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Engineering Economics

1. Introduction ... (4)
2. Interest and Time value of Money -- (6 marks)
3. Basic Methodologies of Engineering Econ. Analysis (16 marks)
4. Comparative Analysis of Alternatives (12 marks)
5. Replacement Analysis (12 marks)
6. Risk Analysis (12 marks)
7. Depreciation and Co-operate Income Tax. (12 marks)
8. Inflation and its Impact (6 marks)

Chapter-7: Depreciation

Depreciation:

- Fixed assets lose their value even as they continue the function and contribute to the engineering project that use them. This losed value is called depreciation.
- Most assets lose their value over time. (In other word: they depriciate) and must be replaced once the end of useful life is reached.

Depreciable property
- Tangible Property
  - Personnel
    - Machinaries
    - Furniture
    - Vehicles.
  - Real
    - Land
- Intangible property
  - Goodwill
  - Trademark
  - Copyright

Depriciation is classified as:

a) Economic depriciation:
- Reduction in assets capacity to perform its intended service due to physical impairments (corrosion, chemical changes, wear and tear)

b) Functional depreciation:
Due to change in organization on its technology that decreases or eliminate need for assets.

7.2 Basic definition:

a) Cost basis:
- Initial cost of acquiring assets (purchase price + tax + transportation and other cost like installation
- It represent the total cost i.e. ~~clam~~ claimed as expenses ~~of~~ over an assets life.

b) Market value:
- The amount that will be paid by the buyer to the seller for property under no compulsion for buying & selling.

c) Recovery period:
- It is the depreciable life 'n' of ~~an~~ the assets in year.

d) Salvage value
- The estimated value of property at the end of useful life.

e) Book value
o The worth of depreciable property as shown in accounting record of the company.
So, Book value (B.V.) = Cost basis - Depreciation amoun

7.3 Methods of depreciation
a) Straight line Depreciation.
b) Sum of Year Digits (SOYD)
c) Declining Balance method
d) Sinking Funnel Methods
e) MACRS

a) Straight line depreciation. (SL method)
It assumes that constant amount is depreciated each year over the useful life of the assets.
So, $D_n = \frac{I-S}{N}$ where, I = Investment on cost basis
S = Salvage value
N = Useful life
D_N = Depreciation amount.

Tutorial 1:
Q. Consider the following data:
Cost of assets = Rs. 10,000
Useful life = 5 years
Estimated salvage value = Rs. 2000
Compute the annual depreciation allowance & the resulting book value using SL method.
Solution,

I = Rs. 10,000

S = Rs. 2000

N = 5 years.

Now,

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

$$= \frac{10,000 - 2000}{5}$$

$$= \text{Rs. } 1600$$

EOY	B_{n-1}	D_n	B_n
1	10,000	1600	8400
2	8400	1600	6800
3	6800	1600	5200
4	5200	1600	3600
5	3600	1600	2000

$B_n = S.V$

b.) Sum of Year Digits (SOYD)

$$D_n = \left(\frac{N-n+1}{SOYD}\right)(I-S)$$, where $n = 1, 2, 3 \cdots$

$SOYD = 1+2+3 \cdots$

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

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Q. A machine costing Rs. 10,000 is bought with an estimated salvage value of Rs. 2,000 having 5 years useful life. Compute the depreciation schedule using SOYD.

Here,

$N = 5$

$I = Rs.\ 10,000$

$S = Rs.\ 2,000$

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

EOY	B_{n-1}	D_n	B_n
1	10,000	2666.67	7333.33
2	7333.33	2133.33	5200
3	5200	1600	3600
4	3600	1066.67	2533.33
5	2533.33	533.33	2000

$\therefore B_n = S.V.$

c.) Declining Balance Method (DDB method)

It is also known as fixed or uniform percentage method.

In this method, book value is multiplied by a fixed rate i.e. $\alpha = \frac{1}{N} \times$ multiplier.

Taking multiplier = 2, $\alpha = \frac{2}{N}$

So, this is also known as double declining balance

method.

Q. A machine costing Rs. 10,000 is bought with an estimated salvage value of Rs. 778 having ~~five~~ 5 year useful life. Find B_n and D_n using DDB metho

Solution

$$\alpha = \frac{2}{N} = \frac{2}{5} = 0.4 = 40\%$$

EOY	B_{n-1}	D_n	B_n
1	10,000	4000	6000
2	6000	2400	3600
3	3600	1440	2160
4	2160	864	1296
5	1296	518.4	~~777.6~~ ≃ 778

$B_n = S.V.$

Case A:

If Salvage value = Rs. 2000

EOY	B_{n-1}	D_n	B_n
1	10,000	4000	6000
2	6000	2400	3600
3	3600	1440	2160
4	2160	864	1296
5	1296	518.4	778

$B_n < S.V.$

So, making new table.

