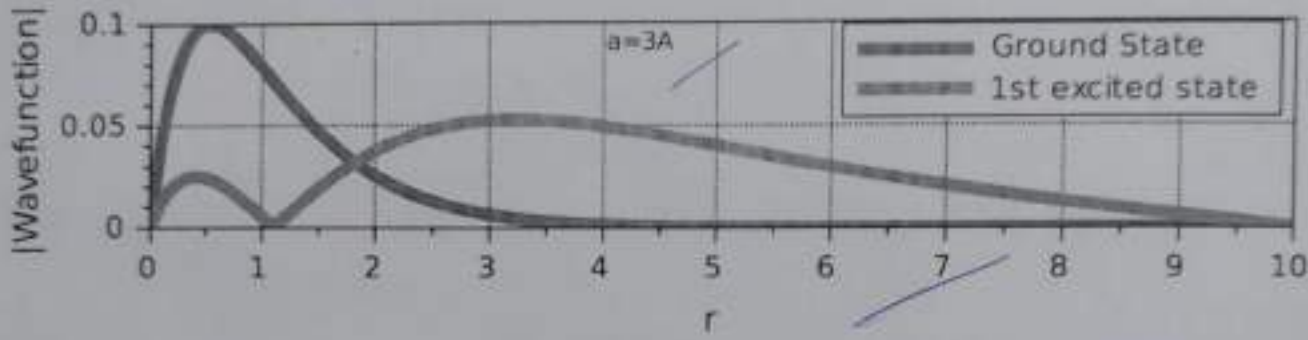
RESULT :

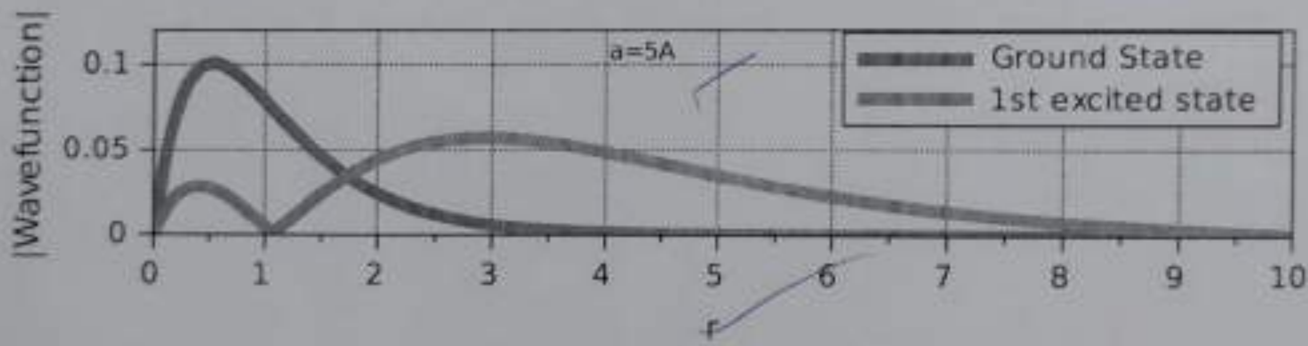
"Ground state energy(eV) for a=3A,5A and 7A"

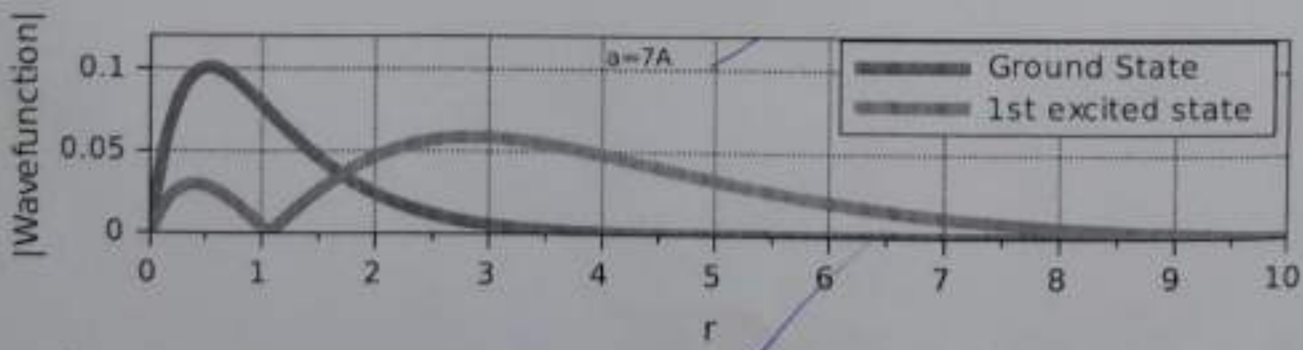
-9.3859942 -10.946712 -11.66656

"1st excited state energy(eV) for a=3A,5A and 7A"

