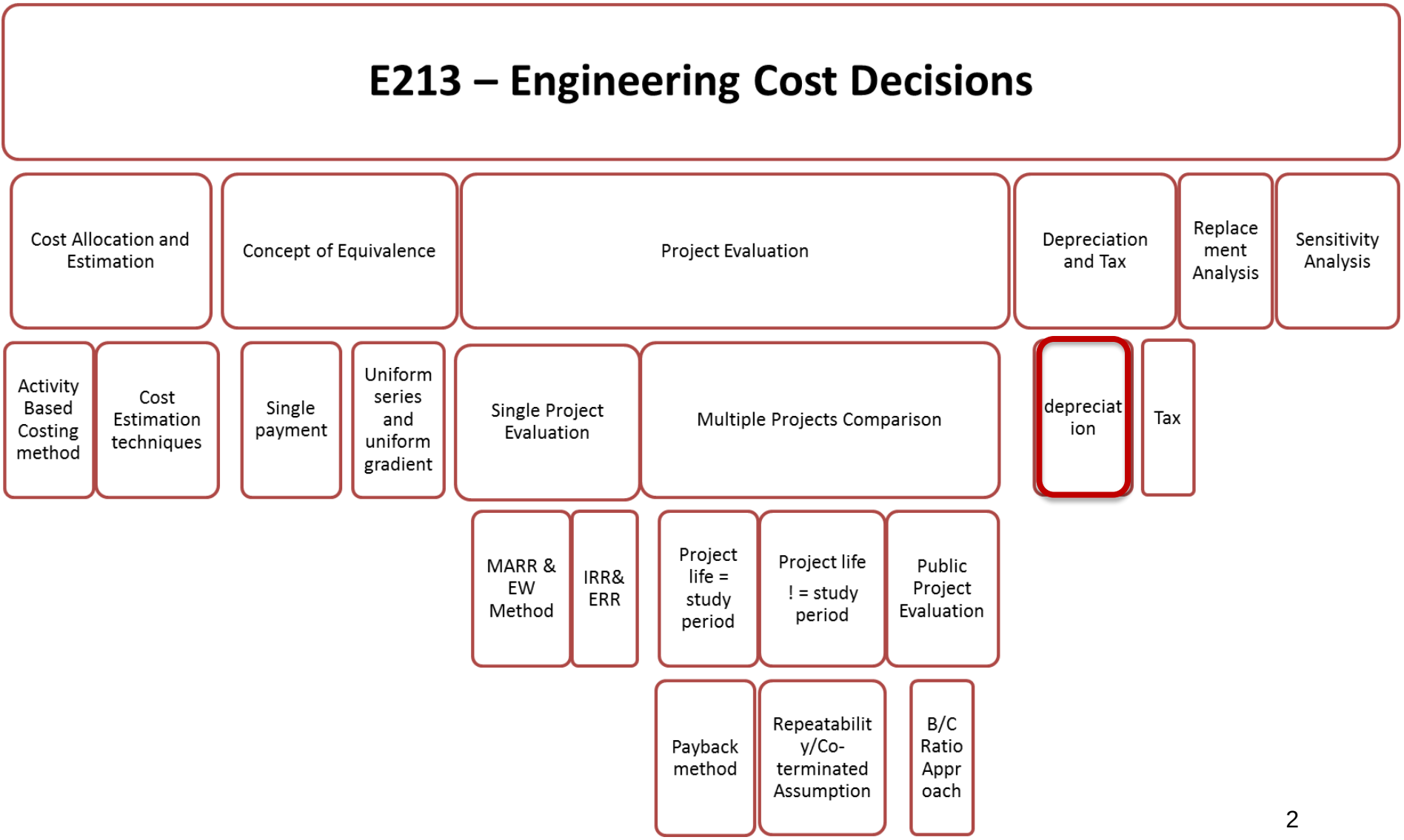
Problem 10

Depreciation

E213 – Engineering Cost Decisions

SCHOOL OF ENGINEERING

Module Coverage: Topic Tree



Depreciation

- Asset will lose its value over time due to
  - Wear and tear
  - Obsolescence

Let P = initial value

SV = salvage value after time N

so, $P - SV$ = loss in value over N periods

- Depreciation does not involve actual cash flow (unlike investment).

