



CHAPTER 1

ENGINEERING ECONOMY



OUTLINE

By the end of this lecture you will be able to:

- Explain the concept of Time Value of Money
- Develop the concept of simple and compound interest
- Develop the concept about Future Value and Present Value of money/ asset
- Calculate present and future value of money/asset



THE TIME VALUE OF MONEY

- The initial amount of money invested or borrowed in transactions is called the **principal (P)**.
- The **interest rate (i)** measures the cost or price of money and is expressed as a percentage per period of time.
- A specified length of time marks the duration of the transaction and thereby establishes a certain **number of interest periods (N)**.
- A **future amount of money (F)** results from the cumulative effects of the interest rate over a number of interest periods.



EFFECT OF MARKET INTEREST RATE

$$\text{Future value} = FV_N = PV(1 + I)^N$$

$$\text{Present value} = PV = \frac{FV_N}{(1 + I)^N}$$



Finding the Present Value : Examples

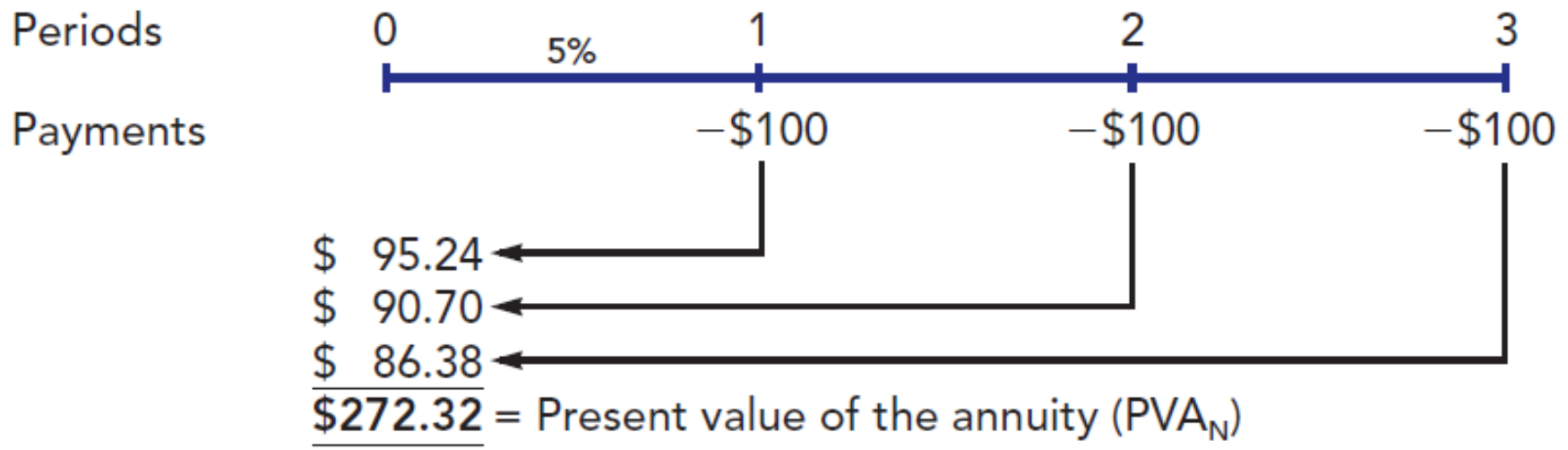
Example 1 : Find the present value of the annuity at 5% interest rate.

Solution:

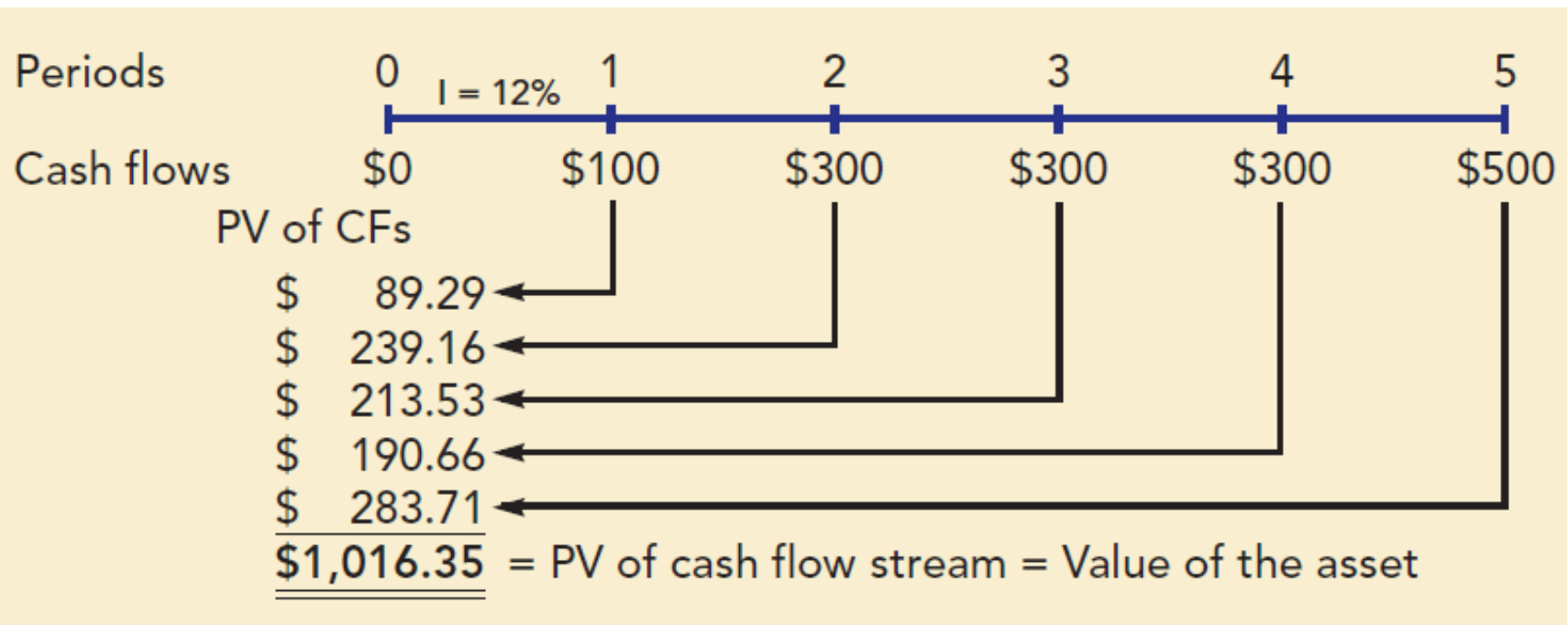
For 1st year , $PV = 100/(1+.05)^1 = 95.24$

For 2nd year , $PV = 100/(1+.05)^2 = 90.70$

For 3rd year , $PV = 100/(1+.05)^3 = 86.38$



Example 2: Find the present value of the asset whose cash flow is shown below (consider 12% interest rate).



Finding the Future Value : Examples

Example 3

Find the Future Worth of the cash flows at 5th year at 12% interest rate.

Solution:

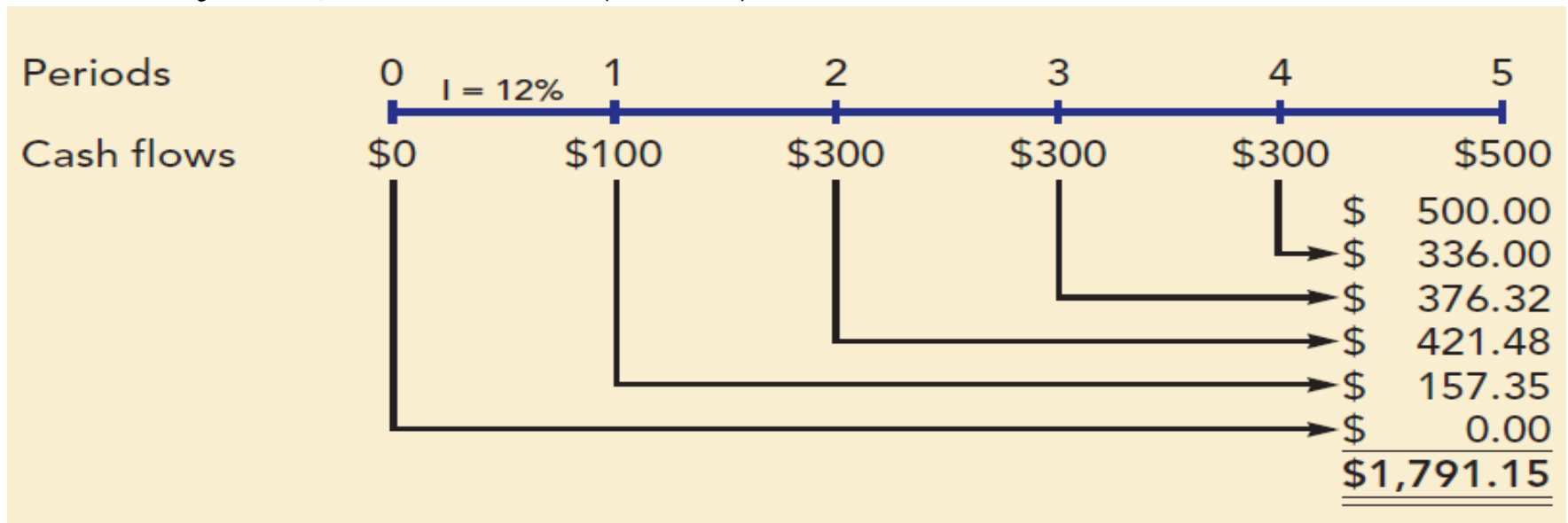
For 5th year , $FV = 500 * (1 + .12)^0 = 500$