-0.482694 -1.272207 -1.7468519







3.SOLVE THE S-WAVE RADIAL SCHRODINGER EQUATION FOR A PARTICLE OF MASS 'm' FOR THE ANHARMONIC OSCILLATOR POTENTIAL [V(r)=(k*r^2/2)+(b*r^3/3)] AND GIVEN [b=0,10,30 MeV] :

```
clf;clear;clc;
m=940;h=197.3;k1=100;b1=0;b2=10;b3=30;
min=0.01;rmax=4;n=1000;
r=linspace(rmin,rmax,n);
d=r(2)-r(1); r
V1=zeros(n,n);
for i=1:n
    V1(i,i)=(k1*r(i)^2)/2+(b1*r(i)^3/3);
end
V2=zeros(n,n);
for i=1:n;
    V2(i,i)=(k1*r(i)^2)/2+(b2*r(i)^3/3);
end
V3=zeros(n,n);
for i=1:n;
    V3(i,i)=(k1*r(i)^2)/2+(b3*r(i)^3/3);
end
K=eye(n,n)*(-2)
for i=1:(n-1)
    K(i,i+1)=1;
    K(i+1,i)=1;
end
H1=(-(h^2)/(2*m*d^2))*K+V1;
H2=(-(h^2)/(2*m*d^2))*K+V2;
H3=(-(h^2)/(2*m*d^2))*K+V3;
[U1,EV1]=spec(H1);[U2,EV2]=spec(H2);[U3,EV3]=spec(H3);
E1=diag(EV1);E2=diag(EV2);E3=diag(EV3);
disp('Ground state energy (MeV) for b=0,10 and 30')
disp([E1(1),E2(1),E3(1)]);
disp('1st excited state energy (MeV) for b=0,10 and 30');
disp([E1(2),E2(2),E3(2)]);
subplot(3,1,1)
plot(r',[abs(U1(:,1)),abs(U1(:,2))],'linewidth',5);
xlabel('r','fontsize',3);ylabel('|Wavefunction|','fontsize',3);
l=legend('Ground State','1st excited state',1);
xset('font size',2);
l.font_size=2;
xgrid();
title('b=0','position',[2.1,0.05])
subplot(3,1,2)
plot(r',[abs(U2(:,1)),abs(U2(:,2))],'linewidth',5);
xlabel('r','fontsize',3);ylabel('|Wavefunction|','fontsize',3);
l=legend('Ground State','1st excited state',1);
xset('font size',2);
l.font_size=2;
xgrid();
title('b=10','position',[2.1,0.05]);
subplot(3,1,3)
plot(r',[abs(U3(:,1)),abs(U3(:,2))],'linewidth',5);
xlabel('r','fontsize',3);ylabel('|Wavefunction|','fontsize',3);
l=legend('Ground State','1st excited state',1);
xset('font size',2);
l.font_size=2;
xgrid();
title('b=30','position',[2.1,0.05])
filename='Screened_Coulomb_Potential'
xs2pdf(0,'Schrodinger_eqn3');
xs2pdf(gcf(),'Schrodinger_eqn3');
```

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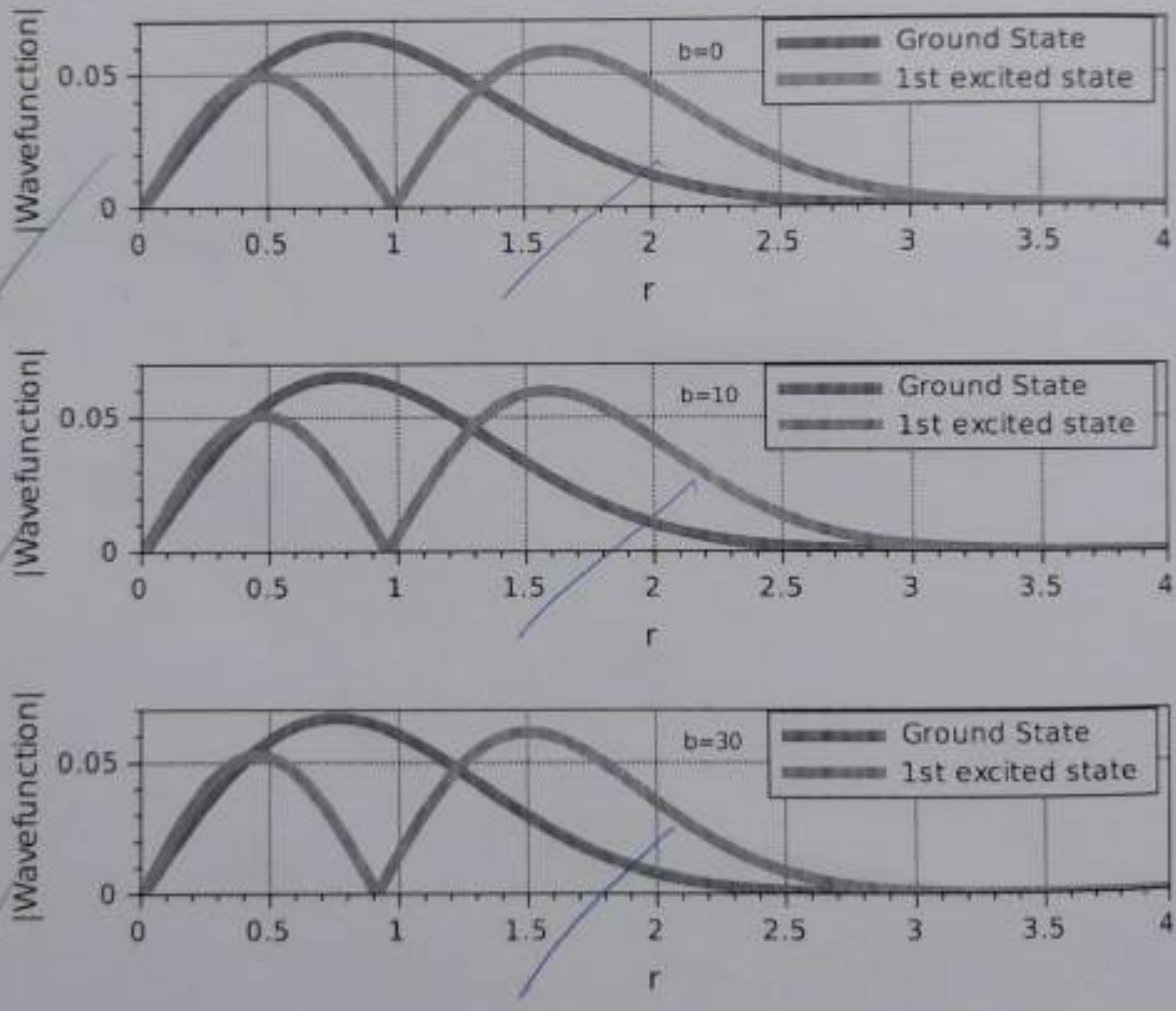
RESULT:

"Ground state energy (MeV) for b=0,10 and 30"

97.07306 100.83197 107.55485

"1st excited state energy (MeV) for b=0,10 and 30"

226.04834 238.92501 261.07822



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4.SOLVE THE S-WAVE RADIAL SCHRODINGER EQUATION FOR THE VIBRATION OF HYDROGEN MOLECULE (MORSE POTENTIAL) [v(r)=D(exp(-2*a*rp)-exp(-a*rp)] and [rp=(r(i)-r0)/r(i)] :

```
clf;clear;clc;
m=940*10^6;h=1973;D=0.755501;a=1.44;r0=0.131349;
rmin=0.01;rmax=10;n=1000;
r=linspace(rmin,rmax,n);
d=r(2)-r(1); r
V1=zeros(n,n);
for i=1:n
    rp=(r(i)-r0)/r(i);
    V(i,i)=D*(exp(-2*a*rp)-exp(-a*rp))
end
K=eye(n,n)*(-2)
for i=1:(n-1)
    K(i,i+1)=1;
    K(i+1,i)=1;
end
H=(-(h^2)/(2*m*d^2))*K+V;
[U,EV]=spec(H);
E=diag(EV);
disp('Ground state energy:'+string(E(1))+'eV','1st excited state
energy:'+string(E(2))+'eV');
plot(r',[abs(U(:,1)),abs(U(:,2))],'linewidth',5);
xlabel('r','fontsize',5);ylabel('|Wavefunction|','fontsize',5);
l=legend('Ground State','1st excited state',1);
xset('font size',2);
l.font_size=2;
xgrid();
//pdf export
filename='Morse_Potential'
xs2pdf(0,'Schrodinger_eqn4');
xs2pdf(gcf(),'Schrodinger_eqn4');
```

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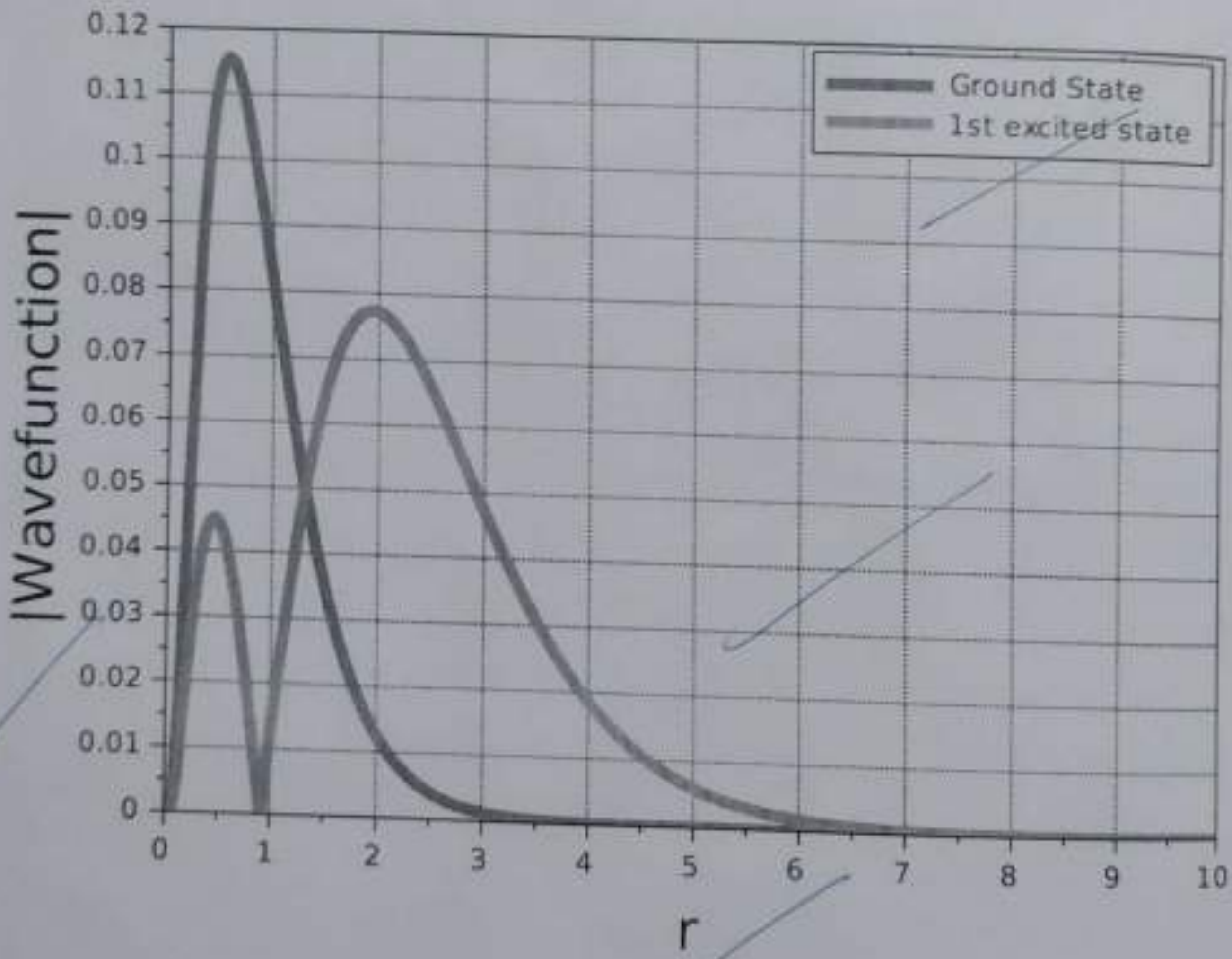
RESULT :

