ESE 2021

UPSC ENGINEERING SERVICES EXAMINATION

Preliminary Examination

General Studies and Engineering Aptitude

Basics of Project Management

Comprehensive Theory *with* Practice Questions
and ESE Solved Questions

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ESE 2021 Preliminary Examination: Basics of Project Management

1st Edition : 2016
2nd Edition : 2017
3rd Edition: 2018
4th Edition: 2019
5th Edition: 2020

Preface

B. Singh (Ex. IES)

The compilation of this book **Basics of Project Management** was motivated by the desire to provide a concise book which can benefit students to understand the concepts of this specific topic of General Studies and Engineering Aptitude section.

This textbook provides all the requirements of the students, i.e. comprehensive coverage of theory, fundamental concepts and objective type questions articulated in a lucid language. The concise presentation will help the readers grasp the theory of this subject with clarity and apply them with ease to solve objective questions quickly. This book not only covers the syllabus of ESE in a holistic manner but is also useful for many other competitive examinations. All the topics are given the emphasis they deserve so that mere reading of the book clarifies all the concepts.

We have put in our sincere efforts to present detailed theory and MCQs without compromising the accuracy of answers. For the interest of the readers, some notes, do you know and interesting facts are given in the comprehensive manner. At the end of each chapter, sets of practice question are given with their keys and detailed explanations, that will allow the readers to evaluate their understanding of the topics and sharpen their question solving skills.

Our team has made their best efforts to remove all possible errors of any kind. Nonetheless, we would highly appreciate and acknowledge if you find and share with us any printing and conceptual errors.

It is impossible to thank all the individuals who helped us, but we would like to sincerely thank all the authors, editors and reviewers for putting in their efforts to publish this book.

With Best Wishes

B. Singh

CMD, MADE EASY Group

Basics of Project Management

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4 Financial Analysis and Project Finances

4.1 FINANCIAL ANALYSIS/FINANCIAL FEASIBILITY

Financial analysis refers to an activity of assessing financial statements to judge the financial performance of a company. It helps in assessing profitability, solvency, liquidity and stability.

Financial appraisal of project consists of two major areas *viz.,* arriving at the cost of the project and arriving at the appropriate means of financing the project.

Financial Appraisal Involves:

- Estimation of project cost
- Estimation of project operating cost
- Estimation of project funds
- Estimation of rate of return

Methods of Financial Analysis/Criteria Used for Selection of Investment Opportunities

1. Average Rate of Return on Investment or Accounting Rate of Return (ARR) or Return on Investment (ROI)

This is an accounting method. There is no agreement on the definition and a number of alternative methods of calculating it are available. The most common ratio is:

$$\text{ARR} = \frac{\text{Average Annual Profit after taxes}}{\text{Average Investment over the project life}} \times 100$$

- Average Annual Profit after taxes is calculated by adding up the after-tax profits for each year of project life and dividing it by the no. of years of estimated useful life (for annuities, after-tax profit is equal to one year's profit).
- Average Investment over the project life is computed by dividing the net investment by two (straight line depreciation is assumed) and adding the salvage value that would be received at the end of the project life (since it remains invested throughout) and full amount of working capital required.

  Average investment over project life

$$= \frac{1}{2}\,[\text{Initial cost} - \text{Salvage value}] + \text{Salvage value} + \text{Working capital}$$

EXAMPLE 4.1

Determine the ARR from the following data:

Sl. No.	Item Details	Machine M (Rs.)	Machine N (Rs.)
1.	Initial Purchase Price	60,000	60,000
2.	Yearly Income after depreciation & Income Tax		

— First Year	4,000	12,000	
— Second Year	5,000	9,000	
— Third Year	7,000	7,000	
— Fourth Year	9,000	5,000	
— Fifth Year	12,000	4,000	
3. Estimated Life (years)	5	5	
4. Estimated Salvage Value	3,000	3,000	
5. Working Capital required	—	—	
ARR can be worked out as below:			
(straight line depreciation is assumed)			
Average Income after taxes/year	37,000	37,000	
	5	5	
	i.e., 7400	7400	...(A)

Average Investment over the project Life = 1/2 (initial cost – Salvage Value) + Salvage Value + Working Capital

= 1/2 (60,000 – 3,000) + 3000 + 0

= 28,500 + 3,000 = 31,500 ...(B)

$$\text{ARR} = \frac{7,400(A)}{31,500(B)} \times 100$$

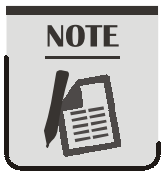
= 23.5%

Alternative Computation of ARR

Some analysis use the Initial Cost instead of the Average investment over the project life, in which case,

$$\text{ARR} = \frac{7,400}{60,000} \times 100 = 12.3\%$$

Companies select projects where ARR exceeds a 'predetermined value' or they rank the alternative proposals in the descending order of magnitude of ARR for selecting the most attractive one.



