

**Operations Research**  
**Chapter 7**  
**Answers**

**Moving Average**

The number of cans of soft drinks sold in a machine each week is recorded below.  
 Develop forecasts using a three period moving average.

338, 219, 278, 265, 314, 323, 299, 259, 287, 302

<b>Time Period</b>	<b>Actual Value</b>	<b>Forecast</b>	<b>Forecast Error</b>	<b> Error </b>	<b>(Error)<sup>2</sup></b>
1	338				
2	219				
3	278				
4	265	278.33	□13.33	13.33	177.6889
5	314	254.00	60.00	60.00	3600
6	323	285.67	37.33	37.33	1393.529
7	299	300.67	-1.67	1.67	2.7889
8	259	312.00	-53.00	53.00	2809
9	287	293.67	-6.67	6.67	44.4889
10	302	281.67	20.33	20.33	413.3089

THE FORECAST FOR PERIOD 11    282.67

MEAN ABSOLUTE ERROR 27.47571

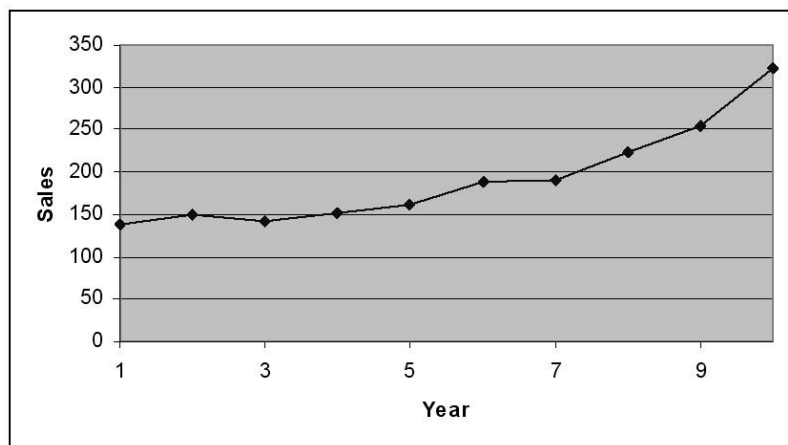
MEAN SQUARED ERROR 1205.829

## Trend Analysis

A company's annual sales are shown below in thousands of dollars for a period of 10 years.

Year (t)	1	2	3	4	5	6	7	8	9	10
Actual Sales (Tt)	138	150	142	151	161	188	191	224	254	322

Plot the time series; find the linear regression model, and also the forecast value and error for each of the years. Also discuss whether you think a linear model appears to be appropriate.



The time series plot shown below appears to somewhat nonlinear as sales appears to be increasing at an increasing rate.

Year (t)	Actual Sales (Tt)	$t^*Tt$	$t^2$	Forecast	Error	MAE	MSE
1	138	138	1	111.89	26.11	26.11	681.7321
2	150	300	4	129.71	20.29	20.29	411.6841
3	142	426	9	147.53	-5.53	5.53	30.5809
4	151	604	16	165.35	-14.35	14.35	205.9225
5	161	805	25	183.17	-22.17	22.17	491.5089
6	188	1128	36	200.99	-12.99	12.99	168.7401
7	191	1337	49	218.81	-27.81	27.81	773.3961
8	224	1792	64	236.63	-12.63	12.63	159.5169
9	254	2286	81	254.45	-0.45	0.45	0.2025
10	322	3220	100	272.27	49.73	49.73	2473.073
Sum	1921	12036	385			<b>19.206</b>	<b>539.6357</b>

The results of the calculations are:  $\hat{y} = 94.07 + 17.82t$ .

The forecast and error for each year, based on this model are shown above.

Based both on the time-series plot and the pattern in the error, it appears that a nonlinear model would probably fit this model better. The pattern in the errors refers to the fact that they are negative for the center values and positive for values on each end of the series, which means they are not randomly positive or negative.

### **Trend and Seasonal Components**

<b>Quarter (t)</b>	<b>Actual Sales (Tt)</b>	<b>Average</b>	<b>Centered Moving average</b>	<b>Seasonal-Irregular</b>
1	73			
2	89			
3	123	94.25	95.25	1.291339
4	92	96.25	96	0.958333
1	81	95.75	94.75	0.854881
2	87	93.75	93.875	0.926764
3	115	94	93.375	1.231593
4	93	92.75	92.5	1.005405
1	76	92.25	91.375	0.831737
2	85	90.5	89.75	0.947075
3	108	89	89.125	1.211781
4	87	89.25	90.125	0.965326
1	77	91	93.875	0.82024
2	92	96.75	98.5	0.93401
3	131	100.25		
4	101			

<b>Season</b>	<b>Average Seasonal Index</b>	<b>Adjusted Seasonal Index</b>
Quarter 1	0.835619	0.8372
Quarter 2	0.93595	0.9377
Quarter 3	1.244904	1.2474
Quarter 4	0.976355	0.9779
	3.992828	

**Multiple Choices Questions:**

1. TRUE
2. FALSE
3. B
4. C
5. D