PART 3

Development of Project Cash Flows

CHAPTER NINE

Accounting for Depreciation and Income Taxes

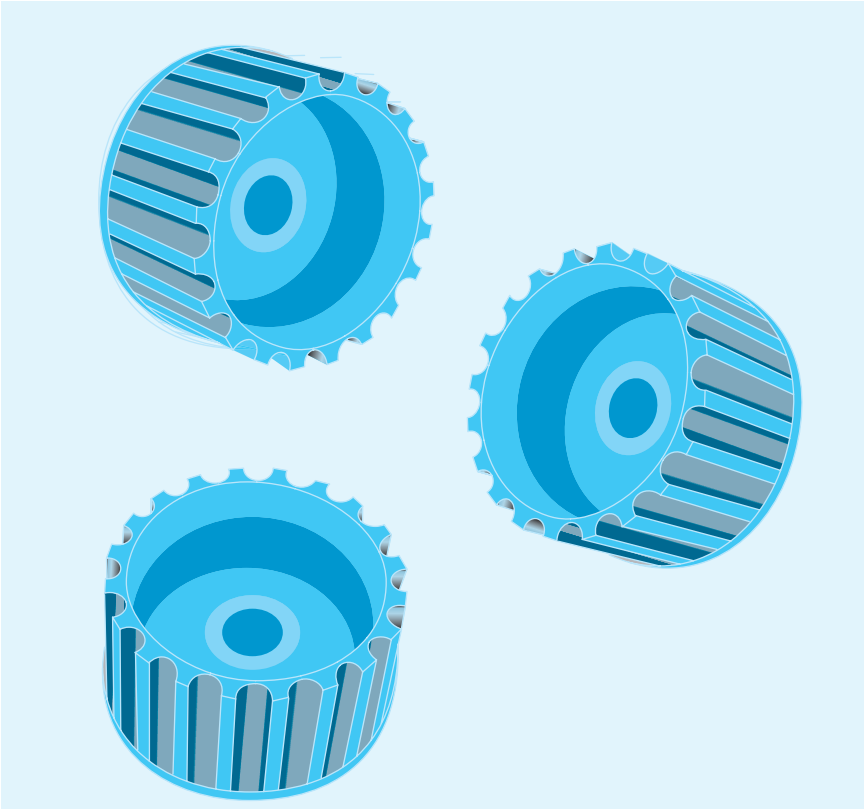
Alcoa Invests $60 Million in 3D Printing Technology[1]

Aluminum giant Alcoa sees a big future in shaping metal with 3D printers. The $60 million expansion of the Alcoa Technical Center in Pennsylvania is aimed at accelerating the development of advanced 3D printing materials and processes. It will be used to research advanced 3D printing techniques and make the technology more appropriate for large-scale manufacturing. Known as forerunners in the manufacturing of aluminum and light metals, the company has been progressing into the 3D printing arena for 20 years now, from 3D printing for jet engine parts to the various 3D-printed airplane components. As their momentum continues to grow, Alcoa will maintain a focus on producing proprietary titanium, nickel, and aluminum powders optimized for 3D printed aerospace parts. Specifically, the company plans to produce materials designed for a variety of additive technologies. Its goal is to meet increasing demand for high-performance 3D-printed parts beyond aerospace and extend into automotive, medical, and construction industries.

Alcoa engineers are excited at the prospect of the fact that the machines are getting better, faster, and cheaper. However, there's still a lot of work to be done before 3D printing is as widespread in manufacturing as traditional methods. Therefore, one of the primary goals for the team working at the new facility will be to attempt to develop cheaper metal materials that can be used to craft 3D-printed objects because current materials used for 3D printing are expensive.[2] Consequently, they are

[1] Jonathan Vanian, "Alcoa Makes a Big Bet on 3D Printing," *Fortune*, September 3, 2015. (http://fortune.com/2015/09/03/alcoa-invests-3d-printing/).

[2] Kristen Moran. "Alcoa Invests $60 Million in 3D Printing Technology," *Investing News*, September 7, 2015. (http://investingnews.com/daily/tech-investing/3d-printing-investing/alcoa-ampliforge-3d-printing/).



wondering how these cost savings, as well as the huge $60 million upfront investment for the facility would affect the profitability of the company.

Now ask yourself: How does the cost of this system affect the financial position of the firm? In the long run, the system promises to create more wealth for the organization by improving product quality and cutting down inspection time. In the short run, however, the high cost of the system will negatively impact the organization's bottom line because it involves high initial costs that are only gradually rewarded by the benefits of the system.

Another consideration should come to mind. This state-of-the-art equipment will inevitably wear out over time. Even if its productive service extends over many years, the cost of maintaining its high level of functioning will increase as the individual hardware pieces wear out and need to be replaced. Of even greater concern is the question of how long the system will be state-of-the-art. When will the competitive advantage the firm has just acquired become a competitive disadvantage due to obsolescence?

One of the facts of life that organizations must contend with is that fixed assets lose their value—even as they continue to function and contribute to the engineering projects that employ them. This loss of value, called **economic depreciation** (= purchase price − current market value), can involve deterioration and obsolescence. Why do engineers need to understand the concept of asset depreciation? All cash flows described in Chapters 5 through 7 are cash flows after taxes. In order to determine the effects of income taxes on project cash flows, we need to understand how a company calculates the profit (or net income) gained from undertaking a project, where depreciation expenses play a very critical role. The main function of **depreciation accounting** is to account for the cost of fixed assets in a pattern that matches their decline in value over time. The cost of the 3D printing system we have just described, for example, will be allocated over several years in the firm's financial statements so that its pattern of costs roughly matches its pattern of service. In this way, as we shall see, depreciation accounting enables the firm to stabilize the statements of financial position that it distributes to stockholders and the outside world.

On a project level, engineers must be able to assess how the reality of depreciating fixed assets influences the investment value of a given project. To make this assessment, they need to estimate the allocation of capital costs over the life of the project; this requires an understanding of the conventions and techniques that accountants use to depreciate assets, which we'll review in this chapter.

We begin by discussing the nature of acquiring fixed assets, the significance of depreciation, and income taxes. We then focus our attention almost exclusively on the rules and laws that govern asset depreciation and the methods that accountants use to allocate depreciation expenses. Knowledge of these rules will prepare you to assess the depreciation of assets acquired in engineering projects.

9.1 Accounting Depreciation

The acquisition of fixed assets is an important activity for a business organization. This condition is true whether the organization is starting up or is acquiring new assets to remain competitive. In engineering economics, the term **cost** is used in many ways. Like other disbursements, the costs of fixed assets must be recorded as expenses on a firm's balance sheet and income statement. However, unlike costs such as maintenance, material, and labor, acquisition cost of fixed assets are not treated simply as expenses to be accounted for during the year that they are acquired. Rather, these assets are **capitalized**; that is, their costs are distributed by subtracting them as expenses from gross income—one part at a time over a number of periods. The systematic allocation of the initial cost of an asset in parts over a time, known as its depreciable life, is what we mean by **accounting depreciation**, sometimes referred to more generally as **asset depreciation**.

The process of depreciating an asset requires that we make several preliminary determinations: (1) What is the cost of the asset? (2) What is the depreciable life of the asset? (3) What is the asset's value at the end of its useful life? (4) What method of depreciation do we choose? In this section, we will discuss each of these four factors.

9.1.1 Depreciable Property

As a starting point, it is important to recognize what constitutes a **depreciable asset**—that is, a property for which a firm may take depreciation deductions against income. For the purposes of U.S. tax law, any depreciable property must

1. be used in business or held for the production of income;
2. have a definite service life, which must be longer than one year; and
3. be something that wears out, decays, gets used up, becomes obsolete, or loses value from natural causes.

Depreciable property includes buildings, machinery, equipment, vehicles, and some intangible properties.[3] Inventories are not depreciable property, because they are held primarily for sale to customers in the ordinary course of business. If an asset has no definite service life, the asset cannot be depreciated. For example, you can never depreciate land. However, any land improvements such as driveways, parking lots, fences, landscaping, and lighting have limited useful lives, so they are subject to capitalization (depreciation).

As a side note, we should add that, while we have been focusing on depreciation within firms, individuals may also depreciate assets as long as the assets meet the conditions listed previously. For example, an individual may depreciate an automobile if the vehicle is used exclusively for business purposes.

9.1.2 Cost Basis

The **cost basis** of an asset represents the total cost that is claimed as an expense over an asset's life—the sum of the annual depreciation expenses. Cost basis generally includes the actual cost of an asset and all incidental expenses, such as freight, site preparation, and installation.[4] Total cost, rather than the cost of the asset only, must be the basis for depreciation charged as an expense over an asset's life. Besides being used in figuring depreciation deductions, an asset's cost basis is used in calculating the gain or loss to the firm if the asset is ever sold or salvaged.

EXAMPLE 9.1 Determining the Cost Basis

Raymond Stamping Services purchased a stamping machine priced at $21,500. The firm had to pay a sales tax of $1,200 on this purchase. Raymond also paid the inbound transportation charges of $525 on the new machine, as well as a labor cost of $1,350 to install the machine in the factory. In addition, Raymond had to prepare the site before installation at a cost of $2,125. Determine the cost basis for the new machine for depreciation purposes.

DISSECTING THE PROBLEM

Given: Invoice price = $22,700, freight = $525, installation cost = $1,350, and site preparation = $2,125.

Find: The cost basis.

[3] Intangible property is property that has value but cannot be seen or touched. Some intangible properties are (1) copyrights and patents, (2) customer and subscription lists, (3) designs and patterns, and (4) franchises. Generally, you can either amortize or depreciate intangible property.

[4] If you purchase an asset by trading in an old but similar asset, the cost basis for the new asset will be adjusted by the amount of gain or loss, or simply by its net book value. Example 9.6 will illustrate the process of calculating the cost basis with trade-in allowances.

METHODOLOGY

Compute the cost basis.

SOLUTION

The cost of the machine that is applicable for depreciation is computed as follows:

Cost of a new stamping machine	$22,700
Freight	$525
Installation labor	$1,350
Site preparation	$2,125
Cost of machine (cost basis)	$26,700

COMMENTS: Why do we include all the incidental charges relating to the acquisition of a machine in its cost? Why not treat these incidental charges as expenses of the period in which the machine is acquired? The matching of costs and revenue is a basic accounting principle. Consequently, the total costs of the machine should be viewed as an asset and allocated against the future revenue that the machine will generate. All costs incurred in acquiring the machine are costs of the services to be received from using the machine.

9.1.3 Useful Life and Salvage Value

How long will an asset be useful to the company? What do statutes and accounting rules mandate about assessing an asset's span of economic value? These questions must be answered when we are determining an asset's depreciable life, that is, the number of years over which the asset is to be depreciated.

Historically, depreciation accounting included choosing a depreciable life that based on the service life of an asset. Determining the service life of an asset, however, was often very difficult, and the uncertainty of these estimates frequently led to disputes between taxpayers and the Internal Revenue Service (IRS). To alleviate the problems, the IRS now publishes guidelines on lives for categories of assets, known as **asset depreciation ranges,** or **ADRs**. These guidelines specify a range of lives for classes of assets, based on historical data, allowing taxpayers to choose a depreciable life within the specified range for a given asset. An example of ADRs for some assets is given in Table 9.1.

An asset's estimated value at the end of its life is its **salvage value**; it is the amount eventually recovered through sale, trade-in, or salvage. The eventual salvage value of an asset must be estimated when the depreciation schedule for the asset is established. If this estimate subsequently proves to be inaccurate, then an adjustment must be made.