Working capital = Current Assets – Current Liabilities

It represents operating liquidity available to a business.

If current assets are less than current liabilities then working capital is deficit.

2. Payback Period (PB)

- It is a traditional method and widely used for project evaluation.
- It is a measure in terms of time which will take to recover the cost of investment.
- If Cash in Flow After Tax (CFAT) per annum is uniform/even/constant, then

$$\text{Payback Period (PB)} = \frac{\text{Initial investment}}{\text{Constant annual cash flow (CFAT)}}$$

- If cash inflow is non even or variable year to year then

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

Where, A = Last period with negative cumulative cash outflow (Net invested cash flow)
B = Absolute value of cumulative cash outflow (i.e., Net invested cash flow) at the end of period A
C = Cash in flow during the next period after A

NOTE : Accept the project only if its Payback period is less than the targeted Payback period.

- If there are two projects then accept the project with least payback period.

EXAMPLE 4.2

MADE EASY is planning to undertake a project requiring initial investment of Rs. 105 crores. The project is expected to generate Cash Flow After Tax (CFAT) of Rs. 25 crores per year for 7 years, then calculate the payback period of the project.

Solution:

$$\text{Payback Period (PB)} = \frac{\text{Initial Investment}}{\text{Annual Cash Flow}} = \frac{105}{25} = 4.2 \text{ years}$$

EXAMPLE 4.3

A company is planning to take a project requiring initial investment of Rs. 50 crores and is expected to generate Rs. 10 crores cash flow (CFAT) in 1st year, Rs. 13 crores in 2nd year, Rs. 16 crores in 3rd years, Rs. 19 crores in 4th year and Rs. 22 crores in 5th year. Calculate the Payback period of the project.

Solution:

Year	Cash Inflow After Tax (CFAT) (Rs. in crores)	Cumulative Cash Outflow or Net Invested Cash (Rs. in crores)
0	—	–50
1	+10	–40
2	+13	–27
3	+16	–11
4	+19	0
5	+22	0

where, A = Last period with negative net invested cash or cumulative cash flow = 3
B = Absolute value of cumulative cash flow at the end of period A
= Rs. 11 crores
C = Total cash flow during the period after A, i.e., after 3rd year
= Rs. 19 crores

$$\text{PB} = 3 + \frac{11}{19} = 3.58 \text{ years}$$

Advantages of Payback Period:

1. Easy and simple to calculate.
2. It can be used to measure risk in project.
3. For companies facing liquidity problems, it provides a good ranking of projects that would return money early.

Disadvantages of Payback Period:

1. It does not take into account the time value of money. To remove this drawback, discounted cash flow method can be used.
2. It does not take into account the cash flows that occur after payback period.

3. Discounted Cash Flow Techniques

Traditional methods of project evaluation do not take into account the total benefits from the entire life cycle of a project and they do not consider the time value of money. The techniques described below, discount the cash flows by the cost of capital—a discounting factor for adjusting time value of money. This analysis uses the future free cash flow projections and discounts them to arrive at present value estimates which is used to assess the potential of investment.

Discounted cash flow is calculated as

$$\text{DCF} = \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \ldots \frac{CF_n}{(1+r)^n}$$

CF = Future cash flow, r = Discounted rate (WACC), 1, 2, ... n is period.

If DCF > Present value (PV)/Current cost, then project should be preferred.

4.2 PRESENT VALUE OF MONEY (THE CONCEPT OF DISCOUNTING)

We have seen that the future value of a given sum of money is calculated by the process of compounding. Similarly, the present value is calculated through the process of discounting. Discounting refers to the procedure of calculating the present value of future cash flows by applying suitable interest factor, thus adjusting for the time value of money. The technique of discounting is an exact opposite of the technique of compounding.

Present Value of Future Money Receivable after 'n' Years

The maturity value of Rs. 'P' at an interest rate of 'i %' p.a., compounded annually, for a period of 'n' years is given by

$$\text{Maturity value (MV)} = P(1+i)^n$$

When the future value (i.e., Maturity value) is known, the present value can be found out form the above formula. Accordingly,

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

EXAMPLE 4.4

An investor wants to get a sum of Rs. 4,00,000 after 5 years. The prevailing rate of interest for deposits is 11% p.a., and the interest rate is expected to remain stable. Interest is compounded annually. How much money should the investor invest now?

