Economic Appraisal Techniques

Rate of Return Method

- The rate of return is a percentage that indicates the relative yield on different uses of investment.
- RoR=((Beginning Value-Ending Value)/Beginning Value)×100
- Three types of rates of return are;
  - Minimum Acceptable Rate of Return (MARR)
  - Internal Rate of Return (IRR)
  - External Rate of Return (ERR)
- **MARR:** The rate set by an organization to designate the lowest level of return that makes an investment acceptable.
- **IRR:** A discount rate at which NPW equals to zero.
- **ERR:** It is the rate of return that is possible to obtain for an investment under the current conditions.

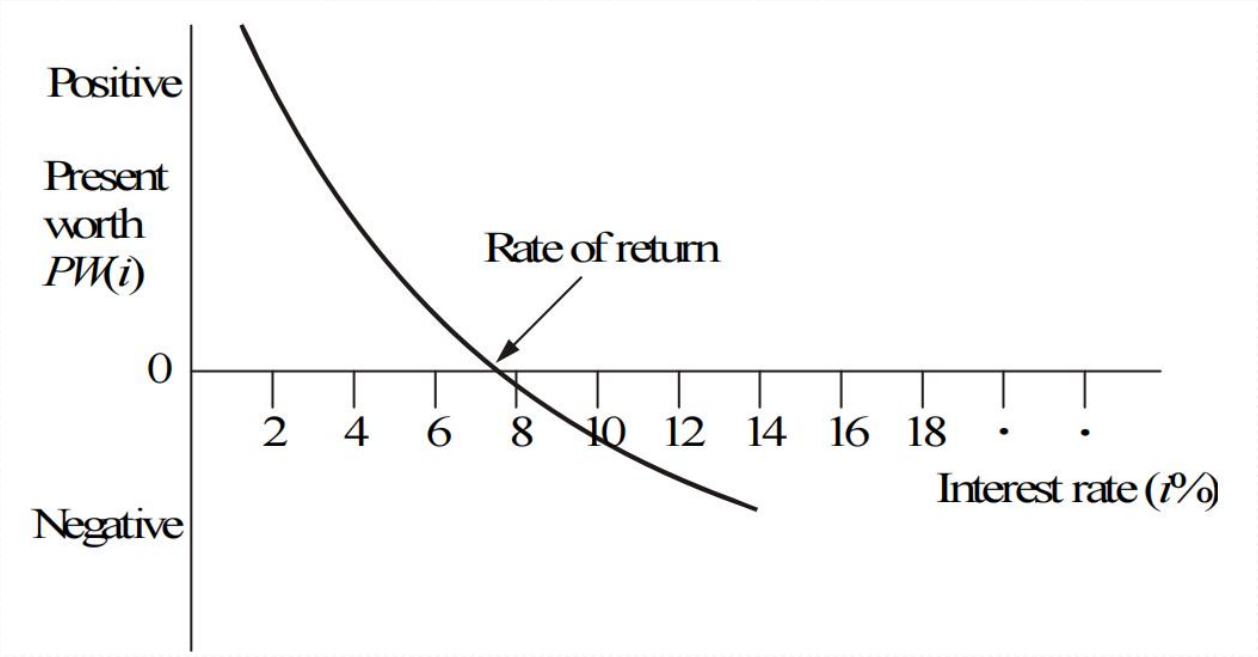
Internal Rate of Return

- The rate of return of a cash flow pattern is the interest rate at which the present worth of that cash flow pattern reduces to zero.
- Since it is very difficult to find the exact value of i at which the present worth function reduces to zero, we have to start with an intuitive value of i and check whether the present worth function is positive. If so, increase the value of i until the present worth becomes negative.
- Then the rate of return is determined by interpolation method in the range of values of i for which the sign of the present worth function changes from positive to negative.