Why Depreciation Needs to be Determined

Objectives

- To provide a clearer picture on the recovery of capital invested in a physical property/equipment by fixing the asset life and the amount of depreciation each year
- To include depreciation as part of the cost incurred during tax assessment (to be discussed in the next lesson)

Types of Depreciable Property

- Tangible assets (machinery, building, furniture, vehicles, equipment etc.)
- Intangible assets (copyright, franchise, patent etc.)

Terminology

- Basis or Cost basis (B):
  - Initial cost of acquiring an asset (purchase price) including transportation expenses and other normal costs of making the asset serviceable for its intended use.

- Book Value (BV):
  - The worth of a depreciable property
  - The book value of an asset is the amount of cost in its asset account less the accumulated depreciation applicable to the asset

Book Value at the end of year k :

$$\textit{Book value } (BV_k) = \textit{Cost Basis} - \sum_{j=1}^{k} (\textit{Depreciation deduction})_j$$

- Market Value (MV):
  - The amount that will be paid by a willing buyer to a willing seller for a property under no compulsion to buy or sell

Types of Depreciation

1. Economic Depreciation:
   - Gradual decline in capability or value of an asset with use & time
   - Economic depreciation
     = Purchase price – Market value

2. Accounting Depreciation:
   - Systematic allocation of the cost of an asset over its useful life
   - Book depreciation
     - Method of depreciation used for financial reports
   - Tax depreciation
     - Method of depreciation used for calculating taxes

Book Value Depreciation Methods

Focus of this module

1. Straight line
2. Declining balance
3. Declining balance with switch over to straight line
4. Sum of Years' Digits
5. Units of production

- Simple methods are preferred (simplicity preferred over realism)
- Each depreciation method differs in its speed of recovery (and therefore profit & value of project/company)
- Faster recovery means funds available for future investment earlier (*always choose a depreciation method that recovers the fastest*)
- Refer to E213_W10_RESOURCES file for additional readings on sum-of-year digits and units-of-production depreciation methods.

Straight Line (SL) Method

- A constant amount is depreciated each year over the asset's life
- Notation:

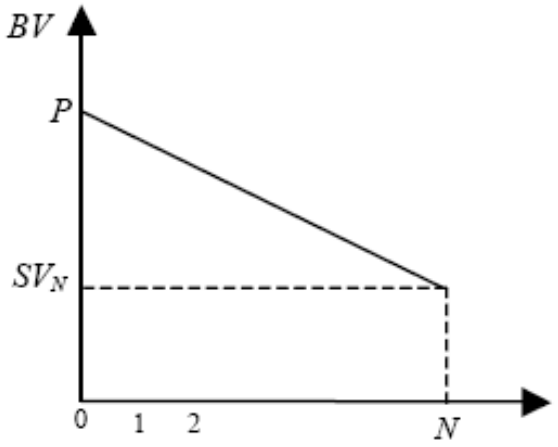
  B = cost basis (similar to first cost, P)

  N = depreciable life of asset (in years)

  SV_N = estimated salvage value at end of year N

  d_k = annual depreciation deduction in year k ($1 \le k \le N$)

  BV_k = book value at the end of year k



Annual depreciation amount

$d_k = (B - SV_N)/N$ **for $1 \le k \le N$**

Cumulative depreciation through year k

$d_k^* = kd_k$ **for $1 \le k \le N$**

Book value at the end of year k

$BV_k = B - d_k^* = B - kd_k$ **for $1 \le k \le N$**

Declining Balance (DB) Method

- An accelerated write-off technique
- Annual depreciation is a *constant percentage* of the asset's value at the beginning of each year
- Largest depreciation in first year, with progressively smaller depreciation charges over time

