

## **The Tax Cuts and Jobs Act and Teaching Engineering Economy**

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## Abstract

The Tax Cuts and Jobs Act (TCJA) has recently changed federal depreciation and taxes. Thus, now is a good time to re-examine how these topics should be addressed in engineering economy courses. One source to examine for guidance is the set of textbooks most commonly used. There are large commonalities and some surprising differences in coverage among the currently available texts. In choosing what *should* be covered, instructors and authors must balance providing key details needed for the FE exam or proper analysis of real decisions shortly after graduation and broader principles important forever.

## Introduction

The Tax Cuts and Jobs Act (TCJA), approved in December 2017, made significant changes in personal and corporate tax policy. Some changes are permanent, and some will begin phasing out after 5 years. Which changes should or could be within the scope typically covered in an engineering economy course?

One source to examine for guidance is the coverage in the current editions of textbooks most commonly used in introductory courses. The differences in these texts are suggestive in deciding what could and should be taught. The starting point is describing coverage of past depreciation and tax rules. Which depreciation methods are covered—straight-line, declining balance, sum-of-years-digits (SOYD), modified accelerated cost recovery system (MACRS)? Are recaptured depreciation, loss on sale, gain on sale, bonus depreciation, and Section 179 included?

The tax law changes included the oft-mentioned immediate expensing of capital investments, which has been accomplished by allowing 100% bonus depreciation—not by changing or repealing MACRS. The corporate tax rate has not only been lowered dramatically, it has also been changed to a flat tax rate rather than progressively increasing with taxable income. In addition, some of the significant changes in the tax law have been implemented as temporary with scheduled phase-outs beginning in 5 years.

With all of this in mind, the decisions of what we should and will cover are complicated by both the near and long-term law changes. Laws can change faster than textbooks can keep up with, yet students need to leave our classrooms with accurate data and current understanding.

## Literature Review

The Engineering Economy Division of ASEE has a history of publishing conference works that explore how we teach engineering economics. Lavelle [1] performed an early survey exploring how engineering economy is taught. This was extended by Lavelle, Needy, and Nachtmann [2]. Nachtmann, Needy, Lavelle, and Eschenbach [3] performed a further analysis of the data from the expanded survey. Lastly, Nachtmann, Needy and Evans [4] provided a refresher survey on the standing of the engineering economy classroom.

Schmahl, et al. [5] explored textbooks, investigating what percent of problems are actually engineering (vs. finance) in context. Hartman [6] described the use of the Wall Street Journal to supplement the course with relevant news articles. Ristroph and Glassinger [7] updated tax law changes as they apply to engineering projects. Sullivan and Terpenney [8] emphasized the need for after-tax analysis after finding that most working engineers were only doing before-tax analysis.

Lundquist [9] is *the* essential reference in examining how depreciation and taxes could and should be taught. Bob Lundquist's paper analyzed several (unnamed) textbooks regarding how they cover a variety of depreciation and tax topics with comparisons to what should be taught.

## Methodology

IRS publications are a primary source of information regarding the changes in tax laws [10, 11]. However, clearer explanations can be found in the popular press or by using a search engine. With these changes to the tax policy in mind, the authors reviewed and compared the coverage of various depreciation and tax topics in the best-selling engineering economy textbooks. The textbooks are listed in alphabetical order of first author.

- Blank & Tarquin (2018) *Engineering Economy* 8/e [12]
- Newnan, Eschenbach, Lavelle, & Lewis (2020) *Engineering Economic Analysis* 14/e [13]
- Park (2016) *Contemporary Engineering Economics* 6/e [14]
- Park (2019) *Fundamentals of Engineering Economics* 4/e [15]
- Sullivan, Wicks, & Koelling (2019) *Engineering Economy* 17/e (supplemented) [16]
- White, Case, & Pratt (2012) *Principles of Engineering Economic Analysis* 6/e [17]
- White, Grasman, Case, Needy, & Pratt (2014) *Fundamentals of Engineering Economic Analysis* [18]

The changes to be included in the Tax Cuts and Jobs Act were subject to revision until the TCJA was finalized and signed in late December 2017. Those texts completed before the TCJA are likely to be revised in their next edition. It is hoped that this paper might influence the coverage in those future editions.

## Results

### *Depreciation methods for valuation and taxes*

According to the U.S. Generally Accepted Accounting Principles (GAAP), there are only four depreciation methods that are permitted for asset valuation: straight-line, declining balance, units of production, and sum-of-years'-digits. Straight-line is the most commonly used. Declining balance may be chosen because a constant rate of decline in the assets' book value may more accurately reflect true market values. Declining balance with a switch to straight-line is part of the basis for MACRS, and is covered in some textbooks.