"Ground state energy:-0.1545978eV"

"1st excited state energy:-0.1429532eV"



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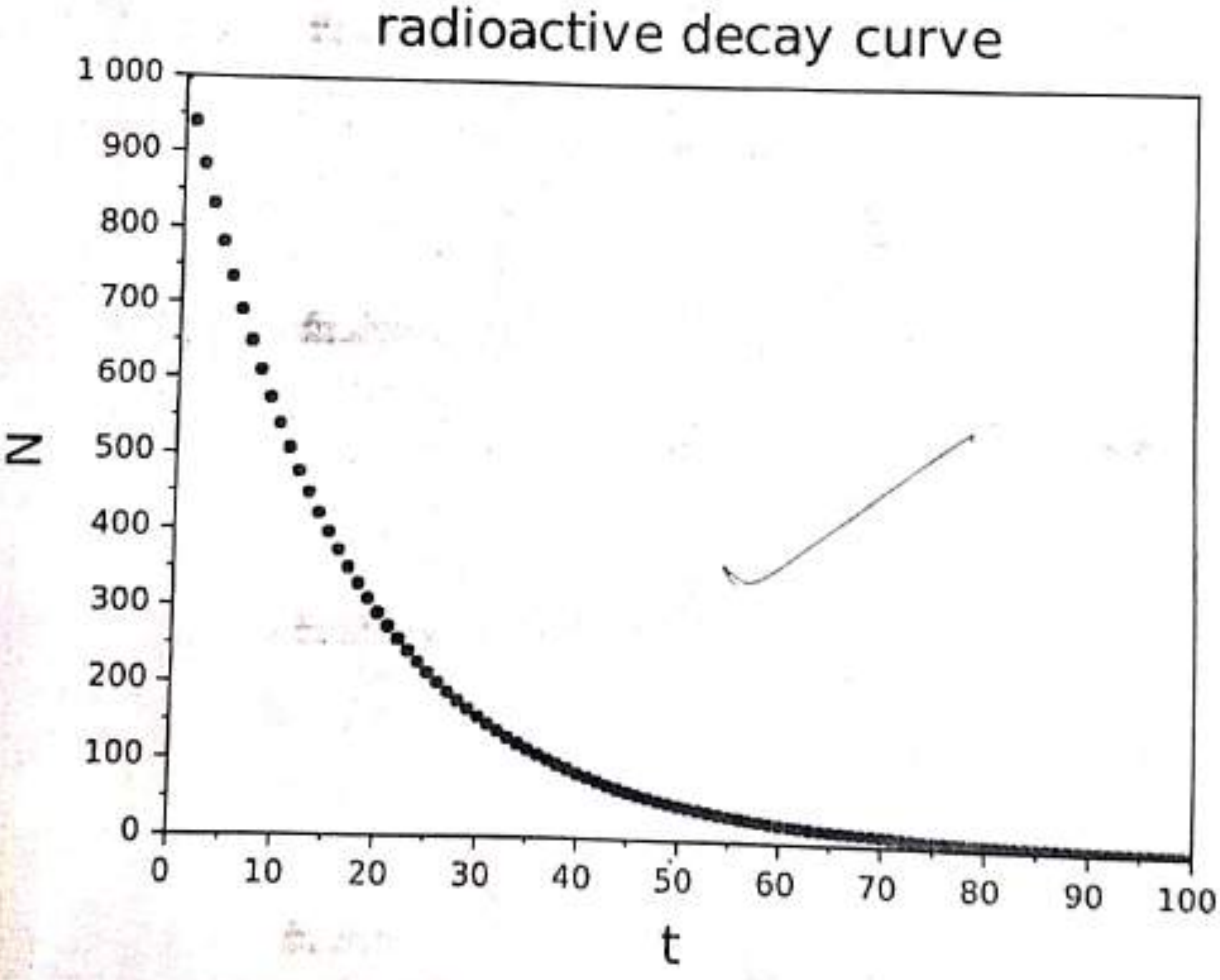
1st order diffrential equation

```
clear;clc;clf
function dNdt=f(N, t)
        dNdt=-lambda*N
endfunction
lambda=0.06;N0=1000;t0=0;
tf=100;n=100;
h=(tf-t0)/n
t(1)=t0;N(1)=N0
for i=1:n
    t(i+1)=t(i)+h
    N(i+1)=N(i)+h*f(N(i),t(i))
end
plot(t,N,'r+','linewidth',4)
xlabel('t','fontsize',5)
ylabel('N','fontsize',5)
title('radioactive decay curve','fontsize',5)
xset('font size',3)
filename='first orde ORD equation.pdf'
xs2pdf(0,filename);
xs2pdf(gcf(),filename);
```