- **Computation:**

  Book value at the end of year k = $BV_k = B(1 - R)^k$

  Depreciation amount for year k = $d_k = R.BV_{k-1} = R.B(1 - R)^{k-1}$

  Cumulative depreciation until year k = $d_k^* = B - B(1-R)^k = B[1 - (1 - R)^k]$

  Terminal book value = $BV_N = B(1 - R)^N$

- **Depreciation rate, R:**

  Example:

  R = 2/N 200% declining balance (twice the straight line rate of 1/*N)*
  Also known as double-declining balance (DDB)

  R = 1.5/N 150% declining balance

- E-learning video for SL and DB methods:
  https://drive.google.com/file/d/0B74OhMtE0KcyWC1WcUVuT012Y3M/edit?usp=sharing

Straight Line and Declining Balance Example

Based on the following accounting information :

Cost basis of the asset, B = $30,000
Useful life, N = 6 years
Estimated salvage value = $800

Determine the Depreciation in the 2nd year, and Book Value at the end of year 3, by the two different depreciation methods below:

a) Straight Line Depreciation
b) Declining Balance Depreciation, at 150% DB

a) Straight Line Depreciation

- **Annual depreciation amount**

d_2 = (30,000-800)/6
= $ 4,867.67

- **Book value at the end of year *3***

BV_3 = 30,000 – 3* 4,867.67
= $ 15,400

b) Declining Balance Depreciation

R = 150%/6 = 25%

- **Depreciation amount for year 2**

$d_2 = 0.25*30{,}000*(1 - 0.25)^{2-1}$
= $ 5,625

- **Book value at the end of year 3**

$BV_3 = 30{,}000*(1-0.25)^3$
= $ 12,656.25

Straight Line and Declining Balance Example

Again, using following accounting information :

Cost basis of the asset, B = $30,000
Useful life, N = 6 years
Estimated salvage value = $800

Complete the table of Depreciation and Book Value over the useful life using the below methods: Straight Line Depreciation, Declining Balance Depreciation (at 150% DB)

Straight Line Depreciation

a) Annual Depreciation,
d_k= (30,000-800)/6 = $4,867

Declining Balance Depreciation

b) R = 150%/6 = 25%
Depreciation at year-k, d_{k-} = R(BV_{k-1})

End Of Year, k	Straight Line SL Depreciation d_K	Straight Line, SL Book Value, BV_K	Declining Balance DB Depreciation, d_K	Declining Balance, DB Book Value,BV_K
0		$ 30,000.00		$ 30,000.00
1	$ 4,866.67	$ 25,133.33	$ 7,500.00	$ 22,500.00
2	$ 4,866.67	$ 20,266.67	$ 5,625.00	$ 16,875.00
3	$ 4,866.67	$ 15,400.00	$ 4,218.75	$ 12,656.25
4	$ 4,866.67	$ 10,533.33	$ 3,164.06	$ 9,492.19
5	$ 4,866.67	$ 5,666.67	$ 2,373.05	$ 7,119.14
6	$ 4,866.67	$ 800.00	$ 1,779.79	$ 5,339.36

0.25 * 30,000 = $7,500

BV_5 is not equal to $800, $SV_6 = \$600$ is not considered

Declining Balance with Switchover to Straight Line Method

- Start with declining balance method
- Calculate the annual depreciation for the remaining balance using straight line (SL) (for current book value and remaining life)
- Switch to straight line method when the SL method gives more depreciation

P10 Suggested Solution

Today's Problem

	Cost basis, B	Useful Life, N	Salvage Value, SV
Facility setup	$ 600,000	10	$ 40,000
Equipment and machineries	$ 3,000,000	8	$ 200,000
Computer hardware and software	$ 30,000	3	$ 5,000

- Different depreciation methods that Carol can use

- Straight-Line Depreciation Method
- Declining Balance Depreciation Method
- Declining Balance Switch over to Straight Line Method