Solution:

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

Substituting the given data, $P = \frac{4,00,000}{(1+0.11)^5}$

$$P = 4,00,000 \times \left[\frac{1}{(1+0.11)^5}\right]$$

$$= 4,00,000 \times 0.5935 = \text{Rs. } 2,37,400$$

∴ Annual to be invested by the investor now = Rs. 2,37,400

Present Value of Perpetual Annuity (or Perpetuity)

When the periodical payments are received at annual intervals perpetually, the present value of such future cash flows is called the present value of perpetuity.

Let A = amount paid (or received) at the end of every year
I = interest rate per annum

Present value of perpetual annuity = $A \times \left(\frac{1}{i}\right)$

EXAMPLE 4.5

If a sum of Rs. 1500 is receivable every year perpetually, find out the present value of the perpetual cash flow. Assume a discount rate of 16% p.a.

Solution:

$$\text{Present value of perpetual annuity} = A \times \left(\frac{1}{i}\right) = 1500 \times \left(\frac{1}{0.16}\right) = \text{Rs. } 9375$$

4.3 FUTURE VALUE OF A SERIES OF CASH FLOW (FUTURE VALUE OF ANNUITY)

A series of payments of a fixed sum at regular intervals over a period of time is called Annuity. We come across investments of this nature in recurring deposits, pension/provident funds, life insurance policies etc., wherein the investor makes investments of constant amounts at regular time intervals, over a period of time:

The maturity value of Annuity (i.e., an annual series of investments) is given by the following relationship:

$$\text{Future value} = \text{Maturity value} = A\left[\frac{\{1+i\}^n - 1}{i}\right]$$

Where, A = Annuity amount (i.e., constant amount invested every year)
i = Interest rate
and n = Number of years

EXAMPLE 4.6

Calculate the compound value (i.e., maturity value) of Rs. 1000.00 invested every year for a period of 10 years, at an interest rate of 12% per annum.

Solution:

$$\text{Maturity value} = A\left[\frac{\{1+i\}^n - 1}{i}\right]$$

Substituting the given data,

$$\text{Maturity value} = 1000\left[\frac{\{1+0.12\}^{10} - 1}{12}\right]$$

$$= 1000\left[\frac{3.1058 - 1}{0.12}\right]$$

$$= 1000\left[\frac{2.1058}{0.12}\right]$$

$$= \text{Rs. } 17548.00$$

4.4 SINKING FUND PAYMENT

Sinking fund refers to the creation of a fund wherein money is accumulated by setting aside a certain sum of money periodically in such a way that the fund along with the interest accrued gets accumulated so a predetermined value at the end of a specified period of time.

Suppose I am in need of, say, Rs. 10 lakhs after 9 years from now. If I am prepared to invest a fixed sum of money regularly every year and if the money so invested is expected to earn interest at the rate of, say, 12% p.a., what shall the annual installments to be invested? The annual instalment is called the 'sinking fund'. This can be arrived at as under:

Expected Maturity value at the end of 9 years

= Rs. 1000000

Interest rate = 12% p.a.

Let the annual instalment to be invested = A

$$\text{Maturity value (MV)} = A\left[\frac{\{(1+i)\}^n - 1}{i}\right]$$

$$A = \frac{MV.i}{\left[(1+i)^n - 1\right]}$$

Substituting the given values, $$A = \left[\frac{1000000 \times 0.12}{(1+0.12)^9 - 1}\right]$$

$$A = \left[\frac{120000}{(2.7731-1)}\right]$$

$\therefore$ Annual sinking fund to be invested = Rs. 67,678

(i) Net Present Value (NPV)

- The money received today is worth more than the sum received in the future i.e., it has time value. This occurs for three reasons.
  - (a) Potential for earning interest (cost of finance)
  - (b) Impact of inflation
  - (c) Effect of risk
- Net Present Value (NPV) computes the net present value of the cash inflows (CFAT) in each of the future year by discounting them suitably and then subtracting the cash outflow in each year, which in our example is Rs. 60,000 equal for each of the two machines M and N.