- The first step is to find the net present worth of the cash flow

$$PW(i) = -P + R1/(1+i)^1 + R2/(1+i)^2 + \ldots + Rj/(1+i)^j + \ldots + Rn/(1+i)^n + S/(1+i)^n$$

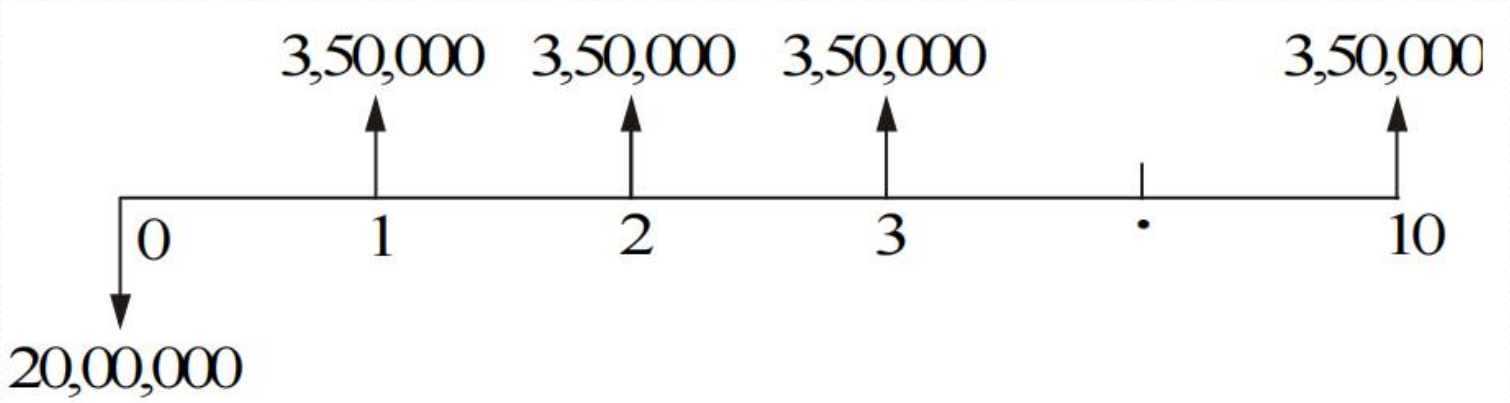
- The above function is to be evaluated for different values of i until the present worth function reduces to zero.



- IRR = $i_1 + \frac{PW1}{PW1 - PW2}(i2 - i1)$
- In this method of comparison, the rate of return for each alternative is computed.
- The alternative which has the highest rate of return is selected as the best alternative.

Example-1

- A company is trying to diversify its business in a new product line. The life of the project is 10 years with no salvage value at the end of its life. The initial outlay of the project is Rs. 20,00,000. The annual net profit is Rs. 3,50,000. Find the rate of return for the new business.



Solution

- Net Present Worth (NPW) (i =10%) = Rs. 1,50,610.
- Net Present Worth (NPW) (i =12%) = Rs. –22,430.
- IRR= $$i = 10\% + \frac{1,50,610 - 0}{1,50,610 - (-22,430)} \times (2\%)$$

$$= 11.74\ \%$$

Example-2

- A firm has identified three mutually exclusive investment proposals whose details are given below. The life of all the three alternatives is estimated to be five years with negligible salvage value.

	Alternative		
	*A*1	*A*2	*A*3
Investment	Rs. 1,50,000	Rs. 2,10,000	Rs. 2,55,000
Annual net income	Rs. 45,570	Rs. 58,260	Rs. 69,000

Find the best alternative based on the rate of return method of comparison.

Solution

Initial outlay = Rs. 1,50,000

Annual profit = Rs. 45,570

Life = 5 years

When $i = 10\%$,

$$PW(10\%) = -1,50,000 + 45,570(P/A, 10\%, 5)$$
$$= -1,50,000 + 45,570(3.7908)$$
$$= \text{Rs. } 22,746.76$$

When $i = 15\%$,

$$PW(15\%) = -1,50,000 + 45,570(P/A, 15\%, 5)$$
$$= -1,50,000 + 45,570(3.3522)$$
$$= \text{Rs. } 2,759.75$$

When $i = 18\%$,

$$PW(18\%) = -1,50,000 + 45,570(P/A, 18\%, 5)$$
$$= -1,50,000 + 45,570(3.1272)$$
$$= \text{Rs. } -7,493.50$$

