

APSC 221 : Assignment 2 Solution - Fall 2013

Question 1: Chapter 4 (12 marks)

A company is planning to replace outdated equipment with models that are more energy-efficient and environmental-friendly. Two models are under consideration. Model A is sold for \$159,000 and can produce at an optimum speed of 78 units/hour. Model B is sold for the same price, but can produce at an optimum speed of 76 units/hour. Model A requires 6 hours of maintenance for every 4300 units produced, while Model B requires 5 hours of maintenance for every 3300 units. The maintenance cost for both models is \$100 per hour. The variable operating cost is \$340 per hour for Model A and \$290 per hour for Model B. Due to obsolete parts, there is a sunk cost of \$2700 for model A and \$1900 for Model B. If the price of the product is \$150 per unit and the company expects to sell 145,000 units each year, which model should be selected? Show your steps and rational.

Often there is “extra” information not required to solve the problem. The purchase price of the equipment and sunk cost are for this problem, irrelevant information. Then because the selling price for the units is the same, no matter which machine produces them, revenue will be the same for either machine, so we want the Model which will cost the least to produce the 145,000 units. Rule 2: page 132. (1 marks)

For Model A;

First figure out how many hours of operation are required to produce 145,000 units.

$\frac{145,000}{78} = 1858.9744 \text{ hours}$, then multiply by the operating cost per hour, $1858.9744 \times 340 = \$632,051.30$ (2 marks)
[$1859 \times 340 = 632,060$ is also acceptable]

Now we need to figure out how many maintenance intervals will be required to produce 145,000 units.

$\frac{145,000}{4300} = 33.72$, however you don't need the partial interval, so round down to 33 maintenance intervals. (1 marks)
Each interval costs you 6 hours at \$100/hr, so, $33 \times 6 \times 100 = \$19,800$. (1 mark) Add to that the operating cost for a total cost of \$651,851.30 (1 mark)

(Note: if the solution fails to round down and uses 34 maintenance intervals and arrives at \$652,451.30, award 1.5 part marks ... losing 3 part marks is a bit harsh)

For Model B; same steps

$\frac{145,000}{76} = 1907.8947 \text{ hours}$, $\rightarrow 1907.8947 \times 290 = \$553,289.46$ (2 marks) [$1907.9 \times 290 = 553,291$ is also acceptable]

$\frac{145,000}{3300} = 43.94$, round down to 43 maintenance intervals. (1 marks) $43 \times 5 \times 100 = \$21,500$. (1 mark) Add to that the operating cost for a total cost of \$574,789.46 (1 mark)

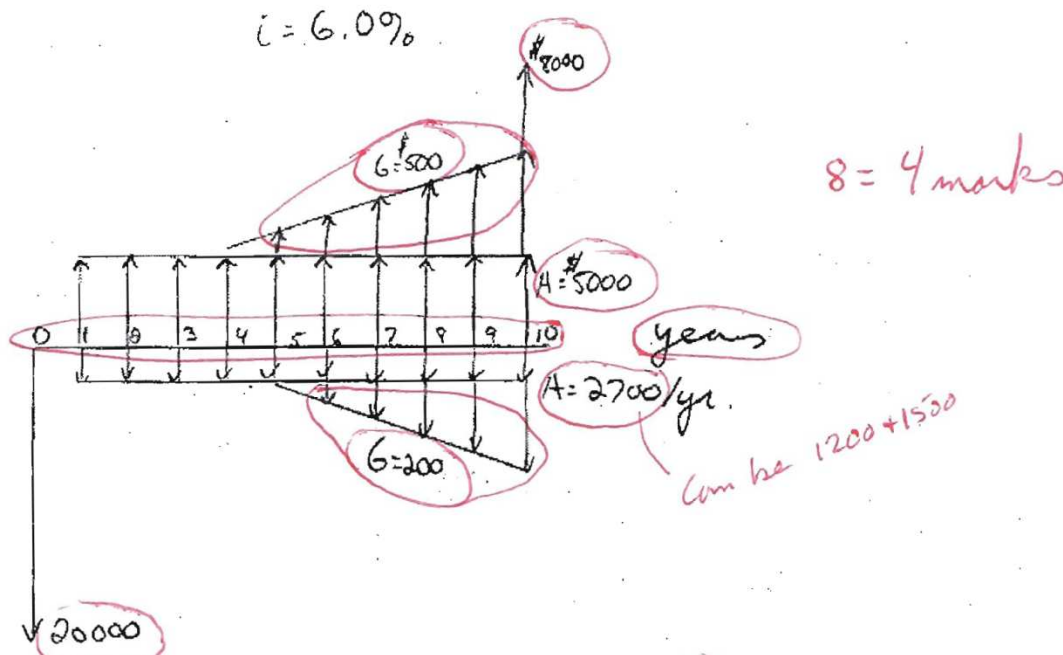
(Note: if the solution fails to round down and uses 44 maintenance intervals and arrives at \$575,289.46, award 1.5 part marks ... losing 3 part marks is a bit harsh)

