Cairo University

Faculty of Engineering

Chemical Engineering Department

Economics Exams' notes

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Introduction

This file contains the exams and their solution from year 2002 till 2009, some problems are very important and unique, and so they are mentioned in the following table:

Other problems like:

- Balance sheet
- TCI / Manufacturing cost

They are totally systematic; anyone in the exams could be solved in the same manner; just take care of the following consideration:
For balance sheet: DONOT take rent as current asset
For MC / PC: if service life is given, take (1/n) as %age from the FCI as depreciation where:

Service life n	1 / n	Depreciation
20 years	0.05	0.05 * FCI
10 years	0.1	0.1 * FCI
7 years	0.143 = 0.15	0.15 * FCI

June 2002

Question 1

Estimate the manufacturing cost per kg of product under the following considerations:

Fixed capital investment = $ 120 millions

Annual production output = 30 million kilograms of product

Raw materials cost = $ 2.0 /kg of product

Utilities: filtered and softened water = 1.5 gal. /kg of product ($2.0/1000gal)

100psig steam = 50 kg/kg of product ($5/1000kg)

Purchased electric power = 1KWh/kg of product ($0.15/KWh)

Operating labor: 50 men per shift at $10 per employee-hour

Plant operates 300 – 24 hour- day per year. Corrosive liquids are involved.

Shipments are in bulk carload lots. A large amount of direct supervision is required. There are no patent, royalty, interest or rent charges. Plant overheads costs amount to 50% of the cost for operating labor, supervision, and maintenance.

The solution:

Direct manufacturing cost calculations:

1. Variable cost

1.1 Raw materials cost = $2.0 /kg

1.2 Miscellaneous materials

Miscellaneous materials are function in the maintenance cost, so we have to calculate the cost of maintenance first and from it, we can calculate the miscellaneous materials cost.

Maintenance cost = (5 - 10) % of FCI

As corrosive liquids are involved, so we take the maintenance cost = 10% FCI = 0.1* 120 = $ 12 million

Miscellaneous materials cost = 10% f maintenance cost = 0.1*12 = $1.2 million
Miscellaneous materials cost per kg of product = $(1.2 * 10^6) / (30 * 10^6)$ = $ 0.04/ kg product

1.3 Utilities:
Water: (1.5gal/kg product) *($2.0/1000gal) = $0.003/kg product
Steam: (50kg/kg product) *($5/1000kg) = $0.25/kg product
Power: (1kWh/kg product) *($0.15/kWh) = $ 0.15/kg of product
Utilities cost = 0.003 + 0.25 +0.15 = $ 0.403/ kg product

1.4 Shipping and packaging cost →neglected

Variable cost = 2 + 0.04 + 0.403 +0 = $ 2.443/kg product

2. Fixed cost

2.1 Maintenance cost = 0.1 of FCI = $ 12millions
Maintenance cost per kg of product = 12/30 = $0.4/kg product

2.2 Labor cost per kg of product = (50 men/shift)*(3 shifts)*(8 hr/day)*(300 day/year)*($10/employee) / (30 million kg product) = $ 0.12/kg product.

2.3 Supervision cost = 20% of labor cost = 0.2 * 0.12= $0.024/kg product

2.4 Plant overheads cost= 50% (labor + supervision + maintenance) = 0.5 *(0.12 + 0.024 +0.4) = $ 0.272/kg product

2.5 Depreciation = 15% of FCI = 0.15 * $120 millions / 30 millions = $0.6/ kg product

2.6 Interest, rent charges, patents, and royalty are neglected

2.7 Insurance cost = 1% of FCI = 0.01 * 120/30 = $0.04/kg of product

Fixed cost = 0.4 + 0.12 + 0.024 + 0.272 +0.6 +0.04 = $ 1.456/kg product

Direct Manufacturing Cost

= variable cost + fixed cost = 2.443 + 1.456 = $3.899 / kg product

Indirect manufacturing cost

Indirect manufacturing cost is not specified, so we will take it as 25% of DMC, thus

Total Manufacturing Cost

= DMC + IMC = 3.899 + 0.25* 3.899 = $4.87/ kg of product

Question 2 (Important)

[I] DCFRR can be calculated for the case of a single lamp investment and constant annual cash flow by the following equation:

$$i = \frac{\mathrm{R}}{\mathrm{I}} - \frac{i}{(1+i)^n - 1}$$

Where: I = annual rate of return

R = annual cash flow

I = investment

N = life of the project (year)

a) Derive this equation from its basic economic relation

Given that: Initial investment (I) =EGP 1,000,000

Useful life of project n = 6 years

Annual cash flow R= EGP 400,000

b) Calculate (true rate of return) TRR

Solution:

a) At DCFRR NPV=0

$$R * \frac{(1+i)^n - 1}{i * (1+i)^n} - I = 0$$

$$\frac{R}{I} * \frac{(1+i)^n - 1}{i * (1+i)^n} - 1 = 0$$

$$\frac{R}{I} - \frac{i * (1+i)^n}{(1+i)^n - 1} = 0$$

$$\frac{R}{I} - \frac{i * (1+i)^n - i + i}{(1+i)^n - 1} = 0$$

$$\frac{R}{I} - i - \frac{i}{(1+i)^n - 1} = 0$$

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

b) $i = \frac{400{,}000}{1{,}000{,}000} - \frac{i}{(1+i)^6 - 1}$

By trial &error $i = 32.67\%$

[II] The following information apply to AZM Company on a given date

Account payable = EGP 5000	Account receivable = EGP 6000
Cash in bank = EGP 12000	Reserve for expansion = EGP 2000
Government bonds = EGP 15000	Social security tax payable = EGP 1000
Long term debts = EGP 2000	Prepaid rent = EGP 500
Reserves for depreciation = EGP 1000	Machinery and equipment = EGP 50000
Inventory = EGP 4000	Debts due within one year = EGP 2000

Determine the <u>current ratio, cash ratio, and working capital</u> for company at the given date.

Solution

Current assets = Cash in bank + Account receivable + Gov. Bonds + Inventory

= 12000 + 6000 + 15000 + 4000 + = EGP 37,000

Current liabilities = debts/1yr + account payable + Taxes

= 2000 + 5000 + 1000 = EGP 8000

Cash = cash + Gov. Bonds = 12000 + 15000 = EGP 27,000

- Working capital = 37000 – 8000 = <u>EGP 29,000</u>

- Current ratio = 37000/8000 = 4.625
- Cash ratio = 27000/8000 = 3.375

Question 3:

A company has two alternative investments which are being considered company policies, based on the current economic situation, dictate a minimum annual return on the original investment of 15 % after taxes must be predicted for any unnecessary investment with interest on investment not included as a cost. Company policies also dictate that, where applicable straight line depreciation is used and for time value of money inter-precipitation end of year and profit analysis is used. Land value and prestart up costs can be ignored. Given the following data:

Investment no.	If , $	Iw ,$	Salvage value ,$	Service life , year	Annual cash flow after taxes, $	Annual cash expenses Constant ,$
1	200,000	15,000	18,000	7	60,000	32,000
2	250,000	20,000	25,000	8	65,000	25,000

Determine and comment which investment, **if any**, should be made by alternative analysis profitability – evaluation methods of:

i) Rate of return on initial investment.
ii) Minimum payout period with no interest charge.

