CH2404 Process Economics

Unit – II

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Depreciation

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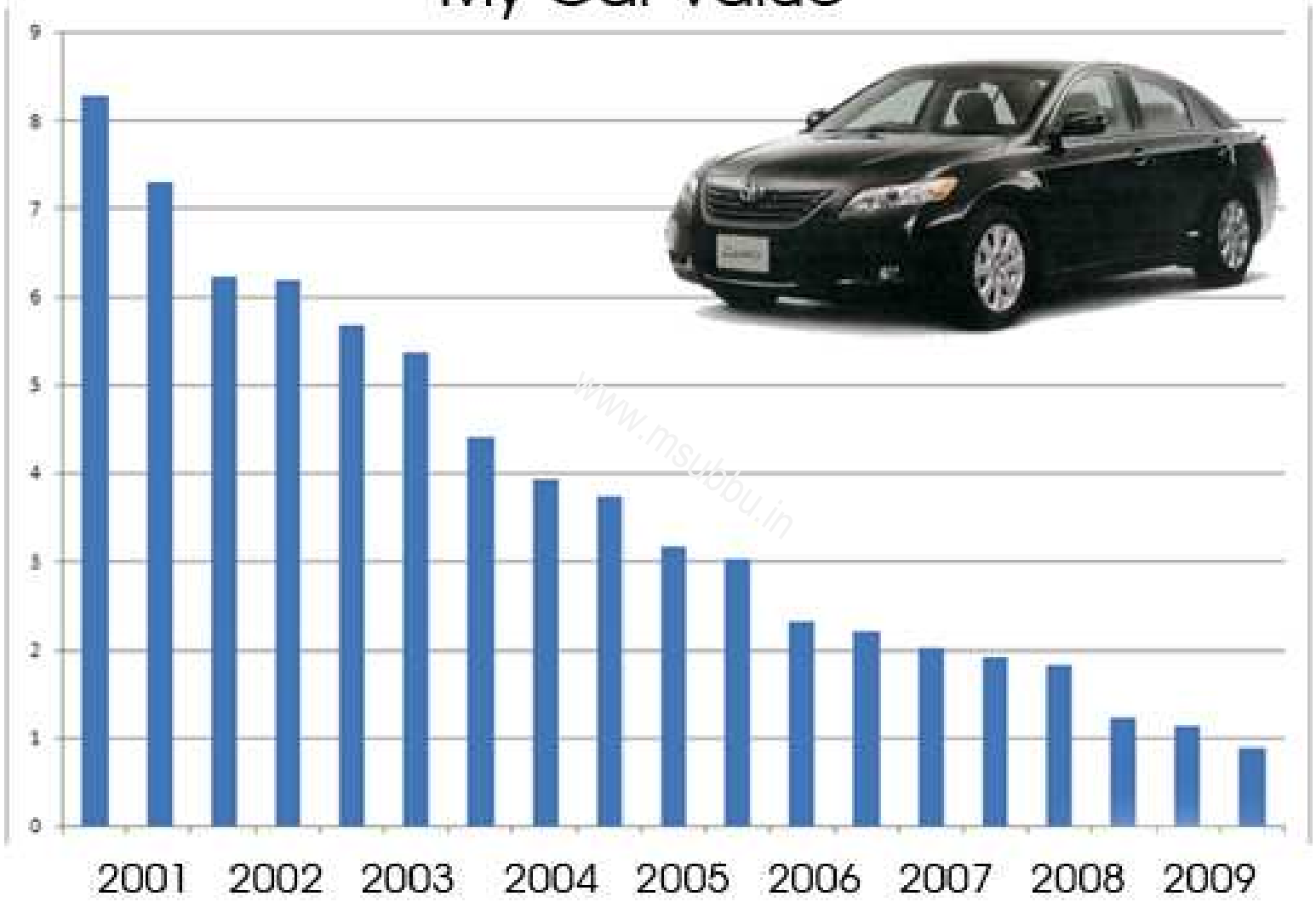
My Car Value



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Introduction

- Depreciation is a decrease in value of a property over a period of time. Events that can cause a property to depreciate include wear and tear, age, deterioration, and normal obsolescence.
- Depreciation plays a vital role in deciding the taxable profits from business and profession.
- Depreciation is a non-cash expense that is used to write down the value of an asset over its useful life.
- The intent of depreciation is to allow a business to recover the cost of an asset over a period of time.
- Depreciation begins when a property is placed in service in a business or trade for the production of income. It ends when the cost of the asset has been fully recovered or when the asset is retired from service, whichever occurs first.

Introduction (contd.)

- The type of property to be depreciated may be tangible or intangible.
  - A tangible property is one that one can touch or see, whereas an intangible property is one that has value but cannot be touched or seen, e.g., copyrights, patents, trademarks, franchises, trade names, and software.

- Depreciation expense is the amount of cost allocation within an accounting period.

- Only items that lose useful value over time can be depreciated. Land can't be depreciated because it can always be used for a purpose.

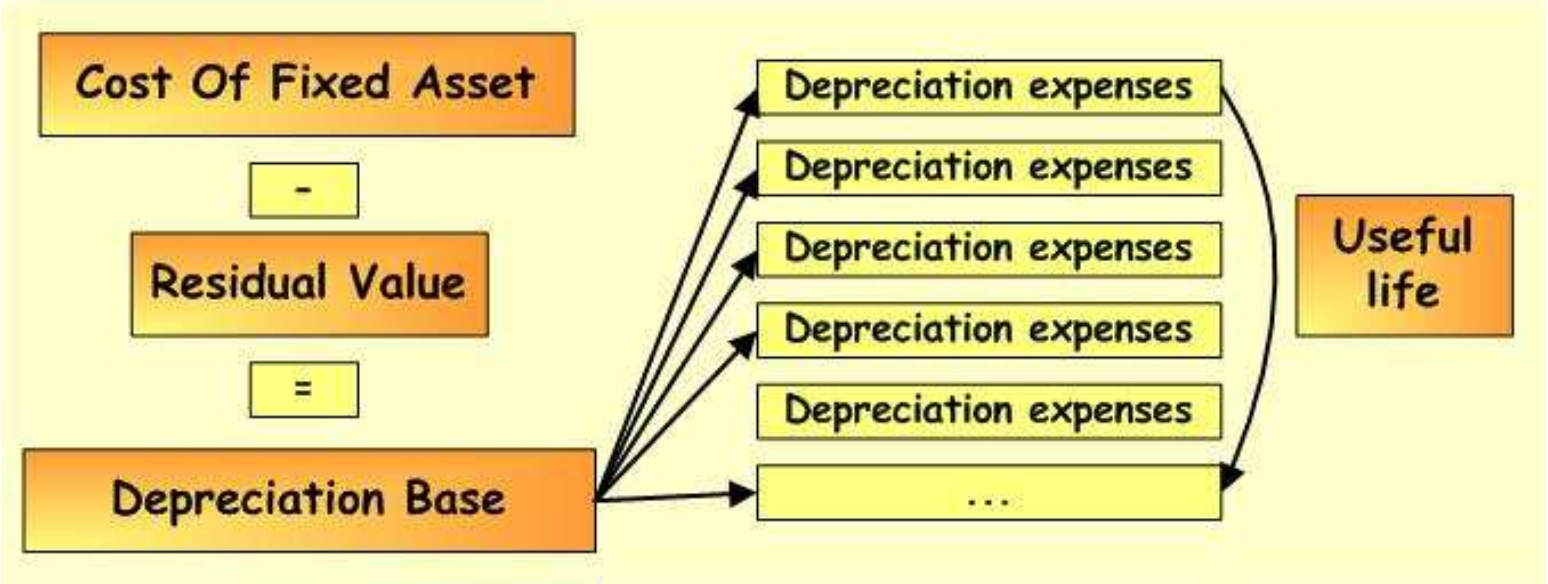
"You won't find a better system for under $20."