\therefore Choose Model B to produce the units as it has the lower total cost. (1 mark)

Question 2: Chapter 6 and 7 (11 marks)

A university student at Queen's has decided to help fund his university education by purchasing a car and running a taxi business for the next 10 years. He has asked you to help him decide if this business venture will be profitable. He has decided to purchase a Honda Civic for \$20,000 and will be able to sell the vehicle for \$8,000 at the end of the 10 years. He estimates that his fuel cost will be \$1500 per year and that his maintenance costs will be \$1200 for the first five years and will then increase every year by \$200 (e.g. Year 6 maintenance costs will be \$1400). During the first four years of his undergraduate degree, he estimates that he can make \$5000 per year by taxiing students to entertainment establishments on weekends. After four years he believes he will be able to dedicate more time to the business and expects his profits will increase by \$500 every year (e.g. \$5500 in Year 5).

- (a) Draw a clearly labelled cash flow diagram for the taxi business. (4 marks)



- (b) Determine the present value of the proposed business. Use an interest rate of 6% compounded annually for your analysis. Show ALL work for full marks. (4 marks)

$$PW = -20,000 + (5,000 - 1,200 - 1,500)(P/A, 6\%, 10) + 500(P/G, 6\%, 7)(P/F, 6\%, 3) - 200(P/G, 6\%, 6)(P/F, 6\%, 4) + 8000(P/F, 6\%, 10) \quad (3 \text{ marks})$$

$$PW = -20,000 + (2,300)(7.3601) + 500(15.4497)(0.83962) - 200(11.4594)(0.79209) + 8000(0.55839)$$

$$PW = \$6,065.91 \quad (1 \text{ mark})$$

- (c) The salesperson at the Honda dealership has provided the Queen's student with a quote to finance the entire purchase cost of the vehicle. He will pay \$386.65 per month for 60 months and the interest on the loan is compounded monthly. What are the nominal yearly interest rate and the effective annual interest rate that the salesperson is offering? (3 marks)

$$P = A(P/A, i\%, n)$$

$$\$20,000 = \$386.65(P/A, i\%, 60) \quad (1 \text{ mark})$$

$$(P/A, i\%, 60) = 51.726$$

Look in the interest tables under the P/A column and row n=60 to find that $i\% = 0.5\%$ (1/2 mark)

$$r/m = 0.5\%, \text{ and } m=12$$

$$r = 0.5\%(12) = 6\% \text{ nominal} \quad (1/2 \text{ mark})$$

$$i_e = (1 + r/m)^m - 1 = (1 + 0.06/12)^{12} - 1 = (1 + 0.005)^{12} - 1 = 6.17\% \quad (1 \text{ mark})$$

Question 3: Chapter 7 (5 marks)

