CHAPTER TWO

2.1 What does having knowledge of the fundamentals of engineering economics allow engineers to do for clients.

Engineers use the time value of money in the analysis of alternatives they perform for clients. Knowledge of the fundamentals of engineering economics allows engineers to recommend alternatives to clients on the basis of either the:

1) Least equivalent cost
2) Greatest equivalent net worth

2.2 How is interest defined in terms of engineering economics and what is the formula for interest owed on principal at the end of one year?

To understand how interest is defined in terms of monetary policies it needs to be viewed as a commodity such as rent on money borrowed or loaned from one individual to another, from one institution to another institution, or from an institution to an individual. The interest or rent charged is normally a percentage of the total amount borrowed during the transaction.

$$interest\ owed\ at\ the\ end\ of\ one\ year = \frac{interest\ rate}{100} \times\ amount\ borrowed\ or\ loaned$$

2.3 What terms associated with loans should borrowers be aware of when borrowing money?

- Amount being borrowed or loaned
- Type of interest rate
- Interest rate
- Interest period
- Other terms of the loan

2.4 Explain the difference between simple and compound interest.

Simple interest is interest charged on the principal (the initial amount borrowed or loaned) for that year.

When interest is not repaid yearly, and the amount of interest owed is carried over into subsequent years and used in the calculations to determine subsequent interest, this is called compound interest.

2.5 How are nominal interest rates different from annual interest rates?

Nominal interest rates apply when the compounding period (interest period) is less than one year. Compounding periods are the point in time where the amount borrowed or loaned has the interest owed calculated for that particular period.

2.6 Explain how effective interest rates are calculated for use in engineering economic formulas.

When the time value of money is considered when calculating the annual interest rate using the period interest rate this is called the effective interest rate $(\mathrm{i_e})$.The formulas for effective interest are the following:

$$i_e = \left(1 + \frac{i_n}{m}\right)^m - 1 \qquad \text{or} \qquad i_e = (1+i)^m - 1$$

2.7 How does continuous compounding effect the amount of interest either received or paid by someone?

Continuous compounding of interest means the interest on the amount in an account is calculated all of the time.

2.8 What is rate of return and why is it important in engineering economic analysis?

The amount of money received in addition to the original investment is called the rate of return (ROR) on the investment.

2.9 Explain the difference between present and future worth.

Present worth represents the present value of a future sum with the interest removed from it. Future worth represents the future value of a present value with interested added to it.

2.10 What are annuities and how are they used in engineering economics?

An annuity (A) is the term used to describe a series of uniform, end of period payments or disbursements. Annuities represent a payment or disbursement stream deposited or withdrawn at equal, set intervals such as daily, weekly, monthly, or yearly. As each annuity is deposited into an interest-bearing account it begins to draw interest at the end of each compounding period.

2.11 Explain salvage value and its application in engineering economics.

Salvage value is a term referring to what an asset is worth at the end of its useful life. In engineering economic analysis the salvage value is represented by a future value occurring at the end of the analysis period.

2.12 Discuss sunk costs and why they are hard to quantify in engineering economics.

Sunk cost represents funds not recoverable because they have already been expended some time in the past.

2.13 Explain how cash flow diagrams are used in engineering economic analysis.

Cash flow diagrams are a visual representation of the flow of funds into and out of investment instruments, maintenance accounts, projects, and any other type of activity involving the movement of money.

2.14 What at the two perspectives shown in cash flow diagrams?

The two perspectives are the borrower's point of view and the lender's point of view.

2.15 Explain what is being shown in Figure 2.6 in the cash flow diagram.

The cash flow diagram in Figure 2.6 represents a loan to a borrower at time zero and the borrower is repaying the funds over ten equal annual installments.

2.16 Explain time value of money in relation to engineering economics.

Time value of money accounts for the interest an investment earns. Time value of money indicates that an amount of money with a certain value now will increase in value in the future due to the interest the money earns during the intervening time period.

2.17 Calculate the yearly interest rate if an investment pay 1.75% interest every 2 months.

$$i_n = i \times m = \frac{1.75\%}{period} \times \frac{6\ periods}{year} = 10.5\% \text{ per year}$$

2.18 Calculate the interest rate per interest period if the yearly interest rate is 13% and the number of interest periods per year is 3?

$$i = \frac{i_n}{m} = \frac{\frac{13\%}{year}}{\frac{3\ periods}{year}} = 4.33\%$$

2.19 Calculate the number of interest periods per year if the yearly interest rate is 15% and the interest rate per interest period is 2.5%.

$$m = \frac{i_n}{i} = \frac{\frac{15\%}{year}}{\frac{2.5\%}{interest\ period}} = 6\ periods\ per\ year$$

2.20 Calculate the yearly interest rate if there are 12 interest periods per year and the interest rate per period is 0.8%.

$$i_n = i \times m = \frac{0.8\%}{period} \times \frac{12\ periods}{year} = 9.6\%$$

2.21 Calculate the effective interest rate if the interest rate per compounding period is 1.5% and the number of compounding periods per year is 12.

$$i_e = (1+i)^m - 1 = (1+0.015)^{12} - 1 = 19.56\%$$

2.22 Calculate the effective interest rate if the nominal interest rate is 16% and the interest is compounded every 2 months.

$$i_e = \left(1 + \frac{i_n}{m}\right)^m - 1 = \left(1 + \frac{0.16}{6}\right)^6 - 1 = 17.10\%$$

2.23 If a bank pays 9% interest per year and the compounding period is weekly what is the effective interest rate?

$$i_e = \left(1 + \frac{i_n}{m}\right)^m - 1 = \left(1 + \frac{0.09}{52}\right)^{52} - 1 = 9.41\%$$

2.24 An engineer locates a bank paying 2% interest per year compounded continuously. If the engineer invests his money in this bank, what is the continuously compounded interest rate?

$$\overline{i_e} = e^{i_n} - 1 = e^{0.02} - 1 = 2.02\%$$

2.25 An engineering firm borrows funds from a bank charging 9% interest compounded continuously. What is the continuously compounded interest rate?

$$\overline{i_e} = e^{i_n} - 1 = e^{0.09} - 1 = 9.42\%$$

2.26 If a credit union pays 1% yearly compounded monthly what is the effective interest rate?

$$i_e = \left(1 + \frac{i_n}{m}\right)^m - 1 = \left(1 + \frac{0.01}{12}\right)^{12} - 1 = 1.0046\%$$

2.27 If an engineer is earning 1.75% interest per year compounded daily, what is the effective interest rate?

$$i_e = \left(1 + \frac{i_n}{m}\right)^m - 1 = \left(1 + \frac{0.0175}{365}\right)^{365} - 1 = 1.76\%$$

2.28 Calculate the nominal interest rate if the period interest rate is 0.5% and there are 4 compounding periods per year.

$$i_n = i \times m = \frac{0.5\%}{per\ period} \times \frac{4\ periods}{year} = 2\%\ per\ year$$

2.29 A firm pays year-end dividends to its employees of 1.5% but the funds in the account compound every 2 months. What is the effective interest rate?

$$i_e = \left(1 + \frac{i_n}{m}\right)^m - 1 = \left(1 + \frac{0.0015}{6}\right)^6 - 1 = 1.5094\%$$

2.30 What is the continuously compounded interest rate if an investor is able to invest her funds at a nominal interest rate of 1.25%?

$$\overline{i_e} = e^{i_n} - 1 = \overline{i_e} = e^{0.0125} - 1 = 1.257\%$$