DIGITAL COMMUNICATION SYSTEM

DIGITAL ASSIGNEMENT -1

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SECTION-1:

WHAT is A NON-LINEAR PHENOMENA?

GRAHAM'S LAW OF DIFFUSION

My topic is graham's law of diffusion, I got this idea while I was using a perfumei got know that gases diffuse in air from one end of the room to another end, I thought about the scientific reason behind it and I came to know about the grahams law of diffusion.

Graham's law states that the rate of diffusion or of effusion of a gas is inversely proportional to the square root of its molecular weight. Thus, if the molecular weight of one gas is four times that of another, it would diffuse through a porous plug or escape through a small pinhole in a vessel at half the rate of the other (heavier gases diffuse more slowly). A complete theoretical explanation of Graham's law was provided years later by the kinetic theory of gases. Graham's law provides a basis for separating isotopes by diffusion—a method that came to play a crucial role in the development of the atomic bomb. Diffusion is a phenomenon where there is a movement of one material move from area of high concentration to the area of low concentration. This means particles or molecules spread through medium. For example, if you spray at the one end of the room you would be able to smell at the other end. This is because of diffusion phenomenon.

$$\frac{\mathrm{Rate}_1}{\mathrm{Rate}_2} = \sqrt{\frac{M_2}{M_1}},$$

From the above equation we can conclude that grahams law of diffusion is non linear in nature.

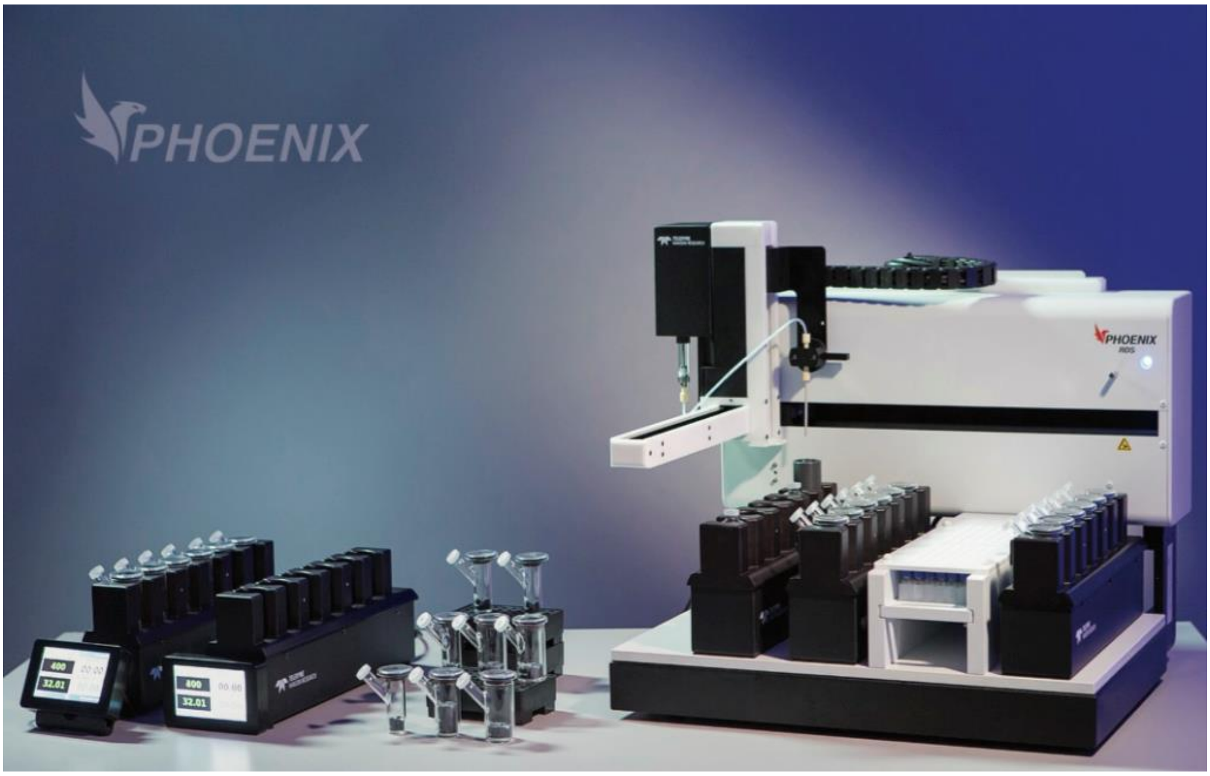
SECTION-2:

Having confirmed that your phenomenon is non-linear in nature, think on how to actually digitize the "data" that makes up the phenomenon. The idea is to record the phenomenon. How would it be done? What kind of transducer should/could be used? What kind of quantization should/could be done? Can the sampling capture the true characteristics of the phenomenon? How would you even characterize the phenomenon? A highly detailed analyses should accompany your answer to this section.