Solution:

By rate of return on initial investment:

First; calculate the depreciation of each alternative

First alternative:

Depreciation = (fixed investment - salvage value)/service life

Depreciation = (200000 – 18000)/7

Depreciation = $ 26000

Second alternative:

Depreciation = (250000 – 25000)/8

Depreciation = $ 28125

R.O.I for alternative 1

= (60,000 – 26,000) / (200,000 + 15,000) = 0.158 = 15.8 %, therefore alternative 1 is valid and now we will compare alternative 2 to 1

R.O.I.I = (saving/ additional investment) * 100

R.O.I.I = [(65000 – 60000) + (26000 – 28125)]/ (270000 – 215000)

R.O.I.I =5.23 % < 15 %

So alternative two is not accepted, and alternative one is recommended.

By minimum payout period with no interest charge:

Pay out period = (fixed investment – salvage value)/annual cash flow

First alternative:

Payout period = (200000 – 18000)/60000 = 3.033 year

Second alternative:

Pay out period = (250000 – 25000)/65000 = 3.462 year

So alternative one is recommended, it has less payout period.

Question 4: The optimization problem (Important)

Vapor needs to be condensed where, vapor flow rate = 5000 lb / hr

Temperature for the vapor is 170 ^{o}F. The heat of condensation of the vapor is 200 Btu/lb.

Cooling water is available at 70 ^{o}F. The cost of the cooling water is ($5/1000m^{3}).

The overall heat transfer coefficient at the optimum conditions may be taken as 50 Btu/hr.ft^{2}.^{o}f. The cost for the installed condenser is $34 per ft^{2} of heat transfer area, and the annual fixed charges including maintenance are 20% of the initial cost.

The heat capacity of the water may be assumed to be constant at 1.0 Btu/lb.^{o}F.

If the condenser is to operate 6000 hr/year, determine the cooling water flow rate in m^{3}/hr for optimum economic conditions.

Solution:

The procedure will be as follows:

1. Assume outlet water temperature t_o
2. Calculate water flow rate where: $Q = V*LH = m\ c_p\ (t_o - t_i)$
3. Calculate Δt_m
4. Buy knowing Q, U & Δt_m, calculate A
5. Calculate capital cost of the condenser by knowing A and price per ft^{2} of area
6. Calculate the fixed charges which are certain, given percentage of the initial cost of the condenser
7. Calculate the operating cost of water by knowing, water flow rate per year and price of cooling water per lb
8. Add the fixed charges and the operating cost
9. Draw 3 curves, one for fixed charges and one for the operating cost and last for the total and from this figure, obtain minimum cost
10. From this cost, you can get optimum t_o, consequently the optimum water flow rate and optimum area of condenser.

Trials	t_o	m_w	Δt_m	A	Capital	FC / yr	OC / yr	TC
1	120	$\frac{5000*200}{1*(170-120)}$ = 20,000 lb / hr	72.1	$\frac{5000 * 200}{72 * 50}$ = 266.7	266.7 * 34 = 9068	0.2 * 9028 = 1814	20,000 *6000*0 .005 = 600,000	601,814
2								
3								
4								
5								
6								
7								
8								

June 2003

Question 1:

(i) A process plant making 2000 tons per year of a product selling for $0.8 per lb has an annual direct production costs of $2 million at 100%and other fixed costs of $700000.what is the fixed cost per pound at the breakeven point? if the selling price of product is increased by 15% what is the dollar increase in net profit at full capacity if the income tax rate is 25% of gross earnings.

Solution:

Production= 2000 tons = 2,000,000 kg = 4415011.038 lb

Variable cost/lb = 2,000,000/4415011.038 = $ 0.453

Profit = Sales – variable cost – Fixed cost

@ BEP

0 = 0.8*X – 0.453*X – 700,000

No. of lb @ BEP

X = 2017291.066 lb

Therefore,

Fixed cost/lb = Fixed cost/No. of lb = 700,000/2017291.066 = $ 0.347/lb

Profit = Sales – variable cost – Fixed cost

Profit = 0.8*4415011.038 – 700000 – 2000000 = $ 832,008

Net profit = profit – Taxes = 0.75* profit = $624,006

Price of product increased 15%, therefore

Price of product = 0.8 *(1+0.15) = 0.92

Profit = 0.92*4415011.038 – 700000 – 2000000 = $ 1,361,810

Net profit = profit – Taxes = 0.75* profit = $1,021,358

Increase in the net profit = 1,021,358 – 624,006 = $397,351

(ii) The following information applies to AZM Company on a given data

Determine the current ratio, cash ratio, and working capital

reserve for expansion	1200
reserve depreciation	600
cash in bank	5000
Inventory	2000
accounts receivable	3000
prepaid rent	300
government bond	6000
debts due within one year	1500
social security taxes payable	340
accounts payable	2500
long term depts.	1600
machinery and equipment	20000

Solution:

current assets=cash in bank + inventory + accounts receivable + government bond
current assets=5000+2000+3000+6000
current assets=16000 EGP

current liabilities=debts due within one year + social security taxes payable + accounts payable
current liabilities=1500+340+2500
current liabilities=4340 EGP

working capital=current assets-current liabilities
working capital=16000-4340=11660 EGP

current ratio=16000/4340=3.7

cash ratio=(cash + government bond)/current liabilities=2.534562

Question 2:

(i) Write short notes on each of the following:

1. Stocks Market.
2. Main Features of Corporation
3. Added Value
4. M & S Cost Index

Solution:

1. ***Stocks Market:*** It's the place where we buy and sell the stocks after the company produces it.

   There are 2 markets for money:

   i. Production Market: The market where it is dealt with it at the beginning through the side which produces the stock, it might be a company or a bank.

   ii. Exchange Market: The market where we deal after buying the stocks,

   The stock market produces a daily report containing the prices of stocks so that people can compare between what happened today and the day before.

2. ***Main Features of Corporation:*** It's an organization (company, factory,etc) that doesn't belong to a soul owner nor does it belong to some people but it'd rather be divided into shares and stocks.

   Advantages:

   i. Perpetual life.
   ii. Limited liability to stockholders.
   iii. Ease of transferring ownership.
   iv. Ease of expansion.
   v. Applicability to all sizes of firms.

Disadvantages:

i. Government regulations.
ii. Capital stock tax.
iii. Expense of organization.

3. ***Added Value:*** It's the difference between the value of the product and the value of what it takes to produce it from its raw materials, axillaries (water and electricity) and chemicals added. Added Value is used to judge on the industrial efficiency.

4. ***M & S cost index:***

Marshall and Swift Stevens equipment cost index where cost index is defined as:

As the value of money changes with time, what cost x last year, would probably cost more than x this year

Cost index is used to obtain the price of certain item at the present time by knowing its price before

Present cost = original cost * $\frac{inderx\ value\ at\ present\ time}{index\ value\ at\ time\ original\ cost\ was\ estimated}$

(ii) (important)The facilities of an existing company must be increased if the company is to continue in operation. There are two alternatives. One of the alternatives is to expand the present plant, if this is done, the expansion would cost $ 130,000. Additional labor cost would be $ 150,000 per year, while additional cost s for overhead, depreciation, taxes and insurance would be $ 60,000 per year.

A second alternative requires construction and operation of mew facilities at a location about 50 miles from the present plant. This alternative is attractive because cheaper labor is available at this location the new facilities would cost $ 200,000, labor costs would be $ 120,000 per year, overhead costs would be $ 70,000 per year, annual insurance and taxes would amount to 2% of the initial cost, all other costs **except depreciation** would be the same at each location. If the minimum return on any acceptable investment is 9 %, determine the minimum service life allowable for the facilities at the distant location for this

alternative to meet the required incremental return. The salvage value should be

	Alternative 1(Expand the present plant)	Alternative 2(Build new facilities at a location)
Expansion/new facilities at new location	$ 130,000	$ 200,000
Additional labor cost	$ 150,000/year	$ 120,000/year
Overhead (O)		$ 70,000/year
Depreciation (D)		D
Taxes (T)		
Insurance (I)		
T+I		0.02*$ 200,000 = 4,000
O+T+I+D	$ 60,000	70,000+4,000+D

assumed to be zero, and straight line depreciation accounting is used.