Straight-Line Depreciation

	Cost basis, B	Useful Life, N	Salvage Value, SV	Annual Depreciation, d_K
Facility setup	$ 600,000	10	$ 40,000	(600,000 - 40,000) / 10 = $56,000
Equipment and machineries	$ 3,000,000	8	$ 200,000	(3,000,000 - 200,000) / 8 = $ 350,000
Computer hardware and software	$ 30,000	3	$ 5,000	(30,000 - 5,000) / 3 = $8,333

Facility setup

EOY, k	Depreciation, d_K	Book Value, BV_K
0		$ 600,000
1	$ 56,000	$ 544,000
2	$ 56,000	$ 488,000
3	$ 56,000	$ 432,000
4	$ 56,000	$ 376,000
5	$ 56,000	$ 320,000
6	$ 56,000	$ 264,000
7	$ 56,000	$ 208,000
8	$ 56,000	$ 152,000
9	$ 56,000	$ 96,000
10	$ 56,000	$ 40,000

Equipment and machineries

EOY, k	Depreciation, d_K	Book Value, BV_K
0		$ 3,000,000
1	$ 350,000	$ 2,650,000
2	$ 350,000	$ 2,300,000
3	$ 350,000	$ 1,950,000
4	$ 350,000	$ 1,600,000
5	$ 350,000	$ 1,250,000
6	$ 350,000	$ 900,000
7	$ 350,000	$ 550,000
8	$ 350,000	$ 200,000

Computer hardware/software

EOY, k	Depreciation, d_K	Book Value, BV_K
0		$ 30,000
1	$ 8,333	$ 21,667
2	$ 8,333	$ 13,333
3	$ 8,333	$ 5,000

e.g. 152,000 – 56,000 = $96,000

Declining Balance (DB)

- Large depreciation deductions (in initial years) via the DB method is generally viewed as desirable for companies.
- E.g. using R = 2/N = 2/10 = 0.2 (if 200% declining balance is used).
- Depreciation, $\mathbf{d_k} = \boldsymbol{R.BV_{k-1}}$

Facility setup

EOY, k	Declining Balance DB Depreciation, d_K	Declining Balance DB Book Value, BV_K
0		$ 600,000.00
1	$ 120,000.00	$ 480,000.00
2	$ 96,000.00	$ 384,000.00
3	$ 76,800.00	$ 307,200.00
4	$ 61,440.00	$ 245,760.00
5	$ 49,152.00	$ 196,608.00
6	$ 39,321.60	$ 157,286.40
7	$ 31,457.28	$ 125,829.12
8	$ 25,165.82	$ 100,663.30
9	$ 20,132.66	$ 80,530.64
10	$ 16,106.13	$ 64,424.51