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Adjusted Anyway.

EOY	B_{n-1}	D_n	B_n
1	10,000	4000	6000
2	6000	2400	3600
3	3600	1440	2160
4	2160	80	2080
5	2080	80	2000

Case B:

If Salvage Value (S) = Rs. 0 .

EOY	B_{n-1}	D_n	B_n
1	10,000	4000	6000
2	6000	2400	3600
3	3600	1440	2160
4	2160	864	1296
5	1296	518.4	778

$B_n > S.V.$

★ When $B_n > S.V.$ is the situation where we have n depreciate entire cost of assets. To reduce the book value to its salvage value as quickly as possible, it can be done by switching from (DDB) to SL method

Depreciation for SL can be calculated as

D_n = (Book value at the beginning of year) − (Salvage value)

Remaining useful life of an assets

Switch when S.L ≥ DDB.

After Switching Dn, same value of SL.

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EOY	S.L. Depreciation	DDB Depreciation	Decision
1.	$\frac{10000-0}{5} = 2000$	< 4000	Do not switch
2.	$\frac{6000-0}{4} = 1500$	< 2400	Do not switch
3.	$\frac{3600-0}{3} = 1200$	< 1440	Do not switch
⇒ 4.	$\frac{2160-0}{2} = 1080$	> 864	Switch
5.	$\frac{1080-0}{1} = 1080$	518.4	

Optimal year = 4 years

EOY	B_{n-1}	D_n	B_n
1	10,000	4000	6000
2	6000	2400	3600
3	3600	1440	2160
4	2160	1080	1080
5	1080	1080	0

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V.Imp Modified Accelerated Cost Recovery System (MACRS)

- In US, ACRS was launched in 1981 and from 1986, MACRS was implemented.
- It is the principle method for computing depriciation of property in engineering project.
- The salvage value to be defined is zero. & useful life estimates are not used directly in calculating the depriciation amount.
- It includes 8 categories of assets and suppose the useful life of: 3 years, 5, 7, 10, 15, 20, 27.5 years.

★ Half-year convention:

- Assume all the assets are placed in service at mid. So, only half of one year depriciation be taken in first year.
- MACRS asset is depriciated initially by DB and then by SL.

Q. A tax-payer wants to place in service Rs. 10,000 assets i.e. assigned to 5 year class. Compute the MACRS percentage & depreciation amount for the assets.

Here,

N = 5 years

I = Rs. 10,000

$\therefore d = \frac{2}{N} \times 100\% = 40\%$.

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EOY	Calculation %	MACRS %	Decision
1.	$DB = \frac{1}{2} \times 40\% = 20\%$	20%	
2.	$DB = 0.4 \times (100-20)\% = 32\%$ $SL = \frac{100-20}{4.5} = 17.78\%$	32%	Do not switch
3.	$DB = 0.4 \times (100-20-32)\% = 19.2\%$ $SL = \frac{100-20-32}{3.5} = 13.71\%$	19.2%	Do not switch
4.	$DB = 0.4 \times (100-20-32-19.2)\% = 11.52\%$ $SL = \frac{(100-20-32-19.2)\%}{2.5} = 11.52\%$	11.52%	Switch
5.	$SL = \frac{100-20-32-19.2-11.52}{1.5} = 11.52\%$	11.52%	
6.	$SL = \frac{1}{2} \times 11.52\% = 5.76\%$	5.76%	

Depriciation Schedule:

EOY	MACRS	Cost Basis	Depriciation Amount
1.	20%	10,000	2000
2.	32%	10,000	3200
3.	19.2%	10,000	1920
4.	11.52%	10,000	1152
5.	11.52%	10,000	1152
6.	5.76%	10,000	576

Book- value schedule:

EOY	B_{n-1}	D_n	B_n
1.	10,000	2000	8000
2.	8000	3200	4800
3.	4800	1920	2880
4.	2880	1152	1728
5.	1728	1152	576
6.	576	576	0

$\therefore B_n = SL = 0$ //

2. Show the depriciation & book value in each year from an equipment having following details using MACRS method.

Investment (I): Rs. 25,00,000/-

Useful life (N): 7 years

Here,

$N = 7$ years

$\therefore a = \frac{2}{N} \times 100\%$

$= \frac{2}{7} \times 100\%$

$= 28.57\%$.

