

We read the excel file and read the sheet from the source into R

```
> require(XLConnect)
> df = loadWorkbook("ChemicalProcessData.xlsx")
> ChemicalProcessData = readWorksheet(df, sheet = "ChemicalProcessData", header = TRUE)
```

We create a Matrix for the data in the file and create an identity matrix which we bind with our matrix

```
> Mat_ChemicalProcessData<-as.matrix(ChemicalProcessData)
> Identity_Mat<-diag(17)
>
> Matx_Xtnd<-as.matrix(cbind(1,ChemicalProcessData))
```

We extract the independent variables and name it as matrix X

```
> Matx_X<-Matx_Xtnd[,c(1,3,4)]
> Matx_X # Our Matrix X
```

	1	Factor_1	Factor_2
[1,]	1	41.9	29.1
[2,]	1	43.4	29.3
[3,]	1	43.9	29.5
[4,]	1	44.5	29.7
[5,]	1	47.3	29.9
[6,]	1	47.5	30.3
[7,]	1	47.9	30.5
[8,]	1	50.2	30.7
[9,]	1	52.8	30.8
[10,]	1	53.2	30.9
[11,]	1	56.7	31.5
[12,]	1	57.0	31.7
[13,]	1	63.5	31.9
[14,]	1	65.3	32.0

```
[15,] 1 71.1 32.1
```

```
[16,] 1 77.0 32.5
```

```
[17,] 1 77.8 32.9
```

We extract the dependant variables into a new Matrix Y

```
> Matx_Y<-Matx_Xtnd[,c(5)]
```

```
> Matx_Y #Matrix Y
```

```
[1] 251.3 251.3 248.3 267.5 273.0 276.5 270.3 274.9 285.0 290.0 297.0 302.5 304.5
```

```
[14] 309.3 321.7 330.7 349.0
```

We find the transpose of Matrix X and Matrix Y using t()

```
> Matx_X_t<-t(Matx_X) #Transpose of X
```

```
> Matx_Y_t<-t(Matx_Y) #Transpose of Y
```

Value of  $X'X$

```
> Matx_XtX<-Matx_X_t%%Matx_X
```

```
> library(MASS) #import library
```

Value of inverse of  $(X'X)$

```
> Matx_XtX_I<-ginv(Matx_XtX)
```

Value of  $X'Y$

```
> Matx_Xt_Y<-Matx_X_t%%Matx_Y
```

Beta Matrix = inverse of  $(X'X) * X'Y$

```
> Matx_Beta<-Matx_XtX_I%%Matx_Xt_Y #Beta
```

```
> Matx_Beta #Beta Matrix
```

```
[,1]
```

```
[1,] -153.511694
```

```
[2,] 1.238723
```

```
[3,] 12.082353
```

Find Hat Matrix in steps

```
> Matx_Hat_part<-Matx_X%%Matx_XtX_I
```

```
> Matx_Hat<-Matx_Hat_part%*%Matx_X_t
```

```
> Matx_Hat
```

