TIME SERIES ANALYSIS
PRACTICAL – 3

Submitted By: Ridam Singhal(5040)

AIM: To fit straight line, parabolic curve and exponential to the given data. Also estimate the amount for the given year and the curve of best fit.

PRACTICAL: The following data shows life insurance carried per family in the US from 1960 to 1970:

Year	Average Amount (in Dollars)
1960	10200
1961	10800
1962	11400
1963	12200
1964	13300
1965	14700
1966	15900
1967	17200
1968	18400
1969	19500
1970	20900

a) Fit a straight line to the data.
b) Fit a second degree parabola to the data.
c) Fit an exponential curve to the data.
d) Estimate insurance amount for 1971 with every method and compare.
e) Which of the method computed in the above three parts appears to be the line of best fit? Explain your choice.

CALCULATIONS:

a) Fitting a straight line :

TABLE 3.1

Year(t)	Average Amount (in Dollars) Y(t)	x (t-1965)	x^2	xy	Trend Values Ye = a+bx
1960	10200	-5	25	-51000	9413.641
1961	10800	-4	16	-43200	10521.8228
1962	11400	-3	9	-34200	11630.0046
1963	12200	-2	4	-24400	12738.1864

1964	13300	-1	1	-13300	13846.3682
1965	14700	0	0	0	14954.55
1966	15900	1	1	15900	16062.7318
1967	17200	2	4	34400	17170.9136
1968	18400	3	9	55200	18279.0954
1969	19500	4	16	78000	19387.2772
1970	20900	5	25	104500	20495.459
	$\sum Y(t)=164500$	$\sum x=0$	$\sum x^2 =110$	$\sum xy =121900$	

n=11, substituting these values in: $\sum Y(t) = na + b\sum x$ and $\sum xy = a\sum x + b\sum x^2$

We get a = 1108.182 and b = 14954.55

<u>Straight Line: Y=a+bx</u>

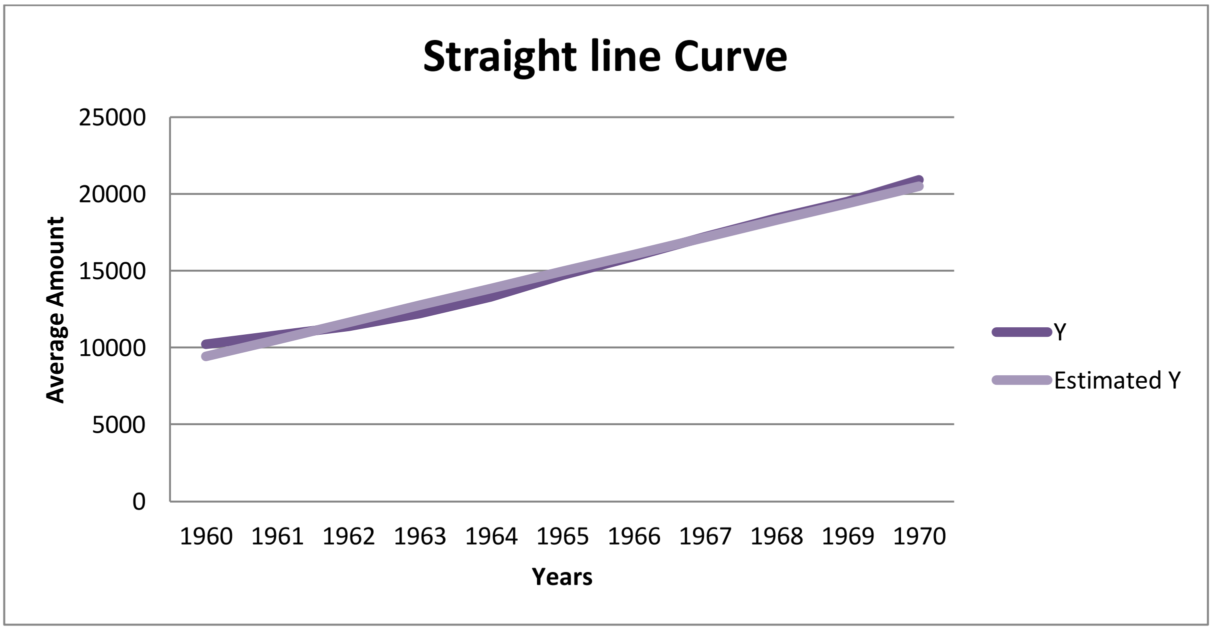
And estimated values of Y have been tabulated in Table 3.1

$R^2 = 0.988151$

Estimated value of insurance amount for 1971:

As x=6, $21603.64.

