

ENSC 201 Assignment 5, Model Answers

5.1

Gerry likes driving small cars, and buys nearly identical ones whenever the old one needs replacing. He typically trades in his old car for a new one costing about \$15 000. A new car warranty covers all repair costs above standard maintenance for the first two years; after that, his records show an average repair expense (over standard maintenance) of \$2 500 in the third year (which we can assume to be paid at year's end), increasing by 50% per year thereafter. If a 30% declining-balance depreciation rate is used to estimate salvage values, and interest is 8%, how often should Gerry get a new car?

To solve this, we need to construct the 'bathtub curve' for the car. The relevant equations are:

$$\text{Capital recovery} = 15,000(A/P, i, N) - S_N(A/F, i, N)$$

And

$$\text{Average Operating Costs} = \Sigma(PW(\text{Operating Costs}))(A/P, i, N)$$

And

$$EUAC = \text{Capital Recovery} + \text{Average Operating Costs}$$

The most painless way to do this is to use a spreadsheet program to construct a table like the one below (although this one was actually constructed by hand so as to show some of the calculations):

Year	S_N	Operating Cost	Capital Recovery	Average Operating Cost	EUAC
1	10,500	0	16,200-10,500	0	5,700
2	7,350	0	8,411-3,533	0	4,878
3	5,145	2,500	5,824-1,584	$1,985 \times 0.388$	5,010
4	3,601	3,750	4,528-799	$4,741 \times 0.302$	5,161

From this we see that Gerry should replace his car every two years.

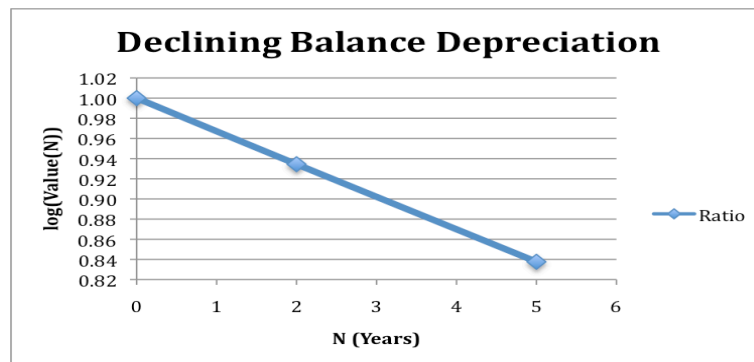
5.2

Kim Gil Dong manufactures and sells jade carvings. He owns a computer-controlled mill, used to cut fine detail into the jade pieces, which is essential to his business. Five years ago it cost him ₩150 000. Three years ago he was considering selling the business, and collected competitive bids for the mill. Based on the bids he received, he concluded that its market value at that time was about ₩108 000. Now he has just solicited a new round of bids, and their average value is ₩66 500. Based on this information, what would be a reasonable estimate for the value of the machine four years from now?

The simplest model for the decline in value of the mill is straight-line depreciation. But if this model were correct, and the mill had lost ₩42 800 in value over the first two years of its life, then after five

years it would have lost $\text{₹}42\,800 \times 5/2 = \text{₹}107\,000$ in value, leaving it worth $\text{₹}43\,000$. The current round of bids shows that it is worth significantly more than that, so the straight-line model cannot be correct.

We next try to fit a declining balance model. If the mill loses a fraction $1-x$ of its value every year, then its value after N years will be $\text{₹}150\,000 x^N$. So a plot of $\log(\text{Value}(\text{Year } N))$ against N should be a straight line with slope $\log(x)$. We construct such a plot in the accompanying spreadsheet, **6S3.xls**, and note that it is a good approximation to a straight line, and that its slope is -0.162 , corresponding to $x=0.85$. This implies a declining balance model, in which the current value drops by 15% each year. So in four years time, Kim would expect the value to be $\text{₹}66\,500 \times 0.85^4$, which is $\text{₹}34\,713$.



5.3

Mr Patel, a retired economist, owns a small store in Mumbai. In one corner of the store is a video-game machine. Ten years ago, it cost him Rs 5 000, but lately it has been breaking down more frequently. Last year he had to spend Rs 500 on repairs, and he expects the repair bill to go up by about 10% every year from now on. Also, it has been bringing in less money every year; he empties the coin box every month, and on average it contains about Rs 100. He expects the annual income to go down by Rs 100 every year from now on. If he got rid of the machine, he could use the space to stock more goods, and he expects this would increase his annual profit by Rs 500. But the machine is not worth anything as scrap, and he will have to pay Rs 200 to have it taken away. Mr Patel's MARR is 10%.

He carries out a replacement analysis, treating all the cash flows as discrete and annually compounded. What conclusion does he reach?

After he has completed his analysis, his teenage daughter Rajni says, "Kaka, you are forgetting something. Usually when a boy comes in to play the machine, he will also buy a soda, and you make as much profit from selling the soda as the boy puts into the machine. You should do your analysis again!" So he does the analysis again. Does his conclusion change?