9.1.4 Depreciation Methods: Book and Tax Depreciation

One important distinction regarding the general definition of accounting depreciation must be introduced. Most firms calculate depreciation in two different ways, depending on whether the calculation is (1) intended for financial reports (**book depreciation method**), such as for the balance sheet or income statement, or (2) intended for the Internal Revenue Service (IRS) for the purpose of calculating taxes (**tax depreciation method**). (See Figure 9.1.) In the United States, this distinction is totally legitimate under IRS regulations, as it is in many other countries. Calculating depreciation differently for financial reports and for tax purposes allows for the following benefits:

TABLE 9.1 Asset Depreciation Ranges (ADRs)

Assets Used	Asset Depreciation Range (years)		
	Lower Limit	Midpoint Life	Upper Limit
Office furniture, fixtures, and equipment	8	10	12
Information systems (computers)	5	6	7
Airplanes	5	6	7
Automobiles and taxis	2.5	3	3.5
Buses	7	9	11
Light trucks	3	4	5
Heavy trucks (concrete ready mixer)	5	6	7
Railroad cars and locomotives	12	15	18
Tractor units	5	6	7
Vessels, barges, tugs, and water transportation systems	14.5	18	21.5
Industrial steam and electrical generation or distribution systems	17.5	22	26.5
Manufacturer of electrical machinery	8	10	12
Manufacturer of electronic components, products, and systems	5	6	7
Manufacturer of motor vehicles	9.5	12	14.5
Telephone distribution plant	28	35	42

- The book depreciation enables firms to report depreciation to stockholders and other significant outsiders on the basis of the **matching principle**. Therefore, the actual loss in value of the assets is generally reflected.
- The tax depreciation method allows firms to benefit from the tax advantages of depreciating assets more quickly than would be possible under the matching concept. In many cases, tax depreciation allows firms to defer paying income taxes. *This deferral does not mean that they pay less tax overall because the total depreciation expense accounted for over time is the same in either case*. However, because tax depreciation methods generally permit a higher depreciation in earlier years than do book depreciation methods, the tax benefit of depreciation is enjoyed earlier, and firms usually pay lower taxes in the initial years of an investment project. Typically, this factor leads to a better cash flow position in early years with the added cash leading to increased future wealth because of the time value of the funds. As we will see in a later section, the Tax Cuts and Jobs Act of 2017 was intended to help businesses maximize the tax deferring effect, so that businesses could invest the deterred tax money in other business activities.

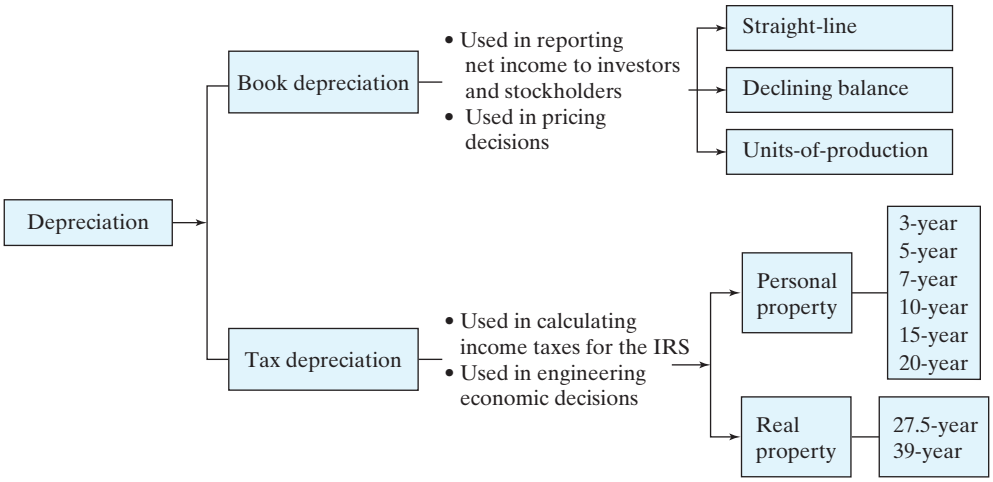


Figure 9.1 Types of accounting depreciation and their primary purposes.

9.2 Book Depreciation Methods

Consider a machine purchased for $10,000 with an estimated life of five years and estimated salvage value of $2,000. The objective of depreciation accounting is to charge this net cost of $8,000 as an expense over the five-year period. How much should be charged as an expense each year? Three different methods can be used to calculate the periodic depreciation allowances for financial reporting: (1) the straight-line (SL) method, (2) the declining-balance (DB) method, and (3) the unit-of-production method. In engineering economic analysis, we are interested primarily in depreciation in the context of income-tax computation. Nonetheless, a number of reasons make the study of book depreciation methods useful:

- First, many product pricing decisions are based on book depreciation methods.
- Second, tax depreciation methods are based largely on the same principles that are used in book depreciation methods.
- Third, firms continue to use book depreciation methods for financial reporting to stockholders and outside parties.
- Finally, book depreciation methods are still used for state income-tax purposes in many states and foreign countries.

9.2.1 Straight-Line Method

The **straight-line (SL) method** of depreciation views a fixed asset as an asset that provides its services in a uniform fashion. That is, the asset provides an equal amount of service in each year of its useful life. In other words, the depreciation rate is $1/N$, where N is the depreciable life. Example 9.2 illustrates the straight-line depreciation concept.

EXAMPLE 9.2 Straight-Line Depreciation

Consider the following data on an equipment:

$$\text{Cost basis of the asset } (I) = \$10{,}000;$$
$$\text{Useful life } (N) = 5 \text{ years};$$
$$\text{Estimated salvage value } (S) = \$2{,}000.$$

Compute the annual depreciation allowances and the resulting book values using the straight-line depreciation method.

DISSECTING THE PROBLEM

Given: $I = \$10{,}000$, $S = \$2{,}000$, and $N = 5$ years.
Find: D_n and B_n for $n = 1$ to 5.

METHODOLOGY

Create a straight-line depreciation table.

SOLUTION

The straight-line depreciation rate is $\frac{1}{5}$ or 20%. Therefore, the annual depreciation charge is

$$D_n = (0.20)(\$10{,}000 - \$2{,}000) = \$1{,}600.$$

Then the asset would have the following book values during its useful life, where B_n represents the book value after the depreciation charge for year n:

$$B_n = I - (D_1 + D_2 + D_3 + \cdots + D_n).$$

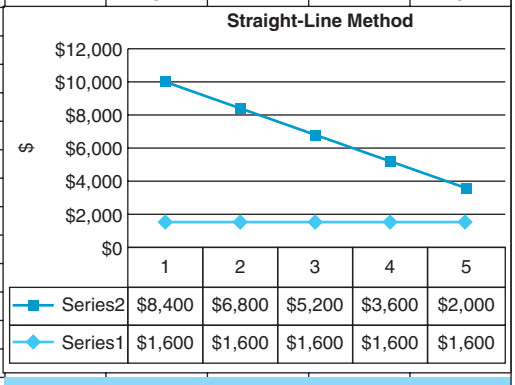
Therefore, the depreciation schedule based on the straight-line method is as follows:

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

COMMENTS: We can easily generate a depreciation schedule just like what we have shown by using a built-in financial command, **= SLN** (**cost, salvage, life**) in Excel. One way to automate the process of generating a depreciation schedule is to develop an Excel worksheet as the one shown in Table 9.2. First, we determine the type of depreciation method, such as, in this example, the straight-line method. Then we enter the cost basis in cell D2, the depreciable life in cell D3, and the salvage value in cell D4. Then, we can generate the depreciation schedule in cells C9 –C13, and also plot the annual depreciation, as well as book value, as a function of age.

TABLE 9.2 **An Excel Worksheet to Calculate the Depreciation Amounts by the Straight-Line Method**

	A	B	C	D	E	F	G	H	I	J
1	**Depreciation Method**			SL						
2	**Cost Basis ($)**			10,000						
3	**Depreciable Life**			5						
4	**Salvage Value ($)**			2,000						
5										
6	**Period**	**Beginning**	**Depreciation**	**Ending**						
7	**(*n*)**	**Book Value**	**Amount**	**Book Value**						
8										
9	1	$10,000	$1,600	$8,400						
10	2	$8,400	$1,600	$6,800						
11	3	$6,800	$1,600	$5,200						
12	4	$5,200	$1,600	$3,600						
13	5	$3,600	$1,600	$2,000						
14										



=($D$2-$D$4)/$D$3

9.2.2 Declining-Balance Method

The second concept recognizes that the stream of services provided by a fixed asset may decrease over time; in other words, the stream may be greatest in the first year of an asset's service life and least in its last year. This pattern may occur because the mechanical efficiency of an asset tends to decline with age, because maintenance costs tend to increase with age, or because of the increasing likelihood that better equipment will become available and make the original asset obsolete. This reasoning leads to a method that charges a larger fraction of the cost as an expense of the early years than of the later years. This method, the **declining-balance method**, is the most widely used.

Depreciation Rate

The declining-balance method of calculating depreciation allocates a fixed fraction of the beginning book balance each year. The fraction α is obtained from the straight-line depreciation rate $(1/N)$ as a basis:

$$\alpha = (1/N)(\text{multiplier}). \tag{9.1}$$

The most commonly used multipliers in the United States are 1.5 (called 150% DB) and 2.0 (called 200% DDB, or double-declining-balance). So, a 200%-DB method specifies that the depreciation rate will be 200% of the straight-line rate. As N increases, α decreases, thereby resulting in a situation in which depreciation is highest in the first year and then decreases over the asset's depreciable life.

EXAMPLE 9.3 Declining-Balance Depreciation

Consider the following accounting information for an industrial equipment:

$$\begin{aligned} \text{Cost basis of the asset } (I) &= \$10{,}000; \\ \text{Useful life } (N) &= 5 \text{ years}; \\ \text{Estimated salvage value } (S) &= \$2{,}000. \end{aligned}$$

Compute the annual depreciation allowances and the resulting book values using the double-declining-balance depreciation method.

DISSECTING THE PROBLEM

Given: $I = \$10{,}000$, $S = \$2{,}000$, and $N = 5$ years.

Find: D_n and B_n for $n = 1$ to 5.

METHODOLOGY

Create a double-declining-balance depreciation schedule in Excel.

SOLUTION

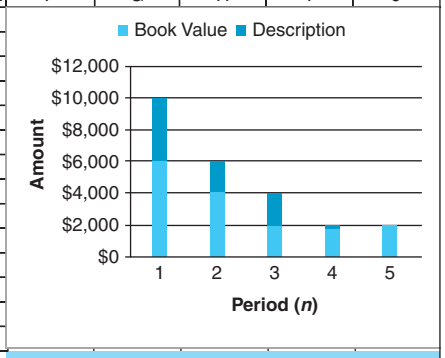
The book value at the beginning of the first year is \$10,000, and the declining-balance rate α is $\frac{1}{5}(2) = 40\%$. Then the depreciation deduction for the first year will be \$4,000 $(40\% \times \$10{,}000 = \$4{,}000)$. To figure out the depreciation deduction in the second year, we must first adjust the book value for the amount of depreciation we deducted in the first year. The first year's depreciation is subtracted from the beginning book value $(\$10{,}000 - \$4{,}000 = \$6{,}000)$. This amount is then multiplied by the rate of depreciation $(\$6{,}000 \times 40\% = \$2{,}400)$. By continuing the process, we obtain D_3. However, in year 4, B_4 would be less than $S = \$2{,}000$ if the full deduction (\$864) were taken. *Tax law does not permit us to depreciate assets below their salvage value.* Therefore, we adjust D_4 to \$160, making $B_4 = \$2{,}000$. D_5 is zero, and B_5 remains at \$2,000. The following table provides a summary of these calculations:

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	

Table 9.3 also illustrates the process of generating a depreciation schedule in Excel. This is basically the same worksheet, where we need to change only the depreciation method from the straight line to the declining balance using a 200% depreciation rate.