<u>GRAPH 3.1</u>



b) <u>Fitting of a second degree parabola to the curve:</u>

TABLE 3.3

Year(t)	Average Amount (in Dollars) (Yt)	x	x^2	x^3	x^4	xy	x^2y	ax^2+bx+c
1960	10200	-5	25	-125	625	-51000	255000	9978.32225
1961	10800	-4	16	-64	256	-43200	172800	10747.69304
1962	11400	-3	9	-27	81	-34200	102600	11592.35521
1963	12200	-2	4	-8	16	-24400	48800	12512.30876
1964	13300	-1	1	-1	1	-13300	13300	13507.55369
1965	14700	0	0	0	0	0	0	14578.09
1966	15900	1	1	1	1	15900	15900	15723.91769
1967	17200	2	4	8	16	34400	68800	16945.03676
1968	18400	3	9	27	81	55200	165600	18241.44721
1969	19500	4	16	64	256	78000	312000	19613.14904
1970	20900	5	25	125	625	104500	522500	21060.14225
	$\sum Y(t) = 164500$	$\sum x = 0$	$\sum x^2=110$	$\sum x^3=0$	$\sum x^4=1958$	$\sum xy$ =121900	$\sum x^2y$ =1677300	

Substituting the above values in the equation:

$$\sum Y(t) = na + b\sum x + c\sum x^2$$

$$\sum xy = a\sum x + b\sum x^2 + c\sum x^3$$

$$\sum x^2y = a\sum x^2 + b\sum x^3 + c\sum x^4$$

We get, a = 37.64569, b = 1108.182, and c = 22803.13

Substituting these values in parabolic curve, we have tabulated the estimated values of Y in Table 3.2.

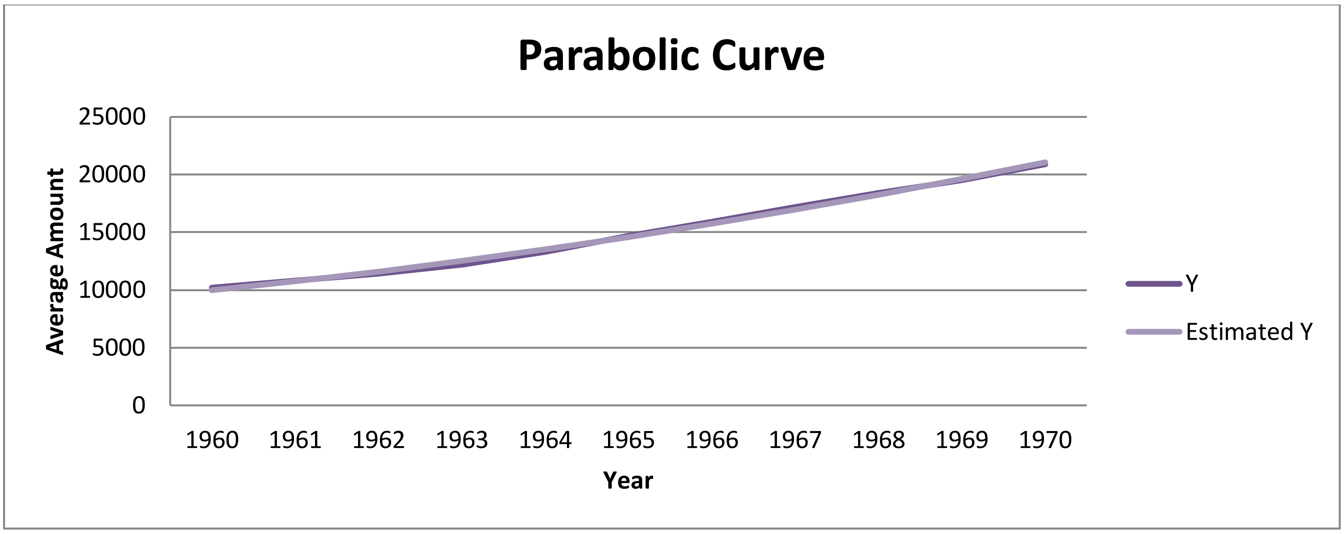
Parabolic Curve: $y=ax^2+bx+c$

$R^2 = 0.997045$.

Estimated value of insurance amount for 1971:

as x=6 , $22582.42.