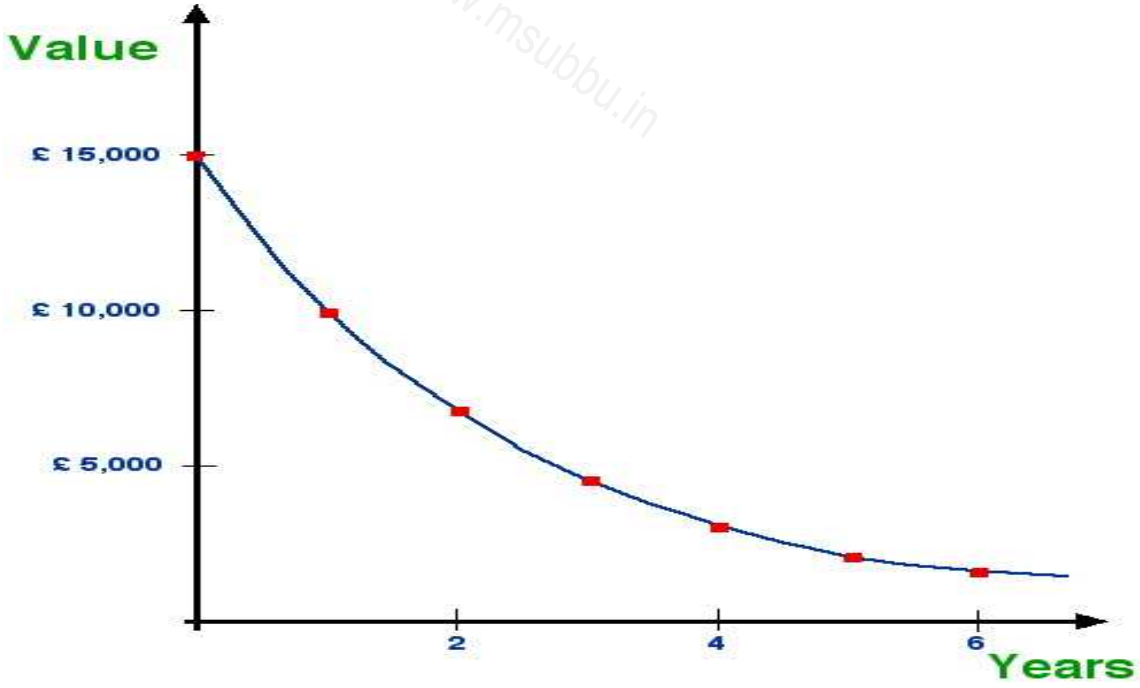
Land and Building

- Buildings depreciate, every year.
- Land appreciates, as a result of our common investment in services and infrastructure; as a result of population increase, as a result of technological innovations and as a result of the natural amenities in the area.
- Land value increases because its supply is fixed.
- Materials for buildings are readily available and one can be substituted for another; Nothing can be substituted for land!

Terminology

- ***Depreciation reserve*** is the accumulated depreciation at a specific time.
- ***Book value*** is the original asset investment minus the accumulated depreciation.
- ***Service life*** is the time period during which an equipment item or asset is in service and is economically feasible.
- ***Salvage value*** is the net amount of money obtained from the sale of a used property over and above any charges involved in the removal and sale of the property. The term implies that the asset can give some type of service.
- ***Scrap value*** implies that the asset has no further useful life and is sold for the value of scrap material in it.