TABLE 9.3 **An Excel Worksheet to Calculate the Depreciation Amounts by the Declining-Balance Method (Example 9.3)**

	A	B	C	D
1	**Declining Depreciation Method**			200%
2	**Cost Basis ($)**			10,000
3	**Depreciable Life**			5
4	**Salvage Value ($)**			2,000
5	**Declining Balance Rate (α)**			0.40
6				
7	**Period**	**Beginning**	**Depreciation**	**Ending**
8	**(*n*)**	**Book Value**	**Amount**	**Book Value**
9				
10	1	$10,000	$4,000	$6,000
11	2	$6,000	$2,400	$3,600
12	3	$3,600	$1,440	$2,160
13	4	$2,160	$160	$2,000
14	5	$2,000	$0	$2,000
15				



=IF(B14*(1-$D$5)<$D$4,B14-$D$4,B14*$D$5)

Switching Policy

When $B_N > S$, we are faced with a situation in which we have not depreciated the entire cost of the asset and thus have not taken full advantage of depreciation's tax-deferring benefits. If we would prefer to reduce the book value of an asset to its salvage value as quickly as possible, we can do so by switching from DB depreciation to SL depreciation whenever SL depreciation results in higher depreciation charges and, therefore, a more rapid reduction in the book value of the asset. The switch from DB to SL depreciation can take place in any of the n years, the objective being to identify the optimal year to switch. The switching rule is as follows: If DB depreciation in any year is less than (or equal to) the depreciation amount calculated by SL depreciation on the basis of the remaining years, switch to and remain with the SL method for the duration of the asset's depreciable life. The straight-line depreciation in any year n is calculated as:

$$D_n = \frac{\text{Book value at beginning of year } n - \text{Salvage value}}{\text{Remaining useful life at beginning of year } n}. \tag{9.2}$$

EXAMPLE 9.4 Declining Balance with Conversion to Straight-Line Depreciation ($B_N > S$)

Suppose the asset given in Example 9.3 has a zero salvage value instead of $2,000:

$$\begin{aligned} \text{Cost basis of the asset } (I) &= \$10{,}000; \\ \text{Useful life } (N) &= 5 \text{ years}; \\ \text{Salvage value } (S) &= \$0; \\ \alpha &= (1/5)(2) = 40\%. \end{aligned}$$

Determine the optimal time to switch from DB to SL depreciation and the resulting depreciation schedule.

DISSECTING THE PROBLEM

Given: $I = \$10{,}000$, $S = \$0$, $N = 5$ years, and $\alpha = 40\%$.

Find: Optimal conversion time; D_n and B_n for $n = 1$ to 5.

METHODOLOGY

Create a table of depreciation amounts in Excel.

SOLUTION

We will first proceed by computing the DDB depreciation for each year, as before. The result is shown in Table 9.4(a). Then we compute the SL depreciation for each year using Eq. (9.2). We compare the SL depreciation with the DDB depreciation for each year and use the decision rule to decide when to change. The result is shown in Table 9.4(b). The switching should take place in the fourth year.

TABLE 9.4 Switching Policy from DDB to SL Depreciation with $S = 0$

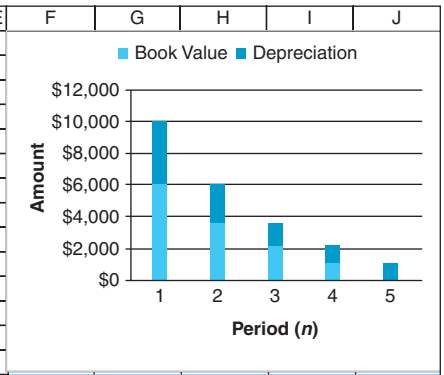
(a) Without switching			(b) With switching to SL depreciation		
n	Depreciation	Book Value	n	Depreciation	Book Value
1	$\$10{,}000(0.4) = \$4{,}000$	\$6,000	1	\$4,000	\$6,000
2	$\$6{,}000(0.4) = \$2{,}400$	\$3,600	2	$\$6{,}000/4 = \$1{,}500 < \$2{,}400$	\$3,600
3	$\$3{,}600(0.4) = \$1{,}440$	\$2,160	3	$\$3{,}600/3 = \$1{,}200 < \$1{,}440$	\$2,160
4	$\$2{,}160(0.4) = \$864$	\$1,296	4	$\$2{,}160/2 = \$1{,}080 > \$864$	\$1,080
5	$\$1{,}296(0.4) = \$518$	\$778	5	$\$1{,}080/1 = \$1{,}080 > \$518$	\$0

Note: Without the switching policy, we do not depreciate the entire cost of the asset and thus do not take full advantage of depreciation's tax-deferring benefits.

COMMENTS: As we have seen in Table 9.4, the process of finding when to switch from DB to SL can be tedious if done manually. This is where we may use Excel to facilitate the calculation process. Table 9.5 demonstrates how we may design an Excel worksheet to accomplish this. Another benefit of Excel is its capability to plot the depreciation and book value as a function of asset age, just as we have seen in Table 9.3.

TABLE 9.5 An Excel Worksheet to Calculate the Depreciation Amounts with DB Switching to SL

	A	B	C	D	E
1	**Declining Depreciation Method**			200%	
2	**Cost Basis ($)**			10,000	
3	**Depreciable Life**			5	
4	**Salvage Value ($)**			-	
5	**Declining Balance Rate (α)**			0.40	
6					
7	**Period**	**Beginning**	**Depreciation**	**Ending**	
8	**(*n*)**	**Book Value**	**Amount**	**Book Value**	
9					
10	1	$10,000	$4,000	$6,000	
11	2	$6,000	$2,400	$3,600	
12	3	$3,600	$1,440	$2,160	
13	4	$2,160	$1,080	$1,080	
14	5	$1,080	$1,080	$0	
15					



=IF(B14*$D$5<(B14-$D$4)/($D$3-A13),(B14-$D$4)/($D$3-A13),B14*$D$5)

9.2.3 Units-of-Production Method

Straight-line depreciation can be defended only if the fixed asset—say, a machine—is used for exactly the same amount of time each year. What happens when a punch-press machine is run 1,670 hours one year and 780 the next, or when some of its output is shifted to a new machining center? This situation leads us to consider another depreciation concept that views the asset as a bundle of service units rather than as a single unit as in the SL and DB methods. However, this concept does not assume that the service units will be consumed in a time-phased pattern. The cost of each service unit is the net cost of the asset divided by the total number of such units. The depreciation charge for a period is then related to the number of service units consumed in that period. This definition leads to the **units-of-production method**. By this method, the depreciation in any year is given by

$$D_n = \frac{\text{Service units consumed during year } n}{\text{Total service units}} (I - S). \tag{9.3}$$

With the units-of-production method, depreciation charges are made proportional to the ratio of actual output to the total expected output; usually, this ratio is figured in machine-hours. Advantages of using this method include the fact that depreciation varies with production volume, and therefore the method gives a more accurate picture of machine usage. A disadvantage of the units-of-production method is that the collection of data on machine use and the accounting methods are somewhat tedious. This method can be useful for depreciating equipment employed to exploit natural resources if the resources will be depleted before the equipment wears out. It is not, however, considered a practical method for general use in depreciating industrial equipment.

EXAMPLE 9.5 Units-of-Production Depreciation

A truck for hauling coal has an estimated net cost of $55,000 and is expected to give service for 250,000 miles, resulting in a $5,000 salvage value. Compute the allowed depreciation amount for truck usage of 30,000 miles.

DISSECTING THE PROBLEM

Given: $I = \$55{,}000$, $S = \$5{,}000$, total service units $= 250{,}000$ miles, and usage for this year $= 30{,}000$ miles.

Find: Depreciation amount in this year.

METHODOLOGY

Compute annual depreciation.

SOLUTION

The depreciation expense in a year in which the truck traveled 30,000 miles would be

$$\frac{30{,}000 \text{ miles}}{250{,}000 \text{ miles}} (\$55{,}000 - \$5{,}000) = \left(\frac{3}{25}\right)(\$50{,}000) = \$6{,}000.$$

9.3 Tax Depreciation Methods

Prior to the Economic Recovery Act of 1981, taxpayers could choose among several methods when depreciating assets for tax purposes. The most widely used methods were the straight-line method and the declining-balance method. The subsequent imposition of the **accelerated cost recovery system** (ACRS) and the **modified accelerated cost recovery system** (MACRS) superseded these methods for use in tax purposes. With the Tax Cuts and Jobs Act of 2017, tax payers are even allowed to choose a capital expensing option (bonus depreciation) for a certain category of assets to determine the allowed depreciation amount in the calculation of income taxes. The foregoing history is summarized in Table 9.6.

9.3.1 MACRS Recovery Periods

Historically, for tax purposes as well as for accounting, an asset's depreciable life was determined by its estimated useful life; it was intended that an asset would be fully depreciated at approximately the end of its useful life. With the MACRS scheme, however, the IRS totally abandoned this practice, and simpler guidelines were set that created several classes of assets, each with a more or less arbitrary lifespan called a **recovery period**. (*Note:* These recovery periods do not necessarily correspond to expected useful lives.)

As shown in Table 9.7, the MACRS scheme includes eight categories of assets: 3, 5, 7, 10, 15, 20, 27.5, and 39 years. Under MACRS, *the salvage value of property is always treated as zero*. MACRS guidelines are summarized as follows:

- Investments in some short-lived assets are depreciated over three years by 200% DB and then by a switch to SL depreciation.
- Computers, automobiles, and light trucks are written off over five years by 200% DB and then by switching to SL depreciation.
- Most types of manufacturing equipment are depreciated over seven years, but some long-lived assets are written off over 10 years. Most equipment write-offs are calculated by the 200% DB method and then by switching to SL depreciation, an approach that allows for faster write-offs in the first few years after an investment is made.

TABLE 9.6 History of Tax Depreciation Methods

Tax Depreciation

• **Purpose:** To compute income taxes for the IRS.
  • Assets placed in service prior to 1981:
  Used book depreciation methods (SL, DB, or SOYD*).
  • Assets placed in service from 1981 to 1986:
  Used ACRS Table.
  • Assets placed in service after 1986:
  Use MACRS Table.
  • Assets placed in service between September 20, 2017 and 2023.
  Use either 100% bonus depreciation or MACRS Table.
  • Assets placed in service between 2024–2028
  Use either phase-down bonus depreciation or MACRS Table.
  • Assets placed in service after 2029
  Use MACRS Table.

* SOYD: Sum-of-Years' Digit Method, no longer used as a book depreciation method.

TABLE 9.7 MACRS Property Classifications (ADR = Asset Depreciation Range)

Recovery Period	ADR Midpoint Class	Applicable Property
3 years	$ADR \leq 4$	Special tools for manufacture of plastic products, fabricated metal products, and motor vehicles
5 years	$4 < ADR \leq 10$	Automobiles, light trucks, high-tech equipment, equipment used for R&D, and computerized telephone-switching systems
7 years	$10 < ADR \leq 16$	Manufacturing equipment, office furniture, and fixtures
10 years	$16 < ADR \leq 20$	Vessels, barges, tugs, and railroad cars
15 years	$20 < ADR \leq 25$	Wastewater plants, telephone-distribution plants, or similar utility property
20 years	$25 \leq ADR$	Municipal sewers and electrical power plants
27.5 years		Residential rental property
39 years		Nonresidential real property, including elevators and escalators

- Electric transmission property, any natural gas distribution line, sewage-treatment plants, and telephone-distribution plants are written off over 15 years by 150% DB and then by switching to SL depreciation.
- Farm buildings, municipal sewers, sewer pipes, and certain other very long-lived equipment are written off over 20 years by 150% DB and then by switching to SL depreciation.
- Investments in residential rental property are written off in straight-line fashion over 27.5 years. On the other hand, nonresidential real estate (commercial buildings) is written off by the SL method over 39 years.

9.3.2 MACRS Depreciation: Personal Property

Prior to 1986, the rate at which the value of an asset actually declined was estimated, and this rate was used for tax depreciation. Thus, different assets were depreciated along different paths over time. The MACRS method, however, establishes prescribed depreciation rates, called **recovery allowance percentages**, for all assets within each class. These rates, as set forth in 1986 and 1993, are shown in Table 9.8.