For 4th year , $FV = 300 * (1 + .12)^1 = 336$

For 3rd year , $FV = 300 * (1 + .12)^2 = 376$

For 2nd year , $FV = 300 * (1 + .12)^3 = 421.48$

For 1st year , $FV = 100 * (1 + .12)^4 = 157.35$



Finding The Interest Rate

Example 4:

Now suppose we know PV, FV, and N, and we want to find I. For example, suppose we know that a given bond has a cost of \$100 and that it will return \$150 after 10 years. Thus, we know PV, FV, and N, and we want to find the rate of return we will earn if we buy the bond. Here's the situation:

$$FV = PV(1 + I)^N$$

$$\$150 = \$100(1 + I)^{10}$$

$$\$150/\$100 = (1 + I)^{10}$$

$$1.5 = (1 + I)^{10}$$

Ans: I = 4.14%



Effective Rate

$$\text{Effective annual rate (EFF\%)} = \left(1 + \frac{I_{\text{NOM}}}{M} \right)^M - 1$$

Here I_{NOM} is the nominal rate expressed as a decimal and M is the number of compounding periods per year. For example, the nominal rate is 10 percent but with semiannual compounding, hence

$$\text{Effective annual rate (EFF\%)} = \left(1 + \frac{0.10}{2} \right)^2 - 1 = 0.1025 = 10.25\%$$



Example 4: Would you rather invest in an account that pays 7 percent with annual compounding or 7 percent with monthly compounding? Would you rather borrow at 7 percent and make annual or monthly payments? Why?

Investment Scenario

1. 7% with Annual Compounding

- Since the compounding is annual, the Effective Annual Rate (EFF%) is the same as the nominal rate, so:

$$\text{EFF}\% = 7\%$$

2. 7% with Monthly Compounding

- For monthly compounding, we use the formula:

$$\text{EFF}\% = \left(1 + \frac{0.07}{12}\right)^{12} - 1$$

- Calculating this:

$$\text{EFF}\% = (1 + 0.005833)^{12} - 1$$

$$\text{EFF}\% \approx (1.005833)^{12} - 1$$

$$\text{EFF}\% \approx 1.0723 - 1 = 0.0723 \text{ or } 7.23\%$$

Conclusion for Investment:

You would rather invest in the account with 7% interest compounded monthly because it yields a higher effective annual rate (7.23%) than the account with annual compounding (7%).

Example 5

Lily invests \$5,000 in an account with a 6% nominal interest rate compounded quarterly. She plans to keep the investment for 3 years. Calculate the Future Value (FV) of her investment using the Effective Annual Rate (EFF%).

Solution Steps:

1. Calculate EFF%

- Nominal Rate (I_{NOM}): 6%
- Compounding Periods (M): 4 (quarterly)
- EFF% Formula: $\left(1 + \frac{I_{NOM}}{M}\right)^M - 1$
- Calculation:

$$EFF\% = \left(1 + \frac{0.06}{4}\right)^4 - 1 = 6.14\%$$

2. Calculate Future Value (FV)

- Formula: $FV = PV \times (1 + EFF\%)^n$
- Calculation:

$$FV = 5,000 \times (1 + 0.0614)^3 = 5,975$$



Example 6

John wants \$10,000 in his savings account in 5 years. The account offers a nominal rate of 8% compounded monthly. How much should he deposit today (Present Value) to reach his goal?