	[,1]	[,2]	[,3]	[,4]	[,5]	[,6]
[1,]	0.27551510	0.25153702	0.20867174	0.1676951876	0.168270450	0.06743015
[2,]	0.25153702	0.23021233	0.19207211	0.1556134463	0.156148956	0.06641609
[3,]	0.20867174	0.19207211	0.16587729	0.1406419863	0.136516106	0.07645031
[4,]	0.16769519	0.15561345	0.14064199	0.1259594981	0.117634391	0.08537970
[5,]	0.16827045	0.15614896	0.13651611	0.1176343912	0.115277661	0.07000288
[6,]	0.06743015	0.06641609	0.07645031	0.0853796961	0.070002875	0.09890993
[7,]	0.02267615	0.02659431	0.04929596	0.0701192641	0.049618889	0.11004898
[8,]	0.01380782	0.01872206	0.04037249	0.0603492979	0.043506480	0.10019630
[9,]	0.03676008	0.03916845	0.04982378	0.0596544070	0.051341743	0.07924995
[10,]	0.01816052	0.02262067	0.03816564	0.0526021348	0.042652021	0.08260982
[11,]	-0.07266093	-0.05816892	-0.02122844	0.0134671922	-0.001223817	0.09061592
[12,]	-0.11930364	-0.09967225	-0.04934230	-0.0020822116	-0.022358938	0.10285980
[13,]	-0.04884577	-0.03691926	-0.01796597	0.0002846411	0.003076349	0.04660435
[14,]	-0.04100327	-0.02992529	-0.01619083	-0.0027220248	0.004902527	0.03449662
[15,]	0.04238800	0.04433082	0.02396507	0.0058301845	0.036774129	-0.02180421
[16,]	0.04920468	0.05044650	0.01859187	-0.0099531135	0.034314075	-0.05587234
[17,]	-0.04030330	-0.02919705	-0.03571681	-0.0404739774	-0.006453897	-0.03359424
	[,7]	[,8]	[,9]	[,10]	[,11]	[,12]
[1,]	0.02267615	0.01380782	0.036760079	0.01816052	-0.072660926	-0.119303640
[2,]	0.02659431	0.01872206	0.039168452	0.02262067	-0.058168920	-0.099672248
[3,]	0.04929596	0.04037249	0.049823777	0.03816564	-0.021228440	-0.049342302
[4,]	0.07011926	0.06034930	0.059654407	0.05260213	0.013467192	-0.002082212
[5,]	0.04961889	0.04350648	0.051341743	0.04265202	-0.001223817	-0.022358938
[6,]	0.11004898	0.10019630	0.079249955	0.08260982	0.090615921	0.102859795

[7,] 0.13462898 0.12352035 0.090729975 0.09926328 0.129801249 0.156259596  
[8,] 0.12352035 0.11504563 0.086540787 0.09485557 0.126334476 0.151332146  
[9,] 0.09072997 0.08654079 0.072488112 0.07657873 0.092050803 0.104355519  
[10,] 0.09926328 0.09485557 0.076578732 0.08268850 0.107153772 0.124915709  
[11,] 0.12980125 0.12633448 0.092050803 0.10715377 0.173078265 0.214508439  
[12,] 0.15625960 0.15133215 0.104355519 0.12491571 0.214508439 0.270978096  
[13,] 0.06626031 0.07256541 0.065529132 0.07395176 0.116758078 0.137116722  
[14,] 0.04849673 0.05744952 0.058074019 0.06454278 0.100433184 0.114698937  
[15,] -0.04440081 -0.02461115 0.017631099 0.01079451 -0.005685604 -0.030513061  
[16,] -0.09103661 -0.06331764 -0.001468316 -0.01243116 -0.041802164 -0.080276080  
[17,] -0.04187661 -0.01666954 0.021491725 0.02087575 0.036568490 0.026523522

[,13] [,14] [,15] [,16] [,17]

[1,] -0.0488457732 -0.041003266 0.042388003 0.049204685 -0.040303304  
[2,] -0.0369192587 -0.029925290 0.044330819 0.050446499 -0.029197049  
[3,] -0.0179659701 -0.016190833 0.023965074 0.018591870 -0.035716814  
[4,] 0.0002846411 -0.002722025 0.005830185 -0.009953113 -0.040473977  
[5,] 0.0030763494 0.004902527 0.036774129 0.034314075 -0.006453897  
[6,] 0.0466043458 0.034496624 -0.021804210 -0.055872335 -0.033594243  
[7,] 0.0662603118 0.048496729 -0.044400811 -0.091036607 -0.041876609  
[8,] 0.0725654071 0.057449520 -0.024611147 -0.063317640 -0.016669539  
[9,] 0.0655291324 0.058074019 0.017631099 -0.001468316 0.021491725  
[10,] 0.0739517606 0.064542776 0.010794510 -0.012431163 0.020875746  
[11,] 0.1167580783 0.100433184 -0.005685604 -0.041802164 0.036568490  
[12,] 0.1371167217 0.114698937 -0.030513061 -0.080276080 0.026523522  
[13,] 0.1139093660 0.112494511 0.082972559 0.086447943 0.125759875  
[14,] 0.1124945105 0.115244194 0.107367956 0.121820114 0.149820323  
[15,] 0.0829725588 0.107367956 0.220997595 0.289578053 0.244384851

```
[16,] 0.0864479432 0.121820114 0.289578053 0.388041362 0.317712818
```

```
[17,] 0.1257598752 0.149820323 0.244384851 0.317712818 0.301148084
```

```
> print("Value of H is : ")
```

```
[1] "Value of H is : "
```

