NAME - GOPAL SHARMA , ROLL NUMBER - 214103220
CODE :

```c
#include<stdio.h>
#include<stdlib.h>
#include<time.h>
#include<math.h>

int main()
{


    for (int r = 0; r <=1; r++)
    {

     int i , j ,k,m,n,p, l,o;

    l=2;//number of inputs neurons
    p=7;//number of training patterns
    p=p-r;
    float in[l][p];
        FILE *fp3 ;
    fp3 = fopen("training.txt","r");
    if(fp3==NULL)
    {
        printf("file can't be opened\n");
        exit(1);
    }
    for ( i = 0; i < l; i++)
    {
        for ( j = 0; j < p; j++)
        {
            fscanf(fp3,"%f",&in[i][j]); }
            fscanf(fp3,"\n");

    }
    fclose(fp3);
    float t[i][p];
    FILE *fp2 ;
    fp2 = fopen("output.txt","r");
    if(fp2==NULL)
    {
        printf("file can't be opened\n");
        exit(2);
    }
```

```
    for ( j = 0; j < 1; j++)
    {
        for ( i = 0; i < p; i++){
        fscanf(fp2,"%f",&t[j][i]); }
        fscanf(fp2,"\n");
         }


     fclose(fp2);
if(p=6){
float in[l][p];
    FILE *fp1 ;
fp1 = fopen("testing.txt","r");
if(fp1==NULL)
{
    printf("file can't be opened\n");
    exit(1);
}
for ( i = 0; i < l; i++)
{
    for ( j = 0; j < p; j++)
    {
        fscanf(fp1,"%f",&in[i][j]); }
        fscanf(fp1,"\n");

}
fclose(fp1);
 float t[i][p];
FILE *fp2 ;
fp2 = fopen("output1.txt","r");// output of testing patterns
if(fp2==NULL)
{
    printf("file can't be opened\n");
    exit(2);
}

    for ( j = 0; j < 1; j++)
    {
        for ( i = 0; i < p; i++){
        fscanf(fp2,"%f",&t[j][i]); }
        fscanf(fp2,"\n");
         }
```

```
}


  m =4 ;//number of hidden layer neuron
int V[l+1][m];
 for ( i = 0; i < l+1; i++)
{
    for ( j = 0; j < m; j++)
    {
        int lower=-1 , upper=1,number  ;
        srand(time(NULL));
        V[i][j]= (rand() % (upper-lower +1))+lower;
              }

        }

n=1;//number of output layer neurons
float W[m+1][n];
 for ( j = 0; j < m+1; j++)
{
    for ( k = 0; k < n; k++)
    {
        int lower=-1 , upper=1,number  ;
        srand(time(NULL));
        W[j][k]= (rand() % (upper-lower +1))+lower;
              }

}
FILE *out ;
out = fopen("iterations.txt","w");
float e=1;
int q=1 ;
while(e> 0.0001)
{
float IH[m][p];
float OH[m][p];


fprintf(out,"Iteration %d\n",q);
//Output of hidden layer neurons
for ( o = 0; o < p; o++)
{

    for ( j = 0; j < m; j++)
```

```
    {
        IH[j][o]=0;
        for ( i = 0; i < l; i++)
        {

            IH[j][o]=IH[j][o]+in[i][o]*V[i][j];

        }

        IH[j][o]=IH[j][o]+V[0][j];

         OH[j][o]= 1.0/(1+exp(-IH[j][o]));



    }


}


   // OUTPUT OF OUTPUT LAYER
    float error,mse;
    float OIH[m][p];
float OOH[m][p],output;
float delW[m][n],delV[l][m], a2=1,a1=10,eta =0.5;
e=0 ;
fprintf(out,"Output\t error \n");
for ( o = 0; o < p; o++)
{

    for ( j = 0; j < m; j++)
    {
        OIH[j][o]=0,mse=0;
        for ( k =0; k < n; k++)
        {
            OIH[j][o]=OIH[j][o]+OH[j][o]*W[j][k];

        }
        OIH[j][o]=OIH[j][o]+W[0][0];


         OOH[j][o]= 1.0/(1+exp(-OIH[j][o]));
           output = OOH[j][o];
```

```
             error =0;
               error =error+ (t[0][o]-OOH[j][o]);

           delW[j][o]=0;
           delW[j][o] = delW[j][o]+ (eta)*error*a2*OOH[j][o]*(1-
OOH[j][o])*OH[j][o];
           W[j][o]=W[j][o]+delW[j][o];


            delW[j][o]=0;
            for(k=0;k<n+1;k++){
                delV[j][k]=0;
            delV[j][k] = delV[j][k] + (eta)/(n)*(t[0][o]-
OOH[j][o])*a2*OOH[j][o]*(1-OOH[j][o])*W[j][k]*a1*OH[j][o]*(1-OH[j][o])*in[k][o];

            V[j][k]=V[j][k]+delV[j][k];

            }

           }
         mse = mse + 0.5*error*error ;
        fprintf(out,"%0.2f\t", output);
             fprintf(out,"%0.2f\n",error);


    }
       e=mse/p ;
         fprintf(out,"mean square error at iteration %d is %f\n",q,e);
         q=q+1;
    }

    }
  return 0;
}
```