Therefore, the rate of return of the alternative $A1$ is

$$i = 15\% + \frac{2,759.75 - 0}{2,759.75 - (-7,493.50)} \times (3\%)$$
$$= 15\% + 0.81\%$$
$$= 15.81\%$$

Calculate of rate of return for alternative $A2$ and A3

Example-3

- A Company is planning to expand its present business activity. It has two alternatives for the expansion programme and the corresponding cash flows are tabulated below. Each alternative has a life of five years and a negligible salvage value. The minimum attractive rate of return for the company is 12%. Suggest the best alternative to the company.

Alternative	Initial Investment (Rs.)	Yearly Revenue (Rs.)
Alternative 1	500000	170000
Alternative 2	800000	270000

Solution

Payback Period

- Payback period is the time in which the initial cash outflow of an investment is expected to be recovered from the cash inflows generated by the investment. It is one of the simplest investment appraisal techniques.
- The formula to calculate payback period of a project depends on whether the cash flow per period from the project is even or uneven.
  - In case they are even, the formula to calculate payback period is:

$$\text{Payback Period} = \frac{\text{Initial Investment}}{\text{Cash Inflow per Period}}$$

Payback Period Contd..

- When cash inflows are uneven, we need to calculate the cumulative net cash flow for each period and then use the following formula for payback period:

$$\text{Payback Period} = A + \frac{B}{C}$$

In the above formula,

- A is the last period with a negative cumulative cash flow;
- B is the absolute value of cumulative cash flow at the end of the period A;
- C is the total cash flow during the period after A

Decision Rule:

- Accept the project only if its payback period is LESS than the target payback period.

Example 1: Even Cash Flows

- Example-1

- Company C is planning to undertake a project requiring initial investment of $105 million. The project is expected to generate $25 million per year for 7 years. Calculate the payback period of the project.

Solution

- Payback Period = Initial Investment ÷ Annual Cash Flow = $105M ÷ $25M = 4.2 years

Example 2: Uneven Cash Flows

- Company C is planning to undertake another project requiring initial investment of $50 million and is expected to generate $10 million in Year 1, $13 million in Year 2, $16 million in year 3, $19 million in Year 4 and $22 million in Year 5. Calculate the payback value of the project.

Soln.

(cash flows in millions)		Cumulative Cash Flow
Year	Cash Flow	
0	- 50	- 50
1	10	- 40
2	13	- 27
3	16	- 11
4	19	8
5	22	30

Payback Period

$= 3 + (|-\$11M| \div \$19M)$

$= 3 + (\$11M \div \$19M)$

$\approx 3 + 0.58 \approx 3.58$ years

Cost-Benefit Analysis

- Cost-Benefit Analysis helps us to infer whether it is socially desirable to undertake a number of investment Projects.

- The main objective of any public alternative (Constructing Bridges, Roads, Dams, Establishing Public Utilities. etc.) is to provide goods/services to the public at the minimum cost.

- Any public activity can be undertaken for implementation, if benefits of the public activity are at least equal to its cost.

- This is nothing but making a decision based on Benefit-Cost ratio given by;

  BC Ratio = Equivalent Benefits/Equivalent Cost

- Benefits may occur at different time periods of the Public Activity and costs may consist of initial investment, yearly operation and maintenance cost. Therefore both Benefits and Costs need to be converted to a common time base (Present Worth, Future Worth or Annual Equivalent)

Cost-Benefit Analysis

- Notations & Formula:

B_P = Present Worth of the total Benefits

P = Initial Investment

C = Yearly cost of operation and maintenance

C_P = Present worth of Yearly cost of operation and maintenance

BC Ratio = $\frac{Bp}{P + Cp}$

Example-1

- In a particular locality of a state, the vehicle users take a roundabout route to reach certain places because of the presence of a river. This results in excessive travel time and increased fuel cost. So, the state govt. is planning to construct a bridge across the river. The estimated initial investment for constructing the bridge is Rs. 4000000. The estimated life of the bridge is 15 years. The annual operation and maintenance cost is Rs. 150000. The value of fuel savings due to construction of the bridge is Rs. 600000 in the first year and it increases by Rs. 50000 every year thereafter till the end of the life of the bridge. Check whether the project is justified based on BC ratio by assuming an interest rate of 12%, compounded annually.

