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MECH 5760 Chapter 5 Assignment #3

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Problem 5.1.

Current age: 26 years

- At age 31: m = 31-26 = 5
- At age 55: m = 51-26 = 29
- At age 66: m = 66-26 = 40

Baseline Option (No Masters)

PV = 60000(P/A, 5%, m = 5, 29, 40)

- For m = 5 → PV = 60000(P/A, 5%, m = 5) = 60000(4.33) → **PV = $259,800**
- For m = 29 → PV = 60000(P/A, 5%, m = 29) = 60000(15.1411) → **PV = $908,466**
- For m = 40 → PV = 60000(P/A, 5%, m = 40) = 60000(17.1591) → **PV = $1,029,546**

Option 1(Pay tuition, graduate in one year)

PV = -40000 + 70000(P/A, 5%, m = 5, 29, 40) – 70000(P/A, 5%, 1)

- For m = 5 →
  PV = -40000 + 70000(P/A, 5%, m = 5) – 70000(P/A, 5%, 1)
  PV = -40000 + 70000(4.33) – 70000(0.950) → **PV = $196,600**

- For m = 29 →
  PV = -40000 + 70000(P/A, 5%, m = 29) – 70000(P/A, 5%, 1)
  PV = -40000 + 70000(15.1411) – 70000(0.950) → **PV = $953,209**

- For m = 40 →
  PV = -40000 + 70000(P/A, 5%, m = 40) – 70000(P/A, 5%, 1)
  PV = -40000 + 70000(17.1591) – 70000(0.950) → **PV = $1,094,469**

Option 2 (Become a TA, no tuition, graduate in two years)

PV = 70000(P/A, 5%, m = 5, 29, 40) – 70000(P/A, 5%, 2)

- For m = 5 →
  PV = 70000(P/A, 5%, m = 5) – 70000(P/A, 5%, 2)
  PV = 70000(4.33) – 70000(1.860) → **PV = $172,900**

- For m = 29 →
  PV = PV = 70000(P/A, 5%, m = 29) – 70000(P/A, 5%, 2)
  PV = 70000(15.1411) – 70000(1.860) → **PV = $929,719**

- For m = 40 →
  PV = PV = 70000(P/A, 5%, m = 40) – 70000(P/A, 5%, 2)
  PV = 70000(17.1591) – 70000(1.860) → **PV = $1,070,979**

Option 3 (Take a loan, graduate in one year, pay loan in ten years, tuition is not in the PV equation goes directly from Bank to University)

PV = 70000(P/A, 5%, m = 5, 29, 40) – 70000(P/F, 5%, 1) - 5000(P/A, 5%, m = 11) + 5000(P/A, 5%, m = 1)

- For m = 5 → PV = 70000(P/A, 5%, m = 5) – 70000(P/F, 5%, 1) - 5000(P/A, 5%, m = 11) + 5000(P/A, 5%, m = 1)
  PV = 70000(4.33) – 70000(0.9525) – 5000(8.310) + 5000(0.950) → **PV = $199,625**

- For m = 29 → PV = 70000(P/A, 5%, m = 29) – 70000(P/F, 5%, 1) - 5000(P/A, 5%, m = 11) + 5000(P/A, 5%, m = 1)
  PV = 70000(15.1411) – 70000(0.9525) – 5000(8.310) + 5000(0.950) → **PV = $956,402**

- For m = 40 → PV = 70000(P/A, 5%, m = 40) – 70000(P/F, 5%, 1) - 5000(P/A, 5%, m = 11) + 5000(P/A, 5%, m = 1)
  PV = 70000(17.1591) – 70000(0.9525) – 5000(8.310) + 5000(0.950) → **PV = $1,097,662**

The results have been summarized in the table below:

	m = 5 years	m = 29 years	m = 40 years
Baseline	**$259,800**	**$908,466**	**$1,029,546**
Option 1	**$196,600**	**$953,209**	**$1,094,469**
Option 2	**$172,900**	**$929,719**	**$1,070,979**
Option 3	**$199,625**	**$956,402**	**$1,097,662**

Analysis:

It is apparent from the above matrix that the student would benefit from baseline option, that is, applying for a job immediately after getting B.S. degree and skipping masters for short term (after 5 years). However, Option 3 where the student borrows money and graduates within one year is more fruitful in both the scenarios where the student wants to retire at 55 years and 66 years.