Method??

09/12/22



1st order diffrential equation by morden euler method

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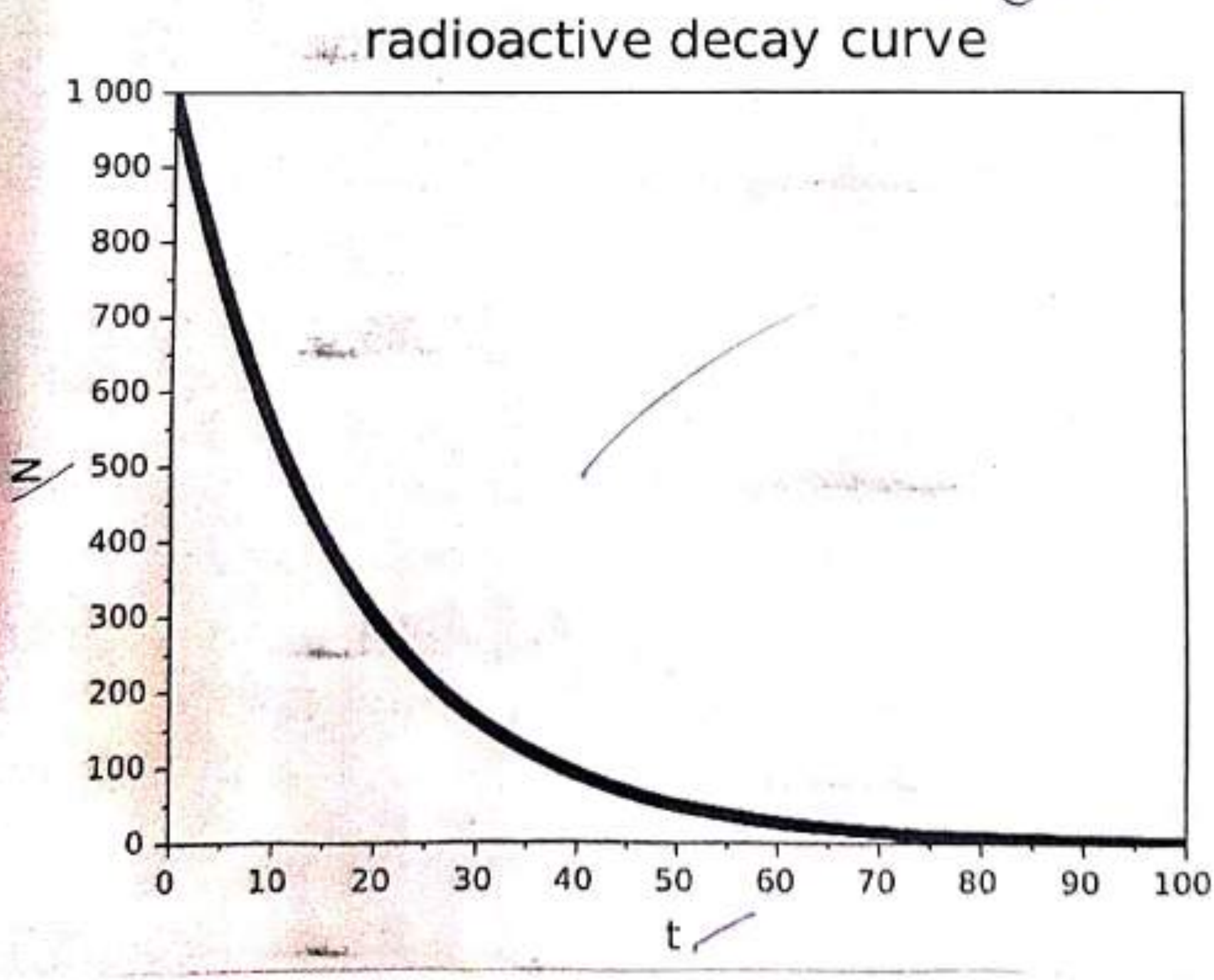
```
clear;clc;clf
function dNdt=f(N, t)
        dNdt=-lambda*N
endfunction
lambda=0.06,N0=1000;t0=0;
tf=100;n=1000;
h=(tf-t0)/n
t(1)=t0;N(1)=N0
for i=1:n
    t(i+1)=t(i)+h
    Np(i+1)=N(i)+h*f(N(i),t(i))
    N(i+1)=N(i)+(h/2)*[f(N(i),t(i))+f(Np(i+1),t(i+1))]
end
plot(t,N,'b+','linewidth',4)
xlabel('t','fontsize',4)
ylabel('N','fontsize',4)
title('radioactive decay curve','fontsize',5)
xset('font size',3)
filename='first order ODE equation morden euler method.pdf'
xs2pdf(0,filename);
xs2pdf(gcf(),filename);
```

modified

@Janai 09/12/22



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2nd order ODE by ruge kutta method