Example-2

- Two mutually exclusive projects are being considered for investment. Project A1 requires an initial outlay of Rs. 3000000 with the net receipts estimated as Rs. 900000 per year for the next five years. The initial outlay for Project A2 is Rs. 6000000, and the net receipts have been estimated at Rs. 1500000 per year for the next seven years. There is no salvage value associated with either of the Projects. Using Benefit-Cost ratio, which project would you select? Assume an interest rate of 10%.

Example-3

- A State govt. is planning a hydroelectric Project for a river basin. In addition to the production of electric power, this project will provide flood control, irrigation and recreation benefits. The estimated benefits and costs that are expected to be derived from this project are as follows.

Particulars	Amount (in Rs.)
Initial Cost	80000000
Annual Power Sales	6000000
Annual flood control savings	3000000
Annual irrigation benefits	5000000
Annual recreation benefits	2000000
Annual operating and maintenance costs	3000000
Life of the Project	50 Years

Check whether the State govt. should implement the Project (assume i = 12%)

Short Question

1. For a accepting a project proposal on the basis of Net Present Value (NPV) and Internal Rate of Return (IRR) which of the following statements is true

- (i) IRR should be equal to the discount rate used for calculating NPV
- (ii) IRR should be less than the discount rate used for calculating NPV
- (iii) IRR should be greater than the discount rate used for calculating NPV
- (iv) All of these

Long Question

Question 1.1

Given the cash flows of a company about an investment proposal in the following table

Time period	0	1	2	3	4	5
Cash Flows	-500000	200000	100000	200000	100000	200000

(i) Calculate the Net Present Value (NPV) for the proposal at 4% cost of money.
(ii) Is the proposal acceptable on the basis of NPV value?
(iii) How do you interpret the estimated NPV if you are the finance manager of the company?

Question- 1.2

- (b) Consider the following particulars about an alternative
- Initial cost = $420000
- Equivalent annual benefit = $116520
- Life (years) = 5
- (i) Draw a cash flow diagram for the alternative.
- (ii) Find the Interest Rate of Return of the alternative.
- If the MARR (Minimum Attractive Rate of Return) is 14%, should the alternative be accepted? Why?

Question- 1.3

A machine has the following particulars

Initial Cost = $800000

Annual Operation/Maintenance cost = $20000

Cost at the end of 4th year to maintain the efficiency = $50000

Cost at the end of 6th year to maintain efficiency = $50000

Salvage value = $300000

Life (year) = 12

Interest rate = 12% compounded annually

(i)Write a cash flow diagram.

(ii)Do an Annual Worth analysis for the machine.

Question 2.1

- Your friend has decided to start a transportation business after his B.Tech. He needs to buy a lorry at the cost of Rs.4000000. The life of this lorry is 20 years. This will produce income of Rs.300000 each year for first 9 years. At the end of 10th year the estimated income is Rs.200000. For each of the remaining period of its life the lorry is expected to earn Rs.340000. The Minimum Attractive Rate of Return (MARR) of your friend is 14% compounded annually. You want to help your friend in deciding about the acceptance of this proposal by calculating the Net Present Value (NPV) of the proposal.
- (i)Calculate the NPV of this proposal.
- (ii)How do you explain the NPV you find?
- (iii)Will you advise your friend to accept this proposal?

Question 2.2

Following particulars are available about a new automatic machine of the surgery department in a medical college.

Particulars	**Amount ($)**
Initial Cost	500000
Annual O/M cost	850
Cost at the end of 12^{th} year for technical update	50000
Annual income from the machine	60000
Salvage value of the machine	40000
Life of the machine (years)	20

(i) Write a cash flow diagram.
(ii) Find the Annual Worth amount of costs and benefits separately at the MARR of 9% set by the medical college.
(iii) Write your impression about purchasing this machine.

