



ENGINEERING ECONOMICS – PROBLEM TITLES

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ENGINEERING ECONOMICS – INTRODUCTION

In many ways, your household expenses dealing with loans fit into engineering economic principles. These principles involve the economic analysis of alternatives. For many problems, the **time value of money** (*interest rate*) is used to move cash flow from one point in time to another point in time. This is referred to as getting an equivalent value for the cash flow at one specific point or series in time (present, uniform series, or future). One principle used is that the interest rate must match the **compounding frequency**. For example, use monthly interest for monthly compounding.

Many economic analysis problems involving interest rate can be solved using one of these analysis techniques:

- **Annual Cost (or Worth)**
- **Present Cost (or Worth)**
- **Future Cost (or Worth)**
- **Internal Rate of Return**
- **Benefit Cost Analysis**

A cost analysis is one where almost all the dollars are going out (except salvage value). You want to *choose the alternative with the least cost*. The least cost alternative will be the same one regardless of the interest rate used in the analysis. The top three techniques rely on the same principles of moving cash flows to the desired analysis reference point (annual, present or future). Annual costs are a type of uniform series amount.

A worth analysis is where an income is present in addition to expenses. For these problems, you want to choose the

highest worth alternative. The interest rate used in the analysis has a direct bearing on the best alternative. A worth analysis can turn out to be either positive or negative. A *positive worth* means the alternative is acceptable at the interest rate used in the analysis. It also represents the additional worth earned above the interest rate used. Further, it indicates that the internal rate of return (the actual return earned on the investment) is greater than the interest rate used in the analysis. *Do not be fooled by a negative answer*. This only means the alternative is not acceptable at the interest rate used. It does not mean the alternative has lost money (although that could happen). It does tell you that the internal rate of return is below the interest rate used in the analysis.

The **internal rate of return** is the actual interest earned by the investment. Only a worth alternative has an internal rate of return. A cost alternative does not have an internal rate of return. A common way to determine the internal rate of return is to write the present worth equation and set it equal to zero. If there are two or more different factors, then solve by trial and error by selecting an interest rate that comes closest to having the present worth equal zero. For the FE exam, select either (B) or (C) to get started. If the present worth is positive (greater than zero), select a higher interest rate. If the present worth is negative (below zero), select a lower interest rate. One of the answers should result in the present worth being very close to zero.

Benefit cost analysis can be used for a single alternative and also for comparing alternatives. These problems are best analyzed by converting all benefits and all costs into equivalent annual amounts. In this manner, any differences in the lives of alternatives can be ignored. Some problems may look like they only have costs and no benefits. In this case, look for a reduction in some common cost to be the benefit in comparing alternatives.

Some specialized elements of cash flows that you could see on the exam include **gradients** (*positive and negative*), **continuous compounding**, **effective interest**, **alternatives with different lives**, and **inflation**. Carefully review these problem solutions on the CD if you are unfamiliar with them.

You are likely to be tested on depreciation. **Depreciation** is used to estimate the book value of an item at some point in time. It is also used to reduce taxes. The two types of depreciation mentioned in the *FE Reference Handbook* are straight line and MACRS. **Straight line** is very simple. **Modified Accelerated Cost Recovery System** was started by the IRS to both simplify tax accounting and create favorable cash flow in the early years of a new company. Carefully look over these depreciation techniques.

Some other types of analysis that do not rely on interest rate are **break even analysis**, **probability analysis**, and **economic order quantity**. You may see one or more of these problems on your exam, so carefully review the principles behind them.



PROBLEMS

Econ 01

At age 30 you invest \$5,000 into a mutual fund. If the fund averages an 8% annual return, your investment is worth how much at age 55?

- (A) \$23,300
- (B) \$34,240
- (C) \$50,310
- (D) \$344,570

Econ 02

Tom's retirement account in a company currently totals \$416,384. What perpetual income can Tom and his heirs receive per year if he retires now and the money is invested in an annuity earning 6% interest?

- (A) \$20,980
- (B) \$22,980
- (C) \$24,980
- (D) \$26,980

Econ 03

You are saving up for a big investment in six years. You estimate it will take \$14,500 to secure this investment. How much do you need to put into a savings account at the end of each year if the savings account earns 4%? Neglect taxes.

- (A) \$2,185
- (B) \$2,375
- (C) \$2,415
- (D) \$2,485

Econ 04

You are buying your first car and need to borrow \$16,000 over 5 years. If interest is 6%, what are your monthly payments?

- (A) \$267
- (B) \$309
- (C) \$347
- (D) \$389

Econ 05

You are considering investing in a 5-yr CD (certificate of deposit) with an annual yield of 6.5% and monthly compounding. If you invest \$5,000, your effective interest earned is most nearly:

- (A) 6.5% (B) 6.6% (C) 6.7% (D) 6.8%

Econ 06

An investment option is available with continuous compounding at 5% interest. If you invest \$8,000 now, how much interest income will you earn if you cash out in 3.5 years?