1st order ODE Solution by 2nd order Runge - Kutta method

```
clear;clc;clf
function dNdt=f(t, N)
        dNdt=-lambda*N
endfunction
lambda=0.06;N0=1000;t0=0;
tf=100;n=100;
h=(tf-t0)/n
t(1)=t0;N(1)=N0
for i=1:n
    t(i+1)=t(i)+h
    k1=h*f(t(i),N(i))
    k2=h*f((t(i)+h),(N(i)+k1))
    N(i+1)=N(i)+(1/2)*(k1+k2)
end
plot(t,N,'b+','linewidth',4)
xlabel('t','fontsize',4)
ylabel('N','fontsize',4)
title('radioactive decay curve','fontsize',5)
xset('font size',3)
filename='2nd order ODE by runge kutta method.pdf'
xs2pdf(0,filename);
xs2pdf(gcf(),filename);
```

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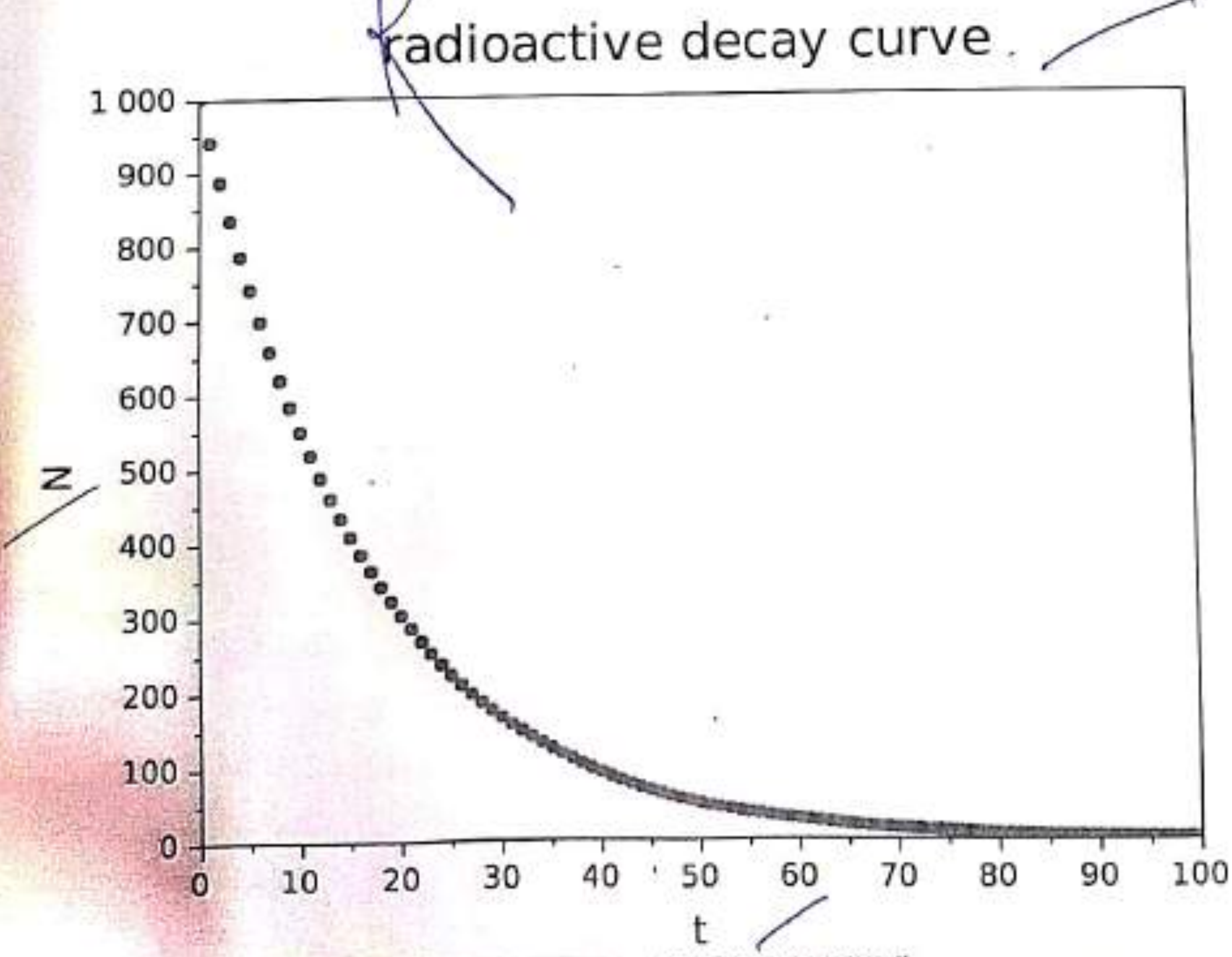