We determine the yearly recovery, or depreciation expense, by multiplying the asset's depreciation base by the applicable recovery-allowance percentage:

- **Half-Year convention:** The MACRS recovery percentages shown in Table 9.8 use the **half-year convention**; that is, it is assumed that all assets are placed in service at midyear and that they will have *zero* salvage value. As a result, only a half-year of depreciation is allowed for the first year that property is placed in service. With half of one year's depreciation being taken in the first year, a full year's depreciation is allowed in each of the remaining years of the asset's recovery period, and the remaining half-year's depreciation is incurred in the year following the end of the recovery period. A half-year of depreciation is also allowed for the year in which the property is disposed of, or is otherwise retired from service, any time before the end of the recovery period.
- **Switching from the DB method to the SL method:** The MACRS asset is depreciated initially by the DB method and then by the SL method. Consequently, the MACRS scheme adopts the switching convention illustrated in Section 9.2.2.

TABLE 9.8 MACRS Depreciation Schedules for Personal Property with Half-Year Convention

Year	Class Depreciation Rate	3 200% DB	5 200% DB	7 200% DB	10 200% DB	15 150% DB	20 150% DB
1		33.33	20.00	14.29	10.00	5.00	3.750
2		44.45	32.00	24.49	18.00	9.50	7.219
3		14.81*	19.20	17.49	14.40	8.55	6.677
4		7.41	11.52*	12.49	11.52	7.70	6.177
5			11.52	8.93*	9.22	6.93	5.713
6			5.76	8.92	7.37	6.23	5.285
7				8.93	6.55*	5.90*	4.888
8				4.46	6.55	5.90	4.522
9					6.56	5.91	4.462*
10					6.55	5.90	4.461
11					3.28	5.91	4.462
12						5.90	4.461
13						5.91	4.462
14						5.90	4.461
15						5.91	4.462
16						2.95	4.461
17							4.462
18							4.461
19							4.462
20							4.461
21							2.231

* Year to switch from declining balance to straight line. *Source:* IRS Publication 946, *How To Depreciate Property*, U.S. Government Printing Offices, Washington, DC, April 06, 2017.

To demonstrate how the MACRS depreciation percentages were calculated by the IRS using the half-year convention, let us consider Example 9.6.

EXAMPLE 9.6 MACRS Depreciation: Personal Property with Trade-In

An old automobile is traded for a new automobile with a list price of $30,000. The old automobile has a net book value of $5,000, but the dealer has given $6,000 trade-in allowance, so the total purchase price is $24,000. The automobile will be depreciated according to the five-year MACRS class. Determine the cost basis to use and compute the MACRS percentages and the depreciation amounts for the new automobile.

DISSECTING THE PROBLEM

If you purchase an asset by trading in an old but similar asset, the cost basis for the new asset will be adjusted by its net book value.

Given: Five-year asset, half-year convention, $\alpha = 40\%$, trade-in allowance $= \$6{,}000$, and $S = \$0$.

Find: (a) Cost basis and (b) MACRS depreciation percentages D_n for the new automobile.

METHODOLOGY

Create a table of MACRS depreciation amounts.

SOLUTION

(a) Cost basis with trade-in allowances:

$$\begin{aligned}\text{Cost basis} &= \text{Cash paid} + \text{Book value}\\ &= \$24{,}000 + \$5{,}000\\ &= \$29{,}000.\end{aligned}$$

(b) As shown in Figure 9.2, we can calculate the depreciation amounts using the percentages taken directly from Table 9.8, which is supplied by the IRS.

- Asset cost = $29,000
- Recovery Period = 5-Year MACRS
- Depreciation Method = Half-year convention, zero salvage value, 200% DB switching to SL

20%	32%	19.20%	11.52%	11.52%	5.76%
$5,800	$9,280	$5,568	$3,341	$3,341	$1,670
	Full	Full	Full	Full	
1	2	3	4	5	6

Half-year convention

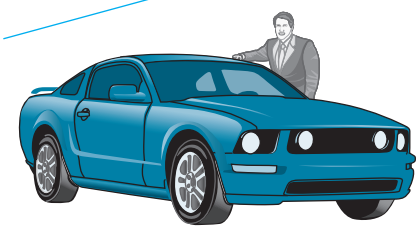
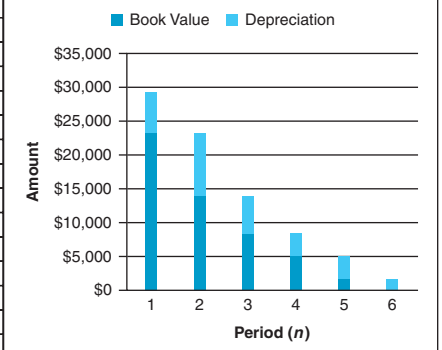


Figure 9.2 Features of MACRS depreciation method.

COMMENTS: Note that when an asset is disposed of before the end of the recovery period, only half of the normal depreciation is allowed. If, for example, the $29,000 asset were to be disposed of in year 2, the MACRS deduction for that year would be only $4,640. Another way to calculate the MACRS depreciation allowances is to use Excel. Table 9.9 shows how you might develop an Excel worksheet to perform the tax depreciation calculations.

TABLE 9.9 An Excel Worksheet to Calculate Tax Depreciation Amounts by MACRS

	A	B	C	D
1	**Property Class**			5-Year
2	**Declining Depreciation Method**			200%
3	**Cost Basis ($)**			$29,000
4	**Depreciable Life**			5
5	**Salvage Value ($)**			-
6	**Declining Balance Rate (α)**			0.40
7				
8	**Period**	**Beginning**	**Depreciation**	**Ending**
9	**(*n*)**	**Book Value**	**Amount**	**Book Value**
10				
11	1	$29,000	$5,800	$23,200
12	2	$23,200	$9,280	$13,920
13	3	$13,920	$5,568	$8,352
14	4	$8,352	$3,341	$5,011
15	5	$5,011	$3,341	$1,670
16	6	$1,670	$1,670	$0
17				



=B11*$D$6/2

=IF(B15*$D$6<(B15-$D$5)/($D$4-A14+0.5),(B15-$D$5)/($D$4-A14+0.5),B15*$D$6)

9.3.3 MACRS Depreciation: Real Property

Real properties are classified into two categories: (1) residential rental properties and (2) commercial buildings or properties. When depreciating such property, the straight-line method and the **midmonth convention** are used. For example, if you placed a property in service in March, you would get 9.5 months worth of depreciation for year 1. If it is disposed of before the end of the recovery period, the depreciation percentage must take into account the number of months the property was in service during the year of its disposal. Residential properties are depreciated over 27.5 years, and commercial properties are depreciated over 39 years.

EXAMPLE 9.7 MACRS Depreciation: Real Property

On May 1, Jack Costanza paid $100,000 for a residential rental property. This purchase price represents $80,000 for the cost of the building and $20,000 for the cost of the land. Nine years and five months later, on October 1, he sold the property for $130,000. Compute the MACRS depreciation for each of the 10 calendar years during which he owned the property.

DISSECTING THE PROBLEM

Given: Residential real property with cost basis = $80,000; the building was put into service on May 1.

Find: The depreciation in each of the 10 tax years the property was in service.

METHODOLOGY

Compute depreciation over the recovery period using Excel.

SOLUTION

In this example, the midmonth convention assumes that the property is placed in service on May 15, which gives 7.5 months of depreciation in the first year. Remembering that only the building (not the land) may be depreciated, we compute the depreciation over a 27.5-year recovery period using the SL method.

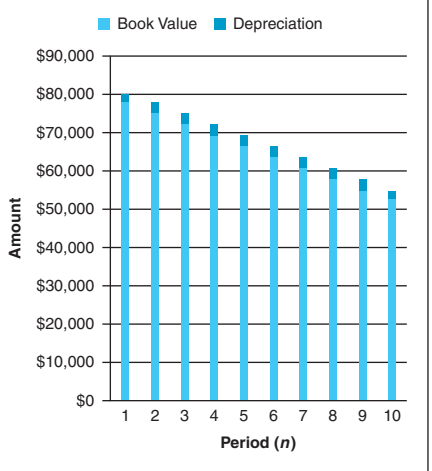
Year	Calculation	D_n	Recovery Percentages
1	$\left(\frac{7.5}{12}\right)\frac{\$80{,}000 - 0}{27.5} =$	\$1,818	2.273%
2–9	$\frac{\$80{,}000 - 0}{27.5} =$	\$2,909	3.636%
10	$\left(\frac{9.5}{12}\right)\frac{\$80{,}000 - 0}{27.5} =$	\$2,303	2.879%

Notice that the midmonth convention also applies to the year of disposal.

COMMENTS: As for personal property, we can obtain depreciation calculations for real property by using Excel as shown in Table 9.10. Unlike the personal-property calculation, you need to specify the month in which the real property was placed in service in cell D5.

TABLE 9.10 An Excel Worksheet to Generate a Depreciation Schedule for a Real Property (Example 9.7)

	A	B	C	D
2	Cost Basis ($)			$80,000
3	Property Class			27.5-Year
4	Holding Period in Years			10
5	Month Placed in Service			1-May
6	Month Taken Out of Service			1-Oct
7	Salvage Value ($)			-
8	Depreciation Rate			0.03636
10	Period	Depreciation	Depreciation	Ending
11	(*n*)	Rate	Amount	Book Value
13	1	0.02273	$1,818	$78,182
14	2	0.03636	$2,909	$75,273
15	3	0.03636	$2,909	$72,364
16	4	0.03636	$2,909	$69,455
17	5	0.03636	$2,909	$66,545
18	6	0.03636	$2,909	$63,636
19	7	0.03636	$2,909	$60,727
20	8	0.03636	$2,909	$57,818
21	9	0.03636	$2,909	$54,909
22	10	0.02879	$2,303	$52,606



=D8*(12-MONTH(D5)+0.5)/12

=D8*(MONTH(D6)-0.5)/12

9.4 Corporate Taxes

As we have seen in Chapters 4 through 7, we make our investment decisions on the basis of the net project cash flows, that is, cash flows *after taxes*. In order to calculate the amount of taxes involved in project evaluation, we need to understand how businesses determine taxable income and thereby net income (profit).

9.4.1 How to Determine "Accounting Profit"

Firms invest in a project because they expect it to increase their wealth. If the project does this—that is, if project revenues exceed project costs—we say it has generated a **profit**, or **income**. If the project reduces a firm's wealth—that is, if project costs exceed project revenues—we say that the project has resulted in a **loss**. One of the most important roles of the accounting function within an organization is to measure the amount of profit or loss a project generates each year, or in any other relevant time period. Any profit generated will be taxed. The accounting measure of a project's after-tax profit during a particular time period is known as **net income**.

Treatment of Depreciation Expenses

Whether you are starting or maintaining a business, you will probably need to acquire assets (such as buildings and equipment). The cost of these assets becomes part of your business expenses. The accounting treatment of capital expenditures differs from the treatment of manufacturing and operating expenses, such as cost of goods sold and business operating expenses.

As mentioned earlier in the chapter, **capital expenditures must be capitalized in principle**, or systematically allocated as expenses over their depreciable lives. Therefore, when you acquire a piece of property that has a productive life extending over several years, you may not deduct the total costs from profits in the year the asset was purchased, unless otherwise allowed by the tax law. Instead, a depreciation allowance is established over the life of the asset, and an appropriate portion of that allowance is included in the company's deductions from profit each year. Because it plays a role in reducing taxable income, depreciation accounting is of special concern to a company. In the next section, we will investigate the relationship between depreciation and net income.

Calculation of Net Income

Accountants measure the net income of a specified operating period by subtracting expenses from revenues for that period. For projects, these terms can be defined as follows:

1. **Gross revenues** are the incomes earned by a business as a result of providing products or services to customers. Revenue comes from sales of merchandise to customers and from fees earned by services performed for clients or others.
2. **Expenses** are costs incurred in doing business to generate the revenues of the specified operating period. Some common expenses are the cost of goods sold (labor, material, inventory, and supplies), depreciation, the cost of employees' salaries, the operating costs (such as the cost of renting buildings and the cost of insurance coverage), interest expenses for any business borrowing, and income taxes.

