

## TIE2140 Engineering Economy Solutions to Tutorial #7

### Question 1.

Cost Basis  $B = \$60,000$ , Useful life  $N = 14$  years,  $SV_N = \$12,000$ .

#### (a) Classical Straight Line Method:

Annual depreciation amount  $d_k = (B - SV_N)/N$  for  $k=1$  to 14.  
 $= (60,000 - 12,000)/14$   
 $= \$3,428.57$

Year	Depreciation	EoY BV
0		60,000.00
1	3,428.57	56,571.43
2	3,428.57	53,142.86
3	3,428.57	49,714.29
4	3,428.57	46,285.71
5	3,428.57	42,857.14
6	3,428.57	39,428.57
13	3,428.57	15,428.57
14	3,428.57	12,000.00

Depreciation in the 3<sup>rd</sup> year = **\$ 3,428.57**

BV at the end of the 5<sup>th</sup> year =  $60,000 - 5(3,428.57) = \$ 42,857.14$

#### (b) 200% DB method:

$R = 2/N = 2/14 = 0.142857$

Annual depreciation amount  $d_k = R \times BV_{k-1}$  for  $k=1$  to 14

Year	Depreciation	EoY BV
0		60,000.00
1	8,571.43	51,428.57
2	7,346.94	44,081.63
3	6,297.38	37,784.26
4	5,397.75	32,386.51
5	4,626.64	27,759.86
6	3,965.69	23,794.17
13	1,348.01	8,088.03
14	1,155.43	6,932.60

Depreciation in the 3<sup>rd</sup> year = **\$ 6,297.38**

BV at the end of the 5<sup>th</sup> year = **\$ 27,759.86**

**(c) Claiming Capital Allowances over 3 years:**

This is equivalent to straight line over 3 years with zero salvage value.

The annual depreciation amounts are

- $d_k = B/3 = \$ 60,000 / 3 = \$20,000$  for  $k = 1, 2, 3$
- $d_k = \$0$  for  $k > 3$

The  $BV$  at the end of each year are:

Year $k$	Depreciation $d_k$	$BV_k$
0		60,000.00
1	20,000.00	40,000.00
2	20,000.00	20,000.00
3	20,000.00	0
4	0	0
5	0	0
...	...	...
13	0	0
14	0	0

Depreciation in the 3<sup>rd</sup> year = \$ 20,000.00

$BV$  at the end of the 5<sup>th</sup> year = \$ 0

**(d) 1-Year Capital Allowances Scheme:**

The annual depreciation amounts are:

- $d_1 = B = \$ 60,000$
- $d_k = \$ 0$  for  $k = 2, 3, 4, \dots, 14$ .

The  $BV$  at the end of each year are:

Year $k$	Depreciation $d_k$	$BV_k$
0		60,000.00
1	60,000.00	0
2	0	0
...	...	...
13	0	0
14	0	0

Depreciation in the 3<sup>rd</sup> year = \$ 0

$BV$  at the end of the 5<sup>th</sup> year = \$ 0

## Question 2.

Cost Basis of tractor = \$ 195,000  
3-year capital allowance scheme  
MV at end of 6 years = \$20,000

(a)

Annual Depreciation Amounts

- $d_k = 195,000 / 3 = \$ 65,000$  for  $k = 1, 2, 3$
- $d_k = \$ 0$  for  $k > 3$

The BV at the end of each year are:

EoY $k$	$d_k$	$BV_k$
0		195,000
1	65,000	130,000
2	65,000	65,000
3	65,000	0
4	0	0
5	0	0
6	0	0

(b)

At the end of year 6:

- $BV_6 = 0$
- $MV_6 = \$20,000$
- $MV_6 - BV_6 = \$20,000$

Hence there is **Balancing Charge** of \$20,000

**Taxable Income** = \$20,000

**Income tax cash flow** =  $-0.17 \times 20,000 = -\$ 3,400$

The company needs to pay \$3,400 in additional tax that year.