A. Present Value of Cash Inflows, year after year

Year	Machine M			Machine N		
	Annual CFAT (Rs.)	Present Value factor	Present value	Annual CFAT (Rs.)	Present factor	Present value
1.	16.000	0.909	14,544	24.000	0.909	21,816
2.	17,000	08.26	14,042	21.000	0.826	17.346
3.	19,000	0.751	14,269	19,000	0.751	14,269
4.	21,000	0.683	14,343	17,000	0.683	11.611
5.	24.000	0.621	14,904	16,000	0.621	9.936
A. Total present value of cash in flow			72,102			74.978
B. Present value of cash outflow			60,000			60,000
Net Present Value (A – B)			12,102			14.978

Capital Expenditure proposal with a positive NPV or which exceeds a predetermined NPV, can be selected for implementation. Alternatively, *the proposals can be ranked in the descending order of the NPV.*

EXAMPLE 4.7

An investment of Rs. 100 crores is to be made today. What is the value of investment after two years if the interest rate is 10%?

Solution:

$$\text{Value after 1 year} = 100 \times 1.1 = 110 \text{ crores}$$

$$\text{Value after 2 years} = 110 \times 1.1 = 121 \text{ crores}$$

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

F = Future value after n years P = Present value

n = Number of period r = Interest rate

Present value for future sum is, $P = \dfrac{F}{(1+r)^n}$

$$P = F(1 + r)^{-n}$$

$(1 + r)^{-n}$ is known as discount factor or present value factor

Net Present Value, NPV = [Present value of cash inflow] – [Present value of cash outflow (investment)]

Note

- If NPV (Net Present Value)
  - > 0, Then project is financially viable.
  - = 0, Then project just meets breakeven.
  - < 0, Then project is not financially viable.
  - Project with increase NPV is preferred.
- Benefit Cost Ratio

$$\text{BCR} = \frac{\text{Total present value of benefits}}{\text{Total present value of investments}}$$

  - > 1 ⇒ Accept
  - < 1 ⇒ Reject
  - = 1 ⇒ Breakeven situation

EXAMPLE 4.8

Initial investment (cash outflow) is Rs. 2,40,000 and cash in flow (after tax) is Rs. 80,000 in 1st year, 1,20,000 in 2nd year, 70,000 in 3rd year, 40,000 in 4th year and 20,000 in 5th year. If the companies cost of capital is 9% (interest rate) then calculate Net Present Value (NPV).

Solution:

Year	Cash flow (Rs.)	D.F. at 9%	Present Value (Rs.)
1.	80,000	0.917	73,360
2.	1,20,000	0.842	1,01,040
3.	70,000	0.772	54,040
4.	40,000	0.708	28,320
5.	20,000	0.650	13,000
			Σ = 2,69,760

Present value of cash in flow, A = 2,69,760

Present value of cash outflow, B = 2,40,000

Net Present Value, NPV = 2,69,760 – 2,4,0000 = +29760

> 0

2. Cost of Operation
3. Cost of Repairs and Maintenance
4. Cost of Replacement of parts/components
5. Salvage Value

LCC = Cost of [Acquisition + Operation + Repair and Maintenance + replacement of components] – Salvage Value

LCC = Sum of items 1 to 4 above less Salvage Value.

In assessing the Value Index, if LCC is used

LCC = (Present value of all cost incurred) – (Present value of Salvage Value)

Previous ESE Prelims Questions

Q.1 During an assessment of economic viability of the project, the ratio of average annual earnings after tax to the average book investment after depreciation is called

(a) Benefit-Cost Ratio (BCR) (b) Net Present Value (NPV)
(c) Pay-Back Period (PBP) (d) Return on Investment (ROI)

[ESE-2020]

Ans. (d)

Q.2 The market price per share of a company is ₹125. The dividend per share (DPS) expected a year is ₹12 and DPS is expected to grow at a constant rate of 8% per annum. The cost of the equity capital to the company will be

(a) 17.6% (b) 15.4%
(c) 13.2% (d) 11.8%

[ESE-2020]

Ans. (a)

Q.3 An individual investor who invests in the e-project usually during an early stage is

(a) corporate strategic investor (b) founder capital
(c) angel investor (d) venture capital

[ESE-2020]

Ans. (c)

Q.4 If the nominal rate of interest is 12% and is compounded quarterly, the effective rate of interest per annum will be nearly

(a) 10.8% (b) 12.6%
(c) 14.4% (d) 16.2%

[ESE-2020]

Ans. (b)

Q.5 In a bank, deposits can be made for periods ranging from 6 months to 10 years. Every quarter, an interest will be added on to the principal. The rate of interest applied is 9% per annum for periods from 12 months to 23 months and 10% per annum for periods from 24 months to 120 months. An amount of ₹1,000 invested for 2 years to grow, will be nearly

(a) ₹1,218 (b) ₹1,334
(c) ₹1,414 (d) ₹1,538

[ESE-2020]

Ans. (a)