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NEPAL ENGINEERING COUNCIL

LICENSE EXAMINATION PREPARATION COURSE
FOR
CIVIL ENGINEERS
ON

Engineering Economics

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10.2 Engineering Economics

- Understanding of project cash flow;
- Discount rate, interest and time value of money;
- Basic methodologies for engineering economics analysis (Discounted Payback Period, NPV, IRR & MARR);
- Comparison of alternatives, depreciation system and taxation system in Nepal.

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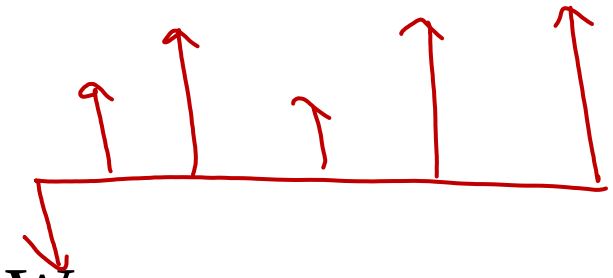
Definition of cash flow

It is the statement that shows the actual amount coming into firm or going out of the firm.

- **Cash Inflows:** Actual rupees coming into a firm.
- **Cash outflows:** Actual rupees going out from the firm.

- **Cash Flow Diagram (CFD)**



  - Diagram representing the cash flow
  - CFD illustrates the **size, sign, and timing** of individual cash flows

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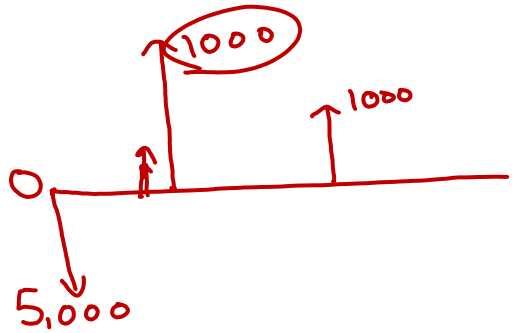
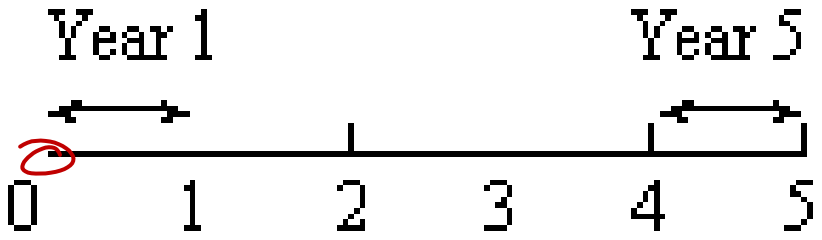
Drawing a Cash Flow Diagram:

- In cash flow diagram (CFD) the end of period t is the same as the beginning of period. (t + 1).

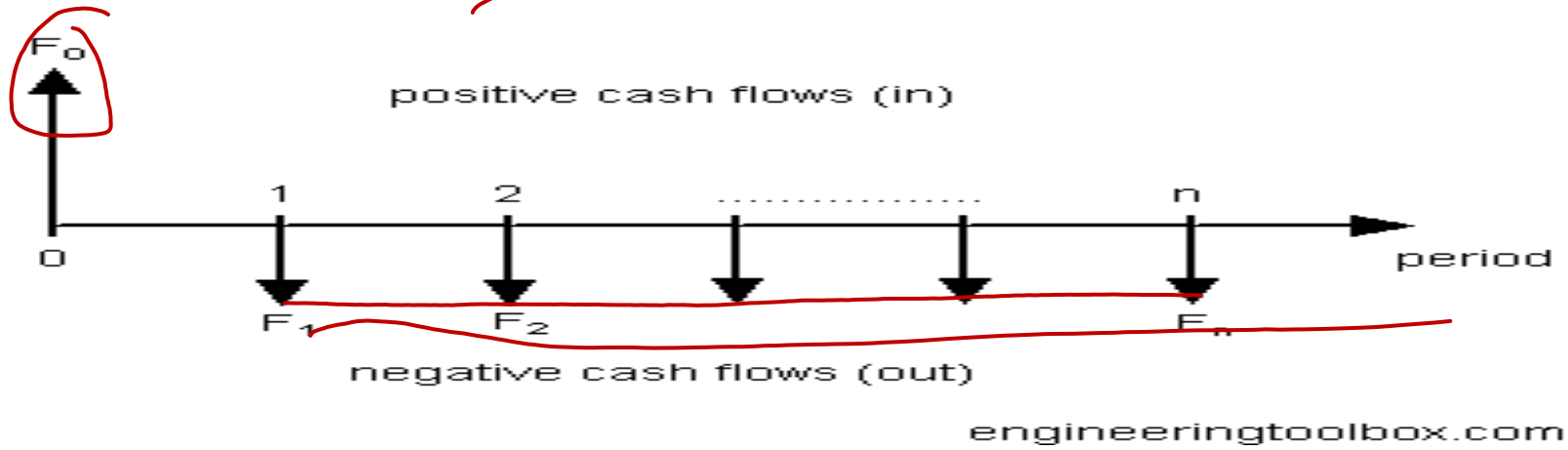




- The choice of time zero is arbitrary. It can be when a project is analyzed, when funding is approved, or when construction begins.

Drawing a Cash Flow Diagram (contd.):

- One person's cash outflow (represented as a negative value) is another person's inflow (represented as a positive value).



- Arrow lengths are approximately proportional to the magnitude of cash flow

Types of Interest

- **a. Simple Interest:**

P = 1000

i = 10 % per year = 0.1

N = 5 yr.

1000 × 0.1 × 5 = 500

A = 1500

SI = P(I)R/100

SI = P.i.n

b. Compound Interest:

$A = P(1+i)^n$

$A = 1000(1+0.1)^5 = 1610.\ldots$

Types of Interest

- **a. Simple Interest:** Interest on Principal Only.
- For a deposit of P Rupees at a simple interest rate of *i* for N periods, the total earned interest **I** would be
- **I = (i × P) N** = PNi (PTR/100)
- The total amount available at the end of N periods, F, thus would be
- F = P + I = P + PNi = P (1 + Ni)
- Alternatively, A = P + **PTR/100**

b. Compound Interest: Interest on Principal as well as Interest after certain Period i.e. one year, half yearly, quarterly, monthly, weekly etc. If there is 'N' interest period.

$$F = P(1 + i)^N$$

Where P is Principal, i is Interest Rate and N is no of Compounding Period

Alternatively, $A = P(1 + R/100)^T$

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Example : Deposit Rs 1000 in a Bank now. What will be the Future amount at the end of Five Years if the interest rate is 10 percent Per year?

- P = 1000, i= 10% (0.1), N = 5 Years and F = ?

Using Simple Interest Formula

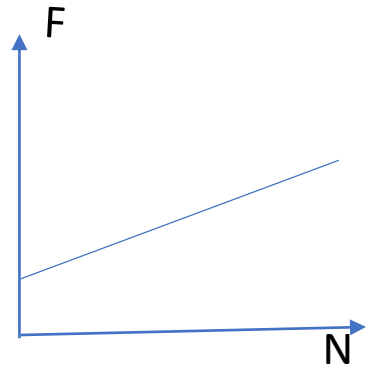
$F = P + P\,i\,\ N$

F= 1000 + 1000 x 5x 0.1

= 1000 + 500

= 1500

Calculate F if N = 100



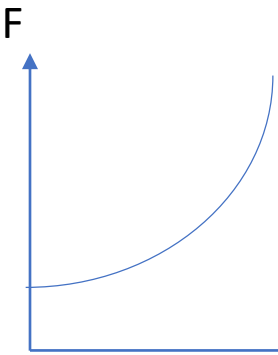
Using Compound Interest Formula

$F = P\,(1+ i)^{N}$

F= 1000 (1+0.1)^ 5

= 1610.51

Calculate F if N = 100



Example : Calculate F if N is 100 year

Simple F = 11000, Compound F= 1,37,80,612.34

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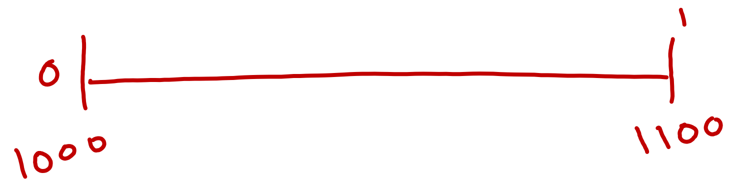
Concept of effective interest rate

- An effective annual interest rate is the real return on any interest-paying investment when the effects of compounding over time are taken into account.
- It also reflects the real percentage rate owed in interest on a loan, a credit card, or any other debt.
- Also called annual equivalent rate

The nominal interest rate does not take into account the compounding period. The effective interest rate does take the compounding period into account and thus is a more accurate measure of interest charges.

