

**AC 2009-1014: THE PEDAGOGY OF TAXES AND TAX PURPOSE  
DEPRECIATION**

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# The Pedagogy of Taxes and Tax-Purpose Depreciation

## Introduction

Most economic analysis in industry is done without considering the effects of taxes. In some cases, typically those involving substantial investments, income tax can make an important difference in the final decision. For this reason most introductory courses in engineering economy include a section on taxes and, necessarily, on tax-purpose depreciation.

In any introductory course there are always some simplifications to be made. We would not, for example, begin a course in circuit analysis with a statement that Ohm's law is an approximation and that we need to understand the exact relationship between voltage and current for each different material. In the introductory engineering economy course these simplifications are mostly of little consequence. Monthly payments on a loan are, after all, about as simple in reality as we present them to be. Taxation, however, is a different matter altogether.

"Tax simplification" is an oxymoron. Tax professionals spend many hours each year just to keep up with the changes in tax laws and their interpretation. In one or two class periods we cannot give our students even a modicum of expertise on the subject. Even an entire semester course can barely scratch the surface of this complex subject. So, oxymoron or not, we must simplify taxes. The goal should be to provide as much useful knowledge as possible without confusing or misinforming. This problem is constrained by the limited time available and the limited background of our students. It is properly the place of the professor to decide which information is useful. This paper will make some suggestions in that regard but there is probably little disagreement on most of the topics to be covered. Most professors would probably agree that many students are confused by these topics. This paper will attempt to show where that confusion arises in the hope that improved presentation can eliminate at least some of it. Misinformation is obviously inadvertent and this paper will point out some of the more important issues which may be incorrectly presented in the introductory course.

The methodology, however, is indirect. Five textbooks were chosen as a representative cross section of those texts currently used in introductory courses. In lieu of a survey or collection of course notes from a number of courses, it will be assumed that the books are representative as well of the way these topics are currently being taught. There is a great variety in approaches and terminology in the books which would seem to indicate a similar variety in approaches and terminology in the courses.

Three of the books are among the most widely used and have been through numerous editions. Two of those are the "essentials" or "fundamentals" versions of those books since these are more widely used in the shorter, one-term courses that are most commonly required across a number of disciplines at many universities. One is less widely used but from a prolific textbook author and the fifth is a completely new book in its first edition.

## Modified Accelerated Cost Recovery System

The Modified Accelerated Cost Recovery System or MACRS came into being with the Tax Reform Act of 1986 and replaced, or modified as the name implies, the Accelerated Cost Recovery System or ACRS which began with the Economic Recovery Act of 1981. It is the only method by which assets can be depreciated for tax purposes in the United States although it contains within it a number of variations which are mandatory in certain cases and optional in others. By the same token it should only be used for taxes, not for any of the other purposes for which we use depreciation. MACRS is officially explained in IRS Publication 946, *How to Depreciate Property*, which is updated annually.

MACRS consists of two depreciation systems, the Alternative Depreciation System (ADS) and the General Depreciation System (GDS). Because it is more advantageous in nearly every situation, the GDS is much more widely used and should be the focus of the introductory course. In its most simplified form this system can be thought of as a three step process. First the recovery period of the asset must be determined. Next the recovery period is used to determine the correct column in the MACRS percentage table. Finally the percentage from that table corresponding to the recovery year of interest is multiplied by the basis of the asset to find the amount of the depreciation for that year.

### 1. History

Before ACRS the IRS published guidelines for acceptable asset lives for tax purposes called Asset Depreciation Ranges or ADRs. The depreciation method could be chosen from any of the commonly used accounting methods, straight line, sum of years digits and declining balance using 150%, 175% and 200%. In most cases the company was permitted to switch one time from any of these methods to any other. Salvage values were also somewhat arbitrary. Naturally most taxpayers selected life, salvage and method to depreciate the property as quickly as possible. ACRS dramatically changed this by specifying a common recovery period for all similar assets, grouping these asset lives into discrete property classes, defining salvage value as zero, and using a single method for most depreciation calculations. The recovery periods were based on the previously used ADRs. The recovery periods did not correspond to useful lives and in most cases were significantly shorter.

None of the five texts go into any detail to explain this history. Only one mentions the situation prior to ACRS. Three briefly mention ACRS; one simply stating that ACRS was the origin of the name MACRS. Two mention ADRs, one at some length. Surprisingly only one even alludes to the origin of the "Accelerated" part of the name in encouraging capital investment to spur economic growth.