- (A) \$1,172
(B) \$1,261
(C) \$1,490
(D) \$1,530

Econ 07

A lift station sewage pump initially costs \$20,000. Annual maintenance costs are \$300. The pump salvage value is 10 percent of the initial cost in 20 years. Using 4% interest, the annual cost of the pump is most nearly:

- (A) \$1,200 (B) \$1,705 (C) \$1,772 (D) \$1,840

Econ 08

A computerized wood lathe, costing \$17,000, will be used to make ornamental parts for sale. Receipts are estimated at \$28,000 per year with costs running \$25,000 per year. The salvage value is \$2,000 at the end of 10 years. If the MARR is 8%, what is the present worth of this investment?

- (A) -\$410 (B) \$3,130 (C) \$4,060 (D) \$5,210

Econ 09

Bill decides to start a 401(k) investment account beginning next year with an initial investment of \$500. His plan is to make annual investments which increase by \$100 each year. If Bill earns 10% on his investment, his 401(k) account will be worth how much in 15 years?

- (A) \$30,820
- (B) \$31,760
- (C) \$32,660
- (D) \$33,520

Econ 10

A project requires 8 yearly investments. The initial investment at end of year one is \$20,000 with a 5% negative gradient for the other 7 investments. Interest is 6%. The present cost of the total investment required is most nearly:

- (A) \$98,465
- (B) \$104,355
- (C) \$110,515
- (D) \$132,000

Econ 11

Two alternatives are available for producing logos on sport shirts. Costs are shown below. Interest is 4%.

| | <u>Machine A</u> | <u>Machine B</u> |
|-----------------|------------------|--|
| Initial Cost | \$54,000 | \$74,000 |
| Salvage Value | \$8,100 | \$7,400 |
| Operating Costs | \$2,100/yr | \$1,400/yr – 1 st 10 years \$1,800/yr – 2 nd 10 years |
| Life | 15 years | 20 years |

Q1: The annual cost for machine A (AC_A) is:
(A) \$6,350 (B) \$6,550 (C) \$6,750 (D) \$6,950

Q2: The annual cost for machine B (AC_B) is:
(A) \$6,360 (B) \$6,560 (C) \$6,760 (D) \$6,960

Econ 12

A product can be manufactured with two different processes. Costs associated with each process are as shown. Interest is 6%.

| | <u>Process Q</u> | <u>Process R</u> |
|-----------------|------------------|-------------------------------------|
| Initial Cost | \$26,000 | \$44,000 |
| Salvage Value | -\$600 | \$4,400 @ yr 20 \$24,200 @ yr 10 |
| Operating Costs | \$1,900/yr | \$1,500/yr |
| Receipts | \$6,000/yr | \$6,000/yr |
| Life | 10 years | 20 years |

Q1: The present worth of process Q (PW_Q) over 10 years is:

(A) \$2,640 (B) \$3,040 (C) \$3,440 (D) \$3,840

Q2: The present worth of process R (PW_R) over 10 years is:

(A) \$2,630 (B) \$3,030 (C) \$3,430 (D) \$3,830

Econ 13

An elevator system in an office building can either be refurbished or replaced.

Refurbishing the elevators will cost \$55,000 and extend the life of the elevators another 20 years. Salvage value at the end of 20 years will be \$11,000. Annual maintenance costs will be \$1,000 per year. The current salvage value of the elevators is \$32,000.

Replacing the elevator system will cost \$140,000, with an expected life of 50 years. Maintenance costs will be \$400 per year. Salvage value at the end of 50 years will be \$28,000. Interest is 4%.

Q1: The annual cost for refurbishing the elevators is:

(A) \$4,680 (B) \$5,930 (C) \$7,030 (D) \$8,240

Q2: The annual cost for replacing the elevators is:

(A) \$5,840 (B) \$6,340 (C) \$6,540 (D) \$6,740

Econ 14

Four alternatives for a manufacturing process have annual benefits and costs as shown.

| Alt. | Benefits | Costs |
|------|----------|--------|
| 1 | 58,000 | 50,000 |
| 2 | 51,000 | 41,000 |
| 3 | 47,000 | 38,000 |
| 4 | 57,000 | 46,000 |

Which is the best alternative?