Concept of effective interest rate

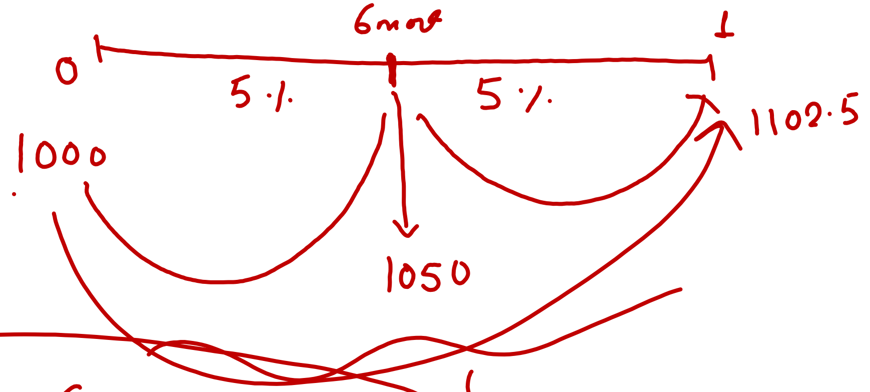


10% per year

10% per year

10% per year compounded semiannually

nominal



$1000(1+0.1025)^1$ → Effective

= - - -

$$i_{eff\ per\ x} = \left(1+\frac{i_{nominal\ per\ x}}{n}\right)^n - 1$$

n = no. of compounding per x.

$$i_{eff} = \left(1+\frac{0.1}{2}\right)^2 - 1 = 10.25\%$$

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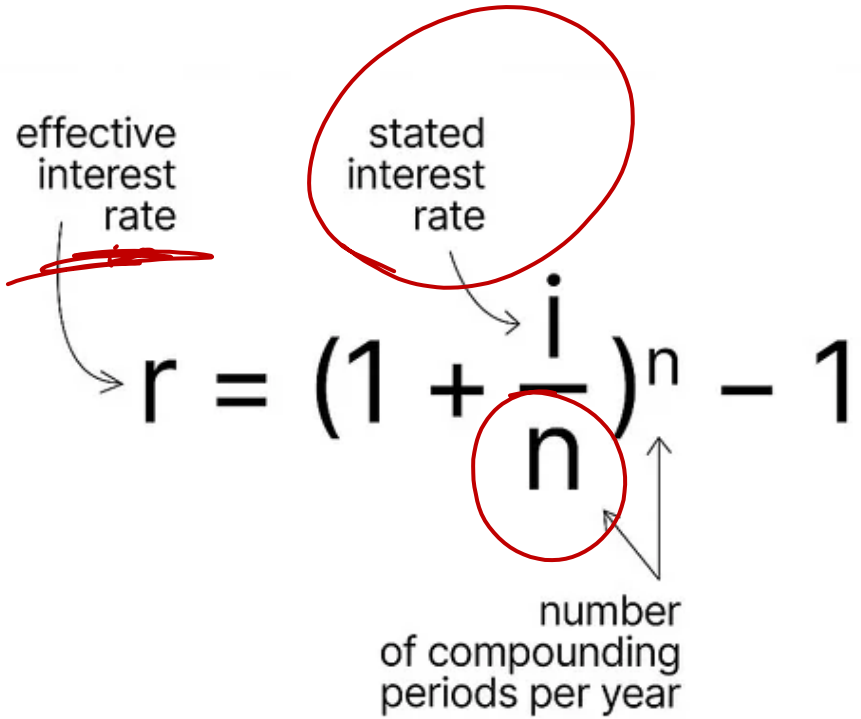
Effective Interest Rate



For continuous compounding :

$$i_{eff} = e^{i} - 1$$

i= nominal rate for period where effective rate is required

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Questions

$$i_{eff.p.x} = \left(1 + \frac{i_{nominal\ per\ x}}{n_{per\ x}}\right)^n - 1$$

1: A bank is starting its nominal interest rate of 9% P.A. and compounded quarterly. Calculate the effective interest rate per year.

a) 9%
b) 9.3%
c) 2.225%
d) 4.55%
e) 0.743%

f) 9.25

$i_{nom.p.year} = 0.09$

$$i_{eff\ p.year} = \left(1 + \frac{0.09}{4}\right)^4 - 1 = 0.093 = 9.3\%$$

2: A bank is starting its nominal interest rate of 9% P.A. and compounded quarterly. Calculate the effective interest rate per semi annual.

a) 9%
b) 9.3%
c) 2.225%
d) 4.55%
e) 0.743%

$i_{nom\ per\ S.A} = \frac{9}{2} = 4.5\% = 0.045$

$$\therefore i_{eff\ p.S.A} = \left(1 + \frac{i_{nom.p.S.A}}{\text{no. of Comp}^n\ p.S.A}\right)^2 - 1$$

$= 0.0455$

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Questions

3 month = 1 Compn

1 month = $\frac{1}{3}$ Compd.

3: A bank is starting its nominal interest rate of 9% P.A. and compounded quarterly. Calculate the effective interest rate per quarter

a) 9%
b) 9.3%
c) 2.225%
d) 4.55%
e) 0.743%

$i_{nom.\ per\ quarter} = \frac{9}{4} = 2.25\%$

$i_{eff\ p.q} = \left(1 + \frac{i_{nom\ p.q}}{no.of\ Compounds\ p.q}\right)^{n} - 1 = \left(1 + \frac{0.0225}{1}\right)^{1} - 1$

$= 0.00225$ #

4: A bank is starting its nominal interest rate of 9% P.A. and compounded quarterly. Calculate the effective interest rate per month.

a) 9%
b) 9.3%
c) 2.225%
d) 4.55%
e) 0.743%

$i_{nom\ p.month} = \frac{9}{12} = 0.75\%$

$i_{eff\ p.month} = \left(1 + \frac{i_{nom.p.M}}{n.p.M}\right)^{n} - 1 = \left(1 + \frac{0.0075}{7/3}\right)^{7/3} - 1$

$= 0.00749.$

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Economic Equivalence and time value of money

- The time value of money (TVM) is the concept that a sum of money is worth more now than the same sum will be at a future date due to its earnings potential.
- Economic equivalence is a combination of interest rate and time value of money to determine the different amounts of money at different points in time that are equal in economic value

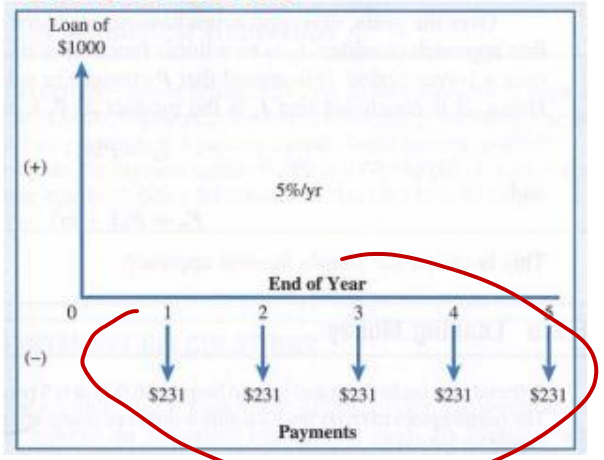
Eg. Getting Rs 20000 now is equal to $getting\ 20000\ (1.06)^6 = 28370.38$ In 6 years considering the rate of interest is 6% per annum

Economic Equivalence and time value of money

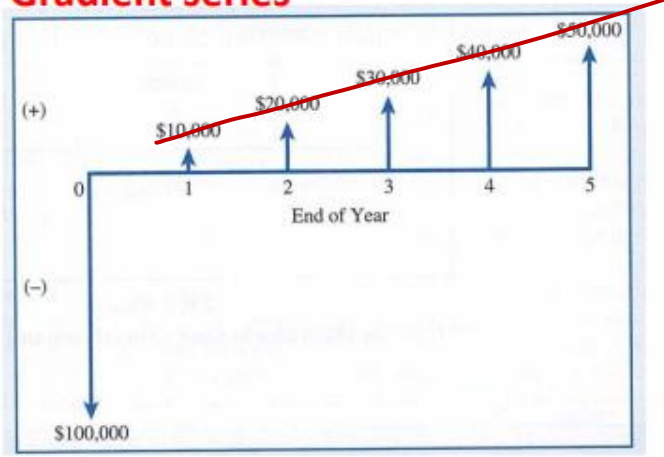
1. Money cannot be added of subtracted unless it occurs at the same point(s) in time
2. To move money forward one time unit, multiply by one plus the discount or interest rate
3. To move money backward one time unit, divide by on plus the discount or interest rate.