Solution:

ROII= 9%=0.09

ROII= $\frac{30{,}000+\left(60{,}000-(74{,}000+\mathrm{D})\right)}{(200{,}000-130{,}000)} = 0.09$

0.09=$\frac{16{,}000-D}{70{,}000}$

D=$ 9,700

As salvage value =$ 0

D=$\frac{Initial\ value-salvage\ value}{No.of\ years}$

D=$\frac{20{,}000-0}{No.of\ years}$=9,700

Therefore, No. of years= 20.6 years

Note: when we calculate the annual savings we noticed that the summation of the depreciation, overhead, insurance and the taxes in the 1st alternative is lower than the overhead, insurance and the taxes (without the depreciation) in the 2nd alternative that's why we count it as a –ve value as we will spend more in the 2nd alternative ➔ (60,000 -(74,000+D))

Question 3

A company has two alternative investments which are being considered Company policies, based on the current economic situation, dictate a minimum annual return on the original investment of 15% after taxes must be predicted for any unnecessary investment with interest on investment not included as a cost. Company policies also dictate that, where applicable, straight-line depreciation is used, for time-value of money interpretation, end of year and profit analysis is used in land value and prestart up costs can be ignored. Given the following data:

Invest NO.	*If, $*	*Iw $*	*Salvage value, $*	*Service life, years*	*Annual cash flow after taxes, $*	*Annual cash expenses constant for each year,$*
1	360,000	24,000	32,000	7	110,000 constant	60,000
2	450,000	40,000	50,000	8	120,000 constant	44,000

Determine and comment which investment, if any, should be made by alternative –analysis profitability- evaluation methods of:

(i) Rate of return on initial investment

(ii) Minimum payout period with no interest charge

(iii) Net present worth (NPW)

(iv)Capitalized cost

Question 4: (optimization / Condenser)

The overhead condenser of a distillation tower is to be designed to condense 8000 lb of vapor/hour. The effective condensation temperature for the vapor is 180 °F. The latent heat of condensation of vapor equals 220 Btu/lb. Cooling water is available at 80 °F. The cost of cooling water is $\$9\times10^{-6}$. The overall heat transfer coefficient equals 100 Btu/hr.ft^2.°F. The cost of the installed condenser is \$33 ft^2 of heat transfer area, and the annual fixed charges including maintenance and interest are 25% of the initial investment. The condenser is to operate 8000 hours/year.

Determine the outlet temperature of cooling water, cooling water flow rate and the heat transfer area for optimum conversion conditions. (c_p of cooling water= 1 Btu/lb. °F)

Solution:

Same procedure as question 4 / 2002

Question 5:

(i) ***Define:*** Discounted cash flow rate of return (DCFRR)
(ii) ***For the following project under study:***

1. The construction of the project will be completed in 3 years. The project needs 5 years from the start till the full capacity change (6th year till 15th year).
2. Data about the construction, operating costs and volume of sales during installation and operation stages are:

Year	Construction Costs (EGP 1000)	Operating Costs (EGP 1000)	Volume of Sales (1000 tons)
1	160	5	-
2	210	5	-
3	260	10	-
4	-	15	10
5	-	20	15
6-15	-	25	20

3. Suggested selling price EGP 10 per ton, and the average interest is 15%.

Required:

a. Project performance evaluation by DCFRR method.
b. Testing project sensitivity if the selling price becomes EGP 9 per ton, and the construction costs increase by 10%.

Solution

(i) DCFRR: Discounted cash flow rate of return

$$0 = \Sigma [F / (1+i)^{n}]$$

It is used to calculate the value of the rate of return (i) which makes NPW = 0.

This value of rate of return (i) is the maximum value that a project can withstand.

Year	**1**	**2**	**3**	**4**	**5**	**6-15**
Construction Costs (EGP 1000)	-160	-210	-260	-	-	-
Operating Costs (EGP 1000)	-5	-5	-10	-15	-20	-25
Volume of Sales (1000 tons)	-	-	-	10	15	20
Volume of Sales (EGP 1000)	-	-	-	100 (=10*10)	150 (=15*10)	200 (=20*10)
Net Cash Flow (EGP 1000)	-165	-215	-270	85	130	175

(ii) a.

DCFRR method:

$0 = -165/ (1+i) – 215/ (1+i)^2 - 270/ (1+i)^3 + 85/ (1+i)^4 + 130/ (1+i)^5$

$+ 175*[(1+i)^{10}-1]/[i*(1+i)^{10}] * 1/(1+i)^5$

By trial and error: DCFRR = 17.39 % > MARR (15%)

Therefore, the project is feasible.

b.

Year	1	2	3	4	5	6-15
Construction Costs (EGP 1000)	-176 (=1.1* 160)	-231 (=1.1* 210)	-286 (=1.1* 260)	-	-	-
Operating Costs (EGP 1000)	-5	-5	-10	-15	-20	-25
Volume of Sales (1000 tons)	-	-	-	10	15	20
Volume of Sales (EGP 1000)	-	-	-	90 (=10*9)	135 (=15*9)	180 (=20*9)
Net Cash Flow (EGP 1000)	-181	-236	-296	75	115	155

DCFRR method:

$0 = -181/ (1+i) – 236/ (1+i)^2 - 296/ (1+i)^3 + 75/ (1+i)^4 + 115/ (1+i)^5$

$+ 155*[(1+i)^{10}-1]/[i*(1+i)^{10}] * 1/(1+i)^5$

By trial and error: DCFRR = 13.46 % < MARR (15%)

Therefore, the project is sensitive.

June 2004

Question (1):

i) Estimate the manufacturing cost per kg of product under the following conditions:

Fixed –capital investment = $ 100 million

Annual production output = 30 million kg of product

Raw materials cost = $1.5/kg of product

Utilities: Filtered and softened water = 15 gal/kg of product, ($2/1000 gal)

100 psig steam = 50 kg/kg of product (5$/1000kg)

Purchased electrical power =1.5KWH/kg of product ($0.2/KWH)

Operating labor 50 men per shift at $15 per employee-hour

Plant operates 300 24-h days per year. Corrosive liquids are involved. Shipments are in bulk car load lots. A large amount of direct supervision is required. There are no patent, royalty, interest or rent charges.

Plant overhead costs amount 60% of the cost for operating labor, supervision and maintenance.