(c)

At the end of year 2:

- $BV_2 = \$65,000$
- $MV_2 = \$40,000$
- $MV_2 - BV_2 = -\$25,000$

Hence there is **Balancing Allowance** of \$25,000

**Taxable Income** =  $-\$25,000$

**Income tax cash flow** =  $-0.17 \times -25,000 = \$ 4,250$

The company **saves** \$ 4,250 from its total tax that year.

**Question 3.**

Initial Cost = \$200,000

Useful life = 10 years

MV at end of useful life = 0

Annual O&M cost = \$64,000

Current annual cost without robot = \$100,000

Hence Annual benefit of robot =  $100,000 - 64,000 = \$36,000$

After-tax *MARR* = 8%

Tax rate = 17%.

After-tax cash flows analysis for the project:

	(A)	(B)	(C) = (A) - (B)	(D) = - t (C)	(E) = (A) + (D)
EoYk	BTCF	Depreciation	Taxable Income	Tax CF	ATCF
0	-200,000.00				-200,000.00
1	36,000.00	200,000.00	-164,000.00	27,880.00	63,880.00
2	36,000.00	0.00	36,000.00	-6,120.00	29,880.00
3	36,000.00	0.00	36,000.00	-6,120.00	29,880.00
4	36,000.00	0.00	36,000.00	-6,120.00	29,880.00
5	36,000.00	0.00	36,000.00	-6,120.00	29,880.00
6	36,000.00	0.00	36,000.00	-6,120.00	29,880.00
7	36,000.00	0.00	36,000.00	-6,120.00	29,880.00
8	36,000.00	0.00	36,000.00	-6,120.00	29,880.00
9	36,000.00	0.00	36,000.00	-6,120.00	29,880.00
10	36,000.00	0.00	36,000.00	-6,120.00	29,880.00
10	0.00		0.00	0.00	0.00

After-tax *IRR* is *i* such that

$$- 200,000 + (63,880 - 29,880) [P/F, i\%, 1] + 29,880 [P/A, i\%, 10] = 0$$

Using an equation solver or Excel Goal Seek:

$$\text{After-tax } IRR = 11.89\% > \text{after-tax } MARR = 8\%$$

Hence the robot should be acquired.

#### Question 4.

After-tax  $MARR = 12\%$

Tax rate =  $17\%$ .

#### Tank Purchase

- Investment cost = \$30,000
- Useful life = 8 years
- Depreciation = 3-year CA claims
- $MV$  at end of useful life = 0
- Relining cost at EoY 4 = \$10,000

Assume *Repeatability* and relining occurs only once at EoY 4 for each tank.

After-Tax Cash Flow Analysis for Purchase Alternative over 1 life cycle of 8 years:

	(A)	(B)	(C) = (A) – (B)	(D) = $-t(C)$	(E) = (A) + (D)	(F) = (E)/(1+i) <sup>k</sup>
EoY	BTCF	Depreciation	Taxable Income	Tax CF	ATCF	
0	-30,000.00				-30,000.00	-30,000.00
1		10,000.00	-10,000.00	1,700.00	1,700.00	1,517.86
2		10,000.00	-10,000.00	1,700.00	1,700.00	1,355.23
3		10,000.00	-10,000.00	1,700.00	1,700.00	1,210.03
4	-10,000.00	0.00	-10,000.00	1,700.00	-8,300.00	-5,274.80
5		0.00	0.00	0.00	0.00	0.00
6		0.00	0.00	0.00	0.00	0.00
7		0.00	0.00	0.00	0.00	0.00
8		0.00	0.00	0.00	0.00	0.00
8	0.00		0.00	0.00	0.00	0.00
					$PW(12\%)=$	<b>-\$ 31,191.69</b>

$$BV_8 = 0, MV_8 = 0$$

$$\begin{aligned} \text{After-tax } PW \text{ over 8 years} &= -30,000 + 1,700 [P/A, 12\%, 3] - 8,300 [P/F, 12\%, 4] \\ &= -\$ 31,191.69 \end{aligned}$$

Or

After-tax  $PW$  over 8 years

$$= -30,000 + \frac{1,700}{(1+0.12)} + \frac{1,700}{(1+0.12)^2} + \frac{1,700}{(1+0.12)^3} - \frac{8,300}{(1+0.12)^4} = -\$31,191.69$$

$$\text{After-tax } AW = -\$ 31,191.69 [A/P, 12\%, 8] = -\$ 6,278.98$$

If the tank is leased at \$  $X$  per year, annual ATCF =  $-(1-t)X = -0.83X$ .