Introduction:

Magnetorheological finishing (MRF), a precision polishing process, becomes an integral part of optics manufacturing industries for its ability to improve figure and surface finish of complex shape optics without introducing surface damage. It employs magnetically stiffened magnetorheological fluid (MR) ribbon as a flexible polishing tool which moves through the converging gap against workpiece. Material removal characteristic of a polishing tool is described as influence function. Influence function is a parameter to evaluate the efficiency or effectiveness of the polishing process. It provides some useful information for setting up appropriate process parameters to finish different surfaces. Rotational speed of the carrier wheel and gap between the workpiece and magnet are the selected process parameters for studying the influence function. The spot (or influence function) profiles are analyzed to calculate the volume of material removal and depth of the deepest penetration (ddp) using 3D noncontact profilometer. The maximum contribution is made by wheel speed on the volume of material removal and depth of the deepest penetration.

Problem :

Setting up appropriate process parameters to finish different surfaces by using Magnetorheological finishing .

Magnetorhelogical finishing:

Magnetorheological finishing (MRF) is a computer-controlled polishing process, which is significantly used in optical lens fabrication. MRF is successfully used for figuring/final polishing of spherical/aspherical lenses and mirrors.
MRF process uses magnetorheological (MR) fluid, which consists of nonmagnetic abrasive particles, magnetic carbonyl iron particles (CIPs), carrier liquid, and some additives or stabilizers. Figure I shows schematic diagram of MRF process for finishing of small optics. MR fluid is deposited over the rotating carrier wheel by a nozzle and pump arrangement. When magnetic field is applied in the working gap using elec tromagnet or permanent magnet, MR fluid gets stiffened as its viscosity and yield stress increases and behave like a visco plastic fluid [9]. Stiffened MR fluid ribbon proceeds towards the finishing zone by rotating carrier wheel and it abrades the workpiece. The zone of contact is restricted to a spot due to the continuous forming of compliant sub-aperture lap.When MR fluid ribbon comes in contact with the workpiece, normal force (Fn) helps the abrasive particles to penetrate in the work-piece, and tangential force (Ft) helps to shear off the peaks.Tangential force (Ft) is exerted on the workpiece surface dueto rotation of the carrier wheel [11].Normal force (Fn) mainly consists of force generated due to squeezing of MR fluid in the finishing zone and magnetic levitation force (Fm).

Influence function:

In MRF, the influence function can be described as the finishing spot which is formed during stationary finishing (without giving motion in x, y, or z direction) in a specified time . It contains the material removal characteristics of a finishing tool for a particular type of workpiece .Before final finishing experimentation, finishing procedure is assessed based on the surface error profile of work-piece and influence function of polishing tool. It has different shapes depending on the configuration of the machine setup. To perceive the material removal mechanism and model the process preciously, the effect of input parameters on the responses should be studied. Central composite design of experiments and subsequent analysis is performed to determine the effect of process parameters (wheel speed and working gap) on influence function (volume of material removed and ddp). A combination of process parameters is selected for further experimentation based on maximum material removal as well as ddp. Final experimentation is carried out by employing longitudinal and cross feed separately, and it is observed that surface produced by cross feed is more uniform.