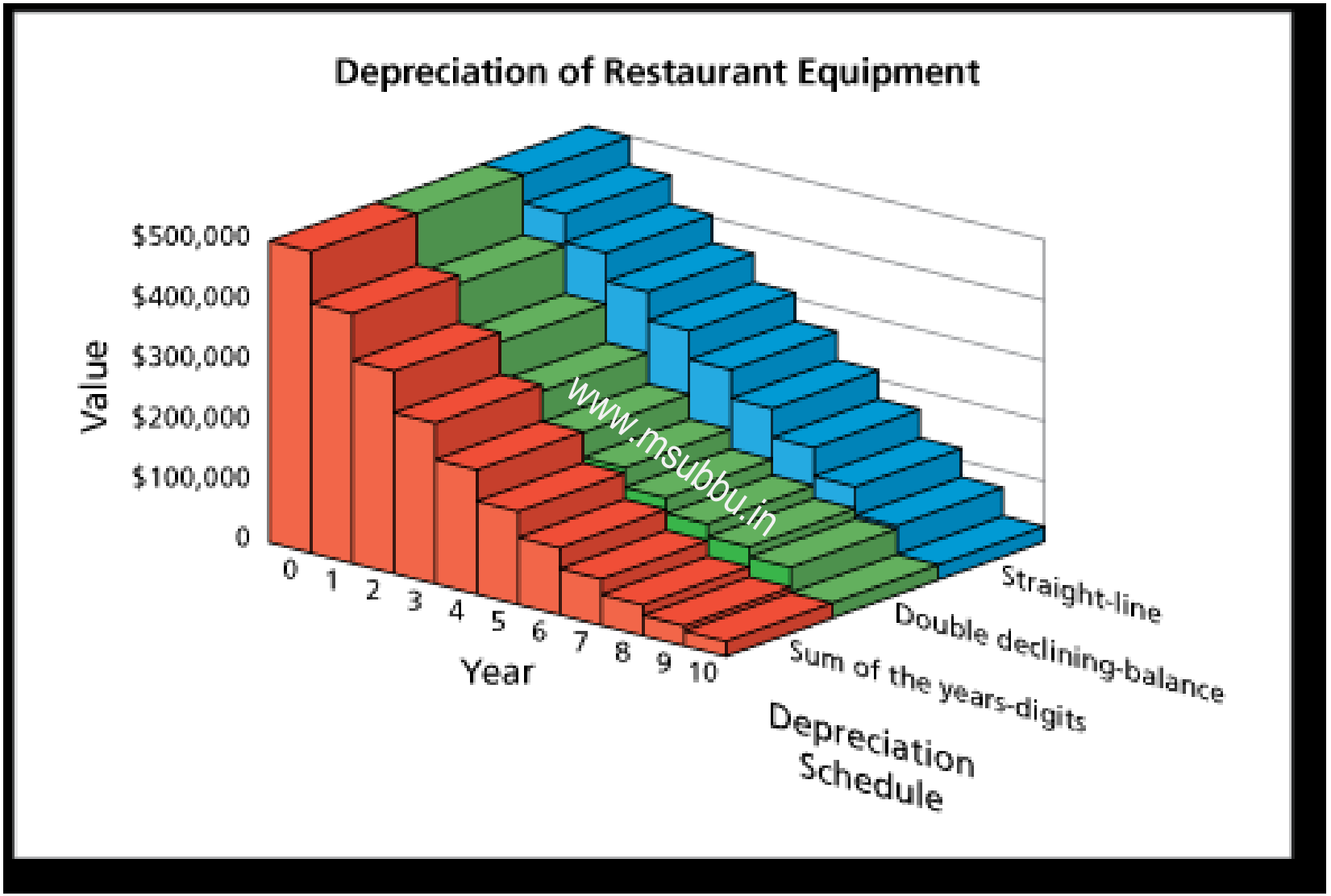


Methods of Depreciation

- There are three main methods of depreciating capital assets:
  - Straight-line
  - Declining balance
  - Sum-of-years-digits

- Declining balance method, as well as the sum-of-the-years-digits, is called an accelerated depreciation method because, by nature of its calculation, it allows more depreciation in earlier years and less in later years.

- Rapid depreciation is most useful when the asset is expected to generate larger incomes in the early life of the asset. This allows for greater tax deductions early in the assets life to offset the larger income that the asset produces.


Depreciation of Restaurant Equipment
Value
$500,000
$400,000
$300,000
$200,000
$100,000
0
0 1 2 3 4 5 6 7 8 9 10
Year
Straight-line
Double declining-balance
Sum of the years-digits
Depreciation Schedule
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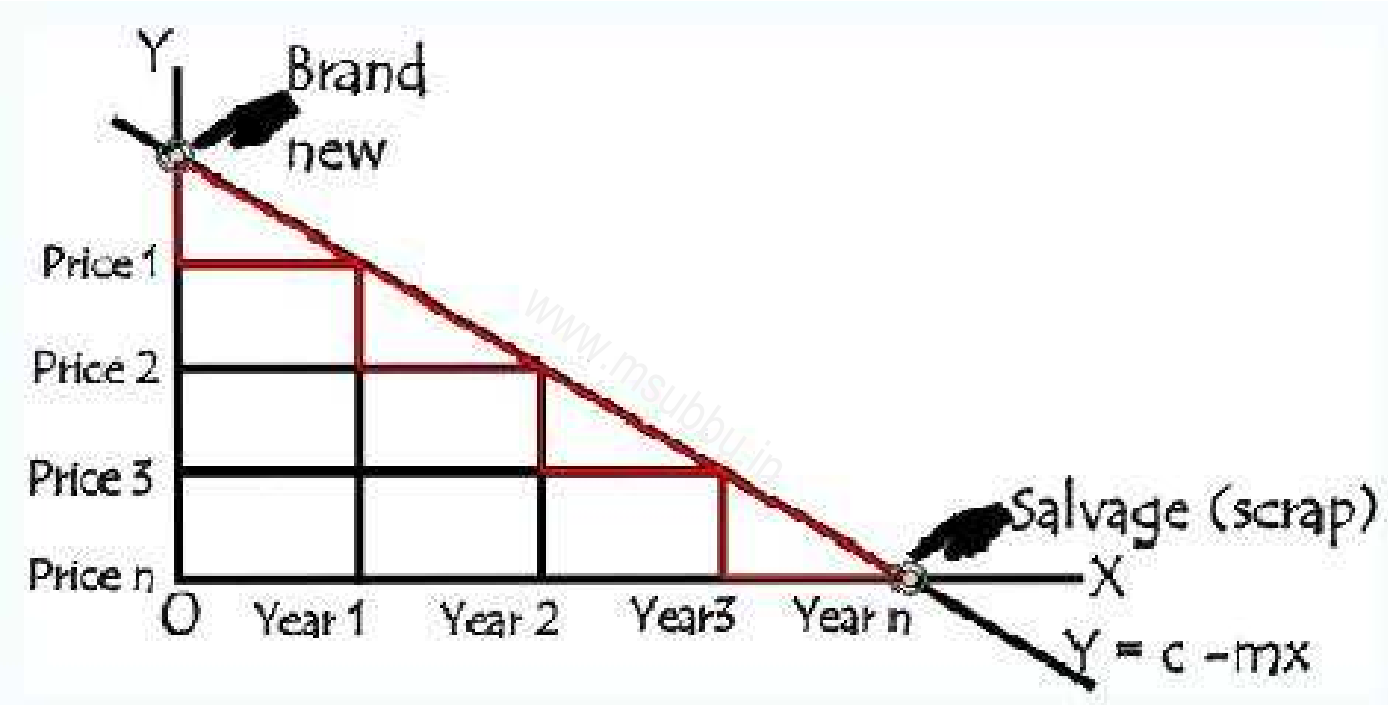
Straight-line Method

- This method is the simplest method of depreciation. This method allows for equal depreciation over the life of the asset.

  Annual Depreciation = (Cost - Residual value) / Useful life
  Book value = Cost - Accumulated depreciation

$$D = \frac{I - S}{n}$$

- As an example, assume an asset has a purchase price of $10,500. The asset has a useful life of five years. The salvage value after the assets useful life is $500.
  - Useful life: 5 years
  - Salvage value: $500
  - Purchase price – salvage value: $10,000 ($15,000 - $500)
  - Depreciation amount per year: $2,000 ($10,000/ 5 years)


Y
Brand new
Price 1
Price 2
Price 3
Price n
O
Year 1
Year 2
Year3
Year n
Salvage (scrap)
X
Y = c -mx

Straight-line Method

- Straight line method is also called as *fixed installment method*.