- Cash flow diagrams (CFDs) helps to analyze the TVOF.
- CFD shows received (+) and spent (-) money vs. time.
- Two reasons to use CFD:
  - ✓ CFDs are powerful communication tool.
  - ✓ CFDs can help in identification of significant cash flow *patterns* within a sequence economic transactions.

Uniform series



Gradient series



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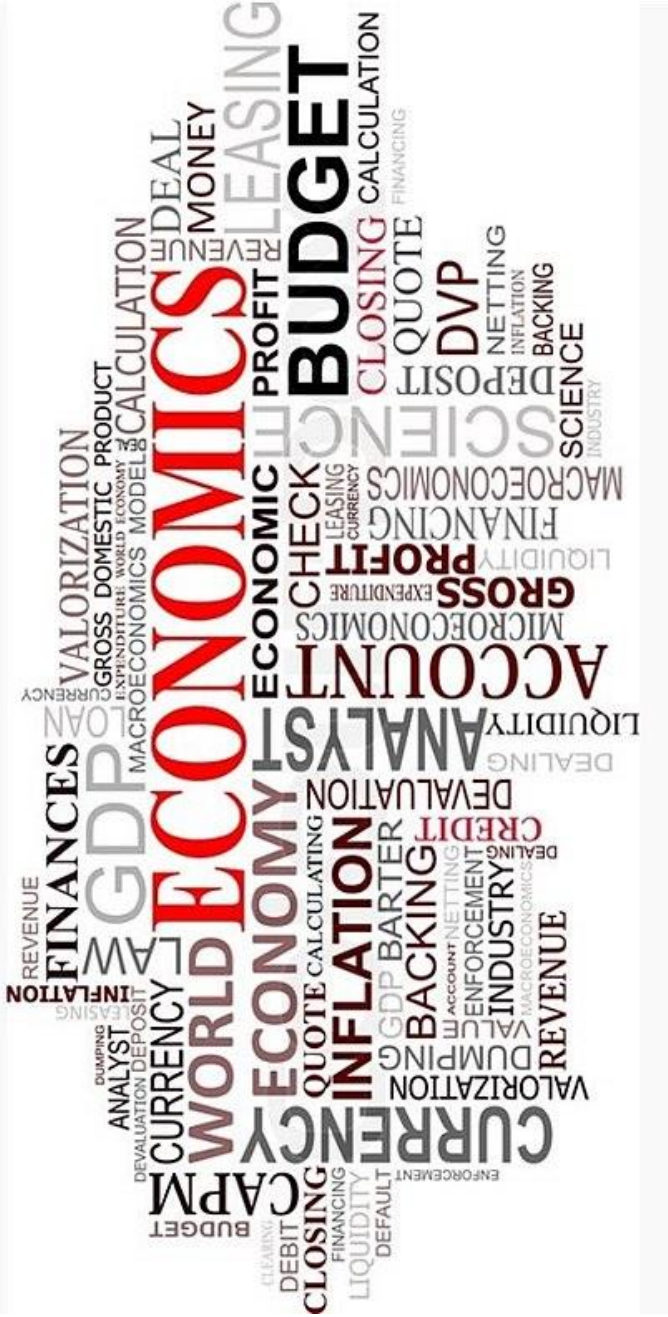
Principle of Economics

Principles of Engineering Economic Analysis

1. Money has a time value;
2. Make investments that are economically justified;
3. Choose the mutually exclusive investment alternative that maximizes economic worth;
4. Two investment alternatives are equivalent if they have the same economic worth;
5. Marginal revenue must exceed marginal cost;
6. Money should continue to be invested as long as each additional increment of investment yields a return that is greater than the investor's time value of money;
7. Consider only differences in cash flows among investment alternatives;
8. Compare investment alternatives over a common period of time;
9. Risks and returns tend to be positively correlated; and
10. Past costs are irrelevant in engineering economic analyses, unless they impact future costs.



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Various Interest formulas:

Single-Payment Compound Amount

$$F = P(1 + i)^n = P(F/P, i, n)$$

Single-Payment Present Worth Amount

$$P = \frac{F}{(1 + i)^n} = F(P/F, i, n)$$

Equal-Payment Series Compound Amount

$$F = A\,\frac{(1 + i)^n - 1}{i} = A(F/A, i, n)$$

Equal-Payment Series Sinking Fund

$$A = F\,\frac{i}{(1 + i)^n - 1} = F(A/F, i, n)$$

Equal-Payment Series Present Worth Amount

$$P = A\,\frac{(1 + i)^n - 1}{i(1 + i)^n} = A(P/A, i, n)$$

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Various Interest formulas:

Equal-Payment Series Present Worth Amount

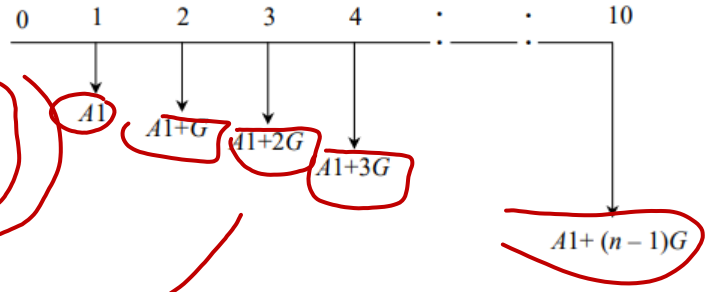
$$P = A\frac{(1+i)^n - 1}{i(1+i)^n} = A(P/A, i, n)$$

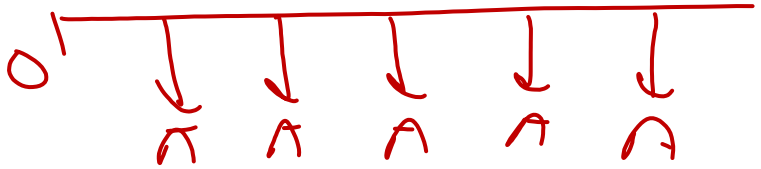
Equal-Payment Series Capital Recovery Amount

$$A = P\frac{i(1+i)^n}{(1+i)^n - 1} = P(A/P, i, n)$$

Uniform Gradient Series Annual Equivalent Amount

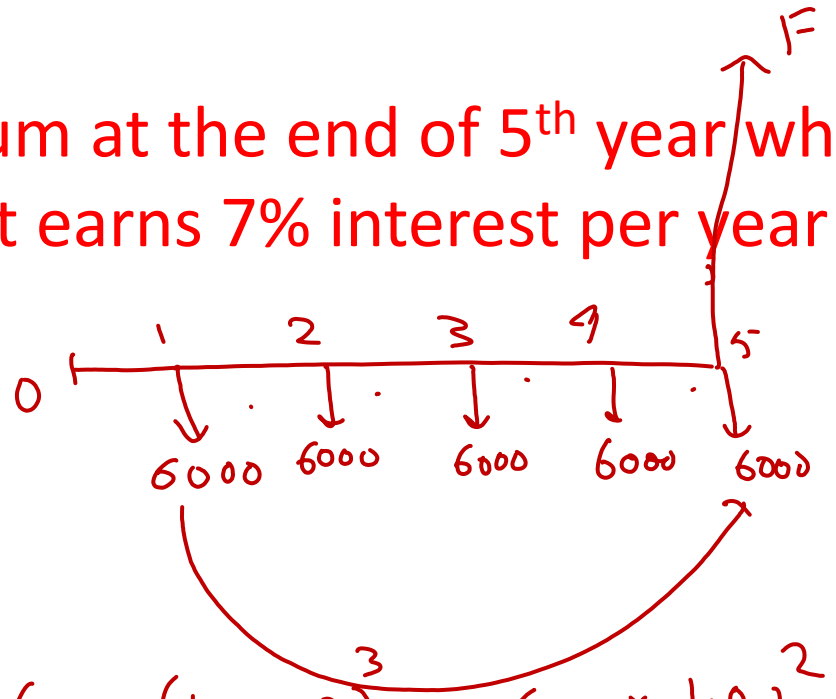
$$A = A1 + G\frac{(1+i)^n - in - 1}{i(1+i)^n - i} = A1 + G(A/G, i, n)$$





Questions

5. Calculate future sum at the end of 5th year when yearly deposit is Rs 6,000 for 5 years that earns 7% interest per year .