METHODOLOGY:

I chose my assignment based on my MTP project . I took a springer paper to choose the number of data sets . The paper is parametric study of influence function on magnetorheological finishing .The inputs are basically my workpiece gap and revolutions per minute . These both contribute to influence function hence resulting to contribute in material removal rate . So , my input neurons are having data of N(rpm) and gap and output neuron is my mrr(material removal rate) .I took 13 data patterns from the paper .

No. of input neuron = 2;

No. of output neuron = 1;

No..of hidden neuron = 4 ;(I chose my number of hidden neuron by hit and trial method for n =4 my code contributes more minimization and more near to actual values so I take this value).

Value of learning rate =0.5(I chose this value because it is type of optimum value as it makes network stable as well as not causing too much slower convergence . As it is taking less number of iterations)

Data set from paper :

no.	Wheel speed(N) (rpm)	Working gap(W) (mm)	MRR(mm3/min)
1	760	1.10	0.0370
2	800	1.20	0.0413
3	800	1.00	0.0674
4	900	1.24	0.0489
5	900	1.10	0.0538

6	900	1.10	0.0559
7	900	1.10	0.0543
8	900	0.96	0.0728
9	1000	1.20	0.0712
10	1000	1.00	0.1045
11	1040	1.10	0.0929
12	900	1.10	0.0551
13	900	1.10	0.0546

I applied normalization method to convert this data set by considering range of 0.1 to 0.9 by using formula

X_p = 0.1 + 0.8 *($\frac{X-Xmin}{Xmax-Xmin}$).

Now new normalized inputs are :

Patterns	I_1	I_2	Output
1	0.1	0.1	0.1
2	0.214	0.214	0.15
3	0.214	0.214	0.46
4	0.5	0.5	0.24
5	0.5	0.5	0.29
6	0.5	0.5	0.32
7	0.5	0.5	0.3
8	0.5	0.5	0.52
9	0.78	0.78	0.5
10	0.78	0.78	0.9
11	0.9	0.9	0.76
12	0.5	0.5	0.313
13	0.5	0.5	0.3

RESULTS AND DISCUSSIONS :