## 2. Recovery Period

Publication 946 provides two tables from which the recovery period of an asset can be determined. The first, Table B-1, is only one page long and is based on the kind of asset, i.e. trucks, computers, office furniture, being depreciated. The second, Table B-2, is currently nine pages long and is based on the specific use of the asset, i.e. agriculture, air transport, motor vehicle manufacture. In general table B-2 takes precedence over B-1. Only if an asset can't be depreciated using the recovery period in B-2 can B-1 be used. These tables provide three different recovery periods labeled class life, GDS (MACRS) and ADS. Class life is the number of years used to establish the GDS and ADS for each kind of property. GDS is the MACRS property class and is the most widely used recovery period. ADS refers to the Alternate Depreciation System which is a straight line depreciation method which can be elected in many cases but would rarely be advantageous. The ADS recovery period is always greater than the GDS recovery period.

Each of the five books provides a table based on Publication 946 with examples drawn from tables B-1 and B-2. Each, as would be expected, uses different examples. Two fail to make it clear that the brief table is only a sampling of the official version. Two provide all three periods from the IRS tables even though they do not offer any use for class life. Two others provide the ADR on which the class life was originally based. The fifth provides an "ADS range" which corresponds neither to the ADS from publication 946 nor to the ADR. All five use automobiles as an example of 5-year property but only one points out the rather stringent IRS limitations on depreciation of passenger cars.

Three of the books properly cite Publication 946, one cites IRS Publication 534, which is titled *Depreciating Property Placed in Service Before 1987*, refers only to ACRS and has not been revised since 1995. One provides no citation at all.

## 3. MACRS Schedule

The most commonly used version of GDS uses percentages from Publication 946 Table A-1 *3, 5, 7, 10, 15, and 20-Year Property Half-Year Convention*. The numbers in this table were originally derived by using 200% declining balance for the 3, 5, 7, and 10-year recovery periods and 150% declining balance for the 15 and 20-year recovery periods. All use the half-year convention, meaning that a half-year's depreciation is taken in the first recovery year and the other half year is taken in the last recovery year. This means that there is always one more recovery year than the length of the recovery period. All six personal property classes also include an optimal switch to straight line depreciation. It should be noted, however, that the table presents a limited number of decimal places, two for the first five classes and three for the 20-year class. Since the salvage is assumed to be zero, the total depreciation taken in each class must add up to 100%. A certain amount of roundoff error must be distributed in each class, thus the table percentages after the switch to straight line are not all the same. Publication 946 appears to require the use of the table percentages rather than the exact values.

Four of the five books reproduce this table as show below in Table 1 although with varying captions. The fifth provides two tables, taken from the IRS Instructions for Form 4562. One is derived using 200% declining balance and the other using 150% declining balance both with switch to straight line and the half-year convention as in table A-1. Since 200% declining balance usually is the best choice, table A-1 is based on using it wherever possible. The 150% table, in both the IRS instructions and the textbook includes a column for a 12-year recovery period which is not supported in Publication 946!

All five books show how the applicable declining balance with optimal switch to straight line method is used in conjunction with the half year convention to derive the percentages in the tables. Two include the percent sign in the tables (as does Publication 946) and two clarify this in the caption for the table.

Year	3-year	5-year	7-year	10-year	15-year	20-year
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

Table 1: MACRS percentages from Publication 946 Table A-1

#### 4. Basis

Publication 946 says that the percentages in the table are applied to the "basis" of the asset. In the glossary it defines basis as "a measure of an individual's investment in property for tax purposes." In context, however, it is clear that basis is intended in most cases to be the initial cost of the property. This should include items such as shipping

and installation costs necessary to prepare the asset to be placed in service. The five books use five different terms to describe the concept: "depreciation base", "initial book value", "cost basis", "first cost" and "initial basis." Only one gives a clear definition: "the cost to obtain and place the asset in service fit for use."

## 5. The Placed in Service Rule

Depreciation of an asset for tax purposes begins when the asset is actually placed in service, not at the time of purchase. Depreciation ends after the last recovery year or when an asset is retired from service whether it is sold or not. Two of the books explain the placed in service rule and two others state that the half-year convention assumes that the asset is placed in service in the middle of the year. The fifth says that the half-year convention assumes purchase half way through the year. Only one discusses the fact that if an asset is retired from service after the first recovery year (which is already a half year in the table) but before the last recovery year (also a half year in the table) only half the percentage in the table may be taken that year.