Equipment and machineries

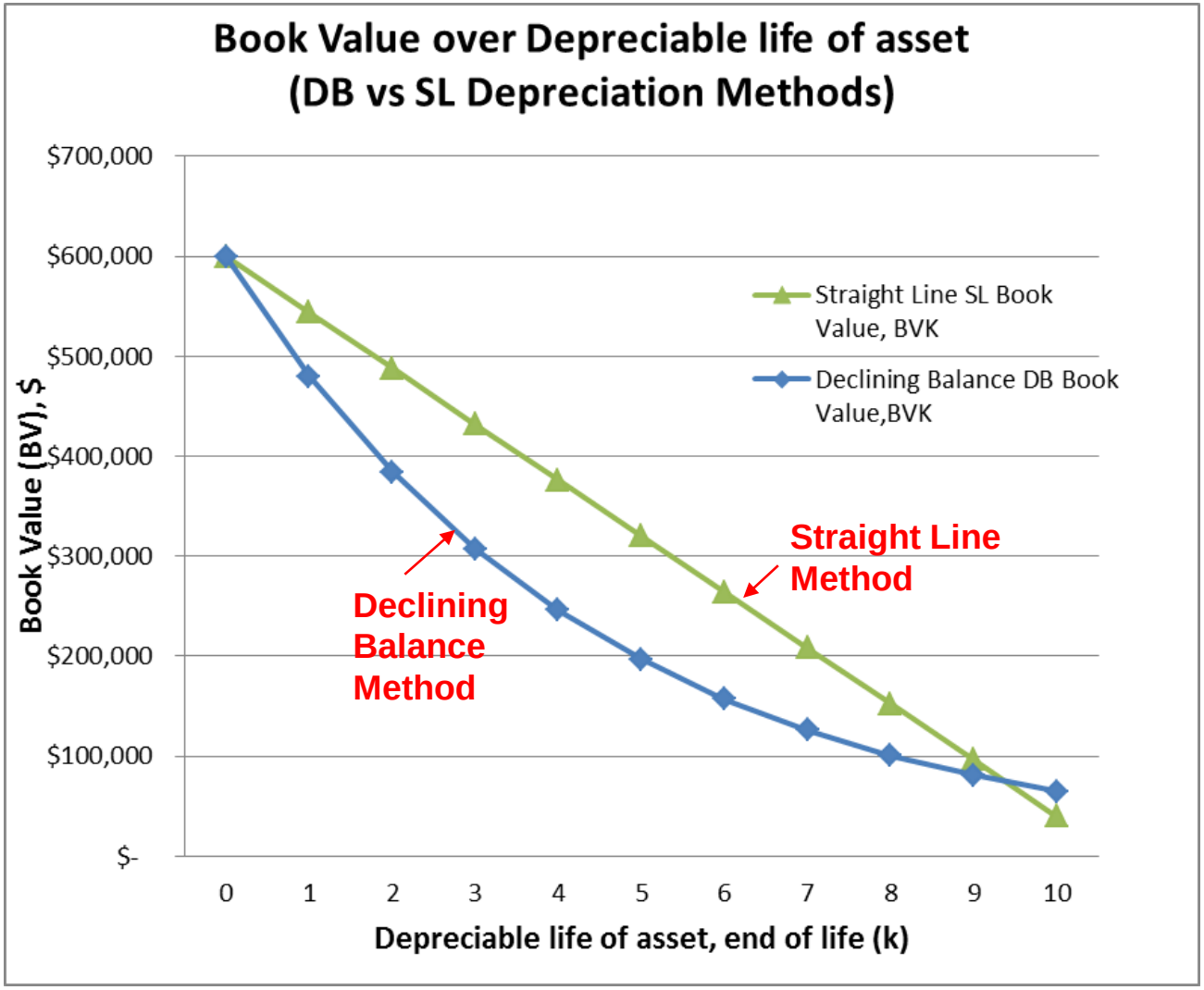
EOY, k	Declining Balance DB Depreciation, d_K	Declining Balance DB Book Value, BV_K
0		$ 3,000,000.00
1	$ 750,000.00	$ 2,250,000.00
2	$ 562,500.00	$ 1,687,500.00
3	$ 421,875.00	$ 1,265,625.00
4	$ 316,406.25	$ 949,218.75
5	$ 237,304.69	$ 711,914.06
6	$ 177,978.52	$ 533,935.55
7	$ 133,483.89	$ 400,451.66
8	$ 100,112.92	$ 300,338.75

Computer hardware and software

EOY, k	Declining Balance DB Depreciation, d_K	Declining Balance DB Book Value, BV_K
0		$ 30,000.00
1	$ 20,000.00	$ 10,000.00
2	$ 6,666.67	$ 3,333.33
3	$ 2,222.22	$ 1,111.11

Note that the asset book values are NOT equal to their respective salvage value.
Facility, BV_{10} (DB) = $64,425 > $40,000
Equipment, BV_6 (DB) = $300,339 > $200,000
Computer hardware and software, BV_3 (DB) = $1,111 < $5,000

Straight Line (SL) vs Declining Balance (DB) (for Facility Setup)



- Depreciation occurs faster in the earlier years with DB method.
- SL permits full cost of the asset to be depreciated over the recovery period but DB method does not.

