Lab Sheet - 2

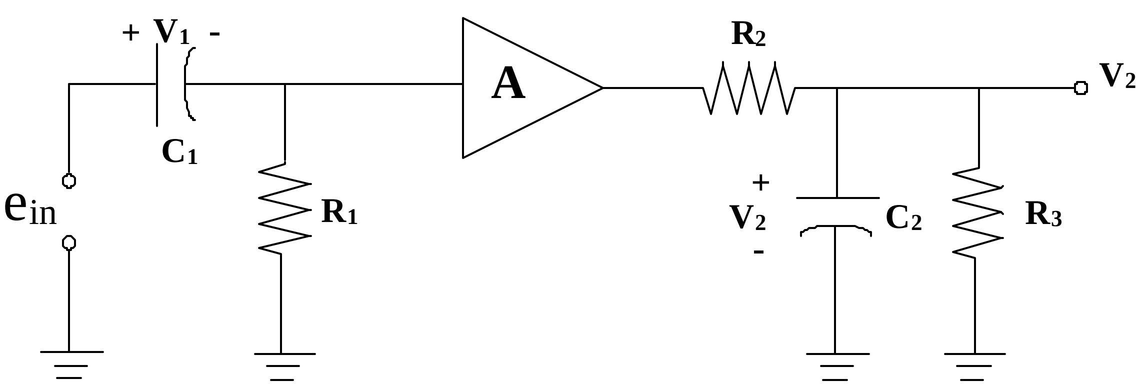
Simulation of the R-C amplifier circuit (continuous system).

Objectives: To develop the mathematical modeling of the continuous system.

Theory:

Simulation and modeling are used for building and analyzing of physical systems. They are mostly used in engineering design and analysis. Simulation and modeling enable us to predict the behavior of a system before it is actually built.

A continuous system is one in which the predominant activities of the system cause smooth changes in the attributes of the system entities. When such a system is modeled mathematically, the variables of the model representing the attributes are controlled by continuous functions. More generally, in continuous systems, the relationships describe the rates at which attributes change, so that the model consists of differential equation. Here we have used R-C amplifier circuit, which is a continuous system.



The system can be described by the following two differential equations. i.e mathematical modeling

Current entering through capacitor C_1, at the input side, is

$C_1 (dV_1/dt) = (e_{in} – V)/R_1$ ----------- (1)

$dV1/dt = (e_{in} – V)/R_1C_1$

Current entering through capacitor C_2, at the output side, is

$C_2 (dV_2/dt) = A/R_2 (e_{in} – V_1) – V_2 (R_2 + R_3)/R_2R_3$ ------------(2)

Hence we can get the two equations for simulation

$dV_1/dt = A_{11} \times V_1 + B_1 \times e_{in}$ ----------- (3)

$dV_2/dt = A_{21} \times V_1 + A_{22} \times V_2 + B_2 \times e_{in}$ ----------- (4)

Where,

$A_{11} = -1/(R_1C_1) = -B_1$

$A_{21} = -A/(R_2C_2) = -B_2$

$A_{22} = -(R_2 + R_3)/(R_2R_3C_2)$

By providing the values of these constant we can calculate the value of V_1 and V_2.

For the calculation of the equation values, we use the Runge – Kutta - 4 methods.

$m_1 = f(x_i, y_i)$

$m_2 = f(x_i + h/2, y_i + m_1h/2)$

$m_3 = f(x_i + h/2, y_i + m_2h/2)$

$m_4 = f(x_i + h, y_i + m_3h)$

$y_{i+1} = y_i + ((m_1 + 2m_2 + 2m_3 + m_4)/6)h$

Initial condition

For t = 0, $V_1 = 0$ and $V_2 = 0$

h = 0.0002 and e_{in} = 1.5 V (t >= 0) { n = 500 data points }

= 0 V (t < 0)

A11 = -50 sec^{-1}

A21 = - 10000 sec^{-1}

A22 = -21.5 sec^{-1}

Program code:

```
#include<stdio.h>
#include<conio.h>
#include<math.h>
#define a11 -50.0
#define a21 -19000.0
#define a22 -21.5
#define ein 1.5

double func1(double);
double func2(double, double);

void main()
 {
  double m11,m12,m13,m14,m21,m22,m23,m24,v11,v21,v10=0.0,v20=0.0,t;
  double h=0.0002;
  int i;
  FILE *ptrf1,*ptrf2;
  clrscr();
  ptrf1=fopen("lab11.txt","w");
  ptrf2=fopen("lab12.txt","w");
  for(i=1;i<800;i++)
   {
     m11=func1(v10);
     m12=func1(v10+m11*h/2);
     m13=func1(v10+m12*h/2);
     m14=func1(v10+m13*h);
     v11=v10+((m11+2*m12+2*m13+m14)/6)*h;

     m21=func2(v10,v20);
     m22=func2(v10+h/2,v20+m21*h/2);
     m23=func2(v10+h/2,v20+m22*h/2);
     m24=func2(v10+h,v20+m23*h);
     v21=v20+((m21+2*m22+2*m23+m24)/6)*h;

     v10=v11;
     v20=v21;
     t=h*i;
     if(i==200)
      getch();
     printf("%f\t%f\n",v10,v20);
     fprintf(ptrf1,"\n%f\t%f",t,v10);
     fprintf(ptrf2,"\n%f\t%f",t,v20);
   }
  fclose(ptrf1);
  fclose(ptrf2);
  getch();
 }
 double func1(double v10)
      {  return (a11*v10-a11*ein);  }
 double func2(double v10,double v20)
      {  return (a21*v10+a22*v20-a21*ein); }
```