## 6. Real Estate

Real property can be in either of two classes. Residential property (homes and apartments) is in the 27.5 year class. Nonresidential real estate property is in the 39 year class. One book also mentions that nonresidential property purchased on or before May 12, 1993 is in a 31.5 year class. Just like personal property, these real property classes also have tables in Publication 946. They are based on straight line depreciation with a mid-month convention which, similar the half-year convention, assumes that the asset is place in service in the middle of a month and is also retired from service in the middle of a month. Two books explain the mid-month convention; one of them provides an example table for 39-year property. One gives yearly rates for the 39-year class without explaining the mid-month convention, one lists the classes in the recovery period example table but does not explain real property depreciation, and the fifth explicitly ignores real property. Only one book indicates that land is not a depreciable asset and none explains that its value must be subtracted from the purchase price of real property in determining the basis.

## 7. Alternative Depreciation System and Exceptions

The IRS permits, in some cases, the use of depreciation methods other than GDS for tax purposes. Publication 946 lays out the Alternative Depreciation System or ADS. ADS uses straight line depreciation with the half-year convention and a recovery period longer than GDS. It would only rarely be economically advantageous. Three of the books explain this but only two of them include the values for the ADS recovery period in their example tables.

There are also exceptions to the use of table A-1 from Publication 946 involving placing in service more than 40% of assets in the last quarter of the year. Only two books refer to this limitation.

## 8. Section 179

Section 179 of the Internal Revenue Service Code allows a certain amount of depreciable property to be treated as an expense in the year in which it is placed in service rather than depreciated. As such it is the ultimate in accelerated depreciation, obviously intended to encourage capital investment, especially by small businesses. Earlier editions of some of these textbooks presented section 179 in some detail but only two have any mention of it now. One refers to section 179 without explanation and the other mentions section 179 in a footnote indicating that for 1999 the limit on the amount that could be expensed was \$19,000. When it was first introduced in the 1958 the amount was \$3000. Today it is adjusted upward yearly and for the 2008 tax year is \$250,000. There is a limit for using section 179 of \$800,000 total assets placed in service in 2008 making it clear that the intent is to encourage investment by small businesses.

### **Taxation of Corporate Income**

In order to do economic analysis of a project using after-tax cash flows one must first determine the before-tax cash flows and the amount of tax paid each year. This can include both State and Federal Taxes on income of the corporation. The use of tax tables is relatively straightforward; it is finding the portion of income that is taxable in any year that makes this a complex subject. While it might seem that the calculation should begin with the before-tax cash flow, not all of that amount, on either the revenue or expenditure side, is treated the same way for tax purposes. Cash flows resulting from the purchase or sale of capital assets must be excluded from the before-tax cash flows to find the operating net income.

#### 1. Operating Net Income and Taxable Income

Operating net income is the net value of revenues and expenses from operations. In corporate finance it is sometimes called earnings before interest and income taxes (EBIT). It differs from the before-tax cash flow (BTCF) in that cash flows related to the purchase and sale of capital assets are excluded. Taxable income is operating net minus MACRS depreciation minus other deductions.

Two of the textbooks say that taxable income is simply revenue minus expenses. One of them says that capital purchases (not depreciation of those purchases) is an expense category. The other says that depreciation is an expense. Calling it an expense unfortunately makes it seem that depreciation is a cash flow. In this book the after-tax cash flow is found from the EBIT minus tax "plus depreciation added back, since depreciation is not a cash flow."

The other three books define taxable income as revenue minus expenses minus depreciation. Only one of them correctly includes the revenue from the sale of assets as a part of the BTCF which makes it a part of the after-tax cash flow (ATCF) as well since it defines ATCF as BTCF minus taxes.

## 2. Other Deductions

In addition to operating expenses and depreciation there are other possible deductions from taxable income. The two most widely discussed in engineering economy courses are amortization and depletion.

Amortization refers to the tax-purpose write-off of intangible assets which cannot be depreciated under MACRS. Examples include incorporation expenses and franchise fees. They are generally amortized using straight line over a number of years related to the life of the asset. Only one book includes amortization.

Depletion is the tax-purpose write-off of mineral property, oil and gas reserves and standing timber. Two methods are used. Cost depletion works like units-of-production depreciation. The purchase price minus the estimated salvage is multiplied by the proportion of the recoverable resource produced during that year. Percentage depletion is based on a fixed percentage of the property's gross income for that year. Standing timber and oil and gas properties can use only cost depletion but mineral properties must take the larger of cost depletion or percentage depletion. Four of the five books explain depletion.

Other deductions such as interest, advertising, charitable contributions and legal expense are mentioned only briefly in two of the books. It should be noted that with the exception of depletion, the deductions in this section are difficult to attribute to an individual project and most often apply only to the calculation of taxable income for a corporation.