- Depreciation of fixed assets is uniform throughout the year. For assets like automobiles, repairs and maintenance costs are heavier in later periods, and this leads to heavier burden. However, when there are a number of assets bought in different years, this method is useful, because of simplicity and leveling out.

Accelerated Depreciation Methods

- Declining balance method and Sum-of-years-digits method are accelerated depreciation methods.

- Accelerated depreciation allows companies to write off their assets faster in earlier years than the straight-line depreciation method and to write off a smaller amount in the later years. The major benefit of using this method is the tax shield it provides. Companies with a large tax burden might like to use the accelerated-depreciation method, even if it reduces the income shown on the financial statement.

- This depreciation method is popular for writing off equipment that might be replaced before the end of its useful life since the equipment might be obsolete (e.g. computers).

Straight line depreciation

Year	Cost	Salvage Value
0	1,000,000	100,000

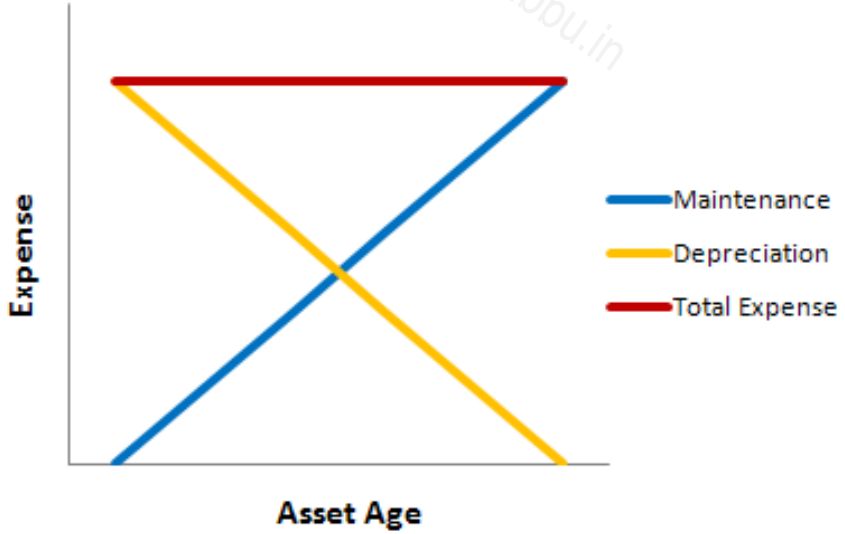
Depreciation Expense	Balance Sheet
1	180,000	820,000
2	180,000	640,000
3	180,000	460,000
4	180,000	280,000
5	180,000	100,000

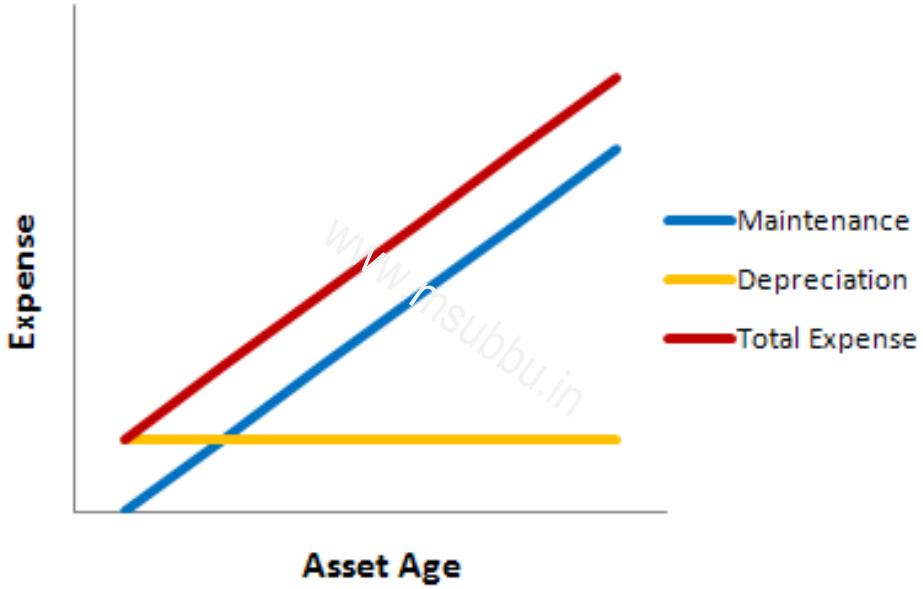
Accelerated depreciation

Year	Cost	Salvage Value	Useful Life
0	1,000,000	100,000	n = 5

Depreciation Expense	Balance Sheet
1	400,000	600,000
2	240,000	360,000
3	144,000	216,000
4	86,400	129,600
5	29,600	100,000

- By writing off more assets against revenue, companies report lower income and thus pay less tax.
- Another point of great benefit is if the equipment requires maintenance.
- Accelerated depreciation will offset the increasing maintenance cost and essentially equalizes the combined charges of both maintenance and depreciation. The graph above is a simplified view of how the accelerated depreciation and maintenance cost works out to give a straight line total expense.





If the straight line method was used, the depreciation would be constant and the maintenance cost would increase which would increase the total expenses.

Declining balance method

- The declining-balance method is also called the *fixed-percentage method*, or written down value (WDV) method

- Depreciation = Book value at the beginning of a year x Depreciation rate

  Book value = Original cost - Accumulated depreciation

- The most common rate used is double the straight-line rate. For this reason, this technique is referred to as the **double-declining-balance method**.

The declining-balance equation is

$$V_e = V_i(1 - f)$$

where

V_i = value of the asset at the beginning of a year
V_e = value of the asset at the end of the year
f = the declining-balance factor applied to each year and is constant from year to year

S.No.	Particular of Assets	WDV Depreciation Rates (%)
1	Building: Residential Factory	 5 10
2	General Plant & Machinery	15
3	Motor Car	15
4	Motor Buses/Lorries Used in Hire	30
5	Computer including Software	60
6	Furniture	10
7	Patents, Know-How, Copyrights, Licenses etc.	25

Example problem

- To illustrate, suppose a business has an asset with **$1,000** original cost, **$100** salvage value, and **5 years** useful life. First, calculate straight-line depreciation rate. Since the asset has 5 years useful life, the straight-line depreciation rate equals **(100% / 5) 20%** per year. With double-declining-balance method, as the name suggests, double that rate, or **40%.**

Year	Book value at beginning of year	Depreciation rate	Depreciation expense	Accumulated depreciation	Book value at end of year
1	**$1,000 (original cost)**	40%	$400	$400	$600
2	$600	40%	$240	$640	$360
3	$360	40%	$144	$784	$216
4	$216	40%	$86.40	$870.40	$129.60
5	$129.60	$129.60 - $100	$29.60	**$900**	**$100 (scrap value)**

Declining balance method (contd.)

