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1. Quaterly sales in millions

year	I	II	III	IV
2002	5.3	4.1	6.8	6.7
2003	4.8	3.8	5.6	6.8
2004	4.3	3.8	5.7	6.0
2005	5.6	4.6	6.4	5.9

Considering whole year as a time period for regression analysis.

(X) Year	(Y) Cumulative Sales	$(X)^2$	XY
2002	22.9	1	22.9
2003	21	4	42
2004	19.8	9	59.4
2005	22.5	16	90

$\Rightarrow \Sigma XY = 214.3 \quad , \Sigma X = 10$

$\bar{x} = \frac{\Sigma X}{n} = \frac{10}{4} = 2.5$

$b = \frac{\Sigma XY - n\bar{x}\bar{y}}{\Sigma X^2 - n(\bar{x})^2}$ * $\bar{y} = \frac{\Sigma Y}{n} = \frac{86.2}{4}$

$= 21.55$

$= \frac{(214.3) - (4)(2.5)(21.55)}{(30) - 4(2.5)^2}$ $\Rightarrow \Sigma X^2 = 30$

$= -0.24$

$\therefore y(5) = a + b(5) \Rightarrow 22.15 + (-0.24)(5) \Rightarrow \boxed{y(5) = 20.95}$

Quaterly factor of each quarter.

$$QF_I = \frac{\sum_{i=1}^{n} \text{Sales}(i)}{\sum_{i=1}^{n} \text{Sales (year)}} = \frac{5.3+4.8+4.8+5.6}{86.2}$$

$$= 0.232$$

$$QF_{II} = \frac{4.1+3.8+3.8+4.6}{86.2} = 0.189$$

$$QF_{III} = \frac{6.8+5.6+5.7+6.4}{86.2} = 0.284$$

$$QF_{IV} = \frac{6.7+6.8+6.0+5.9}{86.2} = 0.294$$

$$Y(5)_I = Y(5) \times QF_{(I)} = 20.95 \times 0.232 = 4.86$$

$$Y(5)_{II} = 20.95 \times 0.189 = 3.96$$

$$Y(5)_{III} = 20.95 \times 0.284 = 5.95$$

$$Y(5)_{IV} = 20.95 \times 0.294 = 6.16$$

Quarterly sales in 2006

2.

Period (X)	Demand (Y)	X^2	XY
1	40	1	40
2	60	4	180
3	80	9	240
4	35	16	140
5	30	25	150
6	50	36	300
7	60	49	420

8	30	64	240
9	35	81	315
10	60	100	600
11	80	121	880
12	40	144	480
13	50	169	650
14	70	196	980
15	100	225	1500
16	50	256	800
136	870	1496	7855

$\bar{x} = \frac{136}{16} = 8.5$, $\bar{y} = \frac{870}{16} = 54.375$

$$b = \frac{\Sigma xy - n\bar{x}\bar{y}}{\Sigma x^2 - n(\bar{x})^2} = \frac{7855 - 16(8.5)(54.375)}{1496 - 16(8.5)^2} = 1.353$$

$$a = \bar{y} - b\bar{x} = 54.375 - 1.353(8.5) = 42.874$$

$$y(18) = a + b(18) = 42.874 + 1.353(18) = 67.2285$$

3.

Period (x)	demand (y)	x^2	xy
1	4	1	4
2	10	4	20
3	7	9	21
4	3	16	12
5	5	25	25
6	12	36	72
7	9	49	63
8	4	64	32