As we know, the sequence of data required can be generated using the above formula.For obtaining this particular sequence, I have varied the value of

x(rate 1) by assuming the other values.

Rate$_1$ is the rate of effusion for the first gas. (volume or number of moles per unit time).
Rate$_2$ is the rate of effusion for the second gas.
M_1 is the molar mass of gas 1
M_2 is the molar mass of gas 2.



Diffusion testing machine

SECTION-3:

Having analysed the phenomenon in some detail, can you either create a mathematical model (highly simplified in the case of very complex phenomenon)? Or if the phenomenon is already described in existing literature, can you recreate that?

Write a MATLAB program that:

i. **Generates sample points of that phenomenon**
ii. **Samples the phenomenon (In MATLAB, i and ii are basically the same, if you take the easy way out)**

iii. Quantize the sampled value

iv. Reconstruct the phenomenon

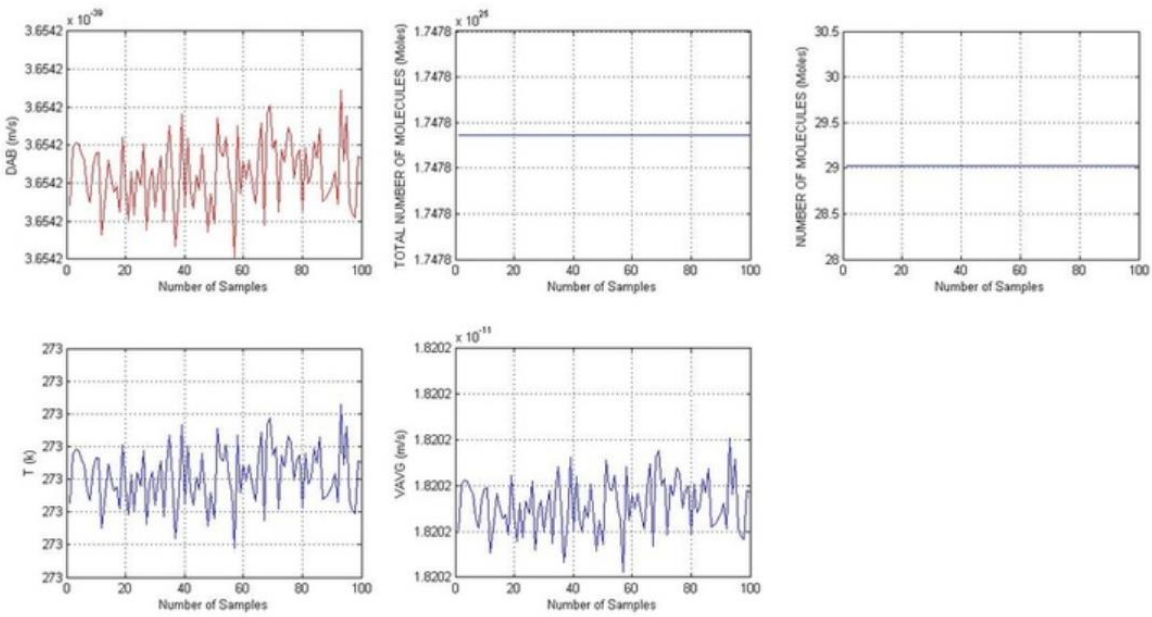
Matlab Code:

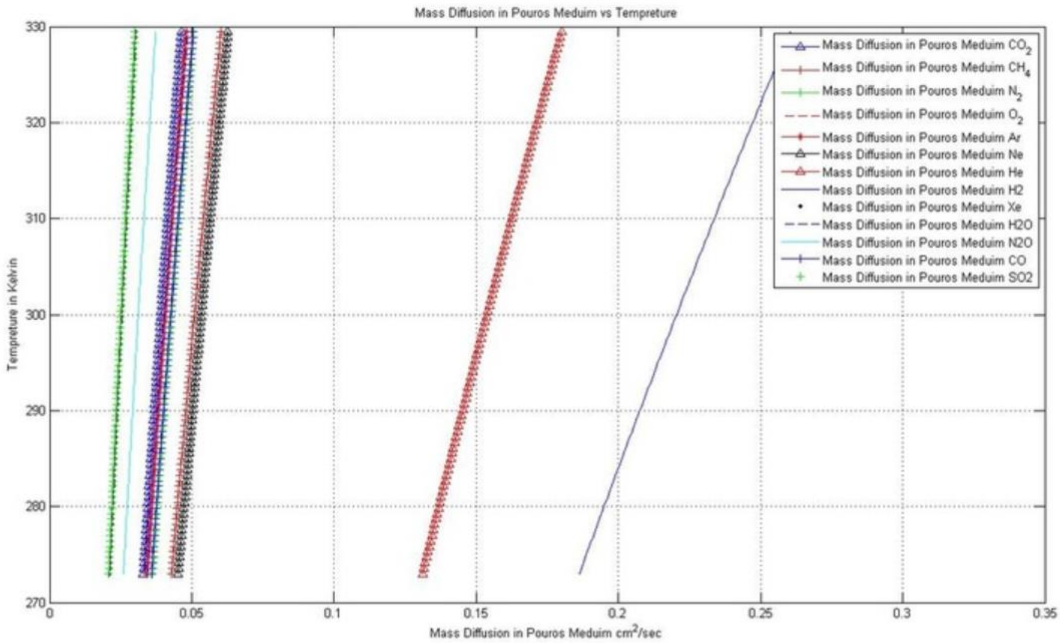
```
clc
clear
KB=1.380658*10^(-23);
M=100;
dx=1;
dy=1;
dz=1;
VV=dx*dy*dz;
AVGADO=6.022*10^23;
P=1.01*10^(5);
RA=0.7;
RB=0.3;
PA=RA*P;
PB=RB*P;
% B=CH4(3.758) + A=AIR(3.711) OR CO2 + AIR
% pV = nRT ;
% T=31+273=304K
% p=1.4*1.01*10^5
% V= 1m^3
% n= 1.4*1.01*10^5*1/8.314*304=55.95moles
% 1 mole contains 6.022*10^23 molecules
% So result 3.369*10^25molecules
% 2) in 1.8m^3 there are in moles 55.95*1.8=100.8moles
% and so 25.2 moles of O2 and 75.6 moles of N2
% mass of O2 25.2*32=806g
```

```
% mass of N2 75.6*28=2117g
a=29;
b=44;
for i=1:M
MAAAA(i)=a;
MBBBB(i)=b;
MAA(i)=806;
MBB(i)=2117;
MAAA(i)=MAA(i)/MAAAA(i);
MBBB(i)=MBB(i)/MBBBB(i);
NA(i)=MAAA(i)/RA;
NB(i)=MBBB(i)/RB;
end
for i=1:M
PP(i)=PA;
TT(i)=273+20;
V(i)=VV;
R(i)=8.314;
NMOLES(i)=(PP(i)*V(i))/(R(i)*TT(i));
TOT_NMOLES(i)=NMOLES(i)*AVGADO;
end
SEKMAA=3.711;
SEKMAB=3.758;
SKMA=0.5*(SEKMAA+SEKMAB);
for i=1:M;
T(i)=273+0.00001*randn(1,1);
P(i)=1.01*10^5;
MA(i)=28.97;
NA(i)=1;
VAVG(i)=(8*KB*T(i)/(pi*MA(i)))^(0.5);
ZA(i)=0.25*(TOT_NMOLES(i)/V(i))*VAVG(i);
LAMDA(i)=(((2)^(0.5))*pi*(TOT_NMOLES(i)/V(i))*(SKMA)^2)^(-1);
DAB(i)=(2/3)*((((KB)^3)*T(i)/((pi^3)*MA(i)))^0.5)*(T(i)/(((SKMA)^2)*P(i
)));
end
scrsz = get(0,'ScreenSize');
figure('Position',[10 10 1500 700])
subplot 231
plot(DAB,'r')
Xlabel('Number of Samples')
ylabel('DAB (m/s)')
grid on
```