When using the double-declining-balance method, the salvage value is not considered in determining the annual depreciation, but the book value of the asset being depreciated is never brought below its salvage value, regardless of the method used.

The process continues until the salvage value or the end of the asset's useful life, is reached. In the last year of depreciation, a subtraction might be needed in order to prevent book value from falling below estimated Scrap Value.

Declining Balance - Text book method

At the end of the first year

$$\text{Asset value} = V_a = V(1 - f)$$

At the end of the second year

$$V_a = V(1 - f)^2$$

At the end of a years

$$V_a = V(1 - f)^a$$

At the end of n years (i.e., at the end of service life)

$$V_a = V(1 - f)^n = V_s$$

Therefore,

$$f = 1 - \left(\frac{V_s}{V}\right)^{1/n}$$

The textbook relationship presented in above equation is seldom used in actual practice, because it places too much emphasis on the salvage value of the property and is certainly not applicable if the salvage value is zero.

Declining balance method (contd.)

- Prior to 1954, the United States government would not accept any depreciation method which permitted depreciation rates more than 50 percent greater than those involved in the straight-line method.

- In 1954, the laws were changed to allow rates up to twice (200 percent) those for the straight-line method. Under these conditions, one arbitrary method for choosing the value of *f* is to fix it at two times the reciprocal of the service life *n*. This permits approximately two-thirds of the depreciable value to be written off in the first half of the useful life.

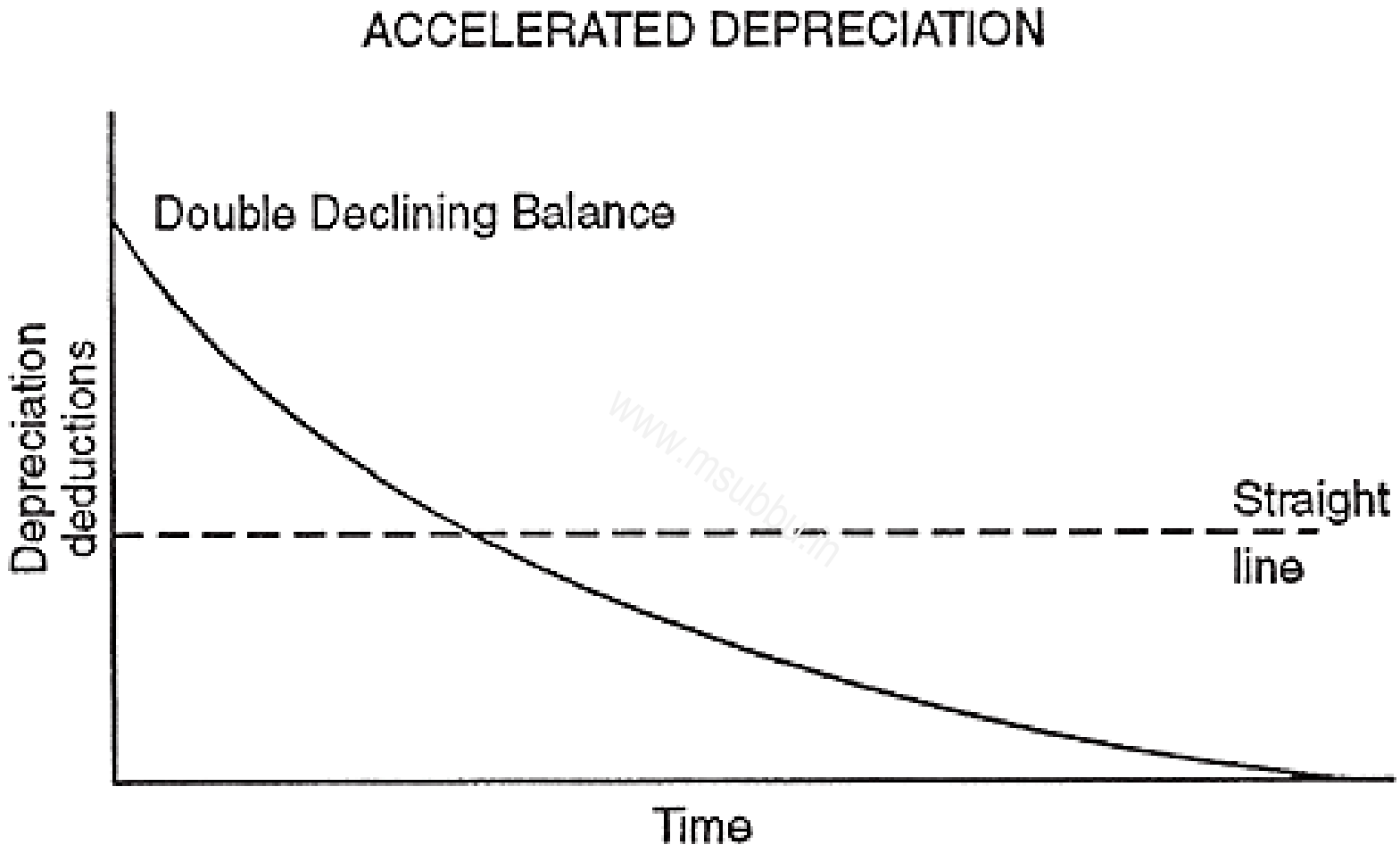


FIGURE 1

Sum-of-years-digits Method

- The sum-of-the year's digit method is calculated by adding the years together for a total sum that's then used as a fraction for a given year.

- Depreciation expense = (Cost - Salvage value) x Fraction

  Fraction for the first year = n / (1+2+3+...+ n)
  Fraction for the second year = (n-1) / (1+2+3+...+ n)
  Fraction for the third year = (n-2) / (1+2+3+...+ n)
  ...
  Fraction for the last year = 1 / (1+2+3+...+ n)

  n represents the number of years of useful life.

Example problem

$10,500 purchase price, 5 years useful life and $500 salvage value.

Add the sums of the year's useful life 5 + 4 + 3 + 2 + 1 = 15

Subtract the salvage value: $10,500 - $500 = $10,000

The depreciation in the first year equals 5/15th of $10,000 or $3,333.

The second years would be 4/15th the third year 3/15th fourth year 2/15th and the final year of depreciation would be 1/15th of $10,000.