Solution Steps:

1. Calculate EFF%

- Nominal Rate (I_{NOM}): 8%
- Compounding Periods (M): 12 (monthly)
- EFF% formula: $\left(1 + \frac{I_{\text{NOM}}}{M}\right)^M - 1$
- $\text{EFF\%} = \left(1 + \frac{0.08}{12}\right)^{12} - 1 = 8.29\%$

2. Calculate Present Value (PV)

- $PV = \frac{FV}{(1 + \text{EFF\%})^n}$
- $PV = \frac{10,000}{(1 + 0.0829)^5} \approx 6,717.76$

Answer:

John should deposit approximately **\$6,717.76** today to reach his goal of \$10,000 in 5 years.

Example: What's the *future value of \$100 after three years if the appropriate* interest rate is 8 percent, compounded annually? Compounded monthly?

(Ans.: \$125.97; \$127.02)

Example : What's the *present value of \$100 due in three years if the appropriate* interest rate is 8 percent, compounded annually? Compounded monthly?

(Ans. \$79.38; \$78.73)



1. NET PRESENT VALUE OR PRESENT WORTH

- Determines whether the project is or is not an acceptable investment.

Example 1.1:

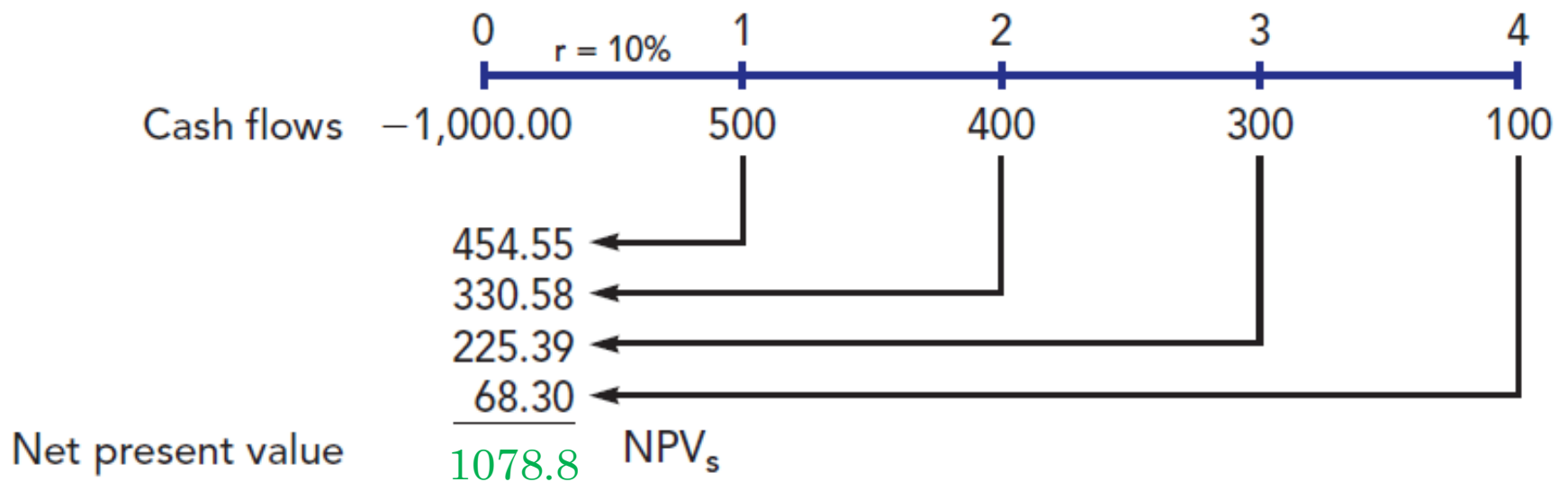
Year (t)	CASH FLOWS, CF_t		
	Project S	Project L	
0	-\$1,000	-\$1,000	Initial cost at yr 0
1	500	100	
2	400	300	Consider 10% cost of capital
3	300	400	
4	100	675	

Project S	0	1	2	3	4
	—\$1,000	\$500	\$400	\$300	\$100

Project L	0	1	2	3	4
	— \$1,000	\$100	\$300	\$400	\$675

Solution 1.1:

At a 10 percent cost of capital, Project S's NPV is



Calculate for project L in the same way.



- **Problem for practice 1.2:**

Tiger Machine Tool Company is considering the acquisition of a new metal cutting machine. The required initial investment of \$75,000 and the projected cash benefits over a three-year project life are as follows. You have been asked by the president of the company to evaluate the economic merit of the acquisition. The firm's MARR (Minimum Annual Rate of Return) is known to be 15%. Find NPV for the project and calculate whether the project should be selected or not

End of Year	Net Cash Flow
0	–\$75,000
1	\$24,400
2	\$27,340
3	\$55,760



The End

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