Declining Balance Switching to Straight-Line Depreciation (for Facility Setup)

- Use Declining Balance Method first to accelerate the depreciation (for earlier write-off)
- Switchover to Straight Line Method at Year 8 where SL d_k > DB d_k: \$28,609.71 > \$25,165.82

Year 4: Max(38,171.43, 61,440) = \$61,440

Straight Line d_k at Year 3: (384,000 - 40,000)/8 =\$43,000

Declining Balance d_k at Year 4: 307,200* 0.2 = \$61,440

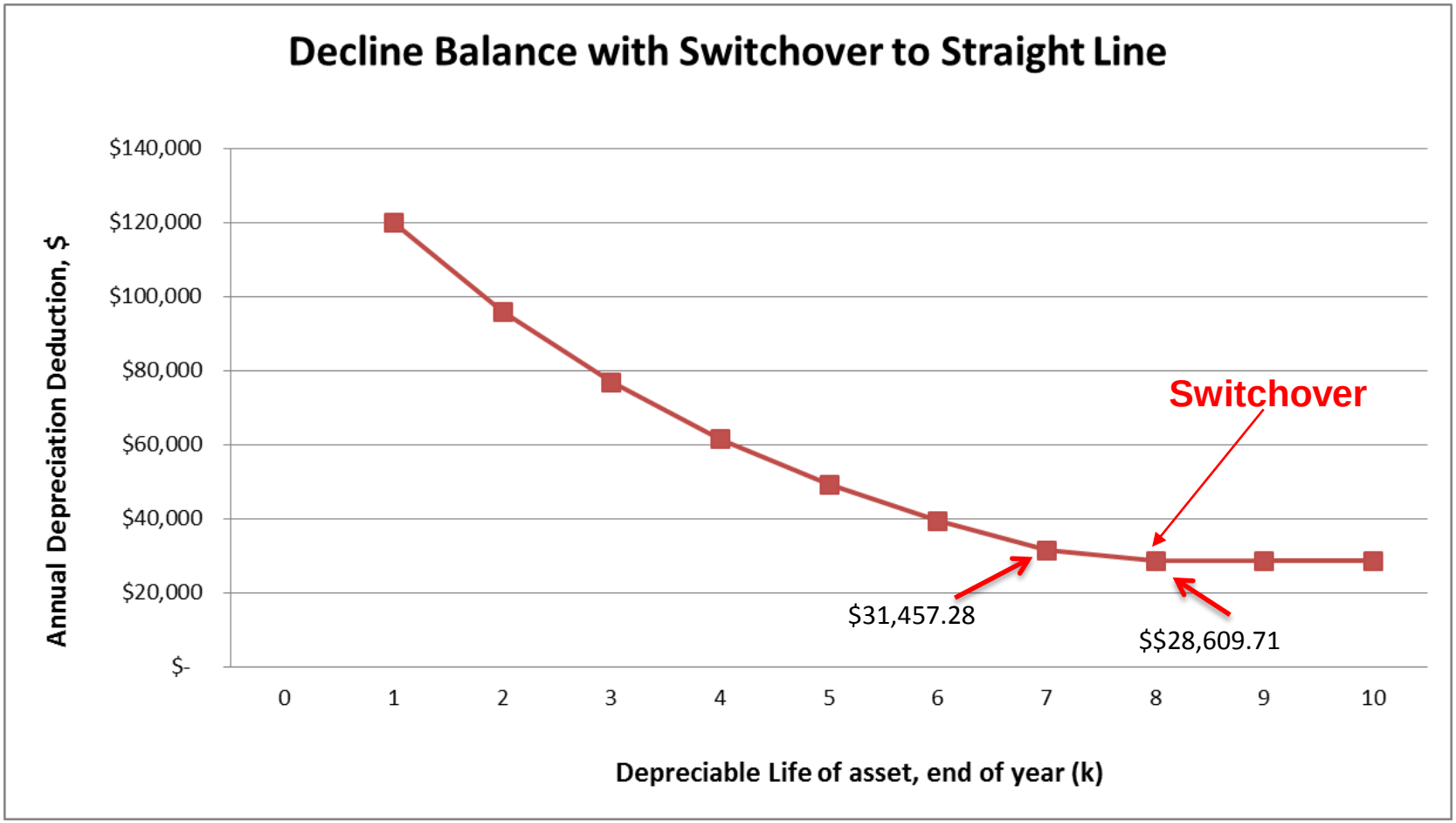
Book Value end of Year 4: 307,200 – 61,440 = \$245,760

