TIE2140 Engineering Economy
Solutions to Tutorial # 9

Question 1.

Year 2014: Index = 220, Cost = \$250,000
Year 2019: Index = 298, Cost = ?

Therefore Year 2019 Cost: $C_{2019} = C_{2014}\left(\frac{I_{2019}}{I_{2014}}\right) = \$250{,}000\left(\frac{298}{220}\right) = \$338{,}636.36$

Question 2.

Let Cost of old loader 8 years ago = \$181,000
Capacity of old loader = X
Cost index 8 years ago = 162

Capacity of new loader = $1.42X$
Cost index now = 221
Cost capacity factor = 0.8

Therefore

Cost new loader with capacity $X = \$181{,}000\left(\frac{221}{162}\right) = \$246{,}919.75$

Cost of new loader with capacity $1.42X = \$246{,}919.75\left(\frac{1.42X}{X}\right)^{0.8} = \$326{,}878.62$

Total Cost with options = \$326,878.62 + \$28,000 = **\$ 354,878.62**

Question 3.

K = 126 hours
s = 0.95 // 95% learning curve
n = (log 0.95) / (log 2) = – 0.074

(*a*) Time to design the 8th tower = Z_8 =126 $(8)^{-0.074}$ = 108.03 hours

Time to design the 50th tower = Z_{50} = 126 $(50)^{-0.074}$ = 94.33 hours

(*b*) Total cumulative time for the first 5 towers =

$$T_5 = 126\sum_{u=1}^{5} u^{-0.074}$$
$$= 126 + 119.7 + 116.16 + 113.72 + 111.85 = 587.43 \text{ hours}$$

Cumulative average time for the first 5 towers = $C_5 = T_5/5$ = 587.43/5 = 117.49 hours

Question 4.

(*a*) Let the regression model be $y = a + b\,x$

Item	x	y	x^2	y^2	$x\,y$
1	230	97	52,900	9,409	22,310
2	280	109	78,400	11,881	30,520
3	210	88	44,100	7,744	18,480
4	190	86	36,100	7,396	16,340
5	320	123	102,400	15,129	39,360
6	300	114	90,000	12,996	34,200
7	280	112	78,400	12,544	31,360
8	260	102	67,600	10,404	26,520
9	270	107	72,900	11,449	28,890
10	190	86	36,100	7,396	16,340
sum	2,530	1,024	658,900	106,348	264,320

$n = 10$

$$\sum x_i = 2{,}530 \qquad \bar{x} = \frac{2{,}530}{10} = 253 \qquad \sum x_i^2 = 658{,}900$$

$$\sum y_i = 1{,}024 \qquad \bar{y} = \frac{1{,}024}{10} = 102.4 \qquad \sum y_i^2 = 106{,}348$$

$$\sum x_i y_i = 264{,}320$$

$$b = \frac{\sum_{i=1}^{n} x_i y_i - \frac{1}{n}\left(\sum_{i=1}^{n} x_i\right)\left(\sum_{i=1}^{n} y_i\right)}{\sum_{i=1}^{n} x_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} x_i\right)^2} = \frac{(264{,}320) - (2{,}530)(1{,}024)/10}{(658{,}900) - (2{,}530)^2/10} = 0.279001$$

$$a = \bar{y} - b\bar{x} = 102.4 - 0.2790(253) = 31.8129$$

Hence the linear regression model is

$$y = 31.8129 + 0.2790\,x$$

(*b*) Coefficient of Correlation Analysis

Item	$(x_i - \bar{x})(y_i - \bar{y})$	$(x_i - \bar{x})^2$	$(y_i - \bar{y})^2$
1	124.200	529.000	29.1600
2	178.200	729.000	43.5600
3	619.200	1849.000	207.3600
4	1033.200	3969.000	268.9600
5	1380.200	4489.000	424.3600
6	545.200	2209.000	134.5600
7	259.200	729.000	92.1600
8	-2.800	49.000	0.1600
9	78.200	289.000	21.1600
10	1033.200	3969.000	268.9600
Total	5248.000	18810.00	1490.40

$$\sum (x_i - \bar{x})(y_i - \bar{y}) = 5{,}248$$

$$\sum (x_i - \bar{x})^2 = 18{,}810$$

$$\sum (y_i - \bar{y})^2 = 1{,}490.40$$

$$R = \frac{\sum_{i=1}^{n} (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\left(\sum_{i=1}^{n} (x_i - \bar{x})^2\right)\left(\sum_{i=1}^{n} (y_i - \bar{y})^2\right)}} = \frac{5{,}248}{\sqrt{(18{,}810)(1{,}490.4)}} = 0.99117$$

(*c*) Prediction:

When x = 250 lbs.

y = 31.8129 + 0.2790 (250) = $ 101.56

Question 5.

K = 1.76 hours // time for 1st item
s = 0.8 // 80% learning curve
n = log(0.80) / log(2) = - 0.32193

Time for the 50^{th} item = $Z_{50} = 1.76\ (50)^{-0.32193} = 0.5$ hours

Manufacturing Cost Analysis:

Direct Labor cost = ($15 / hr)(0.5 hr / item)	= $ 7.50 per item
Direct material cost = $375 / 100 items)	= $ 3.75 per item
Factory overhead cost = (1.25)($7.50 / item)	= $ 9.375 per item
Packing cost = (0.75)($7.50 / item)	= $ 5.625 per item
Total Manufacturing cost	=$ 26.25 per item
Desired profit= (0.20)(26.25)	= $ 5.25 per item
Selling Price	= **$31.50**