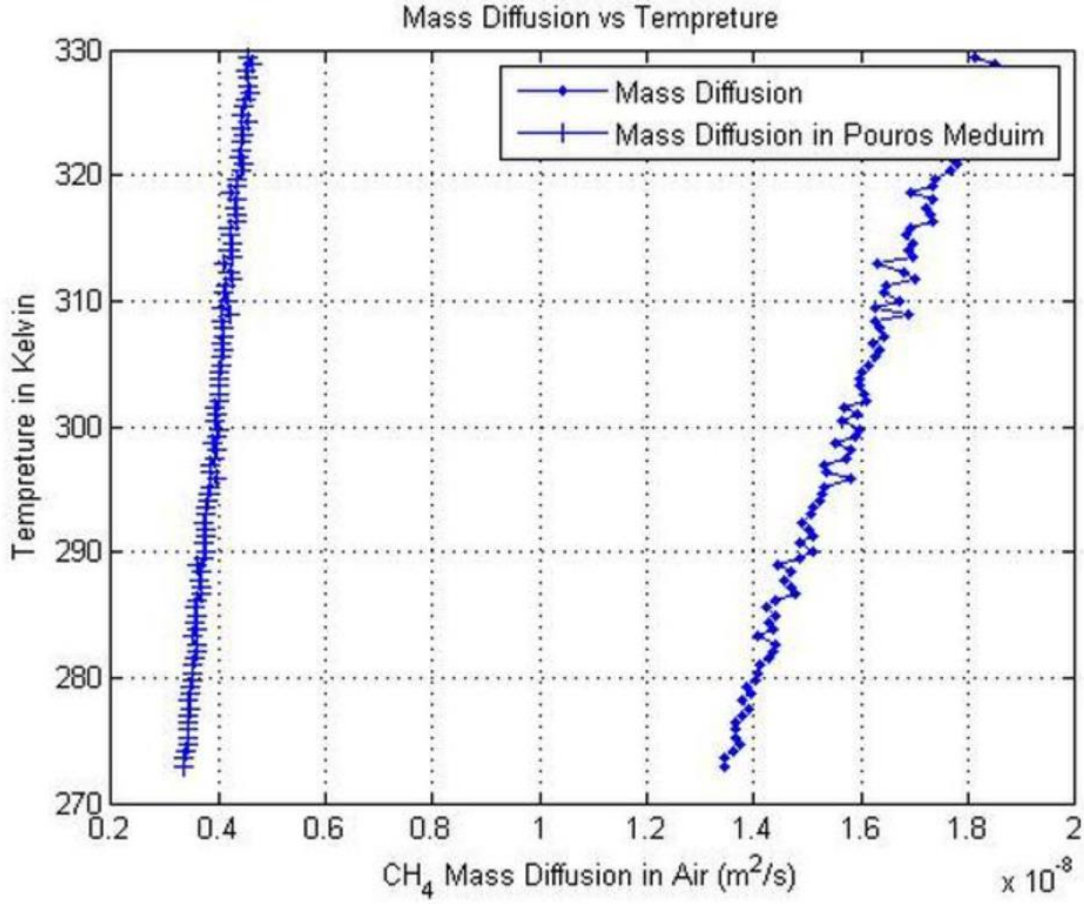
```
subplot 232
plot(TOT_NMOLES)
Xlabel('Number of Samples')
ylabel('TOTAL NUMBER OF MOLECULES (Moles)')
grid on
subplot 233
plot(NMOLES)
Xlabel('Number of Samples')
ylabel('NUMBER OF MOLECULES (Moles)')
grid on
subplot 234
plot(T)
Xlabel('Number of Samples')
ylabel('T (k)')
grid on
subplot 235
plot(VAVG)
Xlabel('Number of Samples')
ylabel('VAVG (m/s)')
grid on
pause(10)
close all
```

Outputs:

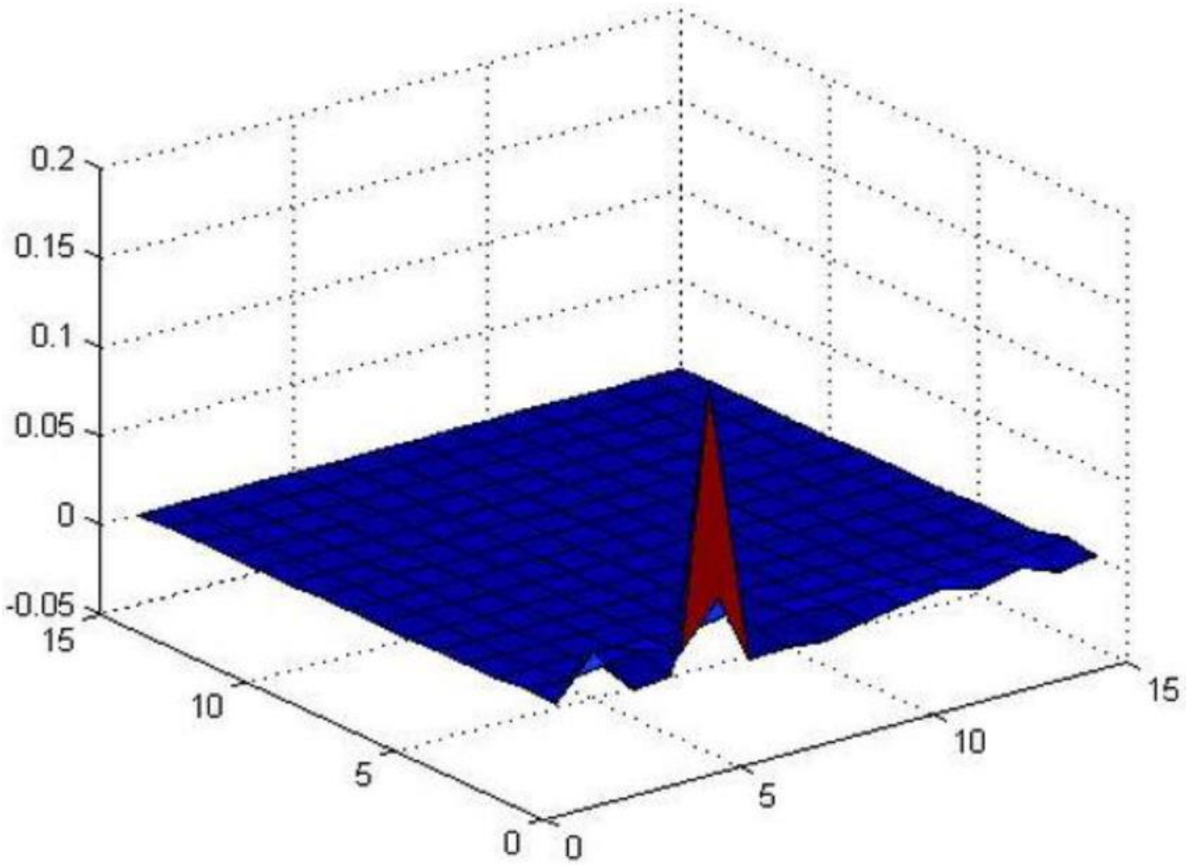




Mass Diffusion in Pouros Meduim vs Tempreture
Mass Diffusion in Pouros Meduim CO_2
Mass Diffusion in Pouros Meduim CH_4
Mass Diffusion in Pouros Meduim N_2
Mass Diffusion in Pouros Meduim O_2
Mass Diffusion in Pouros Meduim Ar
Mass Diffusion in Pouros Meduim Ne
Mass Diffusion in Pouros Meduim He
Mass Diffusion in Pouros Meduim H2
Mass Diffusion in Pouros Meduim Xe
Mass Diffusion in Pouros Meduim H2O
Mass Diffusion in Pouros Meduim N2O
Mass Diffusion in Pouros Meduim CO
Mass Diffusion in Pouros Meduim SO2
Tempreture in Kelvin
Mass Diffusion in Pouros Meduim cm^2/sec



Mass Diffusion vs Tempreture
Mass Diffusion
Mass Diffusion in Pouros Meduim
Tempreture in Kelvin
CH_4 Mass Diffusion in Air (m^2/s)
$x\ 10^{-8}$



Result: We have successfully generated the data and sampled it, the we have quantized and reconstructed the original signal using demodulation.

GITHUB link