The aforementioned business expenses are accounted for in a straightforward fashion on a company's income statement and balance sheet; the amount paid by the organization for each item translates dollar for dollar into the expenses listed in financial reports for the period. One additional category of expenses, the purchase of new assets, is

treated by depreciating the total cost gradually over time. Because capital goods are given this unique accounting treatment, depreciation is accounted for as a separate expense in financial reports. In the next section, we will discuss how depreciation accounting is reflected in net-income calculations. Once we define the gross incomes and expenses, the next step is to determine the corporate taxable income, which is defined as follows:

$$\text{Taxable income} = \text{Gross income (i.e., revenues)} - \text{Allowable deductions}.$$

The allowable deductions include the cost of goods sold, salaries and wages, rent, interest expenses, advertising, depreciation, amortization, depletion, and various tax payments other than federal income tax. Once taxable income is calculated, income taxes are determined as follows:

$$\text{Income taxes} = (\text{Tax rate}) \times (\text{Taxable income}).$$

(We will discuss how we determine the applicable tax rate in Section 9.4.2.) We then calculate net income as follows:

$$\text{Net income} = \text{Taxable income} - \text{Income taxes}.$$

A more common format is to present the net income in the tabular income statement, such as the one given in Figure 9.3. If the gross income and other expenses remain the same, any decrease in depreciation deduction will increase the amount of taxable income and thus the income taxes but result in a higher net income. On the other hand, any increase in depreciation deduction would result in a smaller amount of income taxes but a lower net income. If a firm borrows money to purchase assets or to finance a business operation, the interest payment is viewed as an operating expense that can be deducted from gross income.

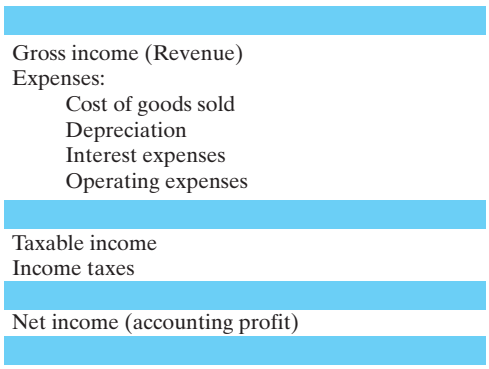


Figure 9.3 Tabular approach to finding the net income.

9.4.2 U.S. Corporate Income Tax System

Now that we have learned what elements constitute taxable income, we turn our attention to the process of computing corporate income taxes in the United States. Corporate tax in the U.S. is typically imposed at the federal, most state, and some local levels on the taxable income. There have been changes in tax code from time to time, but the Tax Cuts and Jobs Act of 2017 is the most sweeping update to the U.S. tax code in more than 30 years. Some of the key changes in the tax code are as follows:

- **Corporate tax rate**: Cuts corporate income tax rate to 21% from 35%, beginning January 1, 2018.
- **Capital expensing**: Allows businesses to immediately write-off, or expense, the full value of equipment for five years, then gradually eliminates 100% expensing over a five-year period beginning in year six.
- **Interest deduction limit**: Caps business deduction for debt interest payments at 30% of taxable income before interest and taxes.

Congress will have to revisit the tax code in the coming years to make many temporary provisions permanent and to make further improvement to the tax code. So it is prudent to check any change in tax law at the time of conducting project analysis. We will first review some of the key elements in the recent tax code that will affect our engineering economic analysis.

Corporate Tax Rates

Federal tax rates on corporate taxable income varied from 15% to 35% until December 31, 2017. However,

- On December 20, 2017, Congress passed the Tax Cut and Jobs Act, setting a flat and effective corporate tax rate of 21% on all businesses starting January 1, 2018 effectively. These changes are permanent.
- The rate applied to the last dollar of income earned is defined as **marginal tax rate**. The **average (or effective) tax rate** is the total tax paid as a percentage of total income earned. With a flat 21% tax rate, the marginal tax rate will always be 21% and the average tax rate would be also 21%. Average tax rate measures tax burden, while marginal tax rate measures the impact of taxes on incentives to earn or spend.
- The provision repeals the maximum corporate tax rate on net capital gain as obsolete. All net capital gain will be treated as ordinary income and taxed at 21%.

Cost Recovery Full Expensing for Certain Business Assets – Bonus Depreciation

As an alternative (optional) to MACRS, the 2017 Tax Cuts and Jobs Act extends and modifies the additional first-year depreciation deduction known as bonus depreciation through 2022 (through 2023 for longer production period property, a recovery period of at least 10 years) and transportation property such as aircraft.

- A **bonus depreciation** is a tax incentive that allows a business to immediately deduct a full purchase price of eligible business assets acquired and placed in service after September 29, 2017, and before January 1, 2023 (January 1, 2024, for longer production period property and certain aircraft).
- Similar to the bonus depreciation, Section 179 of the IRS Code was enacted to allow small businesses the opportunity of taking a depreciation deduction for capital assets in one year up to a maximum limit of $1,000,000. If the company is eligible for a Section 179 deduction, it must be claimed before applying the bonus and standard depreciation rate.

Under the provision, the bonus depreciation percentage rates are shown as in Table 9.11, and its implementation timeline is illustrated in Figure 9.4.

TABLE 9.11 Bonus Depreciation Percentage under the 2017 Tax Cuts and Jobs Act

Placed in Service Year	Bonus Depreciation Percentage	
	Qualified Property in General/ Specified Plants	Longer Production Period Property and Certain Aircraft
	Portion of Basis of Qualified Property Acquired after Sept. 27, 2017	
Sept. 28, 2017–Dec. 31, 2022	100%	100%
2023	80%	100%
2024	60%	80%
2025	40%	60%
2026	20%	40%
2027	None	20%
2028 and thereafter	None	None

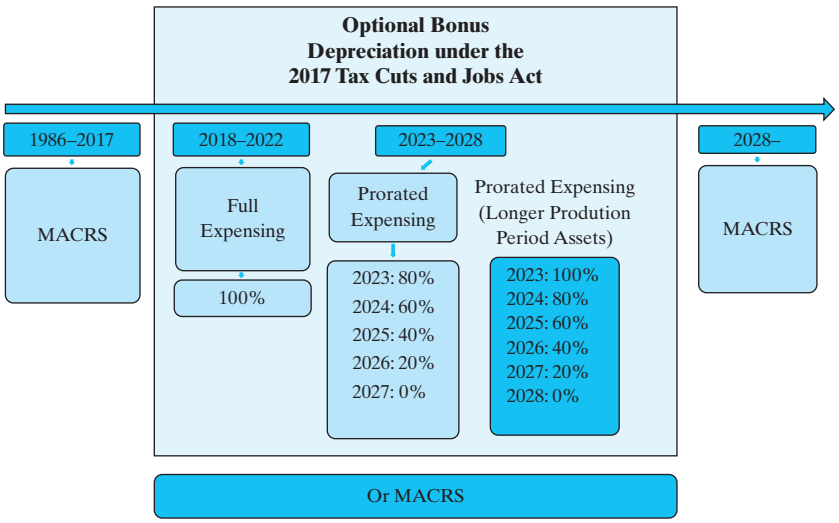


Figure 9.4 Timeline for implementation of bonus depreciation under the 2017 Tax Cuts and Jobs Act.

The bonus depreciation is applied to capital expenses by multiplying the bonus depreciation rate by the **cost basis** of the acquired asset. The resulting amount is the business' accelerated first year bonus depreciation that is allowed to deduct from taxable income. The remaining portion of the cost basis (if any) is then depreciated normally according to MACRS. Recall that a taxpayer is permitted to "elect out" of the bonus depreciation regime all together—just use MACRS.

EXAMPLE 9.8 Bonus Depreciation

Suppose you purchased an equipment of $1,000,000 and placed in service in 2023. The equipment has a service of life of 10 years with a salvage value of $100,000. This equipment is classified as a 7-year property. If you decided to take the optional bonus depreciation, determine the allowed depreciation of the equipment over the recovery period.

DISSECTING THE PROBLEM

Given: $I = \$1{,}000{,}000$, $S = \$100{,}000$, $N = 10$ years, and Recovery Period $= 7$ years.

Find: D_n for $n = 2013$ to 2030.

METHODOLOGY

Since the allowed first-year bonus depreciation is 80% of the equipment cost, the remaining 20% of the equipment cost would be depreciated by the 7-year MACRS.

SOLUTION

In Table 9.11, you can claim \$800,000 as the bonus depreciation, and the remaining \$200,000 will be depreciated according to a 7-year MACRS. Therefore, the depreciation schedule for the asset placed in service in 2023 would be as follows:

Year	Bonus Depreciation	MACRS Depreciation	Total Depreciation
2023	\$800,000	\$28,580	\$828,580
2024		\$48,980	\$48,980
2025		\$34,980	\$34,980
2026		\$24,980	\$24,980
2027		\$17,860	\$17,860
2028		\$17,840	\$17,840
2029		\$17,860	\$17,860
2030		\$8,920	\$8,920
Total	\$800,000	\$200,000	\$1,000,000

COMMENTS: In this case, we assumed that the firm is not eligible for a Section 179 deduction. If it is, the firm can claim the entire cost of \$1,000,000 as the first year depreciation.

EXAMPLE 9.9 How to Determine Corporate Taxes

An online electronics retailer sells various brands of home security systems. The company leased showroom space and a warehouse for \$20,000 a year and installed \$290,000 worth of inventory-checking and packaging equipment. The allowed first-year MACRS depreciation expense for this capital expenditure (\$290,000 total) amounted to \$58,000. The entire amount was financed at an 8% interest rate over five years. The first year interest expense due was \$23,200. The store was completed and operations began on January 1. The company had a gross income of \$1,250,000 for the calendar year. Supplies and all operating expenses other than the lease and interest expenses were itemized as follows:

Merchandise sold in the year	$600,000
Employee salaries and benefits	$150,000
Other supplies and expenses	$90,000
	$840,000

Compute the taxable income, federal income taxes, and net income assuming (a) the regular MACRS depreciation deduction and (b) 100% full capital expensing.

DISSECTING THE PROBLEM

Given: Income, foregoing cost information, and depreciation amount.

Find: (a) Taxable income and amount paid in federal income taxes, (b) Repeat (a) if the firm took 100% full expensing instead of regular depreciation deduction.

METHODOLOGY

Compute taxable income, average corporate tax rate, and net income. Taxable income before interest and taxes are $390,000. Since the interest expense of $23,200 is within a 30% ($390,00) cap, the entire amount would be deductible.

SOLUTION

First, we compute the taxable income as follows:

	(a) With MACRS	(b) With full expensing
Gross revenue	$1,250,000	$1,250,000
Expenses	$840,000	$840,000
Lease expense	$20,000	$20,000
Interest expense	$23,200	$23,200
Depreciation	$58,000	$290,000
Taxable income	$308,800	$76,800
Taxes (21%)	**$64,848**	**$16,128**
Net income	$243,952	$60,672

With the full expensing option, the first year tax due is $48,720 less than the case of regular capitalization through MACRS. Most firms would take this full expensing (if allowed) as they can reinvest the deferred tax savings in other business projects. However, with full expensing during the first year, there will be no more depreciation deduction in future operating years, so taxes will be higher. In this case, the firm is basically deferring the tax obligations into future operating years.

9.4.3 Gain Taxes on Asset Disposals

When a depreciable asset used in business is sold for an amount that differs from its book value, the gains or losses have an important effect on income taxes. To calculate a gain or loss, we first need to determine the book value of the depreciable asset at the time of disposal.