Teacher's Signature

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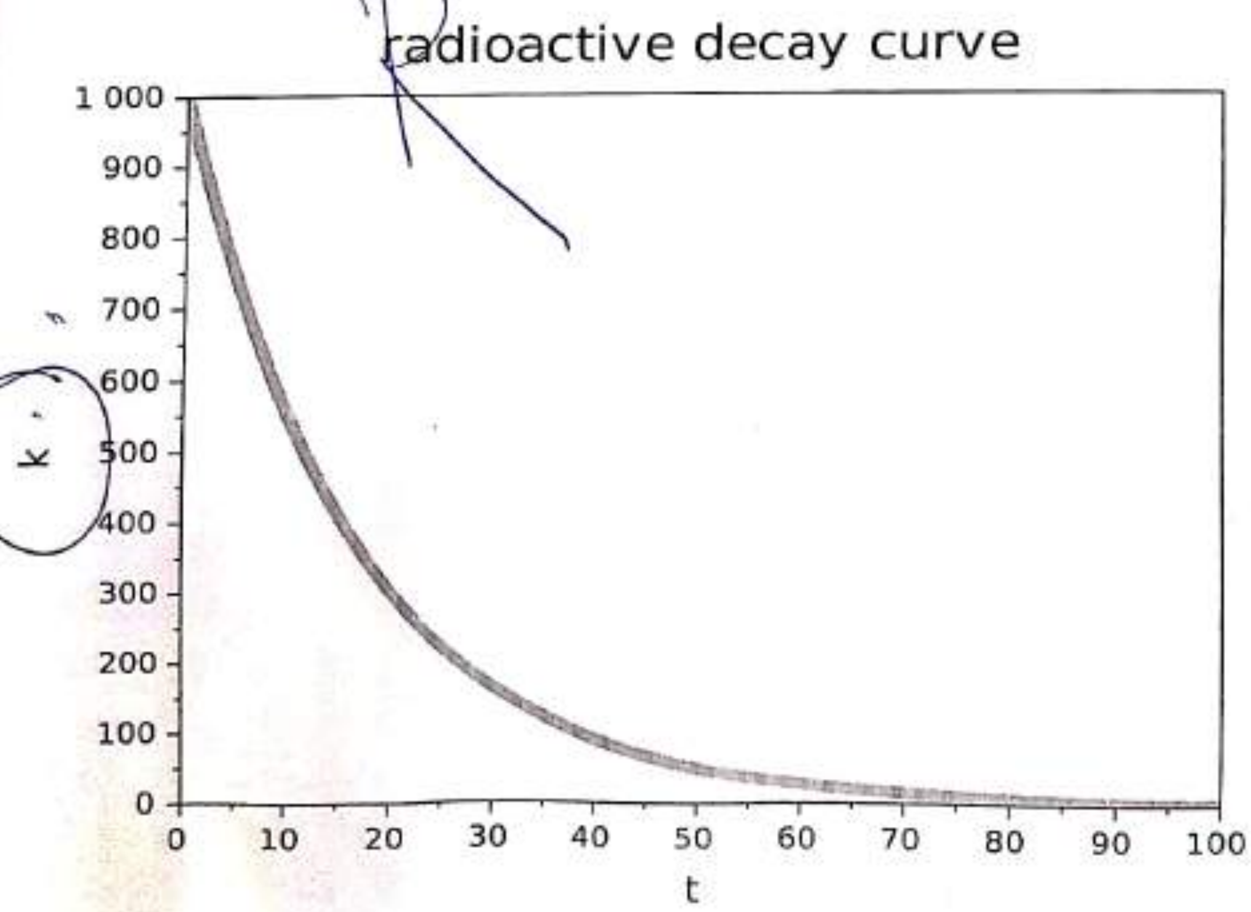
4th order ODE by Runge Kutta method

```
clear;clc;clf
function dkdt=f(k, t)
        dkdt=-lambda*k
endfunction
lambda=0.06;k0=1000;t0=0;
tf=100;n=1000;
h=(tf-t0)/n
k(1)=k0;t(1)=t0
for i=1:n
    t(i+1)=t(i)+h
    a1=h*f(k(i),t(i))
    a2=h*f(k(i)+(h/2),t(i)+(a1/2))
    a3=h*f(k(i)+(h/2),t(i)+(a2/2))
    a4=h*f(k(i)+h,t(i)+a3)
    k(i+1)=k(i)+(1/6)*(a1+2*a2+2*a3+a4)
end
plot(t,k,'r+','linewidth',2)
xlabel('t','fontsize',4)
ylabel('k','fontsize',4)
title('radioactive decay curve','fontsize',5)
xset('font size',3)
filename='4th order ODE by Runge Kutta method.pdf'
xs2pdf(0,filename);
xs2pdf(gcf(),filename);
```