- (A) 1 (B) 2 (C) 3 (D) 4

Econ 15

You purchase 1,000 shares of stock at \$15.00 per share. The stock pays quarterly dividends of \$125 for two years at which time you sell the stock at the trading price of \$16.50 per share. The yearly return on your investment is most nearly:

- (A) 2% (B) 4% (C) 6% (D) 8%

Econ 16

A project requiring an initial cost of \$200,000 has the following operating and maintenance costs in "then-current" dollars.

| End of Year | O&M Costs |
|-------------|-----------|
| 1 | 30,000 |
| 2 | 31,300 |
| 3 | 32,650 |
| 4 | 34,050 |
| 5 | 35,500 |

If inflation averages 4% and the MARR is 6%, determine the present cost of the project.

- (A) \$308,570
- (B) \$322,200
- (C) \$322,970
- (D) \$337,070

Econ 17

An elevator system for a 20-yr old high-rise office building cost \$400,000 when first installed. The system was designed to last 30 years, with salvage at 10% of initial cost. Depreciation is straight line.

Q1: The allowable depreciation charge per year is:

- (A) \$12,000 (B) \$13,333 (C) \$18,000 (D) \$20,000

Q2: The current book value is:

- (A) \$133,333 (B) \$160,000 (C) \$240,000 (D) \$266,667

Econ 18

A new server system for your company will cost \$25,000. Using the MACRS, the computer system has a useful life of 5 years.

Q1: The allowable depreciation for the 2nd year is:

(A) \$4,800 (B) \$5,000 (C) \$8,000 (D) \$13,000

Q2: The book value at the end of the 3rd year is:

(A) \$4,800 (B) \$7,200 (C) \$13,000 (D) \$17,800

Q3: The estimated salvage value at the end of five years is:

(A) \$1,450 (B) \$2,160 (C) \$2,880 (D) \$3,600

Econ 19

A company produces transmission gears used by several farm tractor manufacturers. The base cost of operation is \$596,700 per year. The cost of manufacturing is \$18.40 per gear. If the company sells the gears at an average price of \$37.90 each, how many gears must be sold each year to break even?

(A) 15,740 (B) 18,400 (C) 30,600 (D) 32,430

Econ 20

A recent hurricane caused a dam on a small lake to fail. The town is considering two alternatives to replace the dam. Each design has different costs, storage capacities, life, and estimated damages when floods exceed the storage capacities. Interest is 6%.

| Alt. | Cost | Maximum Capacity | Life | Flood Damage |
|------|-----------|------------------|--------|--------------|
| A | \$450,000 | 1M acre-ft | 40 yrs | \$800,000 |
| B | \$975,000 | 1.5M acre-ft | 50 yrs | \$600,000 |

Rainfall data and flood routing analysis show the probability associated with water flow into the lake.

| Flow (M acre-ft) | Probability |
|------------------|-------------|
| 0.0 to 0.5 | 62% |
| 0.6 to 1.0 | 20% |
| 1.1 to 1.5 | 11% |
| 1.5 to 2.0 | 6% |
| 2.1 or more | 1% |

Q1: The equivalent uniform annual cost (EUAC) of alternative A is:

(A) \$144,925 (B) \$173,925 (C) \$248,925 (D) \$333,925

Q2: The equivalent uniform annual cost (EUAC) of alternative B is:

(A) \$103,815 (B) \$169,815 (C) \$206,815 (D) \$283,815

Econ 21

A tire manufacturer uses 10,000 tons of special additive uniformly throughout the year. It costs \$50 to place each order, with storage costs running \$1.30/ton/yr.

Q1: How many tons should the manufacturer order at a time?

(A) 777 (B) 877 (C) 977 (D) 1077

Q2: How frequently should orders be placed?

(A) 26 days (B) 28 days (C) 30 days (D) 32 days

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ENGINEERING ECONOMICS – LETTER ANSWERS

| | | <u>Answers</u> |
|---------|---|----------------|
| Econ 01 | Future Amount Given Present Amount | B |
| Econ 02 | Annual Amount Given Present Amount | C |
| Econ 03 | Uniform Series Amount Given Future Amount | A |
| Econ 04 | Compounding Within a Year | B |
| Econ 05 | Effective Interest | C |
| Econ 06 | Continuous Compounding | D |
| Econ 07 | Annual Cost | B |
| Econ 08 | Present Worth | C |
| Econ 09 | Positive Gradient | C |
| Econ 10 | Negative Gradient | B |
| Econ 11 | Alternatives With Different Lives – Repeatability | B, C |
| Econ 12 | Alternatives With Different Lives – Cotermination | D, A |
| Econ 13 | Existing Salvage Value | C, D |
| Econ 14 | Benefit / Cost Analysis | D |
| Econ 15 | Internal Rate of Return | D |
| Econ 16 | Inflation | B |
| Econ 17 | Straight Line Depreciation | A, B |
| Econ 18 | MACRS Depreciation | C, B, A |
| Econ 19 | Break Even Analysis | C |
| Econ 20 | Probability Analysis | B, A |
| Econ 21 | Economic Order Quantity | B, D |