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EOY	Calculation %	MACRS%	Decision
1.	$\frac{1}{2} \times 28.57\% = 14.285\%$	14.285	
2.	DB = (100 - 14.285) x 28.57 = 24.488 SL = $\frac{100-14.285}{6.5}$ = 13.19 %	24.48%	Do not switch
3.	DB = (100 - 14.285 - 24.48) x 28.57 = 17.49% SL = $\frac{100-14.285-24.48}{5.5}$ = 11.1%	17.49%	Do not switch
4.	DB = 12.49 SL = 9.72	12.49%	Do not switch
5.	DB = 8.92% SL = 8.92%	8.92%	Switch
6	SL = 8.92%	8.92%	
7.	SL = 8.92%	8.92%	
8.	SL = 4.46%	4.46%	

Depriciation Schedule

EOY	MACRS	Cost Basis	Depriciation amount
1	14.285%	25,00,000	357125
2	24.48%	25,00,000	612000
3	17.49%	25,00,000	437250
4	12.49%	25,00,000	312250
5	8.92%	25,00,000	223000
6	8.92%	25,00,000	223000
7	8.92%	25,00,000	223000
8	4.46%	25,00,000	111500

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Book - value schedule

EOY	B_{n-1}	D_n	B_n
1	25,00,000	357125	2142875
2	21,42,875	612000	1530675
3	15,30,675	437250	1093425
4	10,93,425	312250	780925
5	780925	223000	557925
6	557925	223000	334925
7	334925	223000	111925
8	111925	111500	425 ≈ 0

4) Sinking Fund Method.

Sinking fund is like as special purpose of saving account. Corporate deposit's money with an itention to repay a debt or replace an asset in future The money in fund is put regularly and uses only for the predefined purpose.

To find depreciation Amount

$$A = (P-F) \times \left(\frac{A}{F}, i\%, N\right)$$

$$= (P-F) * \left[\frac{i}{(1+i)^N - 1}\right]$$

; i = Rate of inter
N = Number of Y

Compute the depreciation & book value (Bv) in each year using the sinking fund depreciation method.

Cost of assets : Rs. 1,00,000

Salvage value : Rs. 20,000

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Useful life = 8 years
Interest Rate = 12%

Here,

EOY	Depreciation
1.	$(100000 - 20000) \times \left(\frac{0.12}{1.12^8 - 1}\right)$
	= Rs. 6504.22
2.	$6504.22 + \frac{12}{100} \times 6504.22 = Rs. 7284.73$
3.	$7284.73 + \frac{12}{100} \times 7284.73 = 8158.9$
4.	9137.96
5.	10234.52
6.	11462.66
7.	12838.18
8.	14378.76.

EOY	B_{n-1}	D_n	B_n
1.	1,00,000	6504.22	93495.78
2.	93495.78	7284.73	86211.05
3.	86211.05	8158.9	78052.15
4.	78052.15	9137.96	68914.19
5.	68914.19	10234.52	58679.67
6.	58679.67	11462.66	47217.01
7.	47217.01	12838.18	34378.83
8.	34378.83	14378.76	20000.00

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Q. Consider the following information. Compute the annual depriciation & book value of each year by using

a.) SL method.
b.) SOYD method
c.) DDB method
d.) Sinking Fund method

Cost basis = $7,000
Salvage value = $2,000
Useful life = 5 years
MARR = 10%.

a.) SL method:

$$D_n = \frac{I-S}{N} = \$1000$$

EOY	B_{n-1}	D_n	B_n
1.	7000	1000	6000
2.	6000	1000	5000
3.	5000	1000	4000
4.	4000	1000	3000
5	3000	1000	2000

b.) SOYD:

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

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

EOY	B_{n-1}	D_n	B_n
1	7000	1666.67	5333.33
2	5333.33	1333.33	4000
3	4000	1000	3000
4	3000	666.67	233.33
5	2333.33	333.33	2000

c) DDB method

$$\alpha = \frac{2}{N} = \frac{2}{5} \times 100\% = 0.4 = 40\%$$

EOY	B_{n-1}	D_n	B_n	
1.	7000	2800	4200	
2.	4200	1680	2520	←
3.	2520	1008	1512	
4.	1512	604.8	907.2	
5	907.2	362.88	544.32	