Problem 5.2.
Assumption:
Tax Rate = 33% and Straight-Line Depreciation for the Machine.

2-Cavity Mold
Machine Life = $Machine\ Life = 100{,}000\ shots * \frac{2\ parts}{shot} * \frac{1\ year}{40{,}000} = 5\ years$

$$Depreciation = \frac{Asset\ Value - Book\ Value}{Lifecycle} = \frac{45{,}000 - 0}{5} = 9{,}000$$

200,000 parts lifetime = 5 years, profit = $10,000/year

Year End	Before Tax Cash Flow	Depreciation	Taxable Income	Taxes	After Tax Cash Flow
A	B	C	D = B + C	E = -0.33*D	F = B + E
0	-45000				
1	10000	-9000	1000	-333	9667
2	10000	-9000	1000	-333	9667
3	10000	-9000	1000	-333	9667
4	10000	-9000	1000	-333	9667
5	10000	-9000	1000	-333	9667

PV= -45000 + 9667(P/A, i%, m = 5)
Initial guess that i% is between 2% - 3%
Use i = 2% → PV = -45000 + 9667(P/A, 2%, m = 5)
PV = -45000 + 9667(4.71) → PV = $531.57
Use i = 3% → PV = -45000 + 9667(P/A, 3%, m = 5)
PV = -45000 + 9667(4.58) → PV = $-725.14

Since the PV goes from negative (-) to positive (+), the ROI is between 2 and 3%.
Using a prorated average,
531.57 / (531.57 + 725.14) = 0.4229 → 2 + 0.4229 → **ROI = 2.42% (closer to 2% = $531.57 than 3% $725.14)**
Payback Period = 45000 / 10000 → **Payback Period = 4.5 years**

4-Cavity Mold
Machine Life = $Machine\ Life = 100{,}000\ shots * \frac{4\ parts}{shot} * \frac{1\ year}{40{,}000} = 10\ years$

$$Depreciation = \frac{Asset\ Value - Book\ Value}{Lifecycle} = \frac{80{,}000 - 0}{10} = 8{,}000$$

400,000 parts lifetime = 10 years, profit = $10,000/year

Year End	Before Tax Cash Flow	Depreciation	Taxable Income	Taxes	After Tax Cash Flow
A	B	C	D = B + C	E = -0.33*D	F = B + E
0	-80000				
1	10000	-8000	2000	-660	9340
2	10000	-8000	2000	-660	9340
3	10000	-8000	2000	-660	9340

4	10000	-8000	2000	-660	9340
5	10000	-8000	2000	-660	9340
6	10000	-8000	2000	-660	9340
7	10000	-8000	2000	-660	9340
8	10000	-8000	2000	-660	9340
9	10000	-8000	2000	-660	9340
10	10000	-8000	2000	-660	9340

PV= -80,000 + 9333(P/A, i%, m = 10)
Initial guess that i% is between 2% - 3%
Use i = 2% → PV = -80,000 + 9340(P/A, 2%, m = 10)
PV = -80,000 + 9340(8.9826) → PV = $3897.5
Use i = 3% → PV = -80,000 + 9340(P/A, 3%, m = 10)
PV = -80,000 + 9340(8.5302) → PV = $-327.94

Since the PV goes from negative (-) to positive (+), the ROI is between 2 and 3%.
Using a prorated average,
3897.5/ (3897.5 + 327.94) = 0.922 → 2 + 0.922 → **ROI = 2.92% (closer to 3% = $387.64 than 2% $3834.61)**
Payback Period = 80000 / 10000 → **Payback Period = 8 years**

Conclusion:
Clearly, the ROI is greater for four-cavity molding machine (2.91%) than two-cavity molding machine (2.42%). Therefore, the second option can be preferred over first option of two-cavity molding machine.