Solution:

i) F.C.I = $100*10^6

Annual production rate = 30*10^6 kg/yr

Manufacturing cost = D.P.C + I.P.C = Variable cost + fixed cost + I.P.C

1) Variable cost = Raw material + Miscellaneous material + Utilities + Shipping & Package

- R.M cost = 1.5/kg

Miscellaneous materials = 10% Maintenance

Where Maintenance = 5 - 10% F.C.I = $ 0.1 *[(100*10^6)/ (30*10^6)] = $0.333/kg

- Miscellaneous materials = 10% Maintenance = $0.0333/kg
- Utilities = 15*(2/1000) + 50*(5/1000) + 1.5*(0.2/1) = $0.58/kg
- Shipping & Packaging ⟶ Neglect

Variable Cost = 1.5 + 0.0333 + 0.58 = $2.11/kg

2) Fixed Cost = Maintenance + Labor + Supervision + Plant overheads + Rent + Royalty + Insurance + Interest + Depreciation + Patent
   - Labor Cost = (50*15*3*8*300)/(30*10^6) = $0.18/kg
   - Supervision = 20% Labor = $0.036/kg
   - Plant Overheads = 60% (Labor + supervision + maintenance)
     = 0.6 * (0.18 + 0.036 + 0.333) = $0.33
   - Insurance = 1% F.C.I = $0.033/kg
   - Depreciation = 15% F.C.I = $0.5/kg

   Fixed Cost = 0.333 + 0.18 + 0.036 + 0.33 + 0.033 + 0.5 = $1.412/kg

   Manufacturing cost = D.P.C = 2.11 + 1.412 = $3.522/kg

   I.P.C = 20% of D.P.C

Production Cost = 1.2 * 3.522 = $4.23/kg

ii) In order to make it worth able to purchase a new piece of equipment, the annual depreciation costs for the equipment cannot exceed $3000 at any time. The original cost of the equipment is $30,000 and it has zero salvage and scrap value.

Determine the length of service life necessary if the equipment is depreciated:

- By the straight-line method
- By the sum-of-the-years-digits method

Solution:

First considering the straight line method:

Annual depreciation $3000

V_0 = $30.000 V_S =0 n =???

$D_1 = (V_O - V_S)/n = 3000 = (30.000-0)/n$

N "service life" =10 years

Second considering the sum of years digits method

In this method, we have to assume N in order to be able to solve, so we will solve by trial and error by assuming (N) and getting d

- D_1 for 10 years = (10/(1+2+3+4+….+10))*(30.000-0)= $5454.5
- D_1 for 15 years = (15/(1+2+3+….+15))*(30.000-0)= $3750
- D_1 for 19 years = (19/(1+2+3+….+19))*(30.000-0)= $3000

Therefore N = 19 years

Question 2:

(i) Define:

- DCFRR.
- Sensitivity Analysis.

(ii) For the following project under study:

1- The construction of the project will be completed in 3 years. The project need 5 years from the start till the full capacity stage (6th year till 15th year).

Year	Construction Costs (EGP 1000)	Operating Costs (EGP 1000)	Volume of Sales (1000 Tons)
1	600	20	-
2	800	20	-
3	1000	40	-
4	-	60	32
5	-	80	48
6 - 15	-	100	80

2- Data about the construction costs, operating costs and volume of sales during installation and operation stages are as illustrated in the above table.

3- Suggested selling price EGP 12 per Ton, and the average interest cost is 15% percent.

Required:

i. Draw the cash flow diagram of this project.
ii. Project performance evaluation by DCFRR method.
iii. Testing project sensitivity if the selling price is decreased from EGP 12 to EGP 10 per ton, operating costs are increased by 10% and the construction costs is increased by 10% percent.

Solution:

(i) 1- DCFRR = "Discounted Cash Flow Rate of Return"

- It's the rate of discount at which the sum of positive present values is equal to the sum of negative present values which means the (NPW) net present value of the cash flow is zero.

DCFRR ↑ = the more profitable the project.

2- Sensitivity Analysis:

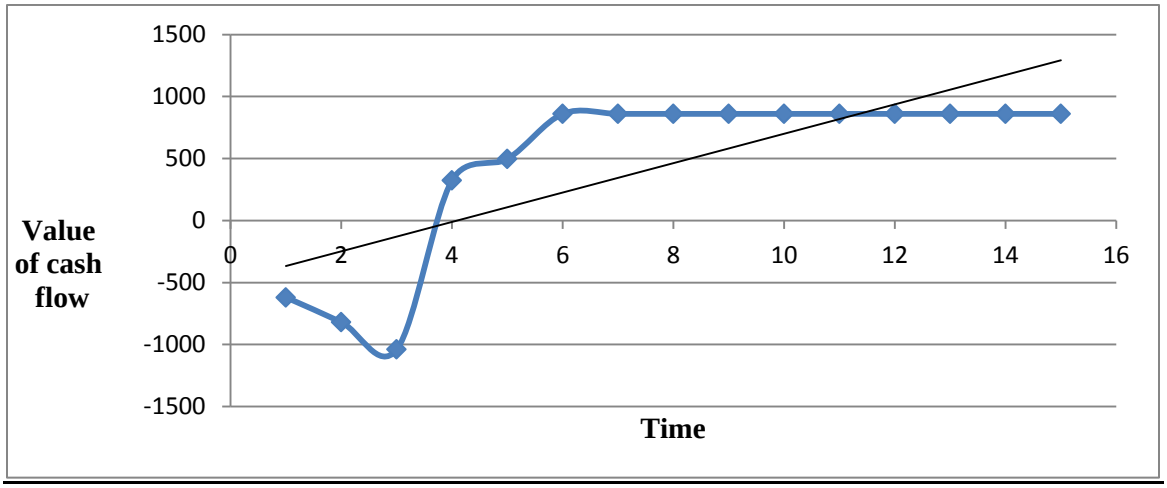
- It is an analysis method to study the change is selling price and its effect on the project to be accepted or not.

(ii)We will have to calculate the net cash flow each year, so we will multiply the selling price by the volume of sales to get sales in EGP, and then subtract both investment and operating costs from it.

Year	1	2	3	4	5	6 - 15
Construction Costs (EGP 1000)	-600	-800	-1000	-	-	-
Operating Costs (EGP 1000)	-20	-20	-40	-60	-80	-100

Volume of Sales (1000 Tons)	-	-	-	32	48	80
Volume of Sales (EGP 1000)	-	-	-	384	576	960
Net Cash Flow	-620	-820	-1040	324	496	860

The non cumulative cash non discounted cash flow can be drawn as follows:



Studying the project performance evaluation by DCFRR method is as follows:

Using the discounted cash flow rate of return technique:

$0 = -620/(1+i) + -820/(1+i)^2 + -1040/(1+i)^3 + 324/(1+i)^4 + 496/(1+i)^5 + 860 * [((1+i)^{10} – 1)/ i (1+i)^{10}] * 1/ (1+i)^5$

By trial and error, DCFRR = 21.7%
Since that MARR (15%) is less than the DCFRR (21.7%), therefore the project is feasible.

Testing the sensitivity:

Here we will resolve using the same procedure but based on the new selling price which is EGP 10 per ton, operating costs are increased by 10% and the construction costs are increased by 10% percent.

Year	1	2	3	4	5	6 - 15
Construction Costs (EGP 1000)	-660	-880	-1100	-	-	-
Operating Costs (EGP 1000)	-22	-22	-44	-66	-88	-110
Volume of Sales (1000 Tons)	-	-	-	32	48	80
Volume of Sales (EGP 1000)	-	-	-	320	480	800
Net Cash Flow	-682	-902	-1144	254	392	690

By trial and error, the value of the DCFRR is = , and as this value is compared to the given MARR, the project is .

Question 3

(i) Write important technical points on the followings:

(a) Stocks market (b) Added Value

(c) Corporation (d) Cost Index

Solution:

Added value:

Added value is defined as the difference between the value of the product and the value of what it takes to produce it from raw materials, auxiliaries, chemicals added and so on.

It is used to judge on the industrial efficiency.

Stocks market:

It is the place where we buy and sell the stocks after the company produce it.

The stock market produces daily a bulletin containing the prices of stocks so that you can compare between what happened yesterday and today.

Corporation:

It does not belong to a certain owner but its ownership would be divided into shares of stocks.