9	6	81	54
10	16	100	160
11	12	121	132
12	4	144	48
78	92	650	843

$\bar{x} = 6.5$

$\bar{y} = 7.67$

$$b = \frac{643 - 12(6.5)(7.67)}{650 - 12(6.5)(6.5)}$$

$$= 0.312$$

$$a = \bar{y} - b\bar{x} = 7.63 - 0.312(6.5) = 5.602$$

$$y(14) = 5.602 + (0.312 \times 14) = 9.97$$

4. C = 50,000 Rs, life = 10 years, r = 10%.

Year (t)	M.C	PVOF	P.V. g(t)	Σ in PV	TC	CRF@10%	Avg Annual cost
1	8000	0.9091	7272.8	7272.8	57,272.8	1.10	63000.08
2	8000	0.8264	6611.2	13884	63884	0.5762	36809.96
3	8000	0.7613	6010.4	19894.4	69894.4	0.402	28104.57
4	8000	0.6830	6464	25398.4	75358.4	0.315	23785.89
5	8,000	0.6209	4967.2	30325.6	80325.6	0.268	21189.89
6	10,000	0.5646	5645	35970.6	85970.6	0.2296	19738.84
7	12,000	0.5192	6158.4	42129	92129	0.2054	18923.29
8	14000	0.4665	6531	48660	98660	0.1874	18488.35
9	16000	0.4241	6785.6	55445.6	105445.6	0.1736	18,305.35
10	18000	0.3855	6939	62384.6	112334.6	0.1618	18296.21

M/C at the end of 10th year . 18296.21 & should be replaced.

5.

t	1	2	3	4	5	6	7	8
P(t)	0.02	0.05	0.12	0.26	0.3	0.14	0.08	0.03

Cost of individual replacement = Rs 100 each

group ——— = Rs 50 each

$N_0 = 400$

$N_1 = N_0P_1 + 400(0.02) = 8$

$N_2 = N_0P_2 + N_1P_1 = 400(0.05) + 8(0.02) = 28.16$

$N_3 = N_0P_3 + N_1P_2 + N_2P_1 = 48.803$

$N_4 = N_0P_4 + N_1P_3 + N_2P_2 + N_3P_1 = 106.914$

$N_5 = 129.073$

$N_6 = 77.426$

$N_7 = 72.692$

$N_8 = 78.723$

Individual replacement policy:-

expected life of value = $1(0.02) + 2(0.05) + 3(0.12) + 4(0.26) + 5(0.3) + 6(0.14) + 7(0.08) + 8(0.03)$

= 4.45 months

Avg replacement/month = $\frac{400}{4.45} = 89.88$

Avg. cost/month = $89.88 \times 100 = 8988.76$ Rs

Group Replacement policy:-

end of month	total cost of Gr. repl. $(\sum_{i=1}^{n} N_i) \times 100 + 20,000$	Avg. cost/month
1	$N_1 \times 100 + 400 \times 50 = 800 + 20,000$	20,800
2	$20,000 + 28.16 \times 50 = 21408$	10704
3	$20,000 + 76.963 \times 50 = 23,848.15$	7949.38
4	$20,000 + 183.907 \times 50 = 29,195.35$	7298.83
5	$20000 + 312.985 \times 50 = 35,649.25$	7129.85
6	$20000 + 390.411 \times 50 = 39,520.55$	6586.75
7	$20000 + 463.103 \times 50 = 43,155.15$	6165.021
8	$20000 + 541.826 \times 50 = 47,091.3$	5886.41

min avg. cost at end of 7 months. ⇒ 6165.021 / month

Company should opt for group replacement at end of 7 month.

6.

t	1	2	3	4	5
% of end of month	10	25	50	80	100
failure each month	100	150	250	300	200
P(t)	0.10	0.15	0.25	0.3	0.2

$N_0 = 1000$, $N_1 = N_0(P_1) = 1000 \times 0.1 = 100$

$N_2 = N_0P_2 + N_1P_1 = 1000 \times 0.15 + 100 \times .1 = 160$

$N_3 = 1000 \times .25 + 160 \times 1 + 100 \times .25 = 281$

$N_4 = 1000 \times 0.3 + 281 \times 0.1 + 160 \times 0.15 + 100 \times 0.25 = 377.1$

$N_5 = 1000 \times 0.2 + 100 \times 0.3 + 160 \times 0.25 + 281 \times 0.15 + 377.1 \times 0.1$

$= 349.86$

at end of month	Total cost of Group repl.	Avg. cost/month
1	$100 \times 2 + 1000 \times .5 = 700$	700
2	$500 + 260 \times 2 = 1020$	510
3	$500 + 541 \times 2 = 1582$	527.33
4	$500 + 918.1 \times 2 = 2336.2$	584.35
5	$500 + 1267.96 \times 2 = 3035.92$	607.184

All bulbs should be replaced at an interval of 2 months.