Kingston is planning on building a new 4 lane bridge over the Cataraqui River which will cost approximately \$180 million dollars to build. It is estimated that the annual maintenance cost will be \$30,000 per year for the first 10 years and will increase to \$60,000 per year for the remaining life of the bridge (i.e., \$60k in year 11 and onward). One of the ways that the city is considering offsetting the cost of the bridge is to charge a toll for each crossing. The city has estimated that it will obtain revenue of \$330,000 per year from toll charges. Knowing that this is a long-lived project and using an annual interest rate of 6%:

- (a) Determine the total present worth of the bridge. (3 marks)

$$P = A / i \text{ as } n \text{ approaches } \infty$$

$$PW = -180,000,000 - 30,000(P/A, 6\%, 10) + 330,000/0.06 - (60,000/0.06)(P/F, 6\%, 10) \text{ (2 marks)}$$

$$PW = -180,000,000 - 30,000(7.3601) + 5,500,000 - (1,000,000)(0.55839)$$

$$PW = \$ -175,279,193 \text{ (1 mark)}$$

Or

$$PW = -180,000,000 + 300,000(P/A, 6\%, 10) + (270,000/0.06)(P/F, 6\%, 10) \text{ (2 marks)}$$

$$PW = -180,000,000 + 300,000(7.3601) + (4,500,000)(0.55839)$$

$$PW = \$ -175,279,215 \text{ (1 mark)}$$

- (b) The difference between the bridge's construction and maintenance costs and the revenues it will generate through tolls (the present worth computed in part (a) above) must be borne by Kingston taxpayers. This contribution can be modeled as an ongoing annuity. How much would each person pay per year for the new bridge, if Kingston has a population of 150,000? (2 marks)

$$P = A / i \text{ as } n \text{ approaches } \infty$$

$$PW \text{ Cost per person} = -175,279,200 / 150,000 = \$1,168.528 \text{ (1 mark)}$$

$$AW \text{ Cost per person} = \$1,168.528(0.06) = \$70.11 \text{ forever (1 mark)}$$

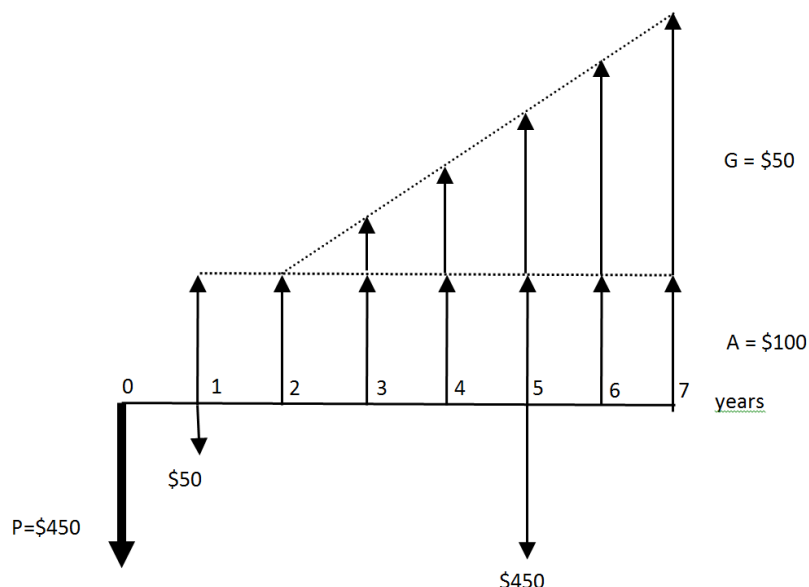
Or

$$-175,279,200 / 150,000 = AW \text{ Cost per person} / 0.06 \text{ (1 mark)}$$

$$AW \text{ Cost per person} = \$70.11 \text{ forever (1 mark)}$$

Question 4: Chapter 8 (7 marks)

You would like to invest some of the money you have saved in a new business opportunity. The Cash Flow Diagram for an investment is depicted below. Note: lines are not drawn to scale.



