11.4. Following is the line graph of year Vs sales for the given data file.

It is clear that there is an upward trend in the graph which implies that the data is nonstationary.

11.5. The two period and four period moving averages are calculated in the spreadsheet ‘SmallBusiness.xlsx’

a. following are the line graphs drawn between moving averages Vs original sales data, differentiated by legend

b. From the above graph it is clear that the trend is upward implying underestimating the original data.

c. For 2 period moving average, y^21 = average (y19, y20) = (y19+y20)/2 = (532+552)/2

= 542.00 (in 1000s)

y^22 = (y20+y^21)/2 = (552+542)/2 = 547.00 (in 1000s)

For 4 period moving average, y^21 = average (y17,y18,y19,y20) = (y17+y18+y19+y20)/4

= (523+528+532+552)/4 = 533.75 (in 1000s)

Y^22 = (y18+y19+y20+y^21)/4 = (528+532+552+533.75)/4 = 536.44 (in 1000s)

The MSE for 2 period and 4 period moving average is 410.55 and 1258.44, shows that the 2 period forecast is far better than 4 period since the error comes to be more in 4 period moving average. Also, from the line graph it is clear that the 4 period moving average is much lower than original data, increasing the errors.

11.6. and 11.6 a. Let w1, w2, w3 be the weights for 3 period moving average which are the **decision variables** in minimizing MSE which is **objective function**. The sum of these weights must be 1 and the weights must lie between 0 and 1, which form as the **constraints** to the model. The solution is in the sheet 11.6 of ‘SmallBusiness.xlsx’ file.

b. The following is the line graph comparing the WMA prediction with original data

c. The forecast for next two years is calculated as follows

y^21 = y18\*w3 + y19\*w2 + y20\*w1 = 552.00 and y^22 = y19\*w3 + y20\*w2 + y^21\*w1 = 552.00

11.8 and 11.8 a. Let α be an exponent on which the forecast depends, signifying are the **decision variable** in minimizing MSE which is **objective function**. The decision variable must lie between 0 and 1, which form as the **constraints** to the model. The solution is in the sheet 11.8 of ‘SmallBusiness.xlsx’ file.

b. The following is the line graph comparing data from exponential smoothening with original data

c. The forecast for next two years is calculated as follows

Y^21 = y^20 + α(y20-y^20) = 552.00 and y for any year is to be 552.00 in this method, hence y^22 = 552.00