Beginning in 1981, taxes have been calculated in the U.S. using a different set of depreciation methods than are used to determine asset value. To stimulate economic activity these methods allow a faster rate of depreciation. Firms generally choose the fastest depreciation legally allowed to maximize the present value of tax savings. The depreciation methods for taxation—

bonus depreciation, MACRS, and a combination of the two—are what makes up present and past tax law. In the U.S., bonus depreciation (immediate expensing of capital, either partial or total) has been a part of U.S. tax law in most years since 2001. However, this option has received limited attention in earlier editions with the exception of a section in *White Principles* and a brief example in Newnan 13e.

From the set of reviewed textbooks, the coverage of depreciation methods for valuation and taxes is shown in Table 1. A single \* shows minor coverage; indicating up to a paragraph on the subject. A double \*\* indicates more extensive coverage, such as an example or a distinct subsection devoted to the topic. A blank value indicates no discussion of the topic in any form.

Table 1. Depreciation method coverage in major textbooks.

Topic	Blank & Tarquin	Newnan et al.	Park Cont.	Park Fund.	Sullivan et al.	White Principles	White Fund.
Straight Line	**	**	**	**	**	**	**
Declining Balance	**	**	**	**	**	**	**
DB w/ SL	**	**	**	**	**	**	**
SOYD	**	*				**	
Units of Production	**	**	**	**	**	*	
MACRS	**	**	**	**	**	**	**
Bonus		**		**	*	**	
Section 179	*	*				**	

\* Minor coverage: mention or paragraph    \*\* Major coverage: more than a paragraph or example

Table 1 illustrates that coverage of many of the depreciation methods is extensive, with the exception of sum-of-years-digits (SOYD), bonus depreciation, and Section 179. Table 2 provides more detail on the coverage of bonus depreciation in these texts. Note that this topic has been added to the most recent editions of *Park Fundamentals* (2019) and *Sullivan* (2019), and *Newnan* (2020) has substantially increased its coverage. We anticipate additional texts will include these topics as new editions become available.

The FE Reference Handbook [19] includes only straight-line and MACRS depreciation so the textbook choices seem to be focused on the perceived needs of students post-graduation.

Table 2. Bonus depreciation in major textbooks.

Topic	Blank & Tarquin	Newnan et al.	Park Cont.	Park Fund.	Sullivan et al.	White Principles	White Fund.
Bonus Dep. History		**				**	
100% Bonus demonstrated		**		**	*	**	
Bonus + MACRS demonstrated		**		**		**	

Given the limited coverage of bonus depreciation since it was introduced in 2001, a reasonable hypothesis is that it has been viewed as a minor or temporary feature. However, it has been part of our tax law for many years, it will likely be so for many more. It has been highlighted by the TCJA, and it has a profound impact on after-tax cash flows. Of course, tax laws may change, and if they do then further textbook changes will be needed.

*Asset disposal*

If an asset is sold, tax implications are likely. A loss is incurred when the asset is sold for less than its book value. A capital gain occurs when the asset is sold for more than its original cost basis. Depreciation recapture occurs when the asset is sold for more than its book value, but for less than its original cost basis. Because bonus depreciation expenses the investment so quickly, asset disposal is of increased importance with current tax law.

Most texts discuss asset disposal, including depreciation recapture, as shown in Table 3. Very few discuss asset disposal when bonus depreciation is involved, including limited coverage in the newest books. We believe that asset disposal should be demonstrated when bonus depreciation is in place because of its large influence on after-tax cash flows. We again anticipate broader coverage as new editions become available.

Table 3. Asset disposal in major textbooks.

Topic	Blank & Tarquin	Newnan et al.	Park Cont.	Park Fund.	Sullivan et al.	White Principles	White Fund.
Asset Disposal demonstrated	**	**	**	**	**	**	**
Asset disposal with bonus depreciation		**		*		**	

*Example: Asset disposal*

Consider a \$10,000 asset that is sold for \$2000 in Year 2. Compare the recaptured depreciation using MACRS, assuming a 5-year property class, with 100% bonus depreciation.

For MACRS, the first year depreciation will be  $\$10,000 \times 0.2000 = \$2000$ . The second year depreciation will be  $\$10,000 \times 0.3200 \times \frac{1}{2} = \$1600$ , for a book value at the end of Year 2 of \$6400. The asset will be sold and taxed as a \$4400 ordinary loss.

For 100% bonus depreciation, the asset is ‘expensed’ during Year 1. The book value during Year 2 will be \$0. The recaptured depreciation will equal the sales value, and taxed as a \$2000 ordinary gain.

*IRR of 100% bonus depreciation*

All major textbooks demonstrate how to calculate after-tax present value and internal rate of return (IRR). However, such analysis is limited regarding bonus depreciation. Most companies update their tax status quarterly, not annually. So if capital equipment is purchased, this will likely be recorded in a matter of months, not years. Let us look at a simple example, where equipment is purchased and “expensed” (via bonus depreciation) in a few months. Because “a few months” is much less than a year, we will record this as year 0 instead of year 1.