#### Find Matrix SSE

```
> Matx_SSE_basic<- Identity_Mat-Matx_Hat
```

```
> Matx_SSE_basic
```

```
      [,1] [,2] [,3] [,4] [,5] [,6]
[1,] 0.72448490 -0.25153702 -0.20867174 -0.1676951876 -0.168270450 -0.06743015
[2,] -0.25153702 0.76978767 -0.19207211 -0.1556134463 -0.156148956 -0.06641609
[3,] -0.20867174 -0.19207211 0.83412271 -0.1406419863 -0.136516106 -0.07645031
[4,] -0.16769519 -0.15561345 -0.14064199 0.8740405019 -0.117634391 -0.08537970
[5,] -0.16827045 -0.15614896 -0.13651611 -0.1176343912 0.884722339 -0.07000288
[6,] -0.06743015 -0.06641609 -0.07645031 -0.0853796961 -0.070002875 0.90109007
[7,] -0.02267615 -0.02659431 -0.04929596 -0.0701192641 -0.049618889 -0.11004898
[8,] -0.01380782 -0.01872206 -0.04037249 -0.0603492979 -0.043506480 -0.10019630
[9,] -0.03676008 -0.03916845 -0.04982378 -0.0596544070 -0.051341743 -0.07924995
[10,] -0.01816052 -0.02262067 -0.03816564 -0.0526021348 -0.042652021 -0.08260982
[11,] 0.07266093 0.05816892 0.02122844 -0.0134671922 0.001223817 -0.09061592
[12,] 0.11930364 0.09967225 0.04934230 0.0020822116 0.022358938 -0.10285980
[13,] 0.04884577 0.03691926 0.01796597 -0.0002846411 -0.003076349 -0.04660435
[14,] 0.04100327 0.02992529 0.01619083 0.0027220248 -0.004902527 -0.03449662
[15,] -0.04238800 -0.04433082 -0.02396507 -0.0058301845 -0.036774129 0.02180421
[16,] -0.04920468 -0.05044650 -0.01859187 0.0099531135 -0.034314075 0.05587234
[17,] 0.04030330 0.02919705 0.03571681 0.0404739774 0.006453897 0.03359424
      [,7] [,8] [,9] [,10] [,11] [,12]
[1,] -0.02267615 -0.01380782 -0.036760079 -0.01816052 0.072660926 0.119303640
```

[2,] -0.02659431 -0.01872206 -0.039168452 -0.02262067 0.058168920 0.099672248  
[3,] -0.04929596 -0.04037249 -0.049823777 -0.03816564 0.021228440 0.049342302  
[4,] -0.07011926 -0.06034930 -0.059654407 -0.05260213 -0.013467192 0.002082212  
[5,] -0.04961889 -0.04350648 -0.051341743 -0.04265202 0.001223817 0.022358938  
[6,] -0.11004898 -0.10019630 -0.079249955 -0.08260982 -0.090615921 -0.102859795  
[7,] 0.86537102 -0.12352035 -0.090729975 -0.09926328 -0.129801249 -0.156259596  
[8,] -0.12352035 0.88495437 -0.086540787 -0.09485557 -0.126334476 -0.151332146  
[9,] -0.09072997 -0.08654079 0.927511888 -0.07657873 -0.092050803 -0.104355519  
[10,] -0.09926328 -0.09485557 -0.076578732 0.91731150 -0.107153772 -0.124915709  
[11,] -0.12980125 -0.12633448 -0.092050803 -0.10715377 0.826921735 -0.214508439  
[12,] -0.15625960 -0.15133215 -0.104355519 -0.12491571 -0.214508439 0.729021904  
[13,] -0.06626031 -0.07256541 -0.065529132 -0.07395176 -0.116758078 -0.137116722  
[14,] -0.04849673 -0.05744952 -0.058074019 -0.06454278 -0.100433184 -0.114698937  
[15,] 0.04440081 0.02461115 -0.017631099 -0.01079451 0.005685604 0.030513061  
[16,] 0.09103661 0.06331764 0.001468316 0.01243116 0.041802164 0.080276080  
[17,] 0.04187661 0.01666954 -0.021491725 -0.02087575 -0.036568490 -0.026523522