Question 2.3

Sudarshan wants to start a small bakery. The Cash flows of his dream project are summerised in the following table.

End of year	0	1	2	3	4	5
Cash flows ($)	-12750	1500	3000	4500	6000	7500

(i) Draw a cash flow diagram of the above cash flows.
(ii) Find the internal rate of return of the proposal by Hit and Trial method (Use the Uniform Gradient Series Annual Equivalent Factor).
(iii) If Sudarshan calculates the Net Present Value (NPV) of this project proposal, at 13.75% compounded annually will it be positive or negative? Why?

Question 2.4

The state government is planning to provide public access to a wild life sanctuary. For this the government has to create the required facilities with the help of the US government. The government will generate good amount of income from tourism if the project is implemented. The costs and benefits associated with this proposal are given in the following table

Particulars	Amounts ($)
First cost	2400000
Annual O/M cost	160000
Annual income	500000
Additional Income at the end 10^{th} year because of increased tourism	200000
Life (years)	20

(i) Calculate the Benefit Cost ratio (B/C ratio) by using the Annual Worth method at the interest rate 12% annual compounding.

(ii) Will the government invest in this project? Why?

Question 3.1

Consider the following table which summarizes data for two alternatives.

Particulars	First cost	Annual return	Life
Alternative 1	₹ 5,00,000	₹ 1,50,000	10 years
Alternative 2	₹ 8,00,000	₹ 2,50,000	10 years

Find the best alternative based on the basis of Net Present value method if i = 15% compounded annually.

QUestion 3.2

A producer wants to purchase a machine. There are two machines available in the market whose initial cost is ₹ 10,00,000 each. From the following information find out which machine will be selected on the basis of Pay-back period method.

End of year	Cash inflow from machine A(in ₹)	Cash inflow from machine B(in ₹)
1	50,000	90,000
2	2,50,000	1,20,000
3	4,00,000	3,50,000
4	6,00,000	7,00,000
5	8,50,000	9,00,000

Question 3.3

A government is planning a hydroelectric project for a river basin. Besides the production of electric power, this project will provide flood control, irrigation and recreation benefits. The estimated benefits and costs expected form the three alternatives under consideration are listed in the following table:

Particulars	A	B
Initial cost(in ₹)	10,00,00,000	15,00,00,000
Annual equivalent benefits and cost		
(i) Operating and maintenance cost	20,00,000	30,00,000
(ii) Power sales/year	1,00,00,000	1,50,00,000
(iii) Flood control savings	30,00,000	40,00,000
(iv) Irrigation benefits	40,00,000	55,00,000
(v) Recreation benefits	15,00,000	35,00,000

If the interest rate is 10% and the life of the projects is estimated to be 40 years, by comparing thee BC ratios, determine which project should be selected.

Question 4.1

The initial investment on a project is Rs.10,00,000. The project will generate the following cash flows during its life period.

Year	1	3	5	7	9	11
Cash Flow ($)	250000	250000	250000	250000	250000	250000

The salvage value of the project is $50000. Find the Net Present value of the project if the Minimum Attractive Rate of Return is 14 percent compounded annually. Should the project be implemented?

Question 4.2

The details of an investment proposal are given below

Year	0	1	2	3	4	5
Cash flow ($)	-150000	45570	45570	45570	45570	45570

Calculate the Internal Rate of Return (IRR) of the project. If your personal MARR is 14%, should you go with the project?

Question 4.3

Government of Odisha is planning to invest Rs.50,00,00,000 in the ring road project around Bhubaneswar city for better communication facilities. Further, the government has to provide another financial support of Rs.10,00,00,000 at the end of 5th year. The project will generate benefit of Rs.5,00,00,000 each year for 20 years first phase of life after which it needs resurfacing. Current rate of interest is 5% yearly compounding. Do a Benefit-cost ratio analysis on the project using present worth method. Should the government go ahead with the proposal?