Table 4 summarizes the cash flows for \$25,000 of equipment that qualifies for 100% bonus depreciation. The equipment is expected to save \$8000 per year over its 5-year life, when it will be sold for \$6000. The before-tax and after-tax IRRs are both 22.2%. This illustrates the impact of bonus depreciation and questions whether bonus depreciation makes after-tax analysis less necessary.

Table 4. Before and After Tax Cash Flows

Year	(a) Before-Tax Cash Flow	(b) Depreciation	(c) Taxable Income (a) - (b)	(d) 21% Income Taxes -0.21(c)	(e) After-Tax Cash Flow (a) + (d) †
0	-\$25,000		-\$25,000 *	\$5250	-\$19,750
1	8,000	0	8,000	-1680	6,320
2	8,000	0	8,000	-1680	6,320
3	8,000	0	8,000	-1680	6,320
4	8,000	0	8,000	-1680	6,320
5	{ 8,000 6,000	0	{ 8,000 6,000	{ -1680 -1260	{ 6,320 4,740

\* Bonus depreciation ‘expenses’ the \$25,000 investment.

*Corporate Tax Rates, Personal Taxes, and Personal Finance*

Until the TCJA both corporate and personal income taxes were based on schedules of marginal tax rates. This provided the opportunity to introduce or reinforce the important conceptual difference between marginal costs/rates and average costs/rates. Now that the corporate tax rate is a flat 21%, we believe that some coverage of personal taxes or state-level corporate income taxes is needed for marginal versus average use.

For many students, their engineering economy course is the only course where they learn anything related to money. Eschenbach, Lavelle, and Lewis [20] suggested that authors and

instructors have a duty to include personal finances. Table 5 summarizes text coverage of personal income tax.

Table 5. Personal taxes in major texts.

Topic	Blank & Tarquin	Newnan et al.	Park Cont.	Park Fund.	Sullivan et al.	White Principles	White Fund.
Personal taxes		**			**	**	
Personal tax revisions		**			**		

*Example: Corporate taxes*

Last year NJT Industries had taxable income of \$12.5 million. What changes in federal taxes would NJT pay prior to and after the TCJA? What is the effect of state taxes?

Prior to TCJA:

- \$ 12.5M in taxable income fits the marginal tax rate bracket of 35% on income between \$10-15M
- The tax obligation is calculate tax:  $\$3.4M + 35\% \text{ over } \$10M$
- Thus, the federal tax due =  $\$3.4M + (0.35)(\$12.5-10M) = \$4.275M$

After TCJA:

- All taxable income is taxed at a flat of 21%
  - Thus, the federal tax due =  $(0.21)(\$12.5M) = \$2.625$
- Thus, the difference in taxes paid (due) is \$1.65 million ( $\$4.275 - 2.675$ )

In addition to federal taxes, NJT Industries may be subject to state corporate taxes:

- 44 states levy a state corporate rate ranging from 3% in NC to 12% top marginal rate in IA; (27 use a flat rate)
- AK, IL, IA, MN, NJ, and PA have top rates above 9%
- AZ, CO, MS, NC, ND, SC, and UT have top rates below 5%
- NV, OH, TX, and WY use gross receipts tax on corporations not income taxes
- SD and WY do not levy corporate income nor gross receipts taxes

Thus, depending on what state NJT Industries is based in there could be a substantial additional tax liability. This tax would range from \$0 to \$1,492,500. Iowa state taxes in 2019 =  $25,000 \times 0.06 + (100,000 - 25,000)(0.08) + (250,000 - 100,000)(0.10) + (12.5M - 250,000)(0.12)$ .

**Conclusions**

The Tax Cuts and Jobs Act made significant changes to corporate and individual taxes. Corporate taxes were not only simplified and generally reduced, but depreciation rules were also changed. The tax change also highlighted the fact that bonus depreciation has been a part of corporate tax law for most of the past 18 years, but this has sometimes been ignored in our engineering economy textbooks.

The newest editions of our major textbooks are including portions of the tax law changes, though the level of coverage varies. Much material still focuses primarily on the 1986 tax code that has

been taught for many years, and on methods allowed for valuation, that have not been used for U.S. taxes since 1981. While most new editions recognize the Tax Cuts and Jobs Act, not all texts have had time to alter their presentation of depreciation and taxes in a major way.

## **Recommendations**

Our courses need to reflect the current tax law. This includes teaching bonus depreciation, MACRS, and a combination of the two—because both are part of current and future tax law. We need to demonstrate how the new tax rates and depreciation laws change after-tax cash flows, and continue to demonstrate how these impact net present value (NPV) and IRR. We also need to recognize that changes in tax law can occur faster than changes in our textbooks; we need to stay agile. We need to continue to draw on potential personal finance aspects of the subject material to promote student learning and excitement.

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