[,13] [,14] [,15] [,16] [,17]

[1,] 0.0488457732 0.041003266 -0.042388003 -0.049204685 0.040303304  
[2,] 0.0369192587 0.029925290 -0.044330819 -0.050446499 0.029197049  
[3,] 0.0179659701 0.016190833 -0.023965074 -0.018591870 0.035716814  
[4,] -0.0002846411 0.002722025 -0.005830185 0.009953113 0.040473977  
[5,] -0.0030763494 -0.004902527 -0.036774129 -0.034314075 0.006453897  
[6,] -0.0466043458 -0.034496624 0.021804210 0.055872335 0.033594243  
[7,] -0.0662603118 -0.048496729 0.044400811 0.091036607 0.041876609  
[8,] -0.0725654071 -0.057449520 0.024611147 0.063317640 0.016669539  
[9,] -0.0655291324 -0.058074019 -0.017631099 0.001468316 -0.021491725  
[10,] -0.0739517606 -0.064542776 -0.010794510 0.012431163 -0.020875746

```
[11,] -0.1167580783 -0.100433184 0.005685604 0.041802164 -0.036568490
[12,] -0.1371167217 -0.114698937 0.030513061 0.080276080 -0.026523522
[13,] 0.8860906340 -0.112494511 -0.082972559 -0.086447943 -0.125759875
[14,] -0.1124945105 0.884755806 -0.107367956 -0.121820114 -0.149820323
[15,] -0.0829725588 -0.107367956 0.779002405 -0.289578053 -0.244384851
[16,] -0.0864479432 -0.121820114 -0.289578053 0.611958638 -0.317712818
[17,] -0.1257598752 -0.149820323 -0.244384851 -0.317712818 0.698851916
```

```
> Matx_SSE_basic1<-Matx_Y_t%%Matx_SSE_basic
```

```
> Matx_SSE<-Matx_SSE_basic1%%Matx_Y
```

```
> print("Value of SSE is : ")
```

```
[1] "Value of SSE is : "
```

```
> Matx_SSE
```

```
    [,1]
```

```
[1,] 423.3741
```

#### Matrix of SSR

```
> J<-matrix(1, nrow=17,ncol=17) # Square matrix J
```

```
> Matx_J<-J/17 # n=17
```

```
> Matx_SSR_part<-Matx_Hat-Matx_J
```

```
> Matx_SSR<-Matx_Y_t%%Matx_SSR_part%%Matx_Y
```

```
> print("Value of SSR is : ")
```

```
[1] "Value of SSR is : "
```

```
> Matx_SSR
```

```
    [,1]
```

```
[1,] 12816.35
```

```
>
```

### Calculate MSE

```
> MSE<-Matx_SSE/14 # Calculate MSE
```

```
> print("Value of MSE is : ")
```

```
[1] "Value of MSE is : "
```

```
> MSE
```

```
      [,1]
```

```
[1,] 30.24101
```

```
>
```

### Calculate MSR

```
> MSR<-Matx_SSR/2 # Calculate MSR
```

```
> print("Value of MSR is : ")
```

```
[1] "Value of MSR is : "
```

```
> MSR
```

```
      [,1]
```

```
[1,] 6408.173
```

```
>
```

### Calculate F0

```
> F0<-MSR/MSE #Calculate F0
```

```
> print("Value of F0 is : ")
```

```
[1] "Value of F0 is : "
```

```
> F0
```

```
      [,1]
```

```
[1,] 211.9034
```

```
>
```