Sum of years digits Method

Year	Cost	Salvage value	Estimated life
0	2,000,000	200,000	5
n!	15		
n	5		

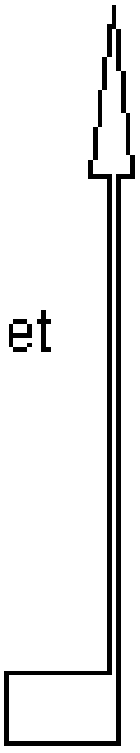
Year	Depreciation expense	Balance sheet	Rate
1	600,000	1,400,000	5/15
2	480,000	920,000	4/15
3	360,000	560,000	3/15
4	240,000	320,000	2/15
5	120,000	200,000	1/15

Depreciation rate varies with year

Double declining balance method

Year	Cost	Salvage value	Estimated life
0	2,000,000	200,000	5
n	5		

Year	Depreciation expense	Balance sheet	Rate
1	800,000	1,200,000	2/5
2	480,000	720,000	2/5
3	288,000	432,000	2/5
4	172,800	259,200	2/5
5	59,200	200,000	2/5



Depreciation rate remains constant with year

Depreciation Methods

- All depreciation methods have the following general formula:

- **Depreciation Expense = Depreciation Base × Depreciation Rate**
- Straight line method:

Depreciation Base	Depreciation Rate
Cost − Salvage value = $100,000 − $10,000 = $90,000	1/ Estimated useful life = 1/5 years = 20%

- Remember that book value has no relationship to market value. If you sold the vehicle for higher price than the book value, you would have taken too much depreciation over the years and would have a gain on sale.

Comparison of Methods

Depreciation Expense = Depreciation Base × Depreciation Rate

V = asset value; V_s = salvage value; n = service life

V_i = value of asset at the start of the given year

Book value = Asset value – accumulated depreciation expenses

Method	**Depreciation base**	**Depreciation rate**
Straight line	$V - V_s$	1/n
Double declining balance	V_i	2/n
Text-book declining balance	V_i	$1 - (V_s/V)^{1/n}$
Sum-of-years-digits	V – Vs	$f = \frac{(n - n' + 1)}{n(n+1)/2}$ n' - end of a particular year

Sinking fund method

- The use of compound interest is involved in the ***sinking-find method.*** It is assumed that the basic purpose of depreciation allowances is to accumulate a sufficient fund to provide for the recovery of the original capital invested in the property.

- An ordinary annuity plan is set up wherein a constant amount of money should theoretically be set aside each year. At the end of the service life, the sum of all the deposits plus accrued interest must equal the total amount of depreciation.

$$R = (V - V_s)\left[\frac{i}{(1+i)^n - 1}\right]$$

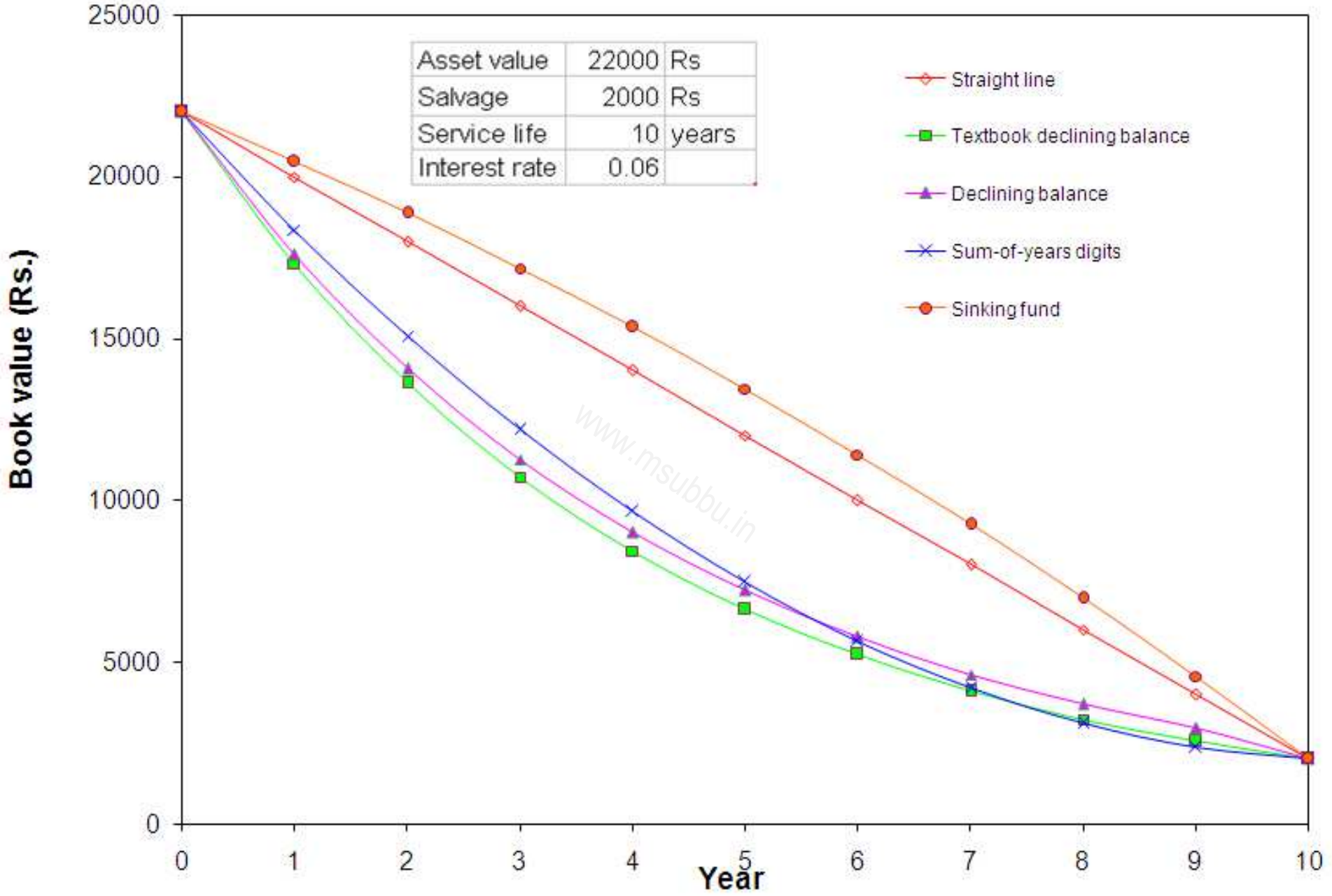
- Since the value of ***R*** represents the annual depreciation cost, the yearly cost for depreciation is constant when the sinking-fund method is used.

Sinking fund method (contd.)

- This method results in book values which are always greater than those obtained with the straight-line method. Because of the effects of interest in the sinking-fund method, the annual decrease in asset value of the property is less in the early-life years than in the later years.