Teacher's Signature

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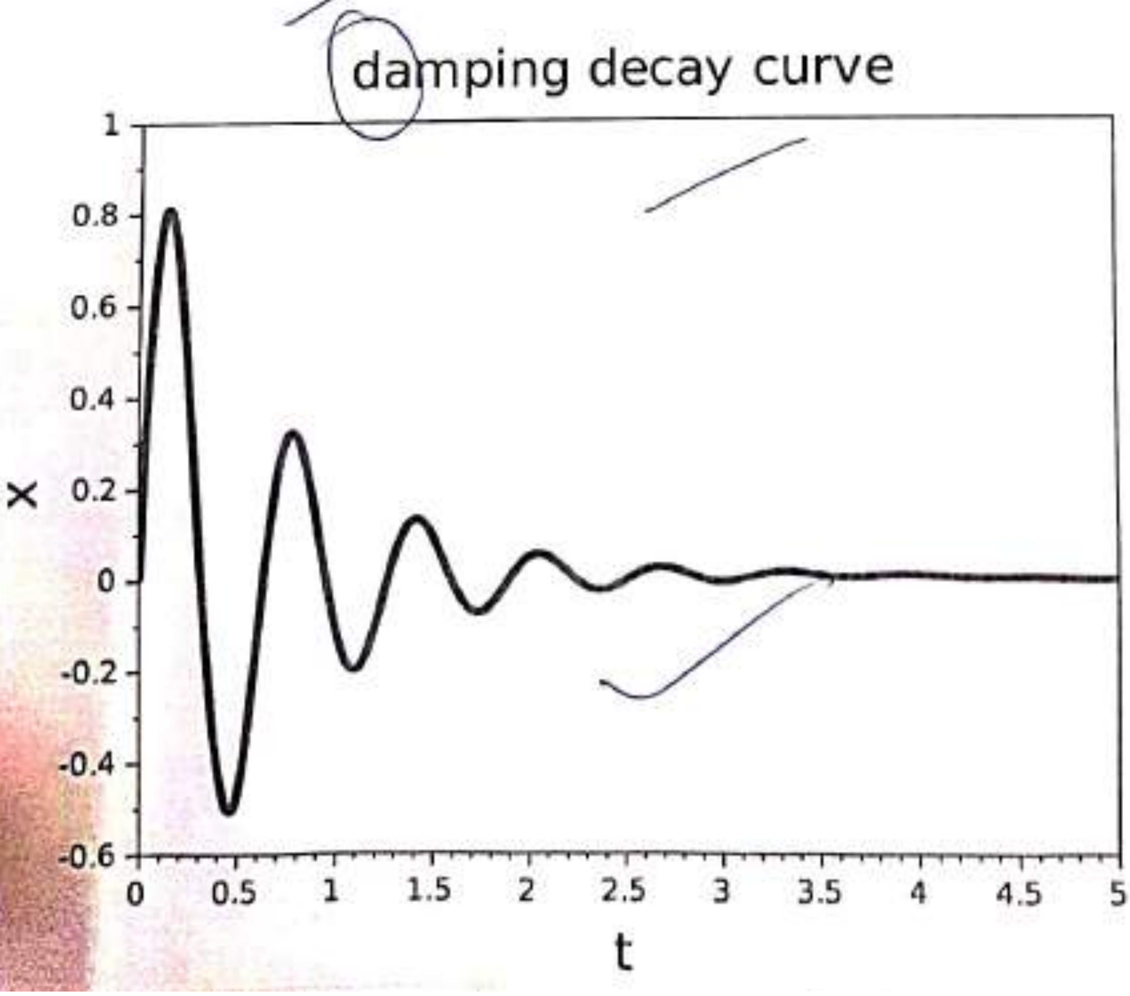
Soluition of 2nd order ODE by Euler's Method

```
clear;clc;clf
function [g, f]=ODE2(t, x, z)
            g=z
            f=-2*b*z-((omega0^2)*x)
endfunction
omega0=10;b=1.5;t0=0;z0=10;x0=0
tf=5;n=10000;
h=(tf-t0)/n
t(1)=t0;x(1)=x0;z(1)=z0,//xexact=x0;
for i=1:n-1
      [g,f]=ODE2(t(i),x(i),z(i))
      t(i+1)=t(i)+h
      x(i+1)=x(i)+h*g
      z(i+1)=z(i)+h*f
      //xexact(i+1)=z0*t(i+1)*exp(-omega0*t(i+1))
      //xexact(i+1)=x0*(1+omega0*t(i+1))*exp(-omega0*t(i+1))
end
//plot(t,x,'linewidth',4)
plot(t,x,'linewidth',4)
xlabel('t','fontsize',5)
ylabel('x','fontsize',5)
title('damping decay curve','fontsize',5)
xset('font size',3)
filename='2nd order ODE by euler method.pdf'
xs2pdf(0,filename);
xs2pdf(gcf(),filename);
```



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2nd order ODE by modified Euler's Method

```
clear;clc;clf
function [g, f]=ODE2(t, x, z)
            g=z
            f=-2*b*z-((omega0^2)*x)
endfunction
omega0=10;b=1.5;t0=0;x0=0;z0=10
tf=10;n=1000
h=(tf-t0)/n
t(1)=t0;x(1)=x0;z(1)=z0
for i=1:n-1
      [g1,f1]=ODE2(t(i),x(i),z(i))
      t(i+1)=t(i)+h
      xp(i+1)=x(i)+(h)*[g1]
      zp(i+1)=z(i)+(h)*[f1]
      [g2,f2]=ODE2(t(i+1),xp(i+1),zp(i+1))
      x(i+1)=x(i)+(h/2)*(g1+g2)
      z(i+1)=z(i)+(h/2)*(f1+f2)
end
plot(t,x,'linewidth',4)
xlabel('t','fontsize',5)
ylabel('x','fontsize',5)
title('Damping decay curve','fontsize',5)
xset('font size',3)
filename='2nd order ODE by modified euler method.pdf'
xs2pdf(0,filename);
xs2pdf(gcf(),filename);
```

13/01/23