Advantage:

- limited liability to stock holders
- perpetual life
- ease of transferring ownership
- ease of expansion

Disadvantage:

- government regulation
- capital stock tax

Cost index:

As the value of money changes with time, what cost x the last year would probably cost more than x this year.

Cost index is used to obtain the price of certain item at the present time by knowing its price before

3) (ii) A Power Plant for generating electricity is one part of a plant design proposal . 2 alternative power plants have been suggested one uses a boiler and steam turbine while the other uses a gas turbine

The following information applies to the two proposals:

	Boiler & steam turbine	Gas turbine
Initial investment	EGP 2,000,000	EGP1,500,000
Fuel costs per year	60,000	90,000
Maintenance and repairs , per year	40,000	60,000
Insurance and taxes , per year	66,000	45,000

Service life , year	25	18
Salvage value at end of service life	0	0

All the costs are the same for either type of power plant A 10 percent return is required on any investment if one of these 2 power plants must be accepted , which one should be recommended

Solution:

R.O.I.I = 10%

Annual additional investment = 2,000,000 -1,500,000 = 500,000

Annual saving:

- Fuel = 90,000 - 60,000 = 30,000
- Maintenance = 60,000- 40,000 = 20,000
- Insurance & taxes = 45,000-66,000 = -21,000
- Deprecation) $_{\text{if st. line method}}$ = (1,500,000/18) – (2,000,000/25) = 3333.33

Annual savings = 30,000 + 20,000 -21,000 + 3333.33 = EGP 32,333

R.O.I.I = (annual savings /annual additional investment) *100

= (32,333/500,000)*100= 6.466 <10 %

Using of gas turbine will be profitable

Question 4: (Important)

A-Optimum economic design could be based on condition giving the least cost per unit of time or the maximum profit per unit of production.

Explain briefly general procedures for determining optimum conditions in one variable and two variables analytically and graphically

B-Sea water is pumped through 61.0 meters line at 0.088m3\s the power requirements being given by: $w=6.89\ v^3/d^5$ KW where : v= volumetric flow rate , m^3/s, d= pipe diameter (m), knowing that the facility operates 24 hours a day and 365 days in a year

a) What is the optimum pipe diameter using mild steel and stainless steel giving minimum total cost/ year?
b) Which material would be specified if a 22% return on capital is acceptable?

Data	Mild steel	Stainless steel
Cost of piping , EGP/m	$8.04\ d^{0.6}$	$14.7d^{0.6}$
service life, years	4	10
Purchased cost of piping, EGP	A	B
Installed cost , EGP	A+1500	B+3000
Maintenance cost , EGP/year	A	0.06b
Cost of electricity ,EGP/KWH	0.005	0.005

Solution:

Operating cost:

Electricity cost per year = $(6.89\ v^3/d^5) * 24 * 365 * 0.005 = \$\ 301.8\ v^3/d^5$ / yr = EGP $(0.2057 / d^5)$/ yr

Purchased cost of piping:

For mild steel, $A = 8.04\ d^{0.6} * 61 = 490.44\ d^{0.6}$
For stainless steel, $B = 14.7d^{0.6} * 61 = 896.7\ d^{0.6}$

Fixed cost:

Maintenance:

For mild steel, $490.44\ d^{0.6}$

For stainless steel, $0.06\ B = 53.8\ d^{0.6}$

Depreciation:

For mild steel, $(490.44\ d^{0.6} + 1500) / 4 = 122.61\ d^{0.6} + 375$

For stainless steel, $(896.7\ d^{0.6} + 3000) / 10 = 89.67\ d^{0.6} + 300$

Total cost = operating cost + Fixed cost

Optimum diameter occurs at [d (total cost) / d (d)] = 0

For mild steel $d = 0.34$ m

For stainless steel $d = 0.392$ m

To compare between them:

We will just substitute by the optimum diameters and get all the costs and the additional investment and calculate the ROII as follows:

	Mild steel (d = 0.34)	Stainless steel (d = 0.392)
Installed cost	1757	3511
Electricity	45	22
Maintenance	257	30.7
Depreciation	439	351
Total cost / yr	741	404

ROII = $\frac{(741-404)}{(3511-1757)}$ = 0.192 = 19.2 %, mild steel is recommended

June 2005

1) The total capital investment for a conventional chemical plant is $1,500,000 and the plant produces 3 million kg of product annually. The selling price of the product is $0.99/kg. Working capital amounts to 15% of the total capital investment. The investment is from company funds and no interest is charged. Raw materials costs for product are $0.09/Kg, labor $0.08/Kg, utilities $0.05/Kg, and packaging $0.08/Kg. Distribution costs are 5% of the total product cost. Plant-overhead costs amount to 60% of the cost for operating labor, supervision, and maintenance. Estimate the following:
   i. Manufacturing cost per kilogram of product.
   ii. Total product cost per year.
   iii. Profit per Kilogram of product before taxes.

Answer:

T.C.I=F.C.I+W.C.I=$1,500,000

Plant produces →3 million Kg/year

Selling price of product =$0.99/Kg

W.C.I=15%* T.C.I= (0.15)*(1,500,000) =$225,000 and interest is neglected

Raw material=$0.09,Labor=$0.08/Kg, Utilities=$0.05/Kg, Packaging=$0.08/Kg.

Sales Distribution costs =5% * T.P.C

Plant overheads=60% [labor cost + supervision + maintenance]

Since: T.C.I=F.C.I+W.C.I then 1,500,000= F.C.I+225,000

F.C.I=$1,275,000/year

P.C=D.P.C+I.P.C

where D.P.C= Fixed cost + Variable cost

Variable cost= Raw material + Miscellaneous materials (10% Maintenance) + Utilities + Packaging

where

Maintenance= (5-10) % * F.C.I, Take it 7%

= $89,250/year =89250/ ($3*10^6$)

=$0.02975

Therefore;

Variable cost =[0.09+0.02975+0.05+0.008]=$0.17775/Kg

Fixed cost= Labor cost + Supervision + Maintenance+ Plant overheads +Rent + Royalty Insurance + Depreciation.

Where,

Supervision=20% Labor cost= $0.016/Kg.

Plant overheads = 0.6 (0.08 + 0.016 + 0.02975) = $0.07545

Royalty =0 as he said in problem it is a conventional plant (means not new idea with royalty)

Insurance =1% F.C.I=12750/3*10^6=$0.00425/Kg

Deprecation=15% F.C.I=191250/3*10^6=$0.06375/Kg.

Therefore,

Fixed cost=$0.2692/Kg

D.P.C= manufacturing cost 0.17775+0.2692= $0.447/Kg

TPC = 1.2 * 0.447 = $0.5364/kg

Total Product Cost per Year= 0.5364 *(3*10^6) =$1609200/year

Profit “before taxes”/kg = 0.08 – 0.5364 = $0.043/kg

2)

i. Write short notes on each of the following:
   i. Stock Markets.
   ii. Corporations.
   iii. Characteristics of Chemical Processes.
   iv. Planning of management functions.

Solution:

1. **Stock Markets:**

   They are the places where we buy and sell the stocks after the company produces it ,

   There are two markets for the money:

   A] Production market: it is the market where the stocks are dealt through the producer of it like a bank or a company.

   B] Trading market: the market where we deal the stocks after buying it from the main source.

2. **Corporations:**

   It is an association that doesn't belong to a certain owner or some but its ownership is divided to stocks and shares

   Advantages:

   a] perpetual life ,b] limited liability to stockholders, c] ease of transferring ownership, d]ease of expansion, e] applicability to all sizes of firms .