- (a) Using the standard payback method, determine the payback period for the investment. (2 marks)

$$\$450 - (\$100 - \$50) = \$400 \Rightarrow \text{Year 1}$$

$$\$400 - \$100 = \$300 \Rightarrow \text{Year 2}$$

$$\$300 - (\$100 + \$50) = \$150 \Rightarrow \text{Year 3}$$

$$\$150 - (\$100 + \$100) = \$-50 \Rightarrow \text{Year 4}$$

Payback occurs between year 3 and year 4, or rounded up to the nearest whole year = year 4.

- (b) Using the discounted payback method with an interest rate of 9%, determine the payback period for the investment. (4 marks)

N	Amount	(P/F, 9%, n)	Cumulative
0	-450 = -450	-450	-450.00
1	100 - 50 = 50	45.87	-404.13
2	100 = 100	84.17	-319.96
3	100 + 50 = 150	115.83	-204.13
4	100 + 100 = 200	141.69	-62.45
5	100 + 150 - 450 = -200	-129.99	-192.43
6	100 + 200 = 300	178.88	-13.55
7	100 + 250 = 350	191.46	177.91

Payback occurs between year 6 and year 7, or rounded up to the nearest whole year = year 7.

- (c) Would you invest in this business if you had to recover your original investment within 4 years? Justify your answer, i.e. a simple "Yes" or "No", or similar answer, will get you zero marks. (1 mark)

With the standard payback this investment would be acceptable; however it ignores the time value of money.

With the discounted payback this investment would NOT be acceptable.

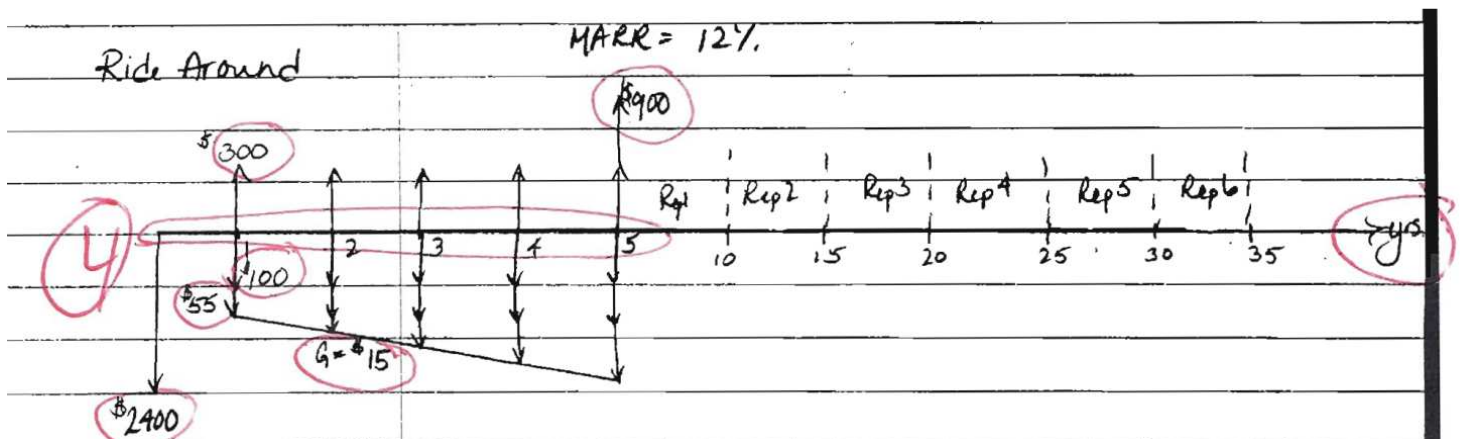
Clearly this investment is marginal at best, when you ignore the time value of money and as such is NOT a good investment.