Book Value Calculation

For a MACRS property, one important consideration at the time of disposal is whether the property is disposed of *during* or *before* its specified recovery period. Moreover, with the half-year convention, which is now mandated by all MACRS depreciation methods, the year of disposal is charged one-half of that year's annual depreciation amount, should the disposal occur during the recovery period. For example, let's consider a five-year MACRS property with a cost basis of $100,000. The book value calculation at the time of disposal looks like the following:

- **Case 1:** If you dispose of the asset *before* the recovery period, say, in year 3, then

$$\text{BV}_3 = \$100{,}000 - \$100{,}000\left[0.20 + 0.32 + \frac{0.192}{2}\right] = \$38{,}400.$$

- **Case 2:** If you dispose of the asset *at the end* of its recovery period, say, in year 5, then

$$\begin{aligned}\text{BV}_5 &= \$100{,}000 - \$100{,}000\left[0.20 + 0.32 + 0.192 + 0.1152 + \frac{0.1152}{2}\right] \\ &= \$11{,}520.\end{aligned}$$

- **Case 3:** If you dispose of the asset *after* the recovery period, say, in year 6, then

$$\begin{aligned}\text{BV}_6 &= \$100{,}000 - \$100{,}000[0.20 + 0.32 + 0.192 + 0.1152 + 0.1152 + 0.0576] \\ &= \$0.\end{aligned}$$

Taxable Gains (or Losses)

Taxable gains are defined as the difference between the salvage value and the book value. If the salvage value is more than the cost basis, these taxable gains can be further divided into capital gains and ordinary gains. Specifically, we consider two cases as follows:

- **Case 1:** Salvage value $<$ Cost basis

  In this case,

$$\text{Gains(losses)} = \text{Salvage value} - \text{Book value},$$

where the salvage value represents the proceeds from the sale (selling price) less any selling expense or removal cost. The gains, commonly known as **ordinary gains** or **depreciation recapture**, are taxed as ordinary income under current tax law.

- **Case 2:** Salvage value > Cost basis

  If an asset is sold for an amount more than its cost basis, the gain (salvage value − book value) is divided into two parts for tax purposes:

$$\begin{aligned}\text{Gains} &= \text{Salvage value} - \text{Book value} \\ &= \underbrace{(\text{Salvage value} - \text{Cost basis})}_{\text{Capital gains}} + \underbrace{(\text{Cost basis} - \text{Book value})}_{\text{Ordinary gains}}\end{aligned}$$

As shown in Figure 9.5, this distinction is necessary only when capital gains are taxed at the capital-gains tax rate and ordinary gains (or depreciation recapture) are taxed at the ordinary income-tax rate. Current tax law does not provide a special low rate of taxation for capital gains for corporations. Currently, capital gains are treated as ordinary income, but the maximum tax rate is set at the U.S. statutory rate of 21%. Nevertheless, the statutory structure for capital gains has been retained in the tax code. This provision could allow Congress to restore preferential treatment for capital gains at some future time.

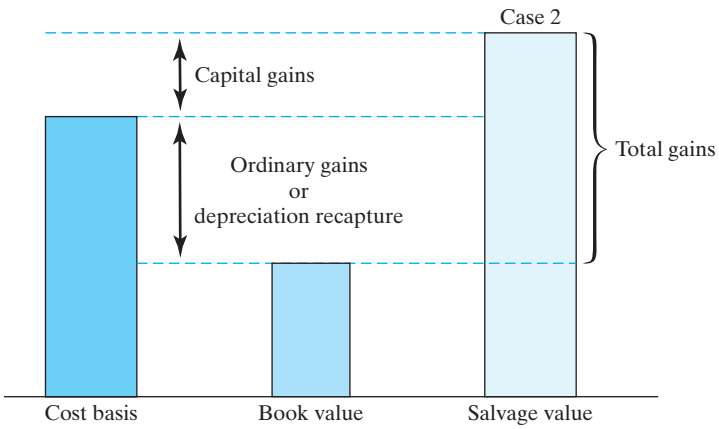


Figure 9.5 Determining ordinary gains and capital gains.

EXAMPLE 9.10 Gains and Losses on Depreciable Assets

A company purchased a drill press costing $230,000 in year 0. The drill press, classified as seven-year recovery property, has been depreciated by the MACRS method. If it is sold at the end of three years for (1) $150,000 or (2) $100,000, compute the gains (losses) for each situation. Assume that both capital gains and ordinary income are taxed at 21%.

DISSECTING THE PROBLEM

Given: Seven-year MACRS asset, cost basis = \$230,000, sold three years after purchase.

Find: Gains or losses, tax effects, and net proceeds from the sale if sold for \$150,000 or \$100,000.

METHODOLOGY

We first compute the current book value of the machine. From the MACRS depreciation schedule in Table 9.8, the allowed annual depreciation percentages for the first three years are 14.29%, 24.49%, and 17.49%, respectively. Since the asset is disposed of *before* the end of its recovery period, the depreciation amount in year 3 will be reduced by half.

SOLUTION

The total depreciation and final book value are calculated as follows:

$$\begin{aligned}\text{Total allowed depreciation} &= \$230{,}000(0.1429 + 0.2449 + 0.1749/2)\\ &= \$109{,}308;\\ \text{Book value} &= \$230{,}000 - \$109{,}308\\ &= \$120{,}692.\end{aligned}$$

- **Case 1:** $S = \$150{,}000$.
  Since the salvage value is less than the cost basis, there are no capital gains to consider. All gains are ordinary gains:

$$\begin{aligned}\text{Ordinary gains} &= \text{Salvage value} - \text{Book value}\\ &= \$150{,}000 - \$120{,}692\\ &= \$29{,}308.\end{aligned}$$

  So, with an ordinary-gains tax of 21%, we find that the amount of tax paid on the gains is

$$0.21(\$29{,}308) = \$6{,}155.$$

  Thus,

$$\begin{aligned}\text{Net proceeds from sale} &= \text{Salvage value} - \text{Gains tax}\\ &= \$150{,}000 - \$6{,}155\\ &= \$143{,}845.\end{aligned}$$

  The computation process is summarized in Figure 9.6.

- **Case 2:** $S = \$100{,}000$.
  Since the book value is \$120,692, the amount of loss will be \$20,693. Since the loss can be applied to offset other gains or ordinary income from business to the extent of the loss, this has a tax-saving effect. The anticipated tax savings will be $(\$120{,}692 - \$100{,}000)(0.21) = \$4{,}345$. Therefore, the net proceeds from sale will be \$104,345.

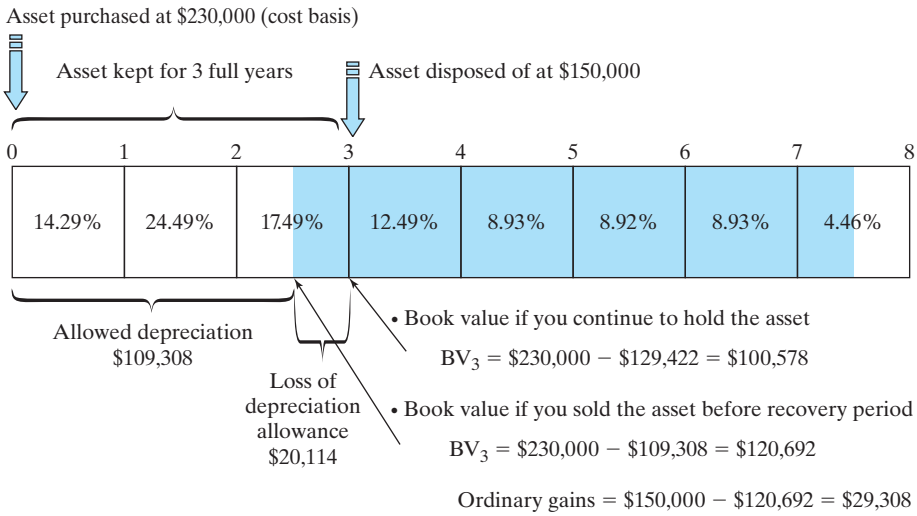


Figure 9.6 Gain or loss on a depreciable asset (Example 9.9).

COMMENTS: If the company took full 100% expensing but disposed of the asset before its recovery period, the book value and taxable calculations for gains would be still based on the assumption of regular MACRS, which is exactly the same as what we have shown in this example. In other words, for Case 1, the firm still has to pay the same gains tax in the amount of $6,155. (See Example 10.4.)

SUMMARY

- Explicit consideration of taxes is a necessary aspect of any complete economic study of an investment project.
- Since we are interested primarily in the measurable financial aspects of depreciation, we consider the effects of depreciation on two important measures of an organization's financial position, **net income** and **cash flow from operations**. Once we understand that depreciation has a significant influence on the income and cash position of a firm, we will be able to appreciate fully the importance of using depreciation as a means to maximize the value both of engineering projects and of the organization as a whole.
- Machine tools and other manufacturing equipment and even factory buildings themselves are subject to wear over time. However, it is not always obvious how to account for the cost of their replacement. How we determine the estimated service life of a machine, and the method used to calculate the cost of operating it, can have significant effects on an asset's management.
- The entire cost of replacing a machine cannot be properly charged to any one year's production; rather, the cost should be spread (or capitalized) over the years in which the machine is in service. The cost charged to operations of an asset during a particular year is called **depreciation**. Several different meanings and applications of depreciation have been presented in this chapter. From an engineering economics point of view, our primary concern is with **accounting depreciation**—the systematic allocation of an asset's value over its depreciable life.
- Accounting depreciation can be broken into two categories:
  1. **Book depreciation** is the method of depreciation used for financial reports and pricing products.

2. **Tax depreciation**, governed by tax legislation, is the method of depreciation used for calculating taxable income and income taxes.

- The four components of information required in order to calculate depreciation are
  1. The cost basis of the asset,
  2. The salvage value of the asset,
  3. The depreciable life of the asset, and
  4. The method of the asset's depreciation.
- Because it employs accelerated methods of depreciation and shorter-than-actual depreciable lives, the **Modified Accelerated Cost Recovery System (MACRS)** gives taxpayers a break by allowing them to take earlier and faster advantage of the tax-deferring benefits of depreciation.
- Many firms select straight-line depreciation for book depreciation because of its relative ease of calculation.
- Given the frequently changing nature of depreciation and tax law, we must use whatever percentages, depreciable lives, and salvage values were mandated *at the time an asset was acquired*.
- Corporate taxable income is defined as

$$\text{Taxable income} = \text{Gross income (i.e., revenues)} - \text{Allowable deductions}.$$

  The allowable deductions include the cost of goods sold, salaries and wages, rent, interest, advertising, depreciation, amortization, depletion, and various tax payments other than federal income tax.
- For corporations, the U.S. tax system has the following characteristics:
  - **Corporate tax rate:** Adopts a flat tax rate of 21% on taxable income, effective on January 1, 2018.
  - **Capital expensing:** Allows businesses to immediately write-off, or expense, the full value of equipment for five years, then gradually eliminates 100% expensing over a five-year period beginning in year six.
  - **Interest deduction limit:** Caps business deduction for debt interest payments at 30% of taxable income before interest and taxes.
- Two distinct terms to describe taxes were used in this chapter: **marginal tax rate,** which is the rate applied to the last dollar of income earned; **average (or effective) tax rate,** which is the ratio of income tax paid to the income earned before tax (or simply taxable income).
- **Capital gains** are currently taxed as ordinary income, and the maximum rate is capped at 21%. **Capital losses** are deducted from capital gains; net remaining losses may be carried forward for consideration in years other than the current tax year.

SELF-TEST QUESTIONS

9s.1 A machine purchased for $65,000 has a depreciable life of five years. It will have an expected salvage value of $5,000 at the end of its depreciable life. If the straight-line method is used, what is the book value at the end of year 2?