   Disadvantages:

   a] governmental regulations, b] capital stock tax, c] expense of organization

3. Characteristics of Chemical Processes:

a) Rapid changes in products and processes.

b) High rate of depreciation.

c) Large capital requirements.

d) Use of standardized unit processes to produce a wide variety of products.

e) Active research programs to cut cost and find new products.

F) Expansion is not limited by existing markets.

g) Chemical industry is the largest consumer of power, water and naturally of chemicals.

h) Hazards of pollution.

I) Requires skilled labor.

4. Planning of management functions:

Planning involves selecting objectives, strategies and policies for either the whole enterprise or for an organization part of it. Planning is all about decisions making since it involves selecting from alternatives, all managers plan to the work of the units that are under their responsibilities.

ii. (Important) A process for sulphonation of phenol requires the use of a 3000 gal Kettle. It is desired to determine the most suitable material of construction for this vessel. The time value of money is to be taken into account by use of an interest rate of 10%. The life of the kettle is calculated by dividing the corrosion allowance of $\frac{1}{8}$ in. by the estimated corrosion rate. The equipment is assumed to have a salvage value of 10% of its original cost at the end of its useful life. For the case in question, corrosion data indicate that only a few corrosion resistant alloys will be suitable.

Vessel Type	Installed Cost, $	Average Corrosion Rate, in/yr
Nickel Clad	80,000	0.02
Monel Clad	95,000	0.01
Hastelloy B (Ni Alloy)	180,000	0.0045

Determine which material of construction should be used with appropriate justification for the selection.

Answer:

R.O.I.I)$_{given}$=10%

Vessel Type	Installed Cost, $	Average Corrosion Rate, in/yr	No. of years =(1/8)in*(1/rate)yr/in	Salvage value	Depreciation
Nickel Clad	80,000	0.02	(1/8)/0.02= 6.25 yr	$8000	$11520
Monel Clad	95,000	0.01	(1/8)/0.01= 12.5 yr	$9500	$6840

Hastelloy B (Ni Alloy)	180,000	0.0045	(1/8)/0.0045= 27.8 yr	$18000	$5827.34

Nickel clad vs. Monel Clad :

R.O.I.I = (annual savings/additional investment)*100 %=(11520 - 6840)/ (95000-80000)

=31.2%

R.O.I.I = 31.2 % >10% then Monel is better than nickel.

Monel Clad vs. Hastelloy B (Ni Alloy):

R.O.I.I = annual savings/additional investment*100%= (6840 – 5827.34)/18000-95000)

=1.2%

R.O.I.I = 1.2 % <10% **then Monel is the preferred one than both materials**

3) (important) A plant produces blowers at the rate of S units/day. The variable costs per blower have been found to be EGP 50 + 0.15S. The total daily fixed charges are EGP 2000 and all other expenses are constant at EGP 8000 per day. If the selling price per blower is EGP 225, determine:

   i. The daily profit at a production schedule giving the minimum cost per blower.
   ii. The daily profit at a production schedule giving the maximum daily profit.
   iii. The production schedule at the break-even point.

Solution:

Variable cost per blower = 50+0.15*S

Total variable cost= (50+0.15S)*S= 50S+0.15S^2/day

a) Minimum cost per blower:

$$\frac{\mathrm{d}(\text{variable cost})}{\mathrm{dS}} = 0$$

$$\frac{\mathrm{d}(50S + 0.15S^2 + 10000/S)}{\mathrm{dS}} = 0$$

$$50 + 0.3S + \frac{-10{,}000}{S^2} = 0$$

$$50S^2 + 0.3S^3 - 10{,}000 = 0$$

$$S_{\min} = \text{units/day}$$

b) Maximum daily profit:

Profit=Sales-Fixed cost-Variable cost

Profit= (225*S) -10,000 - (50S+0.15S^2)

$$\frac{d(\text{Profit})}{dS} = 0$$

$$\frac{d(-0.15S^2 + 175S - 10{,}000)}{dS} = 0$$

$$-0.3S + 175 = 0$$

$$S_{max} = 583.33 \text{ units/day}$$

Maximum profit = 584 * (225) -10,000 – 50*584 - 0.15 *584^2 = $41,042

c) Break-even point

Profit= sales-fixed cost-variable cost

$$0 = 225 * S - 10000 - (50S + 0.15S^2)$$

S = 60.25 = 61 units/day (first BEP)

$S = 1106.41 \text{ units/day}$ = 1107 units/day (units must be a whole digit number) (second BEP)

The values seem not logical somehow, right? , but if we understand the problem, we can see that there is some logic in it!, lets analyze it using numbers and see what does each value mean

- First the BEP occurs at 1107 and maximum profit occurs at 583, which means that I achieved maximum profit at 583 then the profit starts to decrease till I reached 1107, then I started to lose
- If we tried the least value of s which is zero, no production, p = -10,000, because we still pay the fixed charges
- So there is other BEP which gives me the minimum S which I have to produce to get over the value of fixed charges which is 10,000 and there is second BEP which gives me the maximum S that I can produce before I start to lose because the effect of S^2 starts to appear strongly where the variable costs increases exponentially fast

- The two BEP could be calculated from the last equation as it has two roots

Can you draw a curve that describes the shape of the profit with S?

4) (important) For the following project under study for the production of a product for detergents:

   i. The construction of the project will be completed in 3 years. The project needs 5 years from the start till the full capacity stage (6th year till 15th year).

   ii. Data about the construction costs, operating costs and values of sales during installation and operation stages are:

Year	Construction Costs (EGP 1000)	Operating Costs (EGP 1000)	Volume of Sales (1000 tons)
1	600	20	-
2	800	20	-
3	1000	40	-
4	-	60	32
5	-	80	48
6 - 15	-	100	80

   iii. Suggested selling price EGP 12 per ton, and the average interest cost is 15%.

   Required:

   i) Draw the cash flow diagram of this project.

   ii) Project performance evaluation by DCFRR method.

   iii) Testing project sensitivity if the selling price is decreased from EGP 12 to EGP 10 per ton, and the operating costs are increased by 5% while the construction costs are increased by 8%.

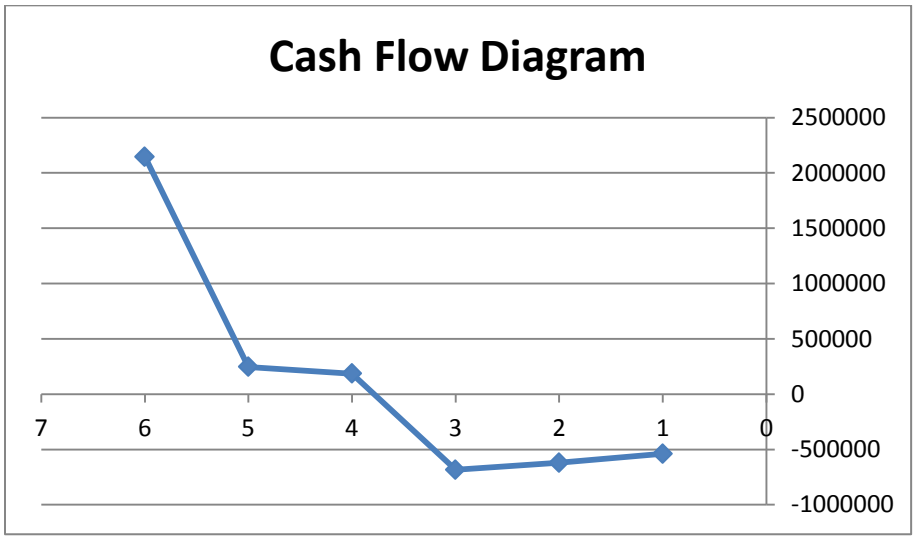
Solution:

Interest Rate= 15%=0.15

1st case: selling price= EGP 12

Yr	Construction Cost (EGP 1000)	Operating Cost (EGP 1000)	Sales (EGP 1000)	Cash flow EGP 1000	Present Value
1	600	20	-	$-620/(1+i)^1$	- 539 130
2	800	20	-	$-820/(1+i)^2$	- 620 038
3	1000	40	-	$-1040/(1+i)^3$	- 683 819
4	-	60	32(12)=384	$(384-60)/(1+i)^4$	185 248
5	-	80	48(12)=576	$(576-80)/(1+i)^5$	246 600
6-15	-	100	80(12)=960	$(960-100)*((1+i)^{10}-1)/(i*(1+i)^{10}))/(1+i)^5$	2 145 885
-	-	-	-	NPV=	734 746

(i) Cash flow diagram (discounted, non cumulative)



Note : the chart should be completed to year 15

(ii) Put NPV=0:

$-620/(1+i)^1 -820/(1+i)^2 -1040/(1+i)^3 + (384-60)/(1+i)^4 + (576-80)/(1+i)^5+(960-100)*((1+i)^{10}-1)/(i*(1+i)^{10}))/(1+i)^5=0$

Multiply both sides by $(1+i)^5$

$=> -620*(1+i)^4 -820*(1+i)^3 -1040*(1+i)^2 + (384-60)*(1+i)^1 + (576-80)+(960-100)*((1+i)^{10}-1)/(i*(1+i)^{10}))=0$

By trail & error: DCFRR= 21.323%

Note that IRR<DCFRR => the project is justified

(iii) 2nd case:

- 8% increase in construction cost
- 5% increase in operating cost
- Selling price is reduced to EGP 10

Yr	Construction Cost (EGP 1000)	Operating Cost (EGP 1000)	Sales (EGP 1000)	Cash flow	Present Value
1	648	21	-	$-669/(1+i)^1$	- 581 739
2	864	21	-	$-885/(1+i)^2$	- 669 187
3	1080	42	-	$-1122/(1+i)^3$	- 737 733
4	-	63	32(10)=320	$(320-63)/(1+i)^4$	146 941
5	-	84	48(10)=480	$(480-84)/(1+i)^5$	196 882
6-15	-	105	80(10)=800	$(800-105)*((1+i)^{10}-1)/(i*(1+i)^{10}))/(1+i)^5$	1 734 174
-	-	-	-	NPV=	89 338

Put NPV=0:

$=> -669*(1+i)^4 -885*(1+i)^3 -1122*(1+i)^2 + (320-63)*(1+i)^1 + (480-84)+ (800-105)*((1+i)^{10}-1)/(i*(1+i)^{10}))=0$

By trail & error: DCFRR=15.8%

Note that IRR<DCFRR but the difference is very narrow and so the project in case 2 is still justified but less than in case 1

5) A company has two alternative investments which are being considered. Company policies based on the current economic situation dictate a minimum annual return on the original investment of 15% after taxes must be predicted for any unnecessary investment. Company policies also dictate that, where applicable, straight-line depreciation is used and, for time-value of money interpretation, end of year and profit analysis is used. Land value and prestart-up costs can be ignored. Given the following data:

Investment no.	**I_f, \$**	**I_{rv}, \$**	**Salvage value, \$**	**Service life, years**	**Annual cash flow after taxes, \$**	**Annual cash expenses, constant for each year, \$**
1	200,000	15,000	18,000	7	60,000 Constant	32,000
2	250,000	20,000	25,000	8	65,000 Constant	25,000

Determine and comment which investment, if any, should be made by alternative-analysis profitability-evaluation methods of:

i) Rate of return on investment.
ii) Payout period.
iii) Net present worth (NPW) at i=15%.
iv) Capitalized cost at i=12%.

Solution:

i. ROII) $_{given}$ = 15%

Depreciation for case (1):

$D_1 = \frac{200,000-18,000}{7}$ = $26,000

Depreciation for case (2):

$D_2 = \frac{250,000-25,000}{8}$ = $28,125

For case (1): Annual Savings = Annual Cash flow-depreciation

= 60,000-26,000 = $34,000

For case (2): Annual Savings = Annual Cash flow-depreciation

= 65,000-28,125 = $36,875

Since,

ROII = $\frac{Savings}{Additional\ Investment} * 100$

ROII = $\frac{36,875-34,000}{(20,000+250,000)-(200,000+15,000)} * 100$ = 5.23% < 15%

∴ Case (1) is more economically profitable.

ii. Payout Period = $\frac{\text{Depreciable fixed capital investment}}{\frac{\text{Average profit}}{\text{year}}+\frac{\text{Average depreciation}}{\text{year}}}$

Depreciable fixed capital investment = Fixed capital investment – salvage value

For Case (1):

Payout Period = $\frac{200,000-18,000}{34,000+26,000}$ = 3.033 years

For Case (2):

Payout Period = $\frac{250{,}000-25{,}000}{65000}$ = 3.46 years

∴ Investment (1) is more economically recommended.

iii. For case (1):

NPW = -200,000 – 15,000 + 60,000[$(1.15)^{-1}$ + $(1.15)^{-2}$ + $(1.15)^{-3}$ + $(1.15)^{-4}$ + $(1.15)^{-5}$ + $(1.15)^{-6}$ + $(1.15)^{-7}$] + (18,000+15,000) $(1.15)^{-7}$

NPW = $47,031.1

For case (2):

NPW = -200,000 – 15,000 + 65,000[$(1.15)^{-1}$ + $(1.15)^{-2}$ + $(1.15)^{-3}$ + $(1.15)^{-4}$ + $(1.15)^{-5}$ + $(1.15)^{-6}$ + $(1.15)^{-7}$ + $(1.15)^{-8}$] + (25,000 + 20,000) $(1.15)^{-8}$

NPW = $91386.477

I. Capitalized Cost for the first investment = 12%

- Capitalized Cost = (F.C – W.C)× $\frac{(1+i)^{n}}{(1+i)^{n}-1}$ + W.C + VS + $\frac{Annual\ Cash\ expenses}{i}$
- Investment No.1;

  Capitalized Cost = (200000 – 15000) × $\frac{(1+0.12)^{7}}{(1+0.12)^{7}-1}$ +15000 + 18000 + $\frac{32000}{0.12}$

  = $ 637.47 * 10^3
- Investment No.2 ;

  Capitalized Cost = (250000 – 20000) × $\frac{(1+0.12)^{8}}{(1+0.12)^{8}-1}$ +20000 + 25000 + $\frac{25000}{0.12}$

  = $ 639.16 * 10^3

Therefore alternative 1 is recommended

June 2006

Question 1:

i. A process plant making 2000 tons per year of a product selling for $0.8 per lb has annual variable costs of $2 million at 100% capacity and other fixed costs of $700,000. What is the fixed cost per pound at the break-even point? If the selling price of the product is increased by 10%, what is the dollar increase in net profit at full capacity if the income tax rate is 20% of gross earnings (1ton=2000 lbs).