## 3. Treatment of State and Local Income Taxes

There are at least three ways to deal with state and local income taxes in an engineering economy course. The easiest is to ignore them altogether. Since several states have no corporate income tax (but may tax businesses in other ways) ignoring state tax might be said to represent projects in one of these states. Another is to include state tax in a combined federal and state tax rate. It should be made clear that this involves approximation. The third is to include state taxes explicitly. State and local income taxes are deductible from federal taxable income (as are all other taxes) but this is complicated by the fact that federal taxes are deductible from state taxable income in five states (only half in two of them.)

Four of the books discuss the use of a combined rate, one even including a local income tax. The other book ignores state and local taxes but uses a rate of 40% in examples which must clearly be a combined rate. The derivation of the combined rate in all four assumes that federal tax is not deductible from state taxable income.

## 4. Net Operating Loss

A net operating loss (NOL) is a negative taxable income which results from expenses, depreciation and other deductions exceeding revenue. The name is confusing because it



sounds like a negative operating net income. Actually it often results more from large depreciation deductions in a year in which the corporation has a substantial, positive operating net income and is quite profitable after taxes. If there is a net operating loss the corporation pays no income tax in that year and is allowed to carry the NOL backward and forward in time to offset positive taxable income. IRS rules, as described in Publication 542, *Corporations*, require that the NOL first be carried back two years, then one year, and then forward for up to twenty years until it has been totally used. Only one of the books mentions the concept of carryback and carryforward but incorrectly states that it applies "when a company loses money."

## 5. Federal Tax Rates

If there is no NOL, the taxable income is used to determine the amount of the federal income tax. Table 2, reproduced from publication 542, is used for this calculation.

<b>Tax Rate Schedule</b>			
If taxable income (line 30, Form 1120, or line 26, Form 1120-A) is:			
Over—	But not over—	Tax is:	Of the amount over—
\$0	50,000	15%	-0-
50,000	75,000	\$ 7,500 + 25%	\$50,000
75,000	100,000	13,750 + 34%	75,000
100,000	335,000	22,250 + 39%	100,000
335,000	10,000,000	113,900 + 34%	335,000
10,000,000	15,000,000	3,400,000 + 35%	10,000,000
15,000,000	18,333,333	5,150,000 + 38%	15,000,000
18,333,333	—	35%	-0-

Table 2 Tax Rate Schedule from Publication 542

This table provides an easy to follow "recipe" for finding tax from taxable income. It results from the system of graduated tax in which smaller incomes are taxed, at least generally, at a smaller rate. Surprisingly, none of the five textbooks copy this table. Two of them show only the marginal rate and explain the actual tax calculation with an example. Two rewrite the recipe from the two rightmost columns in single column. The fifth focuses on the derivation of the dollar amount in the recipe in a way that makes the use of the table quite difficult. This book also states that the rates are indexed annually. The rates in the table have not been changed for many years.

## 6. Tax Credits

The tax calculation in the previous section may not be the amount of tax the corporation is required to pay. In some cases the corporation may be able to subtract a tax credit from this amount. Some examples include the research credit, intended to encourage *increases* in corporate research expenditures, and credits for renewable energy production and the use of electric vehicles. Only one book mentions these credits and cites as an example the long-expired investment tax credit.

## 7. Sale and Disposal of Depreciable Assets

As noted above, the purchase of depreciable assets is handled for tax purposes by deductions from taxable income over a recovery period using MACRS depreciation. The sale and disposal of these assets also has tax consequences. These consequences are governed by IRS Publication 544, *Sales and Other Dispositions of Assets*.

A capital gain occurs when a capital asset (normally a non-depreciable asset) is sold for more than its basis. It is taxable (for a corporation but not always for an individual) as ordinary income. A capital loss occurs when the asset is sold for less than its basis. Capital losses can be subtracted from capital gains to reduce the resulting taxable income however a corporation can deduct capital losses only up to the amount of its capital gains. If losses exceed gains they must be carried forward in much the same way as net operating losses.

If the capital asset being sold has been subject to MACRS depreciation or a Section 179 deduction it is subject to depreciation recapture. If the selling price of the asset exceeds its MACRS book value the difference must be added to taxable income for that year. The book value is the basis of the asset minus the sum of all MACRS and Section 179 depreciation taken up to and including the year of sale. Note that the half-year convention again applies; if the asset is sold between the first and last recovery years a half-year's depreciation is assumed and the percentage in the MACRS table (A-1) must be halved. The principle behind depreciation recapture is that the corporation has taken more depreciation than the loss of market value of the asset and the IRS is "recapturing" the reduction in taxes resulted from this.