$6000(1+0.07)^4 + 6000\times(1+0.07) + 6000\times 1.07^2 + 6000\times 1.07 + 6000$

=

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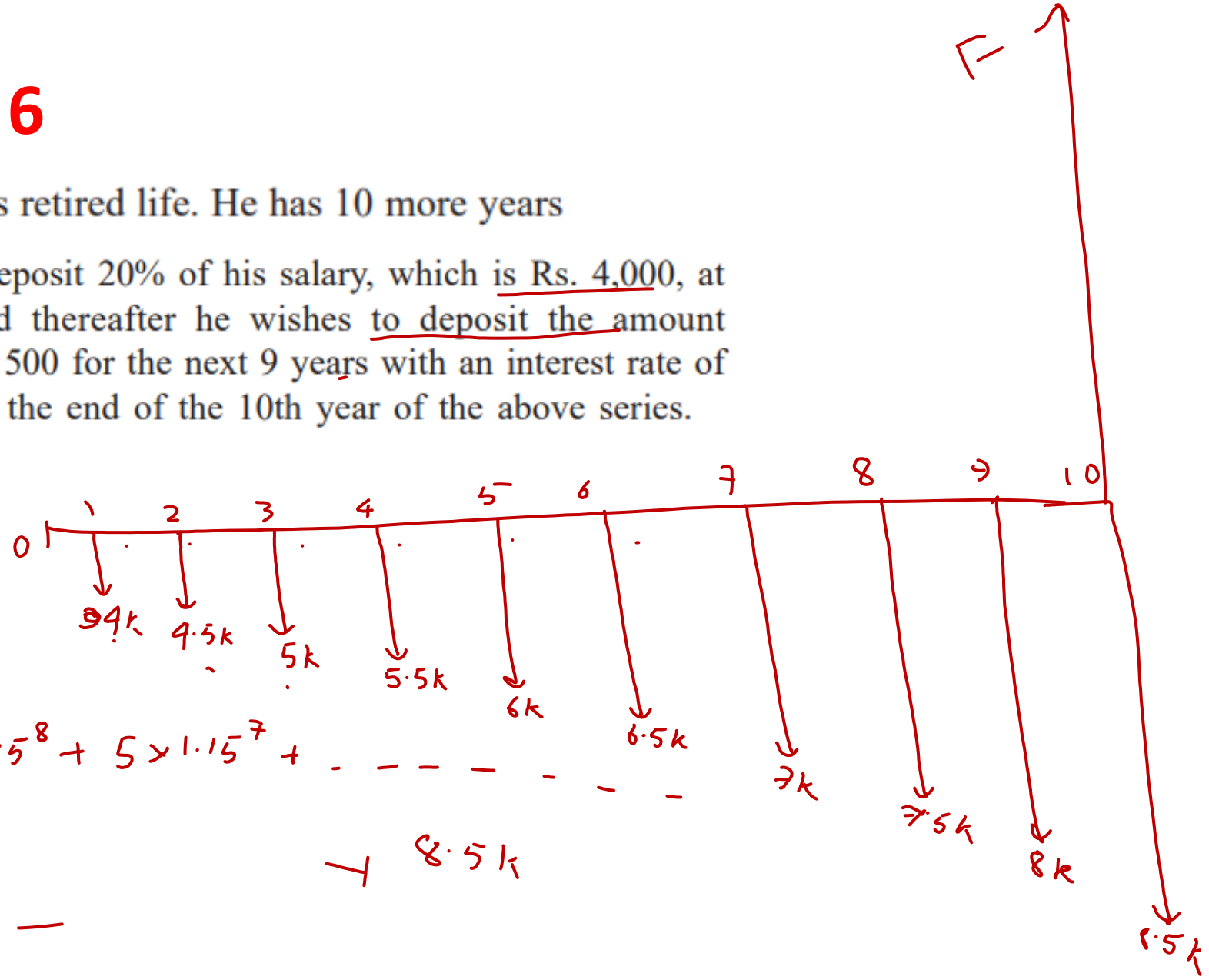
Questions 6

A person is planning for his retired life. He has 10 more years of service. He would like to deposit 20% of his salary, which is Rs. 4,000, at the end of the first year, and thereafter he wishes to deposit the amount with an annual increase of Rs. 500 for the next 9 years with an interest rate of 15%. Find the total amount at the end of the 10th year of the above series.

a. Rs. 1,15,562.25
b. Rs. 1,16,560.25
c. Rs. 1,17,582.25
d. Rs. 1,18,596.25



$4 \times 1.15^9 + 4.5 \times 1.15^8 + 5 \times 1.15^7 + \cdots$

$= \cdots$

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Solution Here,

$A1$ = Rs. 4,000
G = Rs. 500
i = 15%
n = 10 years
A = ? & F = ?

The cash flow diagram is shown in Fig. 3.13.

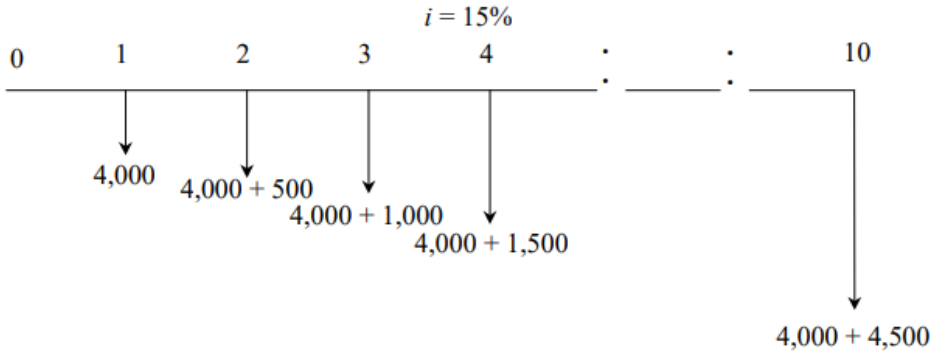

Fig. 3.13 Cash flow diagram of uniform gradient series annual equivalent amount.

$$A = A1 + G\frac{(1+i)^n - in - 1}{i(1+i)^n - i}$$
$$= A1 + G(A/G, i, n)$$
$$= 4{,}000 + 500(A/G, 15\%, 10)$$
$$= 4{,}000 + 500 \times 3.3832$$
$$= \text{Rs. } 5{,}691.60$$

This is equivalent to paying an equivalent amount of Rs. 5,691.60 at the end of every year for the next 10 years. The future worth sum of this revised series at the end of the 10th year is obtained as follows:

$$F = A(F/A, i, n)$$
$$= A(F/A, 15\%, 10)$$
$$= 5{,}691.60(20.304)$$
$$= \text{Rs. } 1{,}15{,}562.25$$

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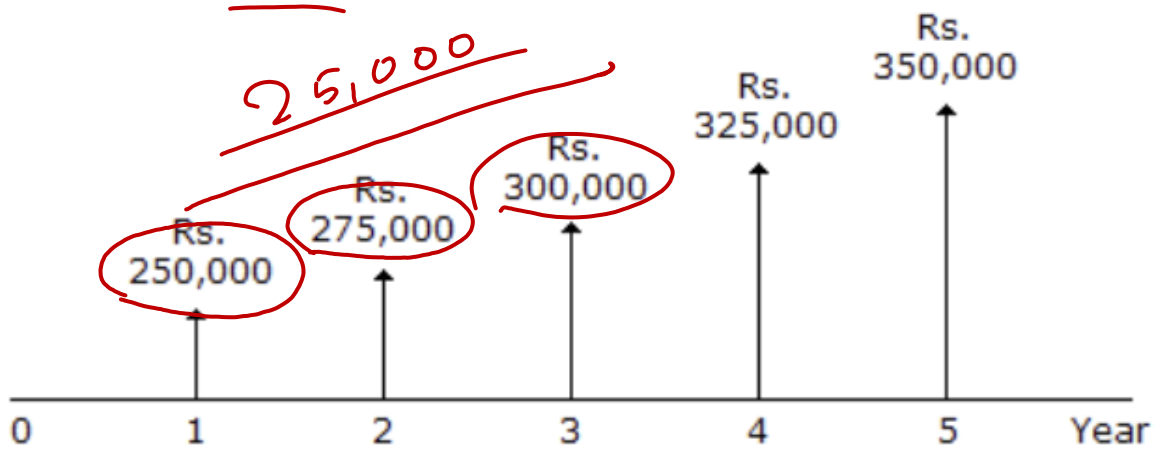
Questions 7

Refer to the cash flow diagram of uniform gradient in a cash flow (in the given figure), the gradient is :



(A) Rs 10000 per year

(B) Rs 15000 per year

(C) Rs 20000 per year

(D) Rs 25000 per year

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Questions 7

If you deposit Rs. 10,000 in a saving account now which gives 10 % nominal interest rate per year. What *will* be the amount after five years if the interest is compounded

a) semi-annually

b) monthly.

$$i_{eff.p.year} = \left(1 + \frac{0.1}{2}\right)^2 - 1 = 0.1025$$

$$F = P(1 + i_{eff})^{n=5} = \text{----}$$

$$i_{eff.p.year} = \left(1 + \frac{0.1}{12}\right)^{12} - 1 = 0.1047$$

$$F = P(1 + i_{eff})^{n=5} = \text{. . .}$$

Methodologies for engineering economic analysis

Engineering economic analysis is a branch of economics that applies economic principles and techniques to assess the financial aspects of engineering projects, investments, and decision-making.