Question 5: Chapter 8 (15 marks)

LawnCare Servicing wants to replace its ride-on lawnmower with new updated models. It is currently evaluating models that seem reasonable. The information on the two alternatives is shown in the table below.

	RideAround	AnywhereRide
First Cost	\$2400	\$2600
Annual Savings	\$300	\$350
Annual Maintenance Cost	\$55 in yr 1, increasing by \$15 each year thereafter	\$25 in yr 1, increasing by \$10 each year thereafter
Annual Servicing and Fuel Cost (estimated)	\$100	\$150
Service Life	5 yrs	7 yrs
Scrap Value	\$900	\$600

Knowing that LawnCare Servicing's MARR is 12%, use an annual worth comparison to determine which lawnmower they should choose? Justify your answer, i.e. a simple "RideAround" or "AnywhereRide", or similar answer, will get you zero marks. Show cash flow diagrams for full marks.



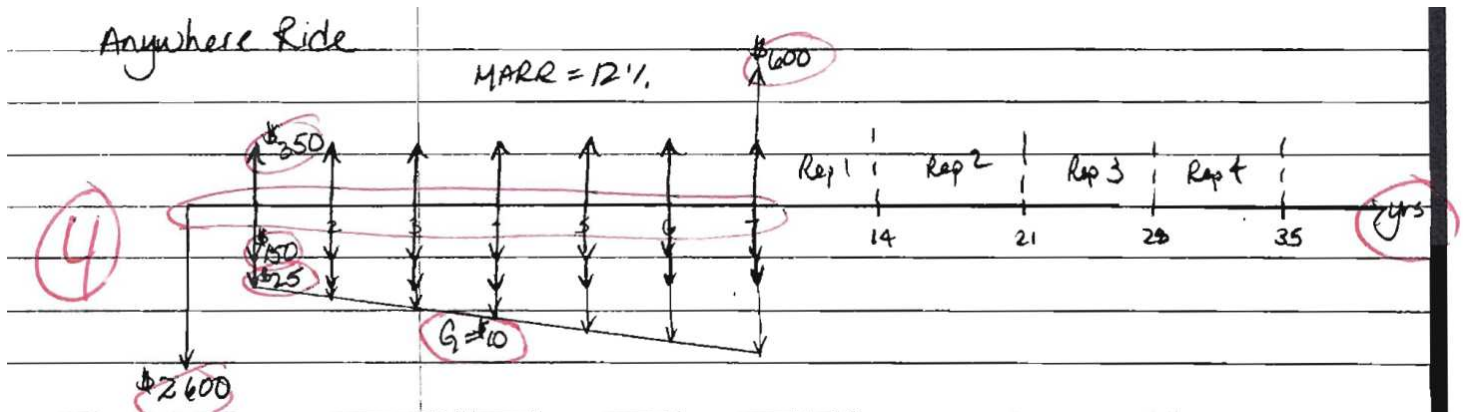
Cash Flow diagram = 4 marks (not required to show repeated lives)

$$AW_R = -2,400(A/P, 12\%, 5) + (300 - 100 - 55) - 15(A/G, 12\%, 5) + 900(A/F, 12\%, 5) \quad (2 \text{ marks})$$

$$AW_R = -2,400(0.27741) + 145 - 15(1.7746) + 900(0.15741)$$

$$AW_R = \$-405.73 \quad (1 \text{ mark})$$

And



Cash Flow diagram = 4 marks (not required to show repeated lives)

$$AW_A = -2,600(A/P, 12\%, 7) + (350 - 150 - 25) - 10(A/G, 12\%, 7) + 600(A/F, 12\%, 7) \quad (2 \text{ marks})$$

$$AW_A = -2,600(0.21912) + 175 - 10(2.5515) + 600(0.09912)$$

$$AW_A = \$-360.76 \quad (1 \text{ mark})$$

Since $AW_{(\text{AnywhereRide})} > AW_{(\text{RideAround})}$, then AnywhereRide is preferred (1 mark)