$B_n < S.V$

EOY	B_{n-1}	D_n	B_n
1	7000	2800	4200
2	4200	1680	2520
3	~~2346.67~~ 2520	173.33	2346.67
4	2346.67 ~~2173.34~~	173.33	2173.33
5	2173.33	173.33	2000

d.) ~~EOY~~ Sinking Fund

EOY	Depreciation
1.	$(7000-2000) \times \left(\frac{0.1}{(1.1)^5-1}\right) = 818.98$
2.	900.88
3.	990.97
4.	1090.07
5	1199.07

~~EOY~~ ~~Deprici~~

EOY	B_{n-1}	D_n	B_n
1	7000	818.98	6181.02
2	6181.02	900.88	5280.14
3	5280.14	990.97	4289.17
4	4289.17	1090.07	3199.1
5	3199.1	1199.07	20000

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Corporate and Income tax.

a.) Income tax:
Income tax are assets as a function of gross revenue minus allowable reduction.

b.) Property tax:
Are assessed as a function of value of property owned such as land, buildings, equipments, etc.

c.) Sales tax:
Are assessed as a basis of ~~pure~~ purchase of goods & services.

d.) Excise tax: (Indirect type of tax)
It is the tax that is levied by the government for the goods and products that are manufactured inside the country.

Note:
Taxable income: Gross revenue - All expenses except investment - deduction.
Income tax: tax rate * Taxable income
Net Income After Tax (NIAT): Taxable income - Income tax -

A company buys a machine for Rs. 28,000 and use for 5 year. Depriciation for the 1st year is Rs. 4,000. Suppose the company estimated following revenue & expenses.

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Gross income = Rs. 50,000
Operating expenses = Rs. 6,000
Wages paid = Rs. 20,000

What is the net income for the 1st year if the tax rate is 40%?

Here,

Taxable income = Rs. 50,000 − (Rs. 6000 + Rs. 20000) − Rs. 40000
= Rs. 20,000

Income tax = 40% x Rs. 20,000
= Rs. 8000

Net Income After Tax (NIAT) = Rs. 20,000 − Rs. 8000
= Rs. 12,000. //

General Procedure for making After Tax Economic Analysis

R_k = Revenue
E_k = Expenses
d_k = Depreciation
t = Effective Income tax rate
T_x = Income tax

Taxable Income = $R_k - E_k - d_k$

$T_x = t * (R_k - E_k - d_k)$

$NIAT = (R_k - E_k - d_k)(1 - t)$

After-tax cash flow (ATCF) = $NIAT + d_k$.

Q. Develop a model to calculate After tax cash flow

Year (Y)	BTCF (A) $R_k - E_k$	Depriciation (B) d_k	Taxable income C = A - B $(R_k - E_k - d_k)$	Tax D = -t*C	ATCF E = A+D

Q. Assets cost basis of Rs. 1,00,000 is deposited as follows:

Year (Y)	1	2	3	4	5	6
Depriciation	10,000	20,000	20,000	20,000	20,000	10,000

& Tax Rate = 40 %

If the ~~next~~ net cash flow of 30,000 per year. Determine the ATCF and BTCF.

Year (Y)	BTCF (A)	Depriciation (B)	Taxable income C (A-B)	Tax D = -t*C	ATCF E = A+D
0	-1,00,000	—	—	—	-1,00,000
1	30,000	10,000	20,000	-8000	22,000
2	30,000	20,000	10,000	-4000	26,000
3	30,000	20,000	10,000	-4000	26,000
4	30,000	20,000	10,000	-4000	26,000
5	30,000	20,000	10,000	-4000	26,000
6	30,000	10,000	20,000	-8000	22,000

analysis

Q. Perform After-tax cash flow to examine the feasibility of the project having the investement of Rs. 1,00,000 in a machine with 0 salvage value, 5 years useful life, Net Annual revenue of Rs. 20,000 at the end of 1st year then after increased by Rs. 10,000 p.a. Tax rate is 25%. ~~Tak~~ And use SL depriciation.

Sol^n:

$$\text{Depreciation} = \frac{I-S}{N} = \frac{1,00,000-0}{5} = \text{Rs}20,000$$

Year (Y)	BTCF (A)	Depriciation (B)	Taxable income C=(A-B)	Tax D=-t*C	ATCF E=A+D
0	-1,00,000	—	—	—	-1,00,0(
1	20,000	20,000	0	0	20,000
2	30,000	20,000	10,000	-2500	27,50(
3	40,000	20,000	20,000	-5000	35,000
4	50,000	20,000	30,000	-7500	42,500
5	60,000	20,000	40,000	-10000	50,000