Iteration 1

Output	error
0.86	-0.76
0.86	-0.71
0.85	-0.39
0.85	-0.61
0.85	-0.56

0.85	-0.53

mean square error at iteration 1 is 0.022987

Iteration 2

Output	error
0.84	-0.74
0.84	-0.69
0.83	-0.37
0.84	-0.60
0.83	-0.54
0.83	-0.51

mean square error at iteration 2 is 0.022044

Iteration 3

Output	error
0.83	-0.73
0.83	-0.68
0.82	-0.36
0.83	-0.59
0.82	-0.53
0.82	-0.50

mean square error at iteration 3 is 0.021041

Iteration 4

Output	error
0.82	-0.72
0.82	-0.67
0.81	-0.35
0.81	-0.57
0.81	-0.52
0.81	-0.49

mean square error at iteration 4 is 0.019976

Iteration 5

Output	error
0.81	-0.71
0.80	-0.65
0.80	-0.34
0.80	-0.56
0.80	-0.51
0.80	-0.48

mean square error at iteration 5 is 0.018851

Iteration 6

Output	error
0.79	-0.69
0.79	-0.64
0.78	-0.32
0.78	-0.54
0.78	-0.49
0.78	-0.46

mean square error at iteration 6 is 0.017671
Iteration 7

Output	error
0.78	-0.68
0.77	-0.62
0.76	-0.30
0.77	-0.53
0.76	-0.47
0.76	-0.44

mean square error at iteration 7 is 0.016440
Iteration 8

Output	error
0.76	-0.66
0.75	-0.60
0.75	-0.29
0.75	-0.51
0.75	-0.46
0.75	-0.43

mean square error at iteration 8 is 0.015169
Iteration 9

Output	error
0.75	-0.65
0.73	-0.58
0.73	-0.27
0.73	-0.49
0.73	-0.44
0.73	-0.41

mean square error at iteration 9 is 0.013867
Iteration 10

Output	error
0.73	-0.63
0.71	-0.56
0.71	-0.25
0.71	-0.47
0.71	-0.42
0.71	-0.39

mean square error at iteration 10 is 0.012549
Iteration 11

Output	error
0.71	-0.61
0.69	-0.54
0.69	-0.23
0.68	-0.44
0.69	-0.40
0.69	-0.37

mean square error at iteration 11 is 0.011231

Iteration 12

Output	error
0.69	-0.59
0.66	-0.51
0.67	-0.21
0.66	-0.42
0.67	-0.38
0.67	-0.35

mean square error at iteration 12 is 0.009930

Iteration 13

Output	error
0.67	-0.57
0.64	-0.49
0.64	-0.18
0.64	-0.40
0.64	-0.35
0.64	-0.32

mean square error at iteration 13 is 0.008665

Iteration 14

Output	error
0.64	-0.54
0.61	-0.46
0.62	-0.16
0.61	-0.37
0.62	-0.33
0.62	-0.30

mean square error at iteration 14 is 0.007455

Iteration 15

Output	error
0.62	-0.52
0.59	-0.44
0.60	-0.14
0.59	-0.35

0.60	-0.31
0.60	-0.28

mean square error at iteration 15 is 0.006317

Iteration 16

Output	error
0.60	-0.50
0.56	-0.41
0.57	-0.11
0.56	-0.32
0.57	-0.28
0.57	-0.25

mean square error at iteration 16 is 0.005265

Iteration 17

Output	error
0.57	-0.47
0.53	-0.38
0.55	-0.09
0.53	-0.29
0.55	-0.26
0.55	-0.23

mean square error at iteration 17 is 0.004310

Iteration 18

Output	error
0.55	-0.45
0.51	-0.36
0.52	-0.06
0.51	-0.27
0.52	-0.23
0.52	-0.20

mean square error at iteration 18 is 0.003460

Iteration 19

Output	error
0.53	-0.43
0.48	-0.33
0.50	-0.04
0.48	-0.24
0.50	-0.21
0.50	-0.18

mean square error at iteration 19 is 0.002717

Iteration 20

Output	error
0.50	-0.40
0.46	-0.31
0.48	-0.02
0.46	-0.22
0.48	-0.19
0.48	-0.16

mean square error at iteration 20 is 0.002081

Iteration 21

Output	error
0.48	-0.38
0.44	-0.29
0.46	0.00
0.44	-0.20
0.46	-0.17
0.46	-0.14

mean square error at iteration 21 is 0.001549

Iteration 22

Output	error
0.46	-0.36
0.41	-0.26
0.44	0.02
0.41	-0.17
0.44	-0.15
0.44	-0.12

mean square error at iteration 22 is 0.001113

Iteration 23

Output	error
0.44	-0.34
0.39	-0.24
0.42	0.04
0.39	-0.15
0.42	-0.13
0.42	-0.10

mean square error at iteration 23 is 0.000765

Iteration 24

Output	error
0.42	-0.32
0.37	-0.22
0.40	0.06
0.37	-0.13

0.40	-0.11
0.40	-0.08

mean square error at iteration 24 is 0.000496

Iteration 25

Output	error
0.40	-0.30
0.35	-0.20
0.38	0.08
0.36	-0.12
0.38	-0.09
0.38	-0.06

mean square error at iteration 25 is 0.000296

Iteration 26

Output	error
0.39	-0.29
0.34	-0.19
0.36	0.10
0.34	-0.10
0.36	-0.07
0.36	-0.04

mean square error at iteration 26 is 0.000155

Iteration 27

Output	error
0.37	-0.27
0.32	-0.17
0.35	0.11
0.32	-0.08
0.35	-0.06
0.35	-0.03

mean square error at iteration 27 is 0.000064

CONCLUSIONS:

We successfully modelled the problem by using multilayer feed forward network . The errors are reducing with increase in number of iterations .Finally , we reaches the value where our mean square error is less than desired mean square value . Three main consideration during this:

1) Choose optimum number of hidden layer neuron
2) Choose optimum value of learning rate
3) Adjusting the value of parameters like a1 and a2 is also required .

By following this , there is always a possibility to solve the problem .

Lower the value of self learning rate our network will take more number of iterations to reach the solution or u can say the rate of convergence is slower . Hence , we have to maintain stability of network as well as its convergence .

Increasing the value of parameters like a1 and a2 also causes rate of convergence faster and solution convergence is possible with less number of parameters . When my answer is not convergence I used this method .

Therefore, we can set up appropriate process parameters to finish different surfaces by using Magnetorheological finishing .