For tank leasing to be more economical than purchasing:

$$-0.83X > \text{After-tax } AW(12\%) \text{ for purchasing} = -\$ 6,278.98$$

$$\Rightarrow X < 6,278.98 / 0.83 = \$ 7,565.03$$

Hence the greatest amount the company can afford to pay for tank leasing is **\$ 7,565.03**

**Question 5.**

	Machine A	Machine B
Capital Investment	\$20,000	\$30,000
Useful Life	12 years	8 years
MV at end of useful life	\$4,000	\$0
Annual receipts	\$150,000	\$188,000
Annual expenses	\$138,000	\$170,000

Tax rate =17%, after-tax  $MARR=10\%$ , Depreciation method = 3-year CA

After-tax Cash flows Analysis for Machine A:

	(A)	(B)	(C) = (A) – (B)	(D) = – t (C)	(E) = (A) + (D)	(F) = (E)/(1+i) <sup>k</sup>
EoYk	BTCF	Depreciation	Taxable Income	Tax CF	ATCF	PW of ATCF
0	-20,000.00				-20,000.00	-20,000.00
1	12,000.00	6,666.67	5,333.33	-906.67	11,093.33	10,084.85
2	12,000.00	6,666.67	5,333.33	-906.67	11,093.33	9,168.04
3	12,000.00	6,666.67	5,333.33	-906.67	11,093.33	8,334.59
4	12,000.00		12,000.00	-2,040.00	9,960.00	6,802.81
5	12,000.00		12,000.00	-2,040.00	9,960.00	6,184.38
6	12,000.00		12,000.00	-2,040.00	9,960.00	5,622.16
7	12,000.00		12,000.00	-2,040.00	9,960.00	5,111.05
8	12,000.00		12,000.00	-2,040.00	9,960.00	4,646.41
9	12,000.00		12,000.00	-2,040.00	9,960.00	4,224.01
10	12,000.00		12,000.00	-2,040.00	9,960.00	3,840.01
11	12,000.00		12,000.00	-2,040.00	9,960.00	3,490.92
12	12,000.00		12,000.00	-2,040.00	9,960.00	3,173.56
12	4,000.00		4,000.00	-680.00	3,320.00	1,057.85
					$PW(10\%)=$	<b>51,740.66</b>

$BV_{12} = 0$ . Final  $SV_{12}=\$4,000$

The amount of \$4,000 (Balancing charge) at the end of year 12 is taxable.

After-Tax  $PW_A(10\%)$  over 12 years = \$ **51, 740.66**

After-tax  $AW_A(10\%) = \$ 51,740.66 [A/P, 10\%, 12] = \$ 7,593.63$

After-tax Cash Flows Analysis for Machine B:

	(A)	(B)	(C) = (A) - (B)	(D) = - t (C)	(E) = (A) + (D)	(F) = (E)/(1+i) <sup>k</sup>
EoYk	BTCF	Depreciation	Taxable Income	Tax CF	ATCF	PW of ATCF
0	-30,000.00				-30,000.00	-30,000.00
1	18,000.00	10,000.00	8,000.00	-1,360.00	16,640.00	15,127.27
2	18,000.00	10,000.00	8,000.00	-1,360.00	16,640.00	13,752.07
3	18,000.00	10,000.00	8,000.00	-1,360.00	16,640.00	12,501.88
4	18,000.00		18,000.00	-3,060.00	14,940.00	10,204.22
5	18,000.00		18,000.00	-3,060.00	14,940.00	9,276.56
6	18,000.00		18,000.00	-3,060.00	14,940.00	8,433.24
7	18,000.00		18,000.00	-3,060.00	14,940.00	7,666.58
8	18,000.00		18,000.00	-3,060.00	14,940.00	6,969.62
8	0.00		0.00	0.00	0.00	0.00
					<i>PW</i> (10%) =	53,931.45

Balancing charge/allowance = 0 at the end of 8 years as  $BV = MV = 0$ .