The present value of getting rid of the video-game machine after N years is an increased profit of Rs 500 per year, extending indefinitely into the future, less the cost of getting rid of the machine. This is

$$(500/0.1 - 200)(P/F, 0.1, N) = 4\,800(P/F, 0.1, N)$$

The present value of keeping the machine for N more years is the income it provides, less the cost of repairs. We represent the income as an annuity of Rs 1,200 plus an arithmetic gradient of –Rs 100. This is

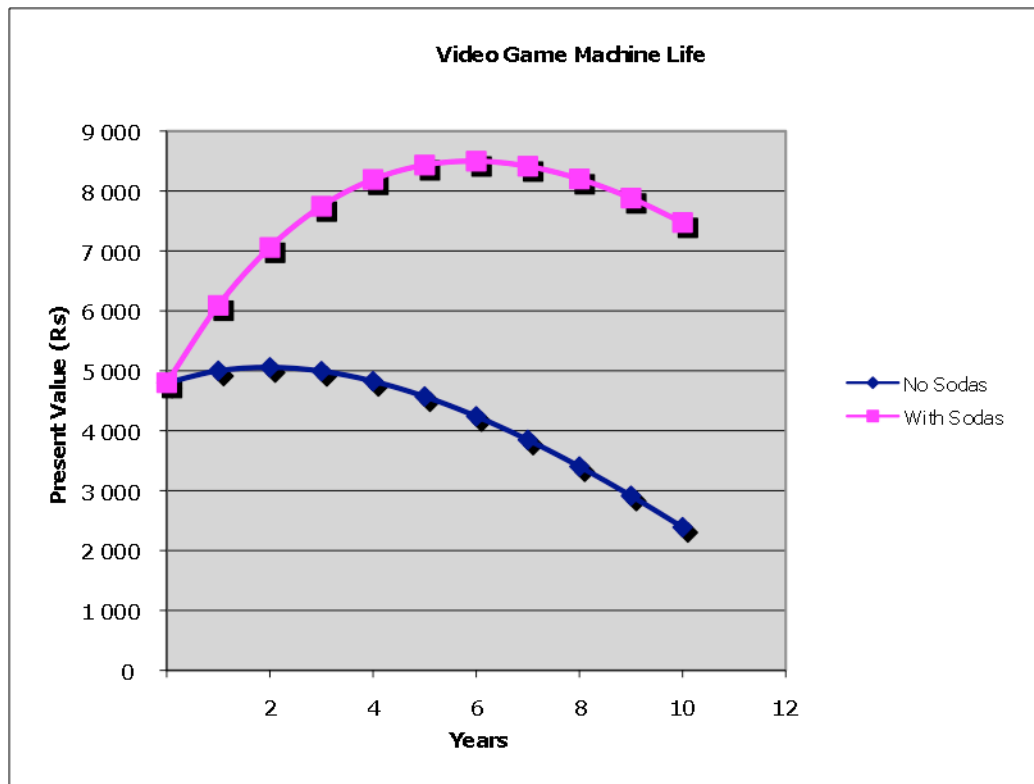
$$(1\,200 - 100(A/G, 0.1, N)) (P/A, 0.1, N) - 500(P/A, 0.1, 0.1, N)$$

$$= (1\,200 - 100(A/G, 0.1, N)) (P/A, 0.1, N) - 500N/1.1$$

The Rs 5 000 paid for the machine is a sunk cost that does not come into the calculation.

We add these two amounts together and plot their value against N in the attached spreadsheet, **7S5.xls**.

Mr Patel's initial analysis shows he should get rid of the machine in two years, but if he includes the money brought in by extra soda sales, he should keep it for another six years.



5.4

A Canadian company owns a machine that cost \$26 000 ten years ago. A new machine is available that costs \$11 000 and will save \$2 000 per year. If the new machine is bought, the old machine can be sold for \$8 000, and the new machine can itself be sold for \$1 000 salvage five years hence. If the old machine is retained, it will be scrapped in five years, for no salvage value. The MARR for the company

is 20%. Should the old machine be replaced now?

The \$26 000 cost of the old machine is a sunk cost, and thus irrelevant to the analysis.

The present cost of switching to the new machine is

$$\begin{aligned} PC &= 11\,000 - 8\,000 - 1\,000(P/F, 0.2, 5) - 2\,000(P/A, 0.2, 5) \\ &= 3\,000 - 1\,000(0.4019) - 2\,000(2.9906) \\ &= -3\,383 \end{aligned}$$

Thus, the company will save \$3 383 by replacing the old machine. So they should do it.

5.5

A British industrial robot has a current salvage value of £10 000. Its remaining physical life is four years. If it is continued in service, it will result in the operating savings for each year shown in the table below; the salvage values at the end of each year are also shown. If the firm owning the robot has an MARR of 15%, when should the equipment be retired from service?

Year	Operating savings in Year	Salvage Value at End of Year
1	£5 000	£6 000
2	£4 000	£4 000
3	£3 000	£2 000
4	£2 000	0

Retiring the machine now has a present value of £10 000.

Retiring it in a year's time has a present value of:

$$PV_1 = (5\,000 + 6\,000)(P/F, 0.15, 1) = 11\,000(0.8696) = £9\,566$$

Retiring it in two years time has a present value of:

$$\begin{aligned} PV_2 &= 5\,000(P/F, 0.15, 1) + (4\,000 + 4\,000)(P/F, 0.15, 2) \\ &= 5\,000(0.8696) + 8\,000(0.7561) = £10\,397 \end{aligned}$$

Retiring it in three years has a present value of:

$$PV_3 = 5\,000(P/F, 0.15, 1) + 4\,000(P/F, 0.15, 2) + (3\,000 + 2\,000)(P/F, 0.15, 3)$$

$$= 5\,000(0.8696) + 4\,000(0.7561) + 5\,000(0.6575) = \text{£}10\,660$$

And waiting until the end of the fourth year has a present value of:

$$\begin{aligned} PV_4 &= 5\,000(P/F, 0.15, 1) + 4\,000(P/F, 0.15, 2) + 3\,000(P/F, 0.15, 3) + 2\,000(P/F, 0.15, 4) \\ &= 5\,000(0.8696) + 4\,000(0.7561) + 3\,000(0.6575) + 2\,000(0.5717) = \text{£}10\,488 \end{aligned}$$

We conclude that the machine should be retired at the end of the third year.