(a) $41,000
(b) $30,000
(c) $26,000
(d) $25,000

9s.2 Consider Problem 9s.1. If the double-declining balance (200% DB) method is used, what is the depreciation amount for year 2?
(a) $9,360
(b) $11,250
(c) $20,000
(d) $15,600

9s.3 Consider problem 9s.2. Suppose the salvage value at the end of year 5 is estimated to be $8,000 instead of $5,000. If the 200% method is used, what is the depreciation amount for year 3?
(a) $1,250
(b) $1,360
(c) $8,000
(d) $9,360

9s.4 A trucking company computes depreciation on its vehicles by a mileage basis. Suppose a delivery truck has a cost of $43,000, a salvage value of $3,000, and an estimated useful life of 400,000 miles. Determine the depreciation rate per mile.
(a) $0.08
(b) $0.09
(c) $0.10
(d) $0.11

9s.5 A company purchased a drill press priced at $170,000 in year 0. The company additionally incurred $30,000 for site preparation and labor to install the machine. The drill press was classified as a seven-year MACRS class property. The company is considering selling the drill press for $70,000 at the end of year 4. Compute the book value at the end of year 4 that should be used in calculating the taxable gains.
(a) $62,480
(b) $53,108
(c) $63,725
(d) $74,970

9s.6 Suppose that you placed a commercial building (warehouse) in service in January. The cost of property is $300,000, which includes the $100,000 value of land. Determine the amount of depreciation that is allowed during the first year of ownership.
(a) $7,692
(b) $5,128
(c) $7,372
(d) $4,915

9s.7 Centronix Corporation purchased new equipment with an estimated useful life of five years. The cost of the equipment was $200,000, and the residual (salvage) value was estimated to be $25,000. In purchasing the new equipment, an old machine was traded in that had an original cost of $180,000, and had been depreciated at the rate of $18,000 a year. The trade-in allowance was $21,000, and accumulated depreciation amounted to $144,000 at the time of the exchange. What should be the cost basis of the new equipment for tax depreciation purposes?

(a) $200,000
(b) $215,000
(c) $175,000
(d) $190,000

9s.8 Omar Shipping Company bought a tugboat for $75,000 (year 0) and expected to use it for five years after which it will be sold for $12,000. Suppose the company estimates the following revenues and expenses from the tugboat investment for the first operating year:

Operating revenue	$200,000
Operating expenses	$84,000
Depreciation	$4,000

If the company pays taxes at the rate of 30% on its taxable income, what is the net income during the first year?
(a) $28,700
(b) $81,200
(c) $78,400
(d) $25,900

9s.9 In Problem 9s.8, assume for the moment that (1) all sales were for cash and (2) all costs, except depreciation, were paid during year 1. How much cash would have been generated from operations?
(a) $82,400
(b) $32,700
(c) $85,200
(d) $3,400

9s.10 Minolta Machine Shop just purchased a controlled vertical drill press for $100,000. The drill press is classified as a three-year MACRS property. Minolta is planning to use the press for five years. Then Minolta will sell the press at the end of its service life for $20,000. The annual revenues are estimated to be $110,000. If the estimated net cash flow at the end of year 5 is $30,000, what are the estimated operating and maintenance expenses in year 5? Minolta's income tax rate in 2017 is 40%.
(a) $60,000
(b) $65,000
(c) $80,000
(d) $88,333

9s.11 Consider a five-year MACRS asset, which can be purchased at $80,000. The salvage value of this asset is expected to be $42,000 at the end of three years. What is the amount of gain (or loss) when the asset is disposed of at the end of three years?
(a) Gain $11,280
(b) Gain $9,860
(c) Loss $9,860
(d) Gain $18,960

9s.12 You purchased a stamping machine that cost $60,000 five years ago. At that time, the machine was estimated to have a service life of five years with salvage value of $5,000. These estimates are still good. The property has been depreciated according to a seven-year MACRS property class. Now (at the end of year 5 from purchase) you are considering selling the machine at $10,000. What book value should you use in determining the taxable gains?

(a) $10,000
(b) $13,386
(c) $16,065
(d) $17,520

9s.13 Nelson Company purchased equipment and incurred the following expenses:

- Cash price = $55,000
- Sales taxes = $4,400
- Insurance during transit = $400
- Site preparation, installation, and testing = $2,300

What amount should be used as the cost basis of the equipment?

(a) $58,000
(b) $62,100
(c) $123,000
(d) $73,000

9s.14 A local private hospital has just purchased a new computerized patient information system with an installed cost of $220,000. The information system is treated as five-year MACRS property. The system would have a salvage value of about $20,000 at the end of five years. What is the 3rd year depreciation allowances?

(a) $42,240
(b) $63,360
(c) $25,344
(d) $37,888

9s.15 In 2018, you purchased a spindle machine (seven-year MACRS property class) for $28,000, which you placed in service in January. Compute the book value at the end of year 5 for the machine.

(a) $4,499
(b) $5,499
(c) $6,247
(d) $8,746

PROBLEMS

Note: Unless otherwise specified, use current tax rates for corporate taxes. Check the IRS website for the most current tax rates for corporations. On December 20, 2017, the U.S. Congress passed the Tax Cuts and Jobs Act, setting a flat and effective corporate tax rate of 21% on all business starting January 1, 2018 effectively.

Depreciation Concept

9.1 Identify which of the following expenditures is considered as a capital expenditure that must be capitalized (depreciated):

(a) Purchase land to build a warehouse at $300,000.

(b) Purchased a copy machine at $15,000.
(c) Installed a conveyor system at a cost of $55,000 to automate some part of production processes.
(d) Painted the office building, both interior and exterior, at a cost of $22,000.
(e) Repaved the parking lot at a cost of $25,000.
(f) Installed a purified water fountain in the employee lounge at a cost of $3,000.
(g) Purchased a spare part for a stamping machine at a cost of $3,800.
(h) Paid $12,000 to lease a dump truck for six months.
(i) Purchased a patent on an energy-saving device over five years at a cost of $30,000.

9.2 A machine now in use was purchased four years ago at a cost of $40,000. It has a book value of $9,690. It can be sold for $18,000, but it could be used for three more years, at the end of which time, it would have no salvage value. What is the current amount of economic depreciation for this asset?

Cost Basis

9.3 The General Service Contractor Company paid $480,000 for a house and lot. The value of the land was appraised at $200,000 and the value of the house at $280,000. The house was then torn down at an additional cost of $24,000 so that a warehouse could be built on the combined lots at a cost of $1,360,000. What is the value of the property with the warehouse? For depreciation purposes, what is the cost basis for the warehouse?

9.4 A new drill press was purchased for $156,000 by trading in a similar machine that had a book value of $48,000. Assuming that the trade-in allowance is $41,500 and that $114,500 cash is to be paid for the new asset, what is the cost basis of the new asset for depreciation purposes?

9.5 A lift truck priced at $37,500 is acquired by trading in a similar lift truck and paying cash for the remaining balance. Assuming that the trade-in allowance is $9,000 and the book value of the asset traded in is $8,750, what is the cost basis of the new asset for the computation of depreciation for tax purposes?

9.6 To automate one of its production processes, the Milwaukee Corporation bought four flexible manufacturing cells at a price of $450,000 each. When they were delivered, Milwaukee paid freight charges of $30,000 and handling fees of $18,000. Site preparation for these cells cost $52,000. Six foremen, each earning $22 an hour, worked five 40-hour weeks to set up and test the manufacturing cells. Special wiring and other materials required for the new manufacturing cells cost $4,800. Determine the cost basis (amount to be capitalized) for these cells.

Book Depreciation Methods

9.7 El Dorado Machinery Company purchased a delivery truck at a cost of $28,000 on March 10, 2018. The truck has a useful life of 10 years with an estimated salvage value of $3,000. Compute the annual depreciation for the first two years using
(a) The straight-line method.
(b) The 150% declining-balance method.

9.8 Consider the following data on an asset:

Cost of the asset, I	$250,000
Useful life, N	4 years
Salvage value, S	$70,000

Compute the annual depreciation allowances and the resulting book values using

(a) The straight-line depreciation method.

(b) The double-declining-balance method.

9.9 Compute the double-declining-balance (DDB) depreciation schedule for the following asset:

Cost of the asset, I	$300,000
Useful life, N	10 years
Salvage value, S	$52,000

9.10 A firm is trying to decide whether to keep an item of construction equipment for another year. The firm has been using DDB for book purposes, and this is the fourth year of ownership of the equipment, which cost $84,000 new. The useful life of the asset was five years. What was the depreciation in year 4?

9.11 Consider the following data on an asset:

Cost of the asset, I	$123,000
Useful life, N	7 years
Salvage value, S	$13,000

Compute the annual depreciation allowances and the resulting book values, initially using the DDB and then switching to SL.

9.12 The double-declining-balance method is to be used for an asset with a cost of $88,000, an estimated salvage value of $13,000, and an estimated useful life of six years.

(a) What is the depreciation for the first three fiscal years, assuming that the asset was placed in service at the beginning of the year?

(b) If switching to the straight-line method is allowed, when is the optimal time to switch?

9.13 Compute the DDB depreciation schedule for the following asset:

Cost of the asset, I	$28,000
Useful life, N	8 years
Salvage value, S	$4,500

(a) What is the value of α?

(b) What is the amount of depreciation for the second full year of use of the asset?

(c) What is the book value of the asset at the end of the sixth year?

9.14 The Upjohn Company purchased new packaging equipment with an estimated useful life of five years. The cost of the equipment was $55,000, and the salvage value was estimated to be $5,000 at the end of year 5. Compute the annual depreciation expenses over the five-year life of the equipment under each of the following methods of book depreciation:

(a) Straight-line method

(b) Double-declining-balance method

9.15 A secondhand bulldozer acquired at the beginning of the fiscal year at a cost of $56,000 has an estimated salvage value of $6,500 and an estimated useful life of 12 years. Determine the following.

(a) The amount of annual depreciation by the straight-line method.

(b) The amount of depreciation for the third year, computed by the double-declining-balance method.

Units-of-Production Method

9.16 Neo Limousine Service owns 10 limos and uses the units-of-production method in computing depreciations on its limos. Each limo, costing $36,000, is expected to be driven 200,000 miles and is expected to have a salvage value of $4,000. Limo #1 was driven 20,000 miles in year 1 and 25,000 miles in year 2. Determine the depreciation for each year and the book value at the end of year 2.

9.17 If a dump truck for hauling coal has an estimated net cost of $100,000 and is expected to give service for 300,000 miles, resulting in a salvage value of $10,000, what would be the depreciation per mile? Compute the allowed depreciation amount if the usage of the same truck amounts to 30,000 miles.

9.18 A diesel-powered generator with a cost of $73,650 is expected to have a useful operating life of 40,000 hours. The expected salvage value of this generator is $8,250. In its first operating year, the generator was operated for 4,800 hours. Determine the depreciation for the year.

9.19 Ingot Land Company owns four trucks dedicated primarily to its landfill business. The company's accounting record indicates the following, using the units-of-production method:

	Truck			
Description	***A***	***B***	***C***	***D***
Purchase cost	$62,000	$240,000	$47,000	$115,000
Salvage value	$2,000	$15,000	$5,000	$17,000
Useful life (miles)	200,000	75,000	120,000	50,000
Accumulated depreciation as year begins	$0	$60,000	$12,250	$19,600
Miles driven during year	18,000	24,000	38,000	12,000

Determine the amount of depreciation for each truck during the year.

9.20 A manufacturing company has purchased three assets:

	Asset Type		
Item	**Lathe**	**Truck**	**Building**
Initial cost	$45,000	$25,000	$800,000
Book life	12 years	200,000 miles	50 years
MACRS class	7 years	5 years	39 years
Salvage value	$3,000	$2,000	$100,000
Book depreciation	DDB	Unit production (UP)	SL

The truck was depreciated by the units-of-production method. Usage of the truck was 22,000 miles and 25,000 miles during the first two years, respectively.

(a) Calculate the book depreciation for each asset for the first two years.

(b) If the lathe is to be depreciated over the early portion of its life by the DDB method and then by a switch to the SL method for the remainder of its life, when should the switch occur?

9.21 The Collins Metal Shop purchased a stamping machine for $257,000 on March 1, 2017. The machine is expected to have a useful life of 10 years, a salvage value of $32,000, a production of 250,000 units, and working hours of 30,000. During 2018, Denver used the stamping machine for 2,450 hours to produce 23,450 units. From the information given, compute the book depreciation expense for 2018 under each of the following methods.

(a) Straight-line

(b) Units-of-production

(c) Working hours

(d) Double-declining-balance (without conversion to straight-line)

(e) Double-declining-balance (with conversion to straight-line)

Tax Depreciation

9.22 The Vermont Construction Company purchased a hauling truck on January 1, 2018 at a cost of $35,000. The truck has a useful life of eight years with an estimated salvage value of $6,000. The straight-line method is used for book purposes. For tax purposes, the truck would be depreciated with the MACRS method over its five-year class life. Determine the annual depreciation amount to be taken over the useful life of the hauling truck for both book and tax purposes.