GRAPH 3.2



c) Fitting an exponential curve:

TABLE 3.3

Year(t)	Average Amount (in Dollars) (Yt)	x	logY(y)	x^2	xy	ae^bx
1960	10200	-5	9.230143	25	-46.1507	9991.1528
1961	10800	-4	9.287301	16	-37.1492	10769.499
1962	11400	-3	9.341369	9	-28.0241	11608.481
1963	12200	-2	9.409191	4	-18.8184	12512.823
1964	13300	-1	9.495519	1	-9.49552	13487.617
1965	14700	0	9.595603	0	0	14538.35
1966	15900	1	9.674074	1	9.674074	15670.939
1967	17200	2	9.752665	4	19.50533	16891.761
1968	18400	3	9.820106	9	29.46032	18207.689
1969	19500	4	9.87817	16	39.51268	19626.133
1970	20900	5	9.947504	25	49.73752	21155.078
	∑Y(t) = 164500	∑x =0	∑logY=105.4316	$\sum x^2$=110	∑xy =8.251994	

Substituting the above values in the equation :

$\sum \log Y = n\,A + b\sum x$

$\sum xy = A\sum x + b\sum x^2$

We get , A = ln(a) = 9.584545455 , therefore a = 14538.35276

b = 0.075018091

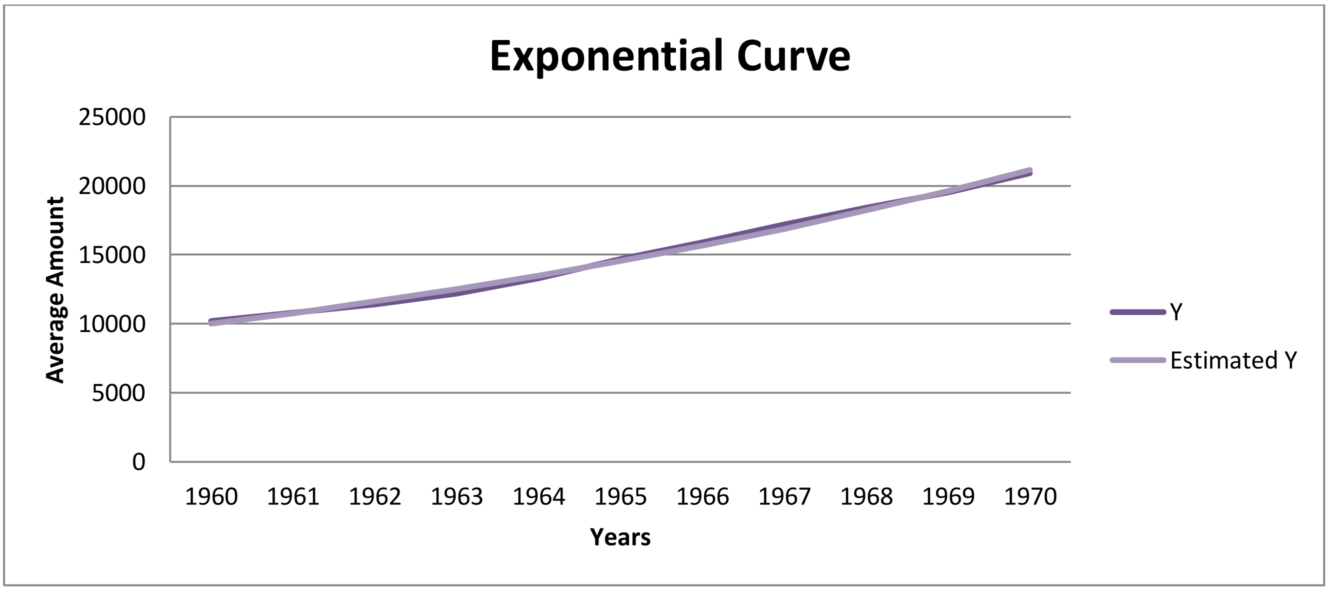
Substituting these values in exponential curve, we have tabulated the estimated values of Y in Table 3.3.

Exponential Curve :y=ae^bx

R^2 = 0.996255.

Estimated value of insurance amount for 1971:
as x=6, $ 22803.13.

GRAPH 3.3



RESULT:

1) Straight line has been fitted in GRAPH 3.1, and the estimated insurance amount for 1971 is $21603.64.
2) Two degree parabolic curve has been plotted in GRAPH 3.2, and the estimated insurance amount for 1971 is $22582.42.
3) Exponential curve has been plotted in GRAPH 3.3, and the estimated insurance amount for 1971 is $22803.13.

CONCLUSION:

1) Two degree parabolic curve is the line of best fit, as the coefficient of determination is maximum (R^2 = 0.996255)
2) Best estimated value for the insurance amount for the year 1971 is $22582.42.