Question 5.1

- KASIA DAS and BABY DAS are two contractors. Both of them want to take one project in which an initial investment of Rs.8,00,00,000 is required. An annual benefit of Rs.2,70,00,000 can be received from the project for 5 years. The personal MARR (Minimum Attractive Rate of Return) of KASIA is 25% and that of BABY DAS is 17.5% percent. Find the Rate of Return (ROR) of the project. Between KASIA and BABY who should not take the project?

Question 5.2

The Hanging Bridge of Gujurat state collapsed recently. The Government of Gujurat has decided to construct another bridge in its place with latest technology. The initial cost of the bridge is Rs.50,00,00,000. The annual maintenance cost of the bridge is Rs.20,00,000 during the first phase of the life of 20 years. At the end of 12th year the Government has to incur an additional cost of Rs.5,00,00,000 to increase the strength of the bridge. The annual public benefit from the use of the bridge is estimated to be Rs.4,50,00,000. An additional benefit of Rs.5,00,00,000 will be received at the end of 10th year because of festive season. Determine the Benefit-Cost ratio of this proposal at the interest rate of 8% compounded annually. Should the bridge be constructed? (Use PW analysis)

Question- 1.1: Answer

Time	0	1	2	3	4	5
Cash Flows	-500000	200000	100000	200000	100000	200000

(i) NPV (4%)

$$= -500000 + \frac{200000}{(1.04)^1} + \frac{100000}{(1.04)^2} + \frac{200000}{(1.04)^3}$$

$$+ \frac{100000}{(1.04)^4} + \frac{200000}{(1.04)^5} = 212428.4258$$

(ii) Proposal is acceptable.

(iii) NPV positive means the company will get more than 4% return.

Question- 1.2: Answer

Initial cost = 420000

Equivalent Annual benefit = 116520

Life = 5 years

(i) Cash flow diagram

(ii) IRR = 12.023 (between 11 and 13 percent)

Students might have done at different percentages

(iii) Proposal should not be accepted as IRR<MARR

Question- 1.3: Answer

Cash flow diagram

(ii) AW (12%)

$$= -800000\left[\frac{.12(1.12)^{12}}{(1.12)^{12}-1}\right] - 20000$$

$$\frac{-50000}{(1.12)^{4}}\left[\frac{.12(1.12)^{12}}{(1.12)^{12}-1}\right]$$

$$\frac{-50000}{(1.12)^{6}}\left[\frac{.12(1.12)^{12}}{(1.12)^{12}-1}\right]$$

$$+300000\left[\frac{.12}{(1.12)^{12}-1}\right] = -145937.6498$$

Question- 2.1: Answer

(i) NPV (14%)

$$= -4000000 + 300000\left[\frac{(1.14)^{9}-1}{.14(1.14)^{9}}\right]$$

$$+\frac{200000}{(1.14)^{10}} + 340000\left[\frac{(1.14)^{10}-1}{.14(1.14)^{10}}\right] \times \frac{1}{(1.14)^{10}} = -1983754.619$$

(ii) He will get less than 14% return

(iii) No, I will not advise my friend to accept the proposal.

Question- 2.2: Answer

(i) Cash flow diagram

(ii) Costs

$$AW(9\%) = -500000\left[\frac{.09(1.09)^{20}}{(1.09)^{20}-1}\right] - 850$$

$$\frac{-50000}{(1.09)^{12}} \times \left[\frac{.09(1.09)^{20}}{(1.09)^{20}-1}\right] = -59852.73642$$

Benefits

$$AW(9\%) = 60000 + 40000\left[\frac{.09}{(1.09)^{20}-1}\right] = 60781.859$$

Since benefits are more than the cost the machine may be purchased.

Question- 2.3: Answer

(i) Cash flow diagram

(ii) NPV (17%)

$$= -12750 + \left[1500 + 1500\left\{\frac{(1.17)^5 - .17\times 5 - 1}{.17(1.17)^5 - .17}\right\}\right] \times \left[\frac{(1.17)^5 - 1}{.17(1.17)^5}\right] = 155.993371$$

NPV (18%)

$$= -12750 + \left[1500 + 1500\left\{\frac{(1.18)^5 - .18\times 5 - 1}{.18(1.18)^5 - .18}\right\}\right] \times \left[\frac{(1.18)^5 - 1}{.18(1.18)^5}\right] = -212.3689703$$

By interpolation

IRR = 17.42347806

NB: Students might have tried at different percentages.