9.23 The Harris Foundry Company purchased new casting equipment in 2018 at a cost of $190,000. Harris also paid $25,000 to have the equipment delivered and installed. The casting machine has an estimated useful life of 10 years, but it will be depreciated with MACRS over its seven-year class life.

(a) What is the cost basis of the casting equipment?

(b) What will be the depreciation allowance in each year of the seven-year class life of the casting equipment?

9.24 A machine is classified as seven-year MACRS property. Compute the book value for tax purposes at the end of three years. The cost basis is $185,000.

9.25 A piece of machinery purchased at a cost of $92,000 has an estimated salvage value of $12,000 and an estimated useful life of five years. It was placed in

service on May 1st of the current fiscal year, which ends on December 31st. The asset falls into a seven-year MACRS property category. Determine the depreciation amounts over the useful life.

9.26 In 2018, three assets were purchased and placed in service by a firm:

Asset Type	Date Placed in Service	Cost Base	MACRS Property Class
Machine tools	March 17	$5,000	3 years
CNC machine	May 25	$125,000	7 years
Warehouse	June 19	$335,000	39 years

Compute the depreciation allowances for each asset.

9.27 On April 1st, Leo Smith paid $310,000 for a residential rental property. This purchase price represents $250,000 for the building and $60,000 for the land. Five years later, on November 1st, he sold the property for $400,000. Compute the MACRS depreciation for each of the five calendar years during which he had the property.

9.28 On October 1st, you purchased a residential home in which to locate your professional office for $350,000. The appraisal is divided into $80,000 for the land and $270,000 for the building.

(a) In your first year of ownership, how much can you deduct for depreciation for tax purposes?

(b) Suppose that the property was sold at $375,000 at the end of fourth year of ownership. What is the book value of the property?

9.29 Ray Electric Company purchased a 10,000 ft^2 office space for $1,000,000 to relocate its engineering office on May 1, 2018. Determine the allowed depreciation in years 2018 and 2019.
(*Note:* There is no land value included in the purchase price.)

9.30 Consider the data in the following two tables:

First cost	$80,000
Book depreciation life	7 years
MACRS property class	7 years
Salvage value	$24,000

Depreciation Schedule

n	*A*	*B*	*C*	*D*
1	$8,000	$22,857	$11,429	$22,857
2	$8,000	$16,327	$19,592	$16,327
3	$8,000	$11,661	$13,994	$11,661
4	$8,000	$5,154	$9,996	$8,330
5	$8,000	$0	$7,140	$6,942
6	$8,000	$0	$7,140	$6,942
7	$8,000	$0	$7,140	$6,942
8	$0	$0	$3,570	$0

Identify the depreciation method used for each depreciation schedule as one of the following:

(a) Double-declining-balance depreciation

(b) Straight-line depreciation

(c) DDB with conversion to straight-line depreciation, assuming a zero salvage value

(d) MACRS seven-year depreciation with the half-year convention

(e) Double-declining-balance (with conversion to straight-line depreciation)

9.31 At the beginning of the fiscal year, the Borland Company acquired new equipment at a cost of $89,000. The equipment has an estimated life of five years and an estimated salvage value of $10,000.

(a) Determine the annual depreciation (for financial reporting) for each of the five years of the estimated useful life of the equipment, the accumulated depreciation at the end of each year, and the book value of the equipment at the end of each year. Use (1) the straight-line method and (2) the double-declining-balance method for each.

(b) Determine the annual depreciation for tax purposes, assuming that the equipment falls into a seven-year MACRS property class.

(c) Assume that the equipment was depreciated under seven-year MACRS. In the first month of the fourth year, the equipment was traded in for similar equipment priced at $92,000. The trade in allowance on the old equipment was $20,000, and cash was paid for the balance. What is the cost basis of the new equipment for computing the amount of depreciation for income tax purposes?

9.32 A company purchased a new forging machine to manufacture disks for airplane turbine engines. The new press cost $3,500,000, and it falls into a seven-year MACRS property class. The company has to pay property taxes to the local township for ownership of this forging machine at a rate of 1.2% on the beginning book value of each year.

(a) Determine the book value of the asset at the beginning of each tax year.

(b) Determine the amount of property taxes over the machine's depreciable life.

Corporate Taxes and Accounting Profits (Net Income)

9.33 Lynn Construction Company had a gross income of $34,000,000 in tax-year 1, $5,000,000 in salaries, $4,000,000 in wages, $1,000,000 in depreciation expenses, a loan principal payment of $200,000, and a loan interest payment of $210,000.

(a) What is the marginal tax rate for Lynn Construction in tax-year 1?

(b) What is the average tax rate in tax-year 1?

(c) Determine the net income of the company in tax-year 1.

9.34 A consumer electronics company was formed to develop cell phones that run on or are recharged by fuel cells. The company purchased a warehouse and converted it into a manufacturing plant for $6,000,000. It completed installation of assembly equipment worth $1,500,000 on December 31st. The plant began operation on January 1st. The company had a gross income of $8,500,000 for the calendar year. Manufacturing costs and all operating expenses, excluding the capital expenditures, were $2,280,000. The depreciation expenses for capital expenditures amounted to $456,000.

(a) Compute the taxable income of this company.

(b) How much will the company pay in federal income taxes for the year?

9.35 ABC Corporation will commence operations on January 1, 2019. The company projects the following financial performance during its first year of operation:

- Sales revenues are estimated at $2,500,000.
- Labor, material, and overhead costs are projected at $800,000.
- The company will purchase a warehouse worth $500,000 in February. To finance this warehouse, on January 1 the company will issue $500,000 of long-term bonds, which carry an interest rate of 10%. The first interest payment will occur on December 31.
- For depreciation purposes, the purchase cost of the warehouse is divided into $100,000 for the land and $400,000 for the building. The building is classified into the 39-year MACRS real-property class and will be depreciated accordingly.
- On January 5, the company will purchase $200,000 of equipment that has a five-year MACRS class life.

(a) Determine the total depreciation expenses allowed in 2019.

(b) Determine ABC's tax liability in 2019.

Gains or Losses

9.36 Consider a five-year MACRS asset purchased at $80,000. (Note that a five-year MACRS property class is depreciated over six years due to the half-year convention. The applicable salvage values would be $40,000 in year 3, $30,000 in year 5, and $10,000 in year 6.) Compute the gain or loss amounts when the asset is disposed of in

(a) Year 3.

(b) Year 5.

(c) Year 6.

9.37 In year 0, an electrical appliance company purchased an industrial robot costing $350,000. The robot is to be used for welding operations, classified as seven-year recovery property, and has been depreciated by the MACRS method. If the robot is to be sold after five years, compute the amounts of gains (losses) for the following two salvage values (assume that both capital gains and ordinary incomes are taxed at 21%):

(a) $20,000

(b) $99,000

9.38 Auburn Crane, Inc., a hydraulic crane service company, had sales revenues of $4,250,000 during tax year 2018. The following table provides other financial information relating to the tax year:

Labor expenses	$1,550,000
Material costs	$785,000
Depreciation	$332,500
Office supplies	$15,000
Debt interest expenses	$42,200
Rental expenses	$45,000
Proceeds from the sale of old cranes	$43,000

The sold cranes had a combined book value of $30,000 at the time of sale.

(a) Determine the taxable income for 2018.
(b) Determine the taxable gains for 2018.
(c) Determine the amount of income taxes and gains taxes (or loss credits) for 2018.

9.39 Electronic Measurement and Control Company (EMCC) has developed a laser speed detector that emits infrared light invisible to humans and radar detectors alike. For full-scale commercial marketing, EMCC needs to invest $5 million in new manufacturing facilities. The system is priced at $3,000 per unit. The company expects to sell 5,000 units annually over the next five years. The new manufacturing facilities will be depreciated according to a seven-year MACRS property class. The expected salvage value of the manufacturing facilities at the end of five years is $1.6 million. The manufacturing cost for the detector is $1,200 per unit excluding depreciation expenses. The operating and maintenance costs are expected to run to $1.2 million per year. EMCC has a combined federal and state income-tax rate of 25%, and undertaking this project will not change this current marginal tax rate.
(a) Determine the incremental taxable income, income taxes, and net income that would result from undertaking this new product for the next five years.
(b) Determine the gains or losses associated with the disposal of the manufacturing facilities at the end of five years.

Short Case Studies with Excel

9.40 A machine now in use that was purchased three years ago at a cost of $4,000 has a book value of $2,000. It can be sold now for $2,500, or it could be used for three more years, at the end of which time it would have no salvage value. The annual O&M costs amount to $10,000 for the machine. If the machine is sold, a new machine can be purchased at an invoice price of $14,000 to replace the present equipment. Freight will amount to $800, and the installation cost will be $200. The new machine has an expected service life of five years and will have no salvage value at the end of that time. With the new machine, the expected direct cash savings amount to $8,000 the first year and $7,000 in O&M for each of the next two years. Corporate income taxes are at an annual rate of 40%, and the net capital gain is taxed at the ordinary income-tax rate. The present machine has been depreciated according to a straight-line method, and the proposed machine would be depreciated on a seven-year MACRS schedule. Consider each of the following questions independently:
(a) If the old asset is to be sold now, what would be the amount of its equivalent book value?
(b) For depreciation purposes, what would be the first cost of the new machine (depreciation base)?
(c) If the old machine is to be sold now, what would be the amount of taxable gains and the gains tax?
(d) If the old machine is sold for $5,000 now instead of $2,500, what would be the amount of the gains tax?
(e) If the old machine had been depreciated by 175% DB and then by a switch to SL depreciation, what would be the current book value?
(f) If the old machine were not replaced by the new one and has been depreciated by the 175% DB method, when would be the time to switch from DB to SL depreciation?

9.41 Phillip Zodrow owns and operates a small unincorporated plumbing service business, Zodrow Plumbing Service (ZPS). Phillip is married and has two children, so he claims four exemptions on his tax return. As business grows steadily, tax considerations are important to him. Therefore, Phillip is considering incorporation of the business. Under either form of the business (corporation or sole ownership), the family will initially own 100% of the firm. Phillip plans to finance the firm's expected growth by drawing a salary just sufficient for his family's living expenses and by retaining all other income in the business. He estimates the income and expenses over the next three years to be as follows:

	Year 1	Year 2	Year 3
Gross income	$200,000	$215,000	$230,000
Salary	$100,000	$110,000	$120,000
Business expenses	$25,000	$30,000	$40,000
Personal exemptions	$14,800	$14,800	$14,800
Itemized deductions	$16,000	$18,000	$20,000

Which form of business (corporation or sole ownership) will allow Phillip to pay the lowest taxes (and retain the most income) during the three years? Personal income-tax brackets and amounts of personal exemption are updated yearly, so you need to consult the IRS tax manual for the tax rates, as well as for the exemptions, that are applicable to the tax years.

9.42 Julie Magnolia has $50,000 cash to invest for three years. Two types of bonds are available for consideration. She can buy a tax-exempt Arizona state bond that pays interest of 9.5% per year, or she can buy a corporate bond. Julie's marginal tax rate is 25% for both ordinary income and capital gains. Assume that any investment decision considered will not change her marginal tax bracket.

(a) If Julie were looking for a corporate bond that was just as safe as the state bond, what interest rate on the corporate bond is required so that Julie would be indifferent between the two bonds? There would be no capital gains or losses at the time of her trading the bond.

(b) In (a), suppose at the time of trading (year 3) that the corporate bond is expected to be sold at a price 5% higher than its face value. What interest rate on the corporate bond is required so that Julie would be indifferent between the two bonds?

(c) Alternatively, Julie can invest the amount in a tract of land that could be sold at $75,000 (after she pays the real-estate commission) at the end of year 3. Is this investment better than the state bond?