Some of the methodologies used are:

a. Payback period
b. Equivalent worth method (Present Worth, Future Worth and Annual Worth)
c. Rate of Return Method (IRR and ERR)
d. Benefit-Cost Ratio

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1. Payback Period:

It refers to that period within which the project will generate the necessary cash to recoup the initial investment.

In case of even cash flows, payback period can be calculated as follows:

$$\text{Payback period} = \frac{\text{Initial Investment}}{\text{Annual Cash Flow}}$$

In case of uneven cash flows, the payback period can be found out by adding up the cash inflows until the total is equal to the initial cash outlay.

Acceptance Rule:

(a) The project would be accepted if it's payback period is less than the maximum or standard payback period set by the management.

(b) In case of selection from a number of projects, the project with the shortest period will be selected.

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Types of Payback period

A. Simple Payback period:

- If the time value of money is not considered in calculation of payback period, then it is called simple payback period.
- B. Discounted Payback period:
- If the time value of money is considered in calculation of Pay back period , then it is called Discounted Payback period.
- **In discounted payback period,**
- we have to calculate the present value of each cash inflow.

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Advantages of Payback Period:

Advantages of payback period are:

1.Payback period is very simple to calculate.

2.It can be a measure of risk inherent in a project. Since cash flows that occur later in a project's life are considered more uncertain.

3.For companies facing liquidity problems, it provides a good ranking of projects that would return money early.

Disadvantages of payback period are:

1.It does not take into account, the cash flows that occur after the payback period. This means that a project having very good cash inflows but beyond its payback period may be ignored.

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Questions

7. The number of years required for the net operating benefits to payback the initial cost of the project is called:

A. Operation period
B. Service period
C. Payback period
D. Maintenance period

EQUIVALENT WORTH METHOD

(a) Present worth method:

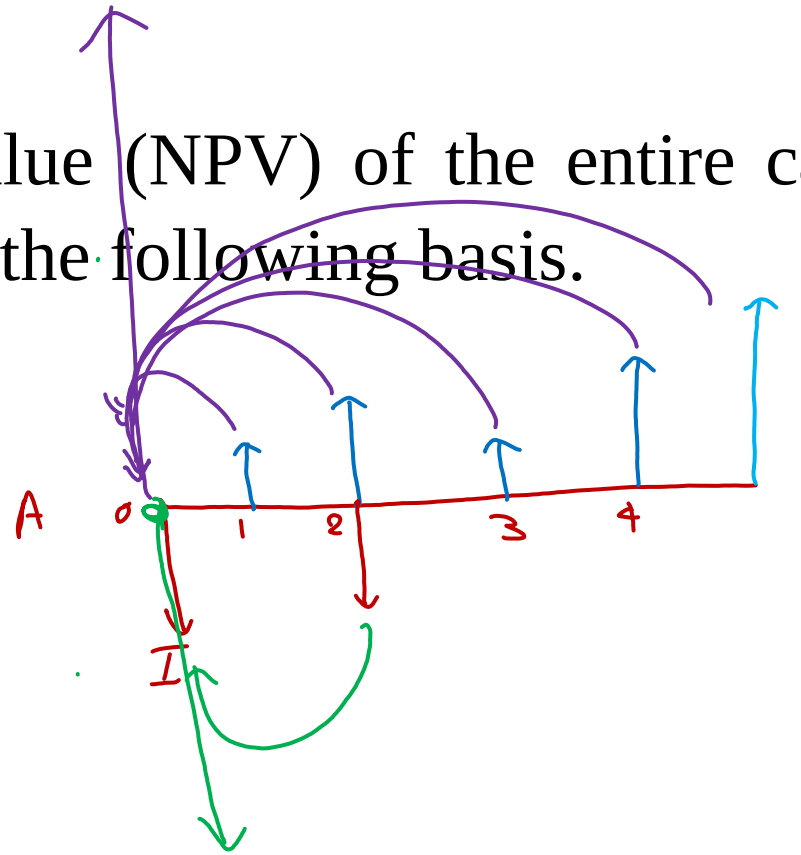
In this method, the net present value (NPV) of the entire cash flow is calculated and decision is made on the following basis.

NPV

NPV > 0 , Accept

NPV =0 , Remain indifferent

NPV < 0 , Reject



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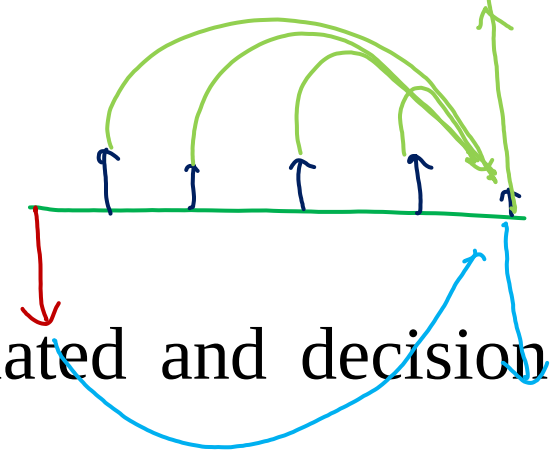
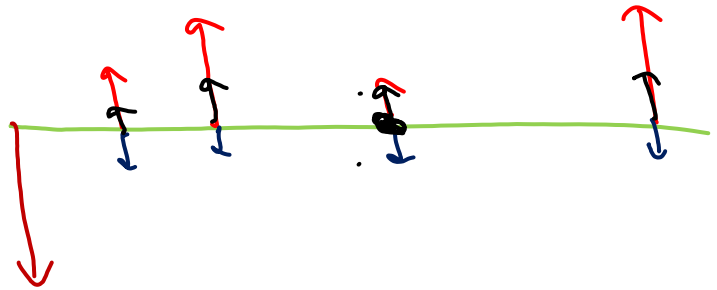
EQUIVALENT WORTH METHOD



(b) Future worth method :

In this method, the future worth is calculated and decision making is similar to that of present worth method.

(c) Annual worth method: In this method, the annuities are calculated and decision is made similar to the above methods.



RATE OF RETURN METHOD

a. Internal Rate of Return – IRR ?

b. External/Modified Rate of Return – ERR/MIRR

Internal rate of return (IRR) :

- The **internal rate of return** is a discount **rate** that makes the net present value (NPV) of all cash flows equal to zero in a discounted cash flow analysis.
- It is the annual rate of growth that an investment is expected to generate

Minimum attractive rate of return(MARR):

This is the minimum interest rate expected by the Company / Organization while investing in a PROJECT.

MARR is the interest rate used in the time value of money calculation, it is generally dictated by management considering the amount of money available for investment and source and cost of the funds for investment

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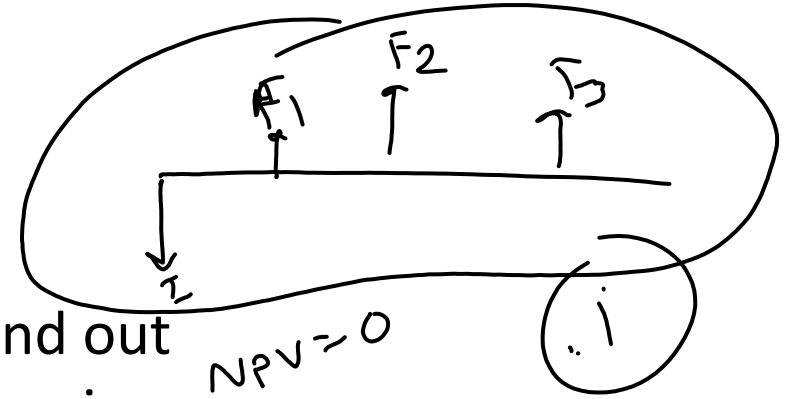
Calculation of IRR



- The entire cash flows of a series is found out
- The internal rate of return is assumed as i
- The or PW or AW or FW of the cash flow series is made zero
- By trial and error or by computations, the internal rate of return is found out

Decision Criteria:

If IRR > MARR Project is Feasible

IRR < MARR Project is Unfeasible

IRR = MARR –> Critically Feasible, Remain Indifferent

Questions

9. You are debating weather or not to invest in your best friend's buisess idea , so use IRR to evaluate the project:

Cost of capital :10 % → MARR

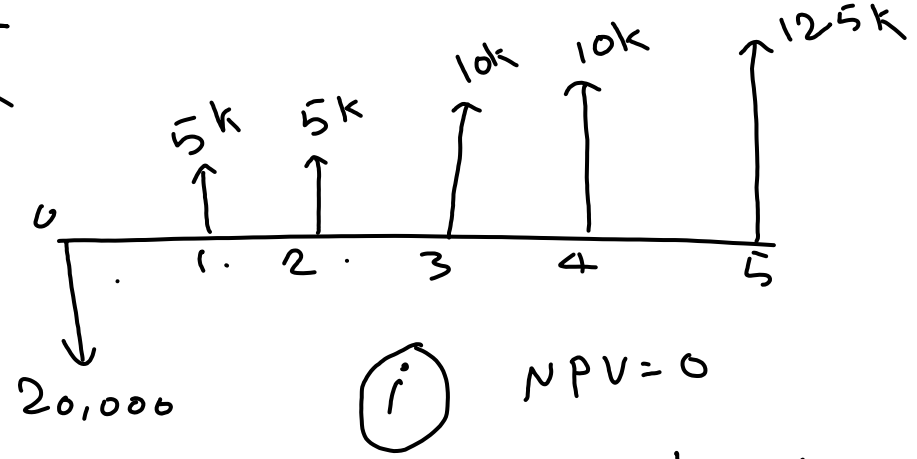
Initial Investment= Rs 20000

Cash flows over past 5 years

Years 1 & 2 : Rs 5000

Years 3 & 4 : Rs 10000

Years 5 : Rs 12500



i

NPV = 0

$$\frac{5000}{(1+i)^1} + \frac{5000}{(1+i)^2} + \frac{10,000}{(1+i)^3} + \frac{10000}{(1+i)^4} + \frac{12500}{(1+i)^5} - 20,000 = 0$$

$$i = 26.04\%$$

IRR= 26.04 %

DRAWBACKS OF IRR

1. There are situations in which its iterative calculation process fails to produce a solution and When the algebraic sign of the cash flow changes in the middle of the series it is possible to obtain two "right" answers.

EOY	Net Cash Flow
0	–1,000
1	+2,300
2	–1,320

From the above cash flow pattern, we find IRR = 10% and 20%, but both of them are incorrect. So we may abandon the IRR method for practical purpose and use the NPW criterion to make the decision.

2. When mutually exclusive projects are considered it can recommend the wrong investment and does not consider the scale of the investment

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Modified Internal Rate of Return

- Another capital budgeting tool for investments
- Assumes that the project's cash flows reinvested at the cost of capital, not at the IRR.
- This slight difference, makes the MIRR more accurate than the IRR.

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BENEFIT COST RATIO / PROFITABILITY INDEX

- It is a ratio that compares the (present) value of the (project's) benefits to the present value of its costs.
- The BCR is calculated by dividing the total discounted benefits by the total discounted costs
- BCR = (Present Value of Benefits) / (Present Value of Costs)

Or

- BCR = (Future Value of Benefits) / (Future Value of Costs)

Or

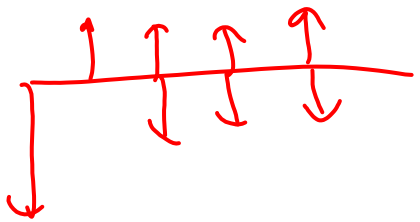
- BCR = (Annual Value of Benefits) / (Annual Value of Costs)

DECISION CRITERIA:

B/C > 1 - FEASIBLE

B/C < 1 – UNFEASIBLE

B/C = 1 – CRITICALLY FEASIBLE



Types of B/C ratio:

A.Conventional B/C ratio:

$$B/C = \frac{\text{PV of (B)}}{\text{I + PV (O\&M) – PV (Sv)}}$$

B. Modified B/C ratio:

$$B/C = \frac{\text{PV of (B)}-\text{PV (O\&M)}}{\text{I – PV (Sv)}}$$

Comparison of Alternatives

- The various methods of economic analysis are used to compare the different alternative projects from each other.
- The project giving the maximum profitability is selected from amongst the different alternatives.
- The criteria of comparing the alternatives are given below:

a. Payback period:

The project with the minimum payback period is selected from the various alternatives.

b. PW method:

The project with maximum value of present worth (PW) is selected from the various alternatives.

Comparison of Alternatives

c. IRR method:

The project with the maximum IRR is selected from the various alternatives.

d. B/C rato:

The project with the maximum B/C ratio is selected from the various alternatives.

NOTE:

Some of the projects having higher values of IRR, or B/C ratio may have lower value of the PW, which may not be the desirable case. So, the incremental analysis should be done to find out the best project.

Eg: Project A : Benefit = 500 Investment = 100 B/C = 5

Project B : Benefit = 3000 Investment = 2000 B/C = 1.5

From B/C point of view, project A seems to be advantageous, but the actual profits earned on project B is more than the project A

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There are nine methods to calculate the economic worth

1. The present worth (PW) method converts all cash flows to a single sum equivalent at time zero using $i = MARR$.
2. The future worth (FW) method converts all cash flows to a single sum equivalent at the end of the planning horizon using $i = MARR$.
3. The annual worth (AW) method converts all cash flows to an equivalent uniform annual series of cash flows over the planning horizon using $i = MARR$.
4. The internal rate of return (IRR) method determines the interest rate that yields a future worth (or present worth or annual worth) of zero.
5. The external rate of return (ERR) method determines the interest rate that equates the future worth of the invested capital to the future worth of recovered capital (when the latter is computed using the *MARR*.)
6. The modified internal rate of return (MIRR) method determines the interest rate that equates the present worth of invested capital (where the present worth is computed using a finance rate) to the future worth of recovered capital (where the future worth is computed using the *MARR*.)
7. The discounted payback period (*DPBP*) method determines how long it takes for the cumulative present worth to be positive using $i = MARR$.
8. The capitalized worth (CW) determines the present worth (using $i = MARR$) when the planning horizon is infinitely long.
9. The benefit/cost ratio (B/C) method determines the ratio of the present worth of benefits (savings or positive-valued cash flows) to the negative of the present worth of the investment(s) (or negative-valued cash flows) using $i = MARR$.

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Depreciation

Loss of value of property due to structural deterioration , use , wear and tear, decay or obsolescence

Depreciation Methods

The most widely used methods are:

1. Straight-line Method
2. Declining Balance Method, and
3. Sum-of-years'- digit method

N I D B
0 SL SL
1 — 10k 490k
2 — 10k 480k
3 — 10k 470k
4 — 10k 460k
5 — 10k 450k

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Depreciation

1. Straight-Line Method

In this method, it is assumed that the fixed asset is depreciated in a uniform way.

$$D_n = \frac{P - S}{N}$$

Where

D_n = the depreciation charge during n year

P = the cost of the asset, including installation expenses

S = salvage value at the end of the useful life of asset

N = the useful life

The book value = cost base - total depreciation charges

$$Bn = P - (D1 + D2 + \ldots\ldots\ldots + Dn)$$

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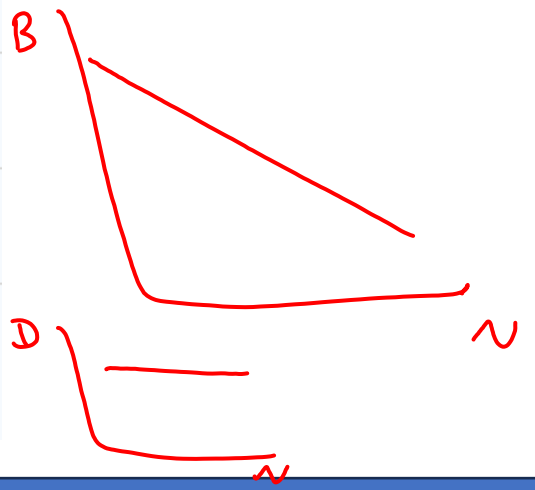
Depreciation

A company buys a truck for $20,000 and estimates to use it for five years with no salvage value. To calculate straight-line depreciation, the company divides the asset's cost by its estimated life:

Straight-line depreciation = $20,000 - $0 / 5 = $4,000

Year #	Opening book value	Depreciation	Ending book value
1	$20,000	$4,000	$16,000
2	$16,000	$4,000	$12,000
3	$12,000	$4,000	$8,000
4	$8,000	$4,000	$4,000
5	$4,000	$4,000	$0

$D = \frac{I - S}{N}$



Depreciation

2. Declining Balance Method

In this method, a **fixed fraction** of the **initial book balance** is deducted each year. The **fraction or declining balance rate** is obtained by

$$D = 1 - \left(\frac{V}{C}\right)^{\frac{1}{n}}$$

$D =$ *percentage rate of annual depreciation,*
$V =$ *scrap value,*
$C =$ *original cost,*
$n =$ *useful life*

The most common multiplier is '1'. If this is '2', then it is called double-declining balance method.

n	O.B	D	C.B
1	5L	50k	450k
2	450k	45k	405k
3	405k	40.5k	

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Depreciation

Declining balance depreciation with D= 1/5

Year #	Opening book value	Depreciation	Ending book value
1	$100,000	$20,000	$80,000
2	$80,000	$16,000	$64,000
3	$64,000	$12,800	$51,200
4	$51,200	$10,240	$40,960
5	$40,960	$8,192	$32,768

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Depreciation

N = 5 yrs.