Problem 5.3.

a. Fully automatic machine, 33% taxes, salvage value = 10%, 5-year life

$$Depreciation = \frac{Asset\ Value - Book\ Value}{Lifecycle} = \frac{800{,}000 - 80{,}000}{5} = \$144{,}000$$

Year End	Before Tax Cash Flow	Depreciation	Taxable Income	Taxes	After Tax Cash Flow
A	B	C	D = B + C	E = -0.33*D	F = B + E
0	-800000				
1	200000	-144000	56000	-18480	181520
2	200000	-144000	56000	-18480	181520
3	200000	-144000	56000	-18480	181520
4	200000	-144000	56000	-18480	181520
5	200000	-144000	56000	-18480	181520
5	80000				

PV = -800000 + 181520(P/A, i%, 5) + 80000(P/F, i%, 5)

Use i = 7% → PV = -800000 + 181520(P/A, 7%, 5) + 80000(P/F, 7%, 5)

PV = -800000 + 181520(4.10) + 80000(0.7130) → PV = $1272

Use i = 8% → PV = -800000 + 181520(P/A, 8%, 5) + 80000(P/F, 8%, 5)

PV = -800000 + 181520(3.99) + 80000(0.6806) → PV = $-21,287.2

Since the PV goes from negative (-) to positive (+), the ROI is between 7 and 8%.

Using a prorated average, closer to 7% since PV = $1272 at 7%

1272 / (1272 + 21287.2) = 0.056→ 7 + 0.056 → **ROI = 7.056%**

b. Fully automatic machine, NO taxes, NO salvage value, 5-year life

PV = -800000 + 200000(P/A, i%, 5)

Use i = 6% → PV = -800000 + 200000(P/A, 6%, 5)

PV = -800000 + 200000(4.21) → PV = $42,000

Use i = 7% → PV = -800000 + 200000(P/A, 7%, 5)

PV = -800000 + 200000(4.10) → PV = $20,000

Use i = 8% → PV = -800000 + 200000(P/A, 8%, 5)

PV = -800000 + 200000(3.99) → PV = -$2,000

Since the PV goes from negative (-) to positive (+), the ROI is between 7 and 8%.

Using a prorated average, closer to 8% since PV = - $2,000 at 8%

20000 / (20000 + 2000) = 0.909 → 7 + 0.909 → **ROI = 7.909%**

c. Semi-automatic machine, taxes = 33%, salvage value = 10%, 5-year life (similar to a)

$$Depreciation = \frac{Asset\ Value - Book\ Value}{Lifecycle} = \frac{500{,}000 - 50{,}000}{5} = \$90{,}000$$

Year End	Before Tax Cash Flow	Depreciation	Taxable Income	Taxes	After Tax Cash Flow
A	B	C	D = B + C	E = -0.33*D	F = B + E
0	-500000				
1	120000	-90000	30000	-9900	110100
2	120000	-90000	30000	-9900	110100
3	120000	-90000	30000	-9900	110100
4	120000	-90000	30000	-9900	110100
5	120000	-90000	30000	-9900	110100

5	50000				

PV = -500000 + 110100(P/A, i%, 5) + 50000(P/F, i%, 5)
Use i = 6% → PV = -500000 + 110100(P/A, 6%, 5) + 50000(P/F, 6%, 5)
PV = -500000 + 110100(4.21) + 50000(0.7473) → PV = $886
Use i = 7% → PV = -500000 + 110100(P/A, 7%, 5) + 50000(P/F, 7%, 5)
PV = -500000 + 110100(4.10) + 50000(0.7130) → PV = $-12,940
Since the PV goes from negative (-) to positive (+), the ROI is between 6 and 7%.
Using a prorated average, closer to 6% since PV = $886 at 6%
886 / (886 + 12940) = 0.064→ 6 + 0.064 → **ROI = 6.064%**

d. Semi-automatic machine, NO taxes, NO salvage value, 5-year life (similar to b)
PV = -500000 + 120000(P/A, i%, 5)
Use i = 6% → PV = -500000 + 120000(P/A, 6%, 5)
PV = -500000 + 120000(4.21) → PV = $5,200
Use i = 7% → PV = -500000 + 120000(P/A, 7%, 5)
PV = -500000 + 120000(4.10) → PV = -$8,000
Since the PV goes from negative (-) to positive (+), the ROI is between 6 and 7%.
Using a prorated average, closer to 6% since PV = $5,200 at 6%
5200/ (5200+ 8000) = 0.3939 → 6 + 0.3939 → **ROI = 6.3939%**

e. Based on the ROI calculations performed in the parts above, the best option would be the highest ROI, Option (b)