After-Tax  $PW_B(10\%)$  over 8 years = \$ 53,931.45

After-tax  $AW_B(10\%) = \$ 53,931.45 [A/P, 10\%, 8] = \mathbf{\$ 10,109.13}$

Based on the Repeatability assumption, we can compare the after-tax  $AW$  for the two machines:

Decision: Choose Machine B which has higher after-tax  $AW$ .

**Question 6.**

	Method I	Method II
Initial Investment	\$10,000	\$40,000
Useful Life	5 years	10 years
<i>MV</i> at end of useful life	\$1,000	\$5,000
Annual expenses		
Labor	\$12,000	\$4,000
Power	\$600	\$300
Rent	\$1,000	\$500
Maintenance	\$500	\$200
Property taxes and insurance	\$400	\$2,000
<b>Total annual expenses</b>	<b>\$14,500</b>	<b>\$7,000</b>

Tax rate = 17%.

After-tax *MARR* = 15%

Depreciation method: 3 Year-CA for both alternatives

After-tax Cash Flows Analysis for Method I:

	(A)	(B)	(C) = (A) - (B)	(D) = - <i>t</i> (C)	(E) = (A) + (D)	(F) = (E)/(1+i) <sup>k</sup>
EoY <i>k</i>	BTCF	Depreciation	TI	Tax CF	ATCF	PW of ATCF
0	-10,000.00				-10,000.00	-10,000.00
1	-14,500.00	3,333.33	-17,833.33	3,031.67	-11,468.33	-9,972.46
2	-14,500.00	3,333.33	-17,833.33	3,031.67	-11,468.33	-8,671.71
3	-14,500.00	3,333.33	-17,833.33	3,031.67	-11,468.33	-7,540.62
4	-14,500.00	0.00	-14,500.00	2,465.00	-12,035.00	-6,881.05
5	-14,500.00	0.00	-14,500.00	2,465.00	-12,035.00	-5,983.52
5	1,000.00		1,000.00	-170.00	830.00	412.66
						<b>-48,636.70</b>

After-Tax  $PW_1(15\%)$  over 5 years = **-\$ 48,636.70**

After-tax  $AW_1(15\%) = -\$51,551.48 [A/P, 15\%, 5] = \mathbf{-\$ 14,509.08}$



After-tax Cash Flows Analysis for Method II:

	(A)	(B)	(C) = (A) - (B)	(D) = - t (C)	(E) = (A) + (D)	(F) = (E)/(1+i)^k
EoY	BTCF	Depreciation	TI	Tax CF	ATCF	PW of ATCF
0	-40,000.00				-40,000.00	-40,000.00
1	-7,000.00	13,333.33	-20,333.33	3,456.67	-3,543.33	-3,081.16
2	-7,000.00	13,333.33	-20,333.33	3,456.67	-3,543.33	-2,679.27
3	-7,000.00	13,333.33	-20,333.33	3,456.67	-3,543.33	-2,329.80
4	-7,000.00	0.00	-7,000.00	1,190.00	-5,810.00	-3,321.89
5	-7,000.00	0.00	-7,000.00	1,190.00	-5,810.00	-2,888.60
6	-7,000.00	0.00	-7,000.00	1,190.00	-5,810.00	-2,511.82
7	-7,000.00	0.00	-7,000.00	1,190.00	-5,810.00	-2,184.19
8	-7,000.00	0.00	-7,000.00	1,190.00	-5,810.00	-1,899.30
9	-7,000.00	0.00	-7,000.00	1,190.00	-5,810.00	-1,651.56
10	-7,000.00	0.00	-7,000.00	1,190.00	-5,810.00	-1,436.14
10	5,000.00		5,000.00	-850.00	4,150.00	1,025.82
						<b>-62,957.92</b>

After-Tax  $PW_{II}(15\%)$  over 10 years = **-\$ 62,957.92**

After-tax  $AW_{II}(15\%) = -\$ 62,957.92 [A/P, 15\%, 10] = -\$ **12,544.50**$

Decision: Based on the Repeatability Assumption, select Method II.