(iii) Sudarshan will get positive NPV value sine IRR is more than 13.75%.

Question- 2.4: Answer

(i) Costs

$$AW(12\%) = 2400000\left[\frac{.12(1.12)^{20}}{(1.12)^{20}-1}\right] + 160000 = 481309.0721$$

Benefits

$$AW(12\%) = 500000 + \frac{200000}{(1.12)^{10}} \times \left[\frac{.12(1.12)^{20}}{(1.12)^{20}-1}\right] = 508621.0768$$

B/C ratio = 1.056745252

(ii) Since B/C ratio is greater than 1, the govt. may invest in this project.

Question- 3.1: Answer

$NPV_{A1} = 2,52,817.915$

$NPV_{A2} = 4,54,696.525$

As annual return from alternative A_2 is more than alternative A_1, **alternative A_2** will be selected.

Question- 3.2: Answer

End of year	Cash inflow from machine A(in ₹)	Years required	Cash inflow from machine B(in ₹)	Years required
1	50,000	1	90,000	1
2	2,50,000	1	1,20,000	1
3	4,00,000	1	3,50,000	1
4	6,00,000	3,00,000/6,00,000 x12 = 6 month	7,00,000	440000/7,00,000 x12 = 7.5 = 8month
5	8,50,000		9,00,000	
Total years required		3 years 6 month		3 years 8month

Question- 3.2: Answer

$PW_A(B) = 18,09,13,457.544$

$PW_A(C) = 11,95,58,211.626$

$(B/C)_A = 1.51$

$PW_B(B) = 27,38,13,450.289$

$PW_B(C) = 17,93,37,317.439$

$(B/C)_B = 1.52$

Project B will be selected as B/C ratio of project B is more than project A.

Question- 4.1: Answer

NPV (14%)

= -1000000 +

$$\frac{250000}{(1.14)^1}+\frac{250000}{(1.14)^3}+\frac{250000}{(1.14)^5}+\frac{250000}{(1.14)^7}+\frac{250000}{(1.14)^9}+\frac{250000}{(1.14)^{11}}+\frac{50000}{(1.14)^{11}}$$

= $ -234345.179

Project to be rejected.

Question- 4.2: Answer

NPV (15%) = -150000 + 45570 (P/A 15% 5)

$$= -150000 + 45570\left[\frac{(1.15)^5-1}{.15(1.15)^5}\right] = \$2757.707816$$

NPV (16%) = -150000 + 45570 (P/A 15% 5)

$$= -150000 + 45570\left[\frac{(1.15)^5-1}{.15(1.15)^5}\right] = \$-790.4382027$$

$$= .15 + \left[\frac{2757.707816}{2757.707816+790.4382027}\right]\times .01 = 15.78\%$$

Question- 4.3: Answer

Benefit

$$PW(5\%) = 50000000\left[\frac{(1.05)^{20}-1}{.05(1.05)^{20}}\right] = 623110517.1$$

Cost

$$PW(5\%) = 500000000\,\frac{100000000}{(1.05)^{5}} = 578352616.6$$

BC ratio = 1.077 Project to be implemented.

Question- 5.1: Answer

NPV (19%)
= -800 00 000 + 270 00 000 (P/A 19% 5)
= 25,56,142.026

NPV (21%)
= 800 00 000 + 270 00 000 (P/A 21% 5)
= –998422.9267
ROR = 20.43823059%
(Students might have tried at different percentages)

KASIA should not take the project.

Question- 5.1: Answer

PW of Benefits

PW (8%)

= 450 00 000 (P/A 8% 20)

+ 500 00 000 (P/F 8% 10)

= 464976307.7

PW of Costs

PW (8%)

= 50 00 00 000 + 20 00 000 (P/A 8% 20)

+ 5 00 00 000 (P/F 8% 12)

= 539491982.7

$\frac{B}{C} = 0.8618780679$

Bridge should not be constructed.