- Book value at the end of year **a** is calculated from:

$$V_a = V - R\left[\frac{(1+i)^a - 1}{i}\right]$$


Asset value 22000 Rs
Salvage 2000 Rs
Service life 10 years
Interest rate 0.06
Straight line
Textbook declining balance
Declining balance
Sum-of-years digits
Sinking fund
Book value (Rs.)
Year
25000
20000
15000
10000
5000
0
0 1 2 3 4 5 6 7 8 9 10
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Unit-of-production Depreciation

- This method provides for depreciation by means of a fixed rate per unit of production. Under this method, one must first determine the cost per one production unit and then multiply that cost per unit with the total number of units the company produced within an accounting period to determine its depreciation expense.

$$\text{Depreciation expense per unit} = \frac{\text{total acquisition cost} - \text{salvage value}}{\text{estimated total units}}$$

Estimated total units = the total units this machine can produce over its lifetime

Depreciation expense = depreciation per unit x number of units produced during an accounting period

Example Problem

- Company ABC purchased a machine that can produce 300,000 products over its useful life for $2,000,000. The company also estimates that this machine has a salvage value of $200,000.

Year	Cost	Salvage value	Total estimated production Capacity
0	2,000,000	200,000	300,000

Cost per unit 6

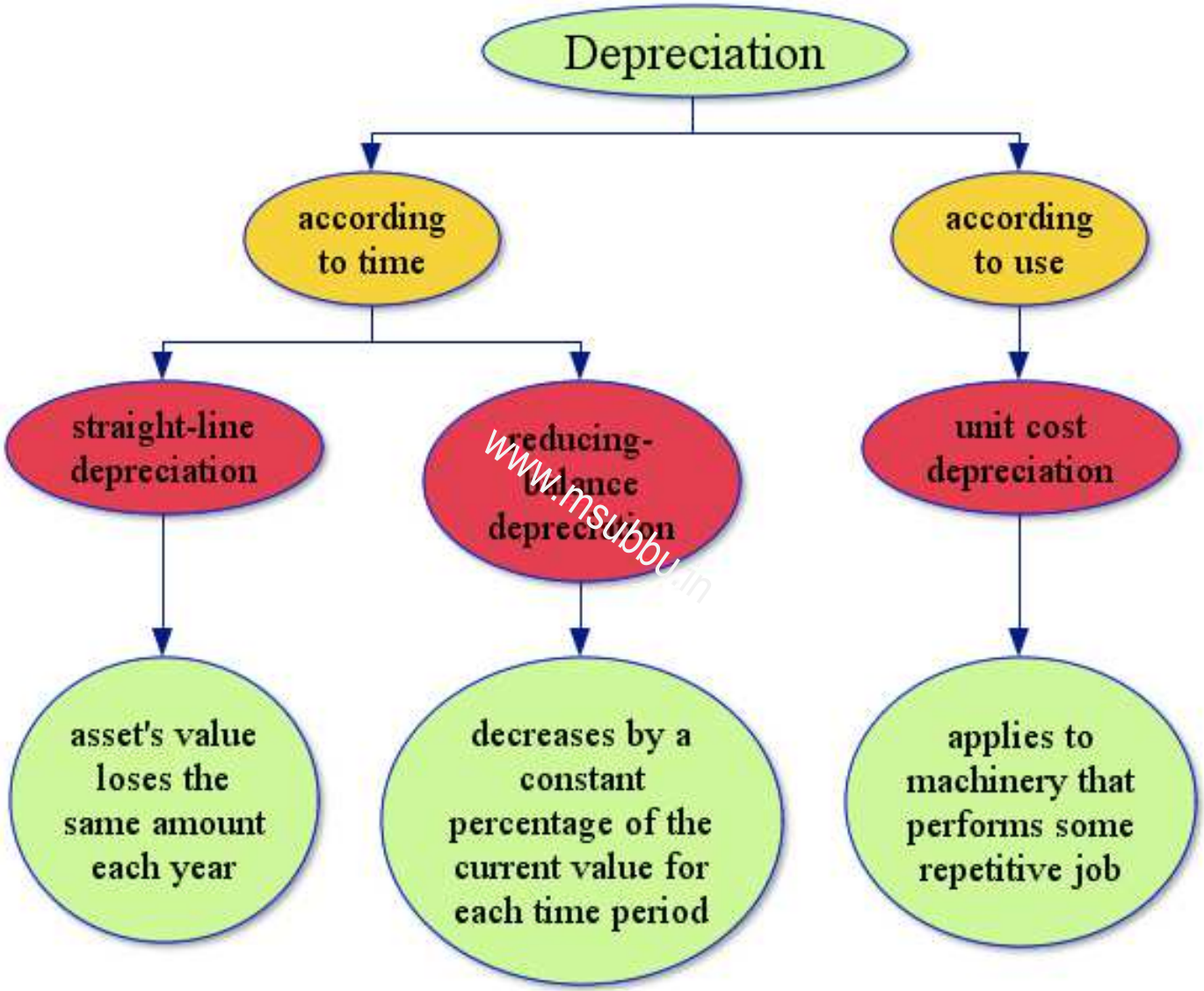
Year	Depreciation expense	Balance sheet	Total units produced in each period
1	300,000	1,700,000	50,000
2	300,000	1,400,000	50,000
3	450,000	950,000	75,000
4	750,000	200,000	125,000

This depreciation method produces a variable depreciation expense and is more reflective of production-to-cost (matching principle).

Unit-of-production Depreciation (contd.)