Year, k	Straight Line, d_k	Declining Balance, d_k	Decline Balance with Switchover to Straight Line, d_k	End-of-Year Book Value, BV_k
0				\$ 600,000.00
1	\$ 56,000.00	\$ 120,000.00	\$ 120,000.00	\$ 480,000.00
2	\$ 48,888.89	\$ 96,000.00	\$ 96,000.00	\$ 384,000.00
3	\$ 43,000.00	\$ 76,800.00	\$ 76,800.00	\$ 307,200.00
4	\$ 38,171.43	\$ 61,440.00	\$ 61,440.00	\$ 245,760.00
5	\$ 34,293.33	\$ 49,152.00	\$ 49,152.00	\$ 196,608.00
6	\$ 31,321.60	\$ 39,321.60	\$ 39,321.60	\$ 157,286.40
7	\$ 29,321.60	\$ 31,457.28	\$ 31,457.28	\$ 125,829.12
8	\$ 28,609.71	\$ 25,165.82	\$ 28,609.71	\$ 97,219.41
9	\$ 28,609.71	\$ 19,443.88	\$ 28,609.71	\$ 68,609.71
10	\$ 28,609.71	\$ 13,721.94	\$ 28,609.71	\$ 40,000.00

B = \$600,000, SV_{10} = \$40,000, N = 10 years, R =2/10=0.2

Declining Balance Switching to Straight-Line Depreciation (for Facility Setup)

- Declining Balance with switchover to straight line method at year 8
- Write-off with higher depreciation charges in the initial years
- Permits full cost of the new investment to be depreciated over the 10 year useful life



Difference in Depreciation for the 1st 3 Years (for Facility Setup)

	Year 1	Year 2	Year 3	Total Depreciation in 1st 3 years
DDB Depreciation Method	$ 890,000.00	$ 665,166.67	$ 500,897.22	$ 2,056,063.89
SL Depreciation Method	$ 414,333.33	$ 414,333.33	$ 414,333.33	$ 1,243,000.00
No Depreciation Treatment	$3,630,000.00	$ -	$ -	$ 3,630,000.00

- Cost of asset purchase is depreciated fully in the 1st year when no depreciation method is used.
- Higher depreciation occurs in the 1st 3 years using Double Declining Balance method compared to Straight Line method.
- How will depreciation impact on tax payable?

Learning Objectives

- Define the concepts and apply terminology (book value, useful life and salvage value) of depreciation.
- Recognize the classification of depreciable property
  - Tangible
  - Intangible
- Apply depreciation methods of calculating depreciation deductions by
  - Straight Line method
  - Declining Balance method
  - Declining Balance method with Switchover to Straight Line method

E213 Engineering Cost Decisions (Topic Flow)

Today's learning

Application of ABC costing method in cost management

Application of different cost estimating techniques

Comparison of alternatives using the concept of equivalence

Alternatives evaluation using single, uniform series and uniform gradient cash flows

Project evaluation using MARR and Equivalent Worth method

Project evaluation based on Internal Rate of Return and External Rate of Return

Evaluate alternatives of equal life spans using payback method

Evaluate alternatives with different life spans

Evaluate public projects through incremental B/C analysis

Depreciation estimation and consideration in economic analysis

Tax consideration in economic analysis

Replacement analysis application

Risk and uncertainties handling in economic analysis