Three of the books explain depreciation recapture. The distinction between capital gain and depreciation recapture, non-depreciable vs. depreciable asset, is not always clear but this is a problem of terminology, not substance. The other two books treat capital gains only as selling price minus basis, but only one of them makes it clear that this applies to non-depreciable assets.

## 8. Project Viewpoint

An important hallmark of an engineering economy course is that it takes a project viewpoint while a finance course focuses more on the entire corporation. Much of the discussion above applies only to taxation of the corporation as a whole, not to the effect of taxation on the analysis of projects. Specifically, the carryback and carryforward of net operating losses, the use of a tax rate table, and offsetting and carrying forward of capital gains and losses apply only to the corporation, not to individual projects within the corporation. Actually these things apply to a project only when the project is the entire corporation, when analyzing startups and spin-offs for example.

A net operating loss resulting from a single project can be used to offset positive taxable income from other projects within the large corporation. This reduction of the total taxable income of the corporation reduces the amount of tax paid by the amount of the NOL times the marginal tax rate, usually 35% for this large corporation. The project thus

increases the cash flow of the corporation which results in the after-tax cash flow for the project actually being greater than the before-tax cash flow!

The use of a single, combined federal and state tax rate obviates the use of the tax tables in project analysis and is correct if the combined rate is derived from the company's marginal federal and state rates. Even the capital losses for a project exceed gains by more than \$3000 they can be used to reduce the taxable income of the project if it is assumed that the corporation has gains from other projects.

The four books which present a combined tax rate could avoid the tax rate problem simply by stating that the federal rate, and the state rate if any, should be the marginal tax rate of the corporation. Two do so explicitly. The fifth book, which does not mention state or local taxes, uses a rate of 40% in one example which is clearly a combined rate. Only one book even mentions carryback and carryforward of losses. This book is also the only one to recognize that the loss from a project can be viewed as providing a tax credit to the project.

## **Conclusions**

At the outset it was assumed that the five textbooks are representative of the way taxes are taught in introductory engineering economy courses. Since the books are very different from one another in this regard, it seems likely that engineering economy courses approach this topic in greatly different ways. On the same basis it is also likely that all of these courses present material which is confusing to the students and that many courses give the student information which is incorrect.

Each of the books includes some information that is confusing. Reading the same points from more than one of them is even more confusing. Much of this results from widely varying terminology for basic terms. Sometimes two of the books will use the same or similar terms for completely different concepts. Even more often two or more books will use different terms for the same concept.

Each of the books also has material that is simply erroneous when compared to IRS publications. It is easy to see how this can come about since the subject is complex to begin with and the government publications are notoriously unreadable. It seems there is a variant of Pareto's law which would say that 90% of the text of these publications applies to fewer than 10% of taxpayers.

## **Recommendations**

The purpose of this paper is not to complain about the writing of textbooks but to inform the teaching of taxes and tax purpose depreciation in the introductory course. To this end some recommendations are in order. These are necessarily the opinion of the author.

1. The terminology needs to be standardized. The only realistic way to do this is to use the IRS terms wherever possible.

2. Use only table A-1 from Publication 946 for MACRS. It applies to a great majority of situations. Teaching the derivation of A-1 is good pedagogy for reinforcing declining balance and switching to straight line. Use and explain the term "basis" in applying A-1.
3. Make it clear that the lists of GDS recovery periods are only examples, not the complete IRS tables.
4. Stress that GDS puts assets into property classes which, while they are somewhat related to lives, do not represent useful life.
5. If ADS is taught it should be clear that it is an alternative and rarely advantageous. It can provide an opportunity to show why accelerated depreciation is advantageous.
6. Omit Section 179. It is difficult to simplify and it is nearly impossible to create good problems incorporating it without confusing students about problems which do not incorporate it.
7. The most confusing concepts seem to be operating net income and taxable income. Like before-tax cash flow, operating net is often simply revenue - expenses but unlike before-tax cash flow it excludes the purchase and sale of depreciable assets. Starting from operating net makes it clear that these cash flows are incorporated into the taxable income by MACRS depreciation which is not a cash flow.
8. Omit the carrying backward and forward of net operating losses (a spectacularly misleading term) and of capital losses.
9. State and local taxes should either be omitted or be used as part of a combined **marginal** rate.
10. Explain the use of the corporation's marginal rate for project analysis. The tax rate table only applies to the entire corporation, not to an individual project.
11. The tax rate table should be the IRS published version. Teaching its derivation, however, is useful, especially in differentiating marginal rates from overall rates.
12. The terms "capital gain" and "depreciation recapture" should be carefully distinguished. Since capital gain applies to non-depreciable assets the easiest way to eliminate confusion is to omit discussion of capital gains altogether.

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