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 = XCost index 8 years ago = 162

Capacity of new loader = 1.42XCost index now = 221Cost 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.

$$K = 126 \text{ hours}$$

 $s = 0.95$ // 95% learning curve
 $n = (log \ 0.95) / (log \ 2) = -0.074$

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

Time to design the 50^{th} 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 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	у	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

$$n = 10$$

$$\sum x_i = 2,530$$

$$\overline{x} = \frac{2,530}{10} = 253$$

$$\sum x_i^2 = 658,900$$

$$\sum y_i = 1,024$$

$$\overline{y} = \frac{1,024}{10} = 102.4$$

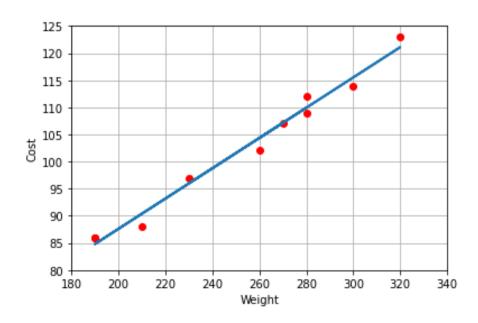
$$\sum y_i^2 = 106,348$$

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

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

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

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

$$\sum_{i} (x_i - x_i)(y_i - y_i) = 5,248$$

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

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

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

(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%
В	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 5m 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] = \$1,245.78

Maximum price to pay for the bond = \$1,245.78

Question 7.

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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
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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 = $865.80 \times 5,000 = \$4,328,991.86$
- (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) $x = 6.88\%$