IE2111 ISE Principles & Practice II
Solutions to Tutorial #7

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 =

$$T_5 = 126\sum_{u=1}^{5} u^{-0.074}$$

$$= 126 + 119.7 + 116.16 + 113.72 + 111.85 = 587.43 \text{ hours}$$

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

$n = 10$

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

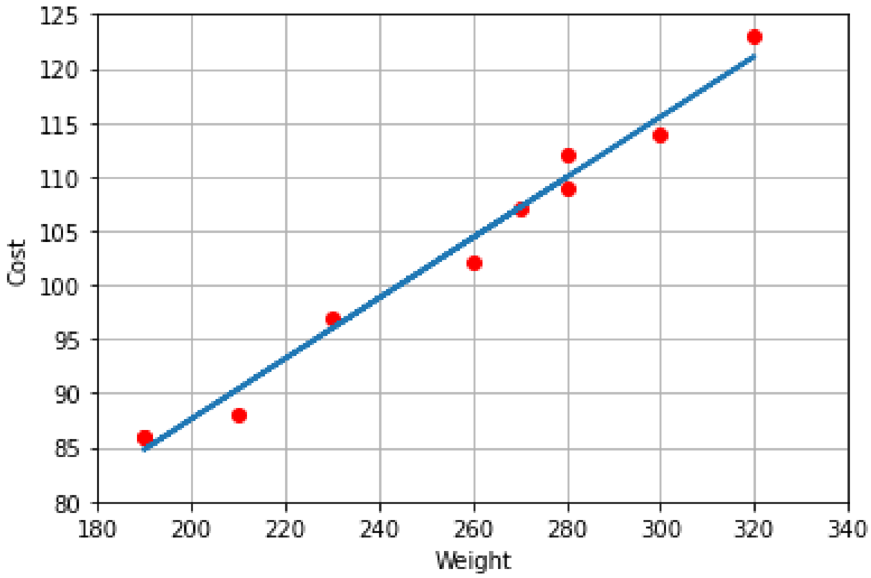
$\sum y_i = 1{,}024$ $\qquad \bar{y} = \dfrac{1{,}024}{10} = 102.4$ $\qquad \sum y_i^2 = 106{,}348$

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

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

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

Hence the linear regression model is $y = 31.8129 + 0.2790\,x$



(*b*) **Coefficient of Correlation Analysis**

Item	$(x_i - \overline{x})(y_i - \overline{y})$	$(x_i - \overline{x})^2$	$(y_i - \overline{y})^2$
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

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

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

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

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

(*c*) **Prediction:**

When x = 250 lbs.

y = 31.8129 + 0.2790 (250) = $ 101.56

Question 5.

The projects in decreasing annual returns and their cumulative investment amounts are shown below:

Project	Investment $m	Cumulative Investment $m	Annual Return
A	10	10	15.0%
E	5	15	12.0%
D	30	45	7.5%
C	30	75	6.0%
B	25	100	5.0%
F	12	112	4.0%

Note that as all the projects have equal life and consists of only an initial cash outflow and a single cash inflow at the end of its life, ranking by project's *IRR* is valid.

(***a***) If the company has $50 million available, and the cost of this capital is 5.5%, then projects *A, E* and *D* should be invested in. The remaining $5*m* should continue to be invested in municipal bonds at 5.5% return. *MARR* = 5.5%.

Note that if the company has only $45 m, remaining fund will be zero, and *MARR* will be 7.5%, which is the *MARR* of the last accepted project.

(***b***) If the company has $100 million available, and the cost of this capital is 5.5%, then projects *A*, *E, D and C* should be invested in. The remaining $25 million should continue to be invested in municipal bonds at 5.5% return. *MARR* = 5.5%

Question 6.

Annual payment = 0.14 (1,000) = $140 for 10 years

Final payment received at the end of 10 years = $1,000

Desired yield = 10% per year

Present worth of receipts = 140 [*P*/*A*, 10%,10] + 1,000 [*P*/*F*, 10%, 10] = $ <u>1,245.78</u>

Maximum price to pay for the bond = **$ <u>1,245.78</u>**

Question 7.

Total bond issues = $1,000,000
Selling fee = $50,000
Annual coupon payment amount = 0.04 (1,000,000) = $40,000
Annual admin cost = $70,256
Final payment at EoY 15 = $1,000,000

The cost of capital to the company is the *IRR* associated with cash flows to the company. That is, we need to solve:

$1{,}000{,}000 – 50{,}000 – (40{,}000 + 70{,}256)\ [P/A, i, 15\%] – 1{,}000{,}000\ [P/F, i, 15] = 0$

$950{,}000 − 110{,}526\ [P/A, i, 15] − 1{,}000{,}000\ [P/F, i, 15] = 0$

When $i = 10\%$: 950,000 – 110,256 (7.606080) − 1,000,000 (0.239392) = −128,007.95
When $i = 12\%$: 950,000 − 110,256 (6.810864) − 1,000,000 (0.182696) = + 16,365.06

By linear interpolation between 10% and 12%, $i \approx$ 11.77%

Using Excel: = RATE (15, 950000, -110526, -1000000, 0, 0.1) = **11.75%**

Similar answer can be obtained by Excel Goal Seek or any equation solver.

Question 8.

Number of bonds issued = 5,000
Maturity period = 10 years
Face value = $1,000
Coupon rate = 6%
Annual coupon payment = 0.06 (1,000) = $60

Expected yield = 8%.

(*a*) Price = 0.06 (1,000) [*P*/*A*, 8%, 10] + 1,000 [*P*/*F*, 8%, 10] = $865.80

(*b*) Amount raised through bond sale = 865.80 × 5,000 = $4,328,991.86

(*c*) Let x = after-tax cost of capital. Then

$865.80 – 60\ (1 – 0.17)\ [P/A, x, 10] – 1{,}000\ [P/F, x, 10] = 0.$

Using Excel: =RATE(10, - 60* (1 - 0.17), 865.80, -1000, 0, 0.1)

x = **6.88%**