3. Sum-of-years'-Digit Method (SOYD)

$SOYD = \frac{N(N+1)}{2} = 15$

In this method,

$D_n = \frac{(N-n+1)\,(P-S)}{SOYD}$

SOYD = 1 +2 +……. +N =N(N +1)/2

Where,

N = the useful life

Dn =(N - n +1)(P - S)/SOYD

Depreciation

Sum of years digits example

A photographer owns a camera worth $10,000 and estimates using the equipment for five years with a zero salvage value.

Year #	Opening book value	Depreciation	Ending book value
1	$10,000	$3,333	$6,667
2	$6,667	$2,667	$4,000
3	$4,000	$2,000	$2,000
4	$2,000	$1,333	$667
5	$667	$667	$0

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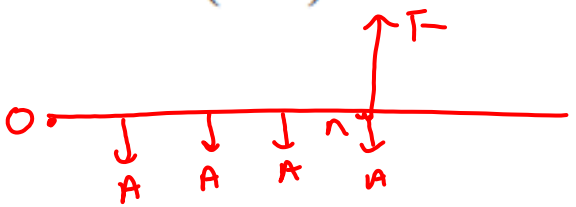
Depreciation

$$A = F\frac{i}{(1+i)^n - 1} = F(A/F,\ i,\ n)$$



4. Sinking fund method.

Depreciation is assumed to be equal to the annual sinking fund amount.

$$\text{Sinking fund}, p = (X - S)\left[\frac{r}{(1+r)^n - 1}\right]$$

Book value for a year = Book value for a previous year – Sinking fund

In this method of depreciation, the book value decreases at increasing rates with respect to the life of the asset.

The fixed sum depreciated at the end of every time period earns an interest at the rate of r% compounded annually, and hence the actual depreciation amount will be in the increasing manner with respect to the time period

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Depreciation

4. Sinking fund method.

Compute the depreciation charge and book value of each year by using sinking fund method with following information, I=Rs 1,00,000.00, S=Rs 20,000 ; Life= 8 years; i=12%

$$\text{Sinking fund}, p = (X - S)\left[\frac{r}{(1 + r)^n - 1}\right]$$

80,000

6504.00

Year	Fixed Depreciation	Net Depreciation	Book Value at the end at year
-	-	-	100,000.00
1.00	6,504.00	6,504.00	93,496.00
2.00	6,504.00	7,284.48	86,211.52
3.00	6,504.00	8,158.62	78,052.90
4.00	6,504.00	9,137.65	68,915.25
5.00	6,504.00	10,234.17	58,681.08
6.00	6,504.00	11,462.27	47,218.81
7.00	6,504.00	12,837.74	34,381.07
8.00	6,504.00	14,378.27	20,002.80

Tax and Taxation in Nepal

Tax:

- Tax is a compulsory financial charge imposed by a government on individuals, businesses, or other entities to generate revenue to fund public expenditures and services.
- It is a key component of public finance and is used to finance government activities, such as infrastructure development, public services, defense, education, healthcare, and social welfare programs.

Taxatioin:

- Taxation is the process through which governments collect taxes from individuals and entities.
- Taxes are typically imposed based on various factors, including income, profits, property ownership, transactions, consumption, and specific activities.

Various forms of tax

- Income Tax:
  - A tax levied on the income earned by individuals, households, and businesses.
  - It may be progressive, where the tax rate increases with higher income levels, or proportional, where the tax rate remains constant regardless of income.
  - Nepal has progressive form of income tax

1% 5L

10% 5C 50L

5L 50K

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Income Tax:

10L
5L × 0.01 = 5K
2L × 10/. = 20,000
3L × 20/. = 60,000

INCOME TAX

SLAB RATE

For Resident Person

Assessed as Individual

Income Level (NPR)	Tax Rate FY FY 2080/81	Income Level (NPR)	Tax Rate FY 2079/80
Upto 5,00,000	1%*	Upto 5,00,000	1%
Next 2,00,000	10%	Next 2,00,000	10%
Next 3,00,000	20%	Next 3,00,000	20%
Next 10,00,000	30%	Next 10,00,000	30%
Next 30,00,000	36%	Next 30,00,000	36%
Above 50,00,000	39%		

Assessed as Couple

Income Level (NPR)	Tax Rate FY 2080/81	Income Level (NPR)	Tax Rate FY 2079/80
Upto 6,00,000	1%*	Upto 6,00,000	1%
Next 2,00,000	10%	Next 2,00,000	10%
Next 3,00,000	20%	Next 3,00,000	20%
Next 9,00,000	30%	Next 9,00,000	30%
Next 30,00,000	36%	Above 30,00,000	36%
Above 50,00,000	39%		

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Various forms of tax

- Corporate Tax:

➢A tax imposed on the profits or income generated by corporations or businesses.

➢The value in Nepal is 25% for most business entities but differ from one entity to other according to the government legislation.

- Value Added Tax (VAT):

➢Value-added tax (VAT) is a consumption tax on goods and services that is levied at each stage of the supply chain where value is added, from initial production to the point of sale.

➢The amount of VAT in case of Nepal is 13 %

- **Custom duty:**

➢Applies at the rate as imposed by the Fiscal Act introduced each fiscal year based on the nature of the goods being imported.

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Various forms of tax

- Property Tax:

➢ A tax assessed on the value of real estate or personal property, such as land, buildings, homes, or vehicles.

- Excise Tax:

➢ Excise duty is a form of tax imposed on goods for their production, licensing and sale.

➢ An indirect tax paid to the Government by producers of goods.

➢ Excise duty is the opposite of Customs duty in that it applies to goods manufactured domestically in the country, while Customs is levied on those coming from outside of the country

- Import and Export Duties:

➢ Taxes imposed on goods imported into or exported out of a country, often used to protect domestic industries or regulate trade.

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Corporate Tax:

Corporate Income Tax	
tax rate of 20%	• special industries, i.e., manufacturing companies (except relating to tobacco and alcoholic beverages); and • entities wholly engaged in projects conducted to build public infrastructure and in the power generation, transmission, or distribution sector;
tax rate of 30%	• banks and other financial institutions and insurance companies; • companies engaged in financial transactions; • companies engaged in the petroleum business; • companies engaged in the business of cigarette, tobacco, cigar, chewing tobacco, alcohol, and beer; • companies engaged in merchant banking business; • telecom and internet service providers (from the financial year 2018-19); and • companies engaged in money transfer, capital market or securities and commodities businesses (from the financial year 2018-19);

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Net Income

When a project's revenue exceeds its expenses, we say that the project generated a ***profit*** or ***income.*** If the project's revenue is less than its expenses, then we say that the project resulted in a ***loss***.

Revenue
- Expenses (cost of goods sold)
Gross Profit
- Operating expenses
- Depreciation
Taxable Income (Income before tax)
- Income Tax
Net Income

Retained Income

Cash flow = net income + depreciation

NET PROFIT EXAMPLE

Total Revenue	**100,000**
Cost of Goods Sold	**(20,000)**
Gross Profit	**80,000**
Operating Expenses	
Salaries	10,000
Rent	10,000
Utilities	5,000
Depreciation	5,000
Total Operating Expenses	**(10,000)**
Taxes	**(10,000)**
Net Profit	**30,000**

Questions

11. If P is principal amount, i is the rate of interest per annum and n is the number of periods in years, the compound amount factor (CAF) is

(a) $(1 + i)^n$

(b) (1+i)

(c) ni

(d) None of these

$F = P(1+i)^n$

$P = A \frac{(1+i)^n - 1}{i}$

$P(1+i)^n$

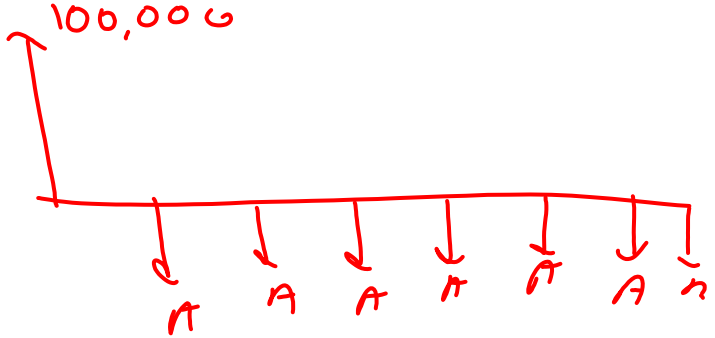
12. A person took a loan of Rs 100,000 for 10 years at 11% compound interest. The person desires to pay off the amount in 10 equal annual installments. The amount of installments is:

(a) Rs 19680

(b) Rs.16980

(c) Rs 18690

(d) Rs 10968



$A = P \frac{(1+i)^n \times i}{(1+i)^n - 1}$

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Questions

13. The ratio of discounted benefit and discounted cost is called
    (a) discount ratio
    (b) B/C ratio
    (c) C/B ratio
    (d) none of the above

14. The difference of discounted benefit and cost is called
    (a) NPV
    (b) PV
    (c) benefit
    (d) all of the above

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Questions

15. The functional depreciation is sometimes called _____.

A. Demand depreciation
B. Obsolescence
C. Life depreciation
D. Failure depreciation

16. What is the limit of annual income for an unmarried individual upto which only 1% income tax is levied?

a. 5 lakhs
b. 6 lakhs
c. 5.5 lakhs
d. 7 lakhs

17. Which of the following methods of charging depreciation of an asset has increased amount of depreciation as the age of asset increases

a) sum-of-year digit
b) sinking fund
c) diminishing balance
d) straight line

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Questions

18. The actual profitability of any project is best analysed from [NEC 2079]

a. IRR
b. Discounted Payback Period
c. MARR
d. None

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Questions

21. Which of the following depreciation method cannot have a salvage value of zero?

A. Declining balance method
B. Sinking fund method
C. Straight line method
D. SYOD method

Questions

22. If the annual worth of a project is 9000 at a 10% discount rate, what will be it's capitalized value?

A. 97,500
B. 90,000
C. 92,300
D. 91,500

$$P = A\frac{(1+i)^n - 1}{i(1+i)^n} = A(P/A, i, n)$$

0.1

9000

P

Capitalized value = Annual value / i

$= \frac{A}{i} - \frac{A}{i(1+i)^n}$

Formulas in Economics

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Formulas in Engineering Economics

	Name	To Find	Given	Expression	Formula
1	Single Sum Present Worth Factor	P	F	(P/F, i, n)	$\frac{1}{(1+i)^n}$
2	Single Sum Future Worth Factor	F	P	(F/P, i, n)	$(1+i)^n$
3	Uniform series Present Worth Factor	P	A	(P/A, i, n)	$\frac{(1+i)^n-1}{i(1+i)^n}$
4	Capital Recovery Factor	A	P	(A/P, i, n)	$\frac{i(1+i)^n}{(1+i)^n-1}$
5	Uniform series Future Worth Factor	F	A	(F/A, i, n)	$\frac{(1+i)^n-1}{i}$
6	Sinking Fund Factor	A	F	(A/F, i, n)	$\frac{i}{(1+i)^n-1}$
7	Gradient Series Present Wroth Factor	P	G	(P/G, i, n)	$\frac{(1+i)^n-(1+ni)}{i^2(1+i)^n}$
8	Gradient to Uniform Series Conversion Factor	A	G	(A/G, i, n)	$\frac{(1+i)^n-(1+ni)}{i[(1+i)^n-1]}$
9	Geometric Series Present Worth Factor	P	A_1	(P/A_1, i, j, n)	$\frac{1-(1+j)^n(1+i)^{-n}}{i-j}$ for $i \neq j$ $\frac{n}{(1+i)}$ for $i = j$
10	Geometric Series Future Worth Factor	F	A_1	(F/A_1, i, j, n)	$\frac{(1+i)^n-(1+j)^n}{i-j}$ for $i \neq j$ $n(1+i)^{n-1}$ for $i = j$

Liquidity Ratios

$$\text{Current Ratio} = \frac{\text{Current assets}}{\text{Current liabilities}}$$

$$\text{Quick Ratio} = \frac{\text{Current assets} - \text{Inventory}}{\text{Current liabilities}}$$

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Some Financial Ratios

Liquidity Ratios

Liquidity ratios measure the company's ability to meet its short-term obligations and how quickly assets are converted into cash. The following table explains how to calculate the major liquidity ratios.

Liquidity ratios	Ratio calculation
Current	$\frac{\text{Current assets}}{\text{Current liabilities}}$
Quick	$\frac{\text{Cash} + \text{Short term marketable securities} + \text{Receivables}}{\text{Current liabilities}}$
Cash	$\frac{\text{Cash} + \text{Short term marketable securities}}{\text{Current liabilities}}$

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Some Financial Ratios

Solvency Ratios

Solvency ratios measure a company's ability to meet long-term obligations. Subsets of these ratios are also known as "leverage" and "long-term debt" ratios

Solvency ratios	Ratio calculation
Debt-to-assets	$\frac{\text{Total debt}}{\text{Total assets}}$
Debt-to-capital	$\frac{\text{Total debt}}{\text{Total debt} + \text{Total shareholders' equity}}$
Debt-to-equity	$\frac{\text{Total debt}}{\text{Total shareholders' equity}}$
Financial leverage	$\frac{\text{Average total assets}}{\text{Total shareholders' equity}}$

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Some Financial Ratios

Profitability Ratios

Profitability ratios measure the company's ability to generate profits from its resources (assets). The table below shows the calculations of these ratios.

Return on sales ratios	Ratio calculation
Gross profit margin	$\frac{\text{Gross profit}}{\text{Revenue}}$
Operating margin	$\frac{\text{Operating profit}}{\text{Revenue}}$
Pretax margin	$\frac{\text{EBT (Earnings Before Taxes)}}{\text{Revenue}}$
Net profit margin	$\frac{\text{Net income}}{\text{Revenue}}$

Some Financial Ratios

Valuation Ratios

Valuation ratios measure the quantity of an asset or flow (i.e., earnings) associated with ownership of a specified claim (i.e., a share or ownership of the enterprise). The following tables show the most of the common valuation ratios

Valuation ratios	Ratio calculation
P/E	$\frac{\text{Price per share}}{\text{Earnings per share}}$
P/CF	$\frac{\text{Price per share}}{\text{Cash flow per share}}$
P/S	$\frac{\text{Price per share}}{\text{Sales per share}}$
P/BV	$\frac{\text{Price per share}}{\text{Book value per share}}$

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Some Financial Ratios

Valuation Ratios

Price per share	Ratio calculation
Basic EPS	$\frac{\text{Net income} - \text{Preferred dividends}}{\text{Weighted average number of ordinary shares outstanding}}$
Diluted EPS	$\frac{\text{Net income} - \text{Preferred dividends} + \text{Aftertax interest on convertible debt}}{\text{Weighted average number of ordinary shares outstanding} + \text{Number of common shares that would have been issued at conversion}}$
Cash flow per share	$\frac{\text{CFO} - \text{Preferred dividends}}{\text{Weighted average number of ordinary shares outstanding}}$
EBITDA per share	$\frac{\text{EBITDA}}{\text{Average number of common stock}}$
Dividends per share	$\frac{\text{Dividends paid}}{\text{Number of shares outstanding}}$

Some Financial Ratios

Leverage ratios

Leverage ratios measure the extent to which a company uses liabilities rather than equity to finance its assets.

Solvency ratios	Ratio calculation
Debt-to-assets	$\frac{\text{Total debt}}{\text{Total assets}}$
Debt-to-capital	$\frac{\text{Total debt}}{\text{Total debt} + \text{Total shareholders' equity}}$
Debt-to-equity	$\frac{\text{Total debt}}{\text{Total shareholders' equity}}$
Financial leverage	$\frac{\text{Average total assets}}{\text{Total shareholders' equity}}$

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Some Financial Ratios

current assets - current liabilities = working capital

current assets / current liabilities = working capital ratio (Current Ratio)

The working capital ratio, like working capital, compares current assets to current liabilities and is a metric used to measure liquidity. The term “liquidity” refers to how easily a company can turn assets into cash to pay short-term obligations.

Quick Ratio = $\frac{current\ assets - inventory\ prepaid\ expenses}{current\ liabilities}$

The quick ratio is also called the acid test. It’s another measure of liquidity. It represents a company’s ability to pay current liabilities with assets that can be converted to cash quickly.

Some Financial Ratios

$$Earning\ Per\ Share\ (EPS) = \frac{Net\ Income - Prefereed\ Dividends}{Weighted\ Average\ no.of\ common\ shares}$$

Earnings per share (EPS) is a measure of the profitability of a company. Earnings per share will also be zero or negative if a company has zero earnings or negative earnings representing a loss. A higher EPS indicates greater value.

Debt-to-Equity (D/E) Ratio= $\frac{Total\ Loabilities}{Total\ Shareholder's\ Equity}$

The debt-to-equity (D/E) ratio measures how much a company is funding its operations using borrowed money. It can indicate whether shareholder equity can cover all debts, if necessary. Investors often use it to compare the leverage used by different companies in the same industry. This can help them to determine which might be a lower-risk investment.