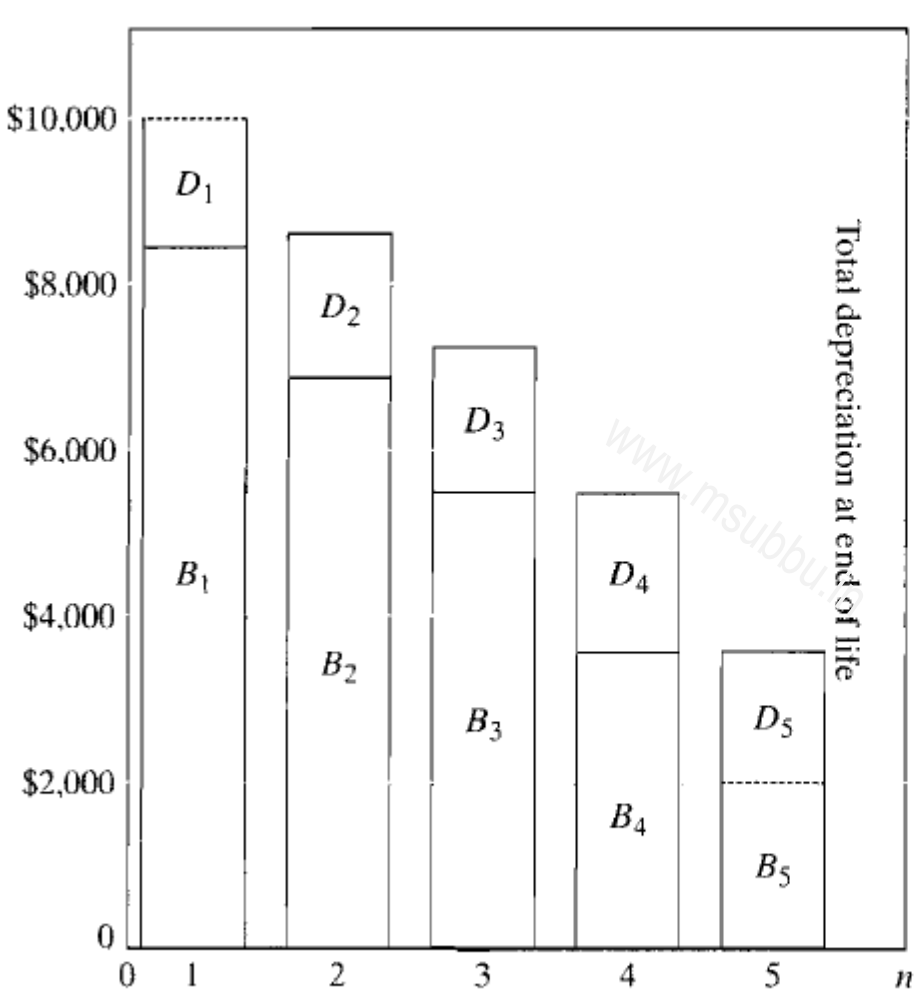
- At the end of the useful life of the asset, its accumulated depreciation is equal to its total cost minus its salvage value. Furthermore, its accumulated production units equal the total estimated production capacity.

- One of the drawbacks of this method is that if the units of products decrease (slowing demand for the product), the depreciation expense also decreases. This results in an overstatement of reported income and asset value.



Conclusions

- Depreciation is a charge against income. There is always a loss in value of the assets, such as plant and machinery, in operation or even if they are lying idle.
- Since the useful life of the asset is longer than the accounting period, a periodic charge is made for depreciation to systematically apportion the asset cost over its useful life.
- Straight line and declining balance are the most common methods.



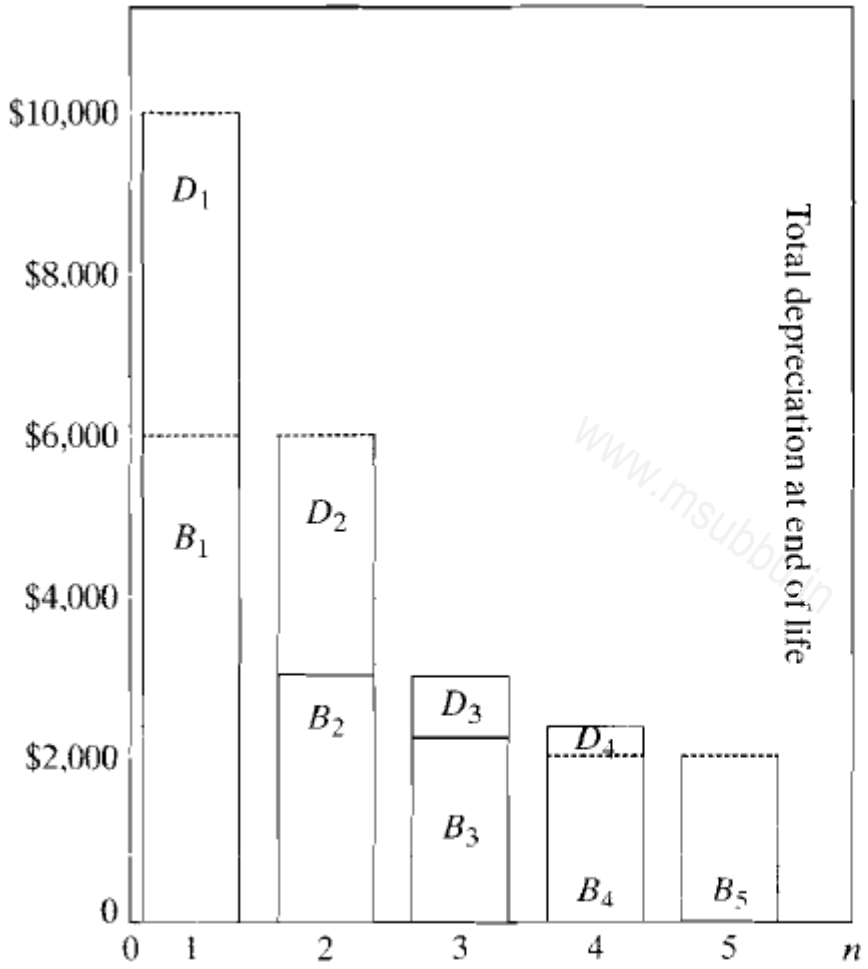
Annual Depreciation

Book Value

I = \$10,000
N = 5 years
S = \$2,000
$D = (I - S)/N$

n	D_n	B_n
0		\$10,000
1	\$1,600	\$8,400
2	\$1,600	\$6,800
3	\$1,600	\$5,200
4	\$1,600	\$3,600
5	\$1,600	\$2,000

Straight-line depreciation method



Annual Depreciation

Book Value

I = \$10,000
N = 5 years
S = \$2,000
$D_n = \alpha B_{n-1}$
$= \alpha I (1 - \alpha)^{n-1}$
$B_n = I (1 - \alpha)^n$

n	D_n	B_n
0		\$10,000
1	\$4,000	\$6,000
2	\$2,400	\$3,600
3	\$1,440	\$2,160
4	\$160	\$2,000
5	\$0	\$2,000

Double-declining-balance method

End of Year	D_n	B_n
1	$0.4(\$10{,}000) = \$4{,}000$	$\$10{,}000 - \$4{,}000 = \$6{,}000$
2	$0.4(\$6{,}000) = \$2{,}400$	$\$6{,}000 - \$2{,}400 = \$3{,}600$
3	$0.4(\$3{,}600) = \$1{,}440$	$\$3{,}600 - \$1{,}440 = \$2{,}160$
4	$0.4(\$2{,}160) = \$864 \rightarrow \boxed{\$160}$	$\$2{,}160 - \$160 = \$2{,}000$
5	0	$\$2{,}000 - \$0 = \$2{,}000$
	Total = $8,000	