Solution

Product; 2000 ton/year = 4,000,000 lb/year;

Selling price = $0.8/lb;

Variable costs = $2,000,000;

Fixed costs = $700,000;

Profit = sales - fixed costs - variable costs;

Let the capacity of production as percentage from total = X;

At the breakeven point:

0.8 * 4,000,000* X – 2,000,000 * X - 700,000 = 0;

X = 0.583 = 58.3%

Fixed cost per Lb at BEP = (700,000) / (0.583 * 400,000) = $3 / Lb product

Profit at full capacity:

Profit = (4000000) * (0.8) - (2000000) - (700,000) = $500,000

Net profit = profit - income tax = 500,000 - 100,000 = $400,000

Profit at full capacity and the selling price of the product is increased by 10%:

New selling price = 1.1 * 0.8 = $0.88;

Profit = (0.88) * (4000000) - (2000000) - (700,000) = $820,000;

Net profit = 820,000 - 164,000 = $656,000;

The dollar increase in net profit = 656,000 - 400,000 = $256,000

ii. The original investment for an asset was EGP 10,000 and the asset was assumed to have a service life of 12 years with EGP 2000 salvage value at the end of the service life. After the asset has been in use for 5 years, the remaining service life and final salvage value are estimated at 10 years and EGP 1000, respectively. Under these conditions, what is the depreciation cost during the sixth year of the total life if straight line depreciation is used?

Solution

Original investment = EGP 10,000;
Service life = 12 years;
Salvage value = EGP 2000;
Depreciation during 1st 5 years = (5) * ((10,000 – 2000) / 12) = EGP 3333.33
Depreciation cost during the 6th year of the total life = ((10,000 – 3333.33 – 1000) / 10) = $566.67

Question 2

i. Write short notes on each of the following:

(a) Stocks market

It is the place where we buy and sell the stocks after the company produces it. There are two markets for the money, Production market; which is the market where it is dealt with it for the first time through the side which produces the stock; it might be a company or a bank. And circulation market which is the market where we deal with it after buying the stocks.
The stocks market produces daily handout containing the prices of stocks so that you can compare between what happened yesterday and today.

(b) Added-value

Added value is defined as the difference between the value of the product and the value of what it takes to produce it from raw materials, auxiliaries (water and electricity), chemicals added and so on and it is used to judge on the industrial efficiency.

(c) Partnership

A partnership is usually defined as an association of two or more persons to carry on as co-owners of a business for profit.

Advantages

- Ease of organization
- Combined talents, judgments and skills
- Larger capital available to the firm
- Tax advantages

Disadvantages

- Unlimited liability
- Limited life
- Divided authority
- Danger of disagreement

(d) Capitalized cost

The capitalized cost is defined as the original cost of the equipment plus the present value of the renewable perpetuity.

$$K = CV + \frac{C_R}{(1+i)^n - 1}$$

(e) Planning in management functions

Planning first is based on identifying the targets then choosing the systems and ways of working planning is mainly taking decisions as you have to choose between the all possible alternatives. The planning responsibility can't be de attached from the work of the other managers where all managers plan to the work of the units that are under their responsibilities.

ii. A process for sulfonation of phenol requires the use of a good kettle. It is desired to determine the most suitable material of construction for this vessel .The time value of money is to be taken into account by use of an interest rate of 10%. The life of the kettle is calculated by dividing the corrosion allowance of $\frac{1}{8}$ inch by the estimated corrosion rate.The equipment is assumed to have a salvage value of 10% of its original cost at the end of its useful life.For the case in question, corrosion data indicate that only a few corrosion resistant alloys will be suitable.

Vessel type	Installed cost	Average corrosion rate, In/yr.
Nickel clad	$ 80,000	0.02
Monel clad	$ 95,000	0.01
Mastelloy (Ni alloy)	$ 180,000	0.0045

Determine which material of construction should be used with appropriate justification of selection.

Solution

Service life = $\frac{\frac{1}{8}"}{\text{corrosin rate}}$;

Salvage value = 10% (installed cost)

Depreciation= $\frac{\text{installed cost} - \text{salvage value}}{\text{service life}}$

Vessel type	Installed cost	depreciation	Service life
Nickel (1)	$80,000	$\frac{80,000-(0.1)(80,000)}{6.25}$ = $11520	(1/8) / 0.02 = 6.25
Monel (2)	$95,000	$\frac{95,000-(0.1)(95,000)}{12.5}$ = $6840	(1/8) / 0.01 = 12.5
Mastelloy (3)	$180,000	$\frac{180,000-(0.1)(180,000)}{27.77}$ = $5833.6	(1/8) / 0.0045 = 27.77

Comparing alternative (2) with alternative (1)

ROII = $\frac{\text{annual savings}}{\text{additional investment}}$ * (100) %

ROII = $\frac{(11520-6840)}{(95,000-80,000)}$ = 0.312 * 100 = 31.2 % > 10 %

Therefore; alternative (2) is accepted.

Comparing alternative (2) with alternative (3)

ROII = $\frac{(6840-5833.6)}{(180,000-95,000)}$ = 0.01184 * 100 = 1.184 % < 10 %

Therefore; Alternative (3) is refused.

Alternative (2) is accepted and optimum material of construction is "monel clad".

Question 3

Determine the optimum economic thickness of insulation that should be used under the following conditions: saturated steam is being passed continuously through a steel pipe with an outside diameter of 16 inches. The temperature of steam is 400 ˚F and the steam is valued at $1 per 100 lb. The pipe is to be insulated with a material that has a thermal conductivity of 0.02 Btu\hr.ft2 (˚E/ft).the cost of the installed insulation per foot of pipe length is $9*X, where X is the thickness of the insulation inches. Annual fixed charges including maintenance amount to 20% of the initial installed cost. The total length of the pipe is 500 ft, and the average temperature of the surroundings may be taken as 70˚F.Heat transfer resistance due to the steam film, Scale and pipe wall are negligible. The air-film coefficient at the outside of the insulation may be assumed constant at 2 Btu\hr.ft2˚F for all insulation thickness-heat capacity of steam at these conditions = 826 Btu\lb.

Question 4:

For the following project;

1-The construction of project will be completed in 3 years. The project needs five years from the start till the full capacity at age (6th year till 15th year).

2-Data about the construction costs, operating costs and volume of sales during installation and operation at ages are:

Year	Construction costs (EGP 1000)	Operating Costs (EGP 1000)	Volume of sales (1000 tons)
1	600	20	—
2	800	20	—
3	1000	40	—
4	—	60	32
5	—	80	48
6-15	—	100	80

3-Suggested selling price EGP 15 per ton, and the average interest cost is 15%.

Required:

i) Draw the cash flow diagram of this project.

ii) Project performance evaluation by TRR method

.

Solution

i) First we multiply the volume of sales which is in tons by the selling price which equals EGP 15 per ton to get the sales cash flow.

year	construction cost(EGP)	operating cost(EGP)	Volume of sales (tons)	sales(EGP)
1	600000	20000	0	0
2	800000	20000	0	0
3	1000000	40000	0	0
4	0	60000	32000	480000
5	0	80000	48000	720000
6	0	100000	80000	1200000
7	0	100000	80000	1200000
8	0	100000	80000	1200000
9	0	100000	80000	1200000
10	0	100000	80000	1200000
11	0	100000	80000	1200000
12	0	100000	80000	1200000
13	0	100000	80000	1200000
14	0	100000	80000	1200000
15	0	100000	80000	1200000

Second we calculate the net cash flow by subtracting the construction cost and the operating cost from the sales:

Net cash flow = sales – (construction cost + operating cost)

year	construction cost(EGP)	operating cost(EGP)	sales(EGP)	Net
1	600000	20000	0	-620000
2	800000	20000	0	-820000
3	1000000	40000	0	-1040000
4	0	60000	480000	420000
5	0	80000	720000	640000
6	0	100000	1200000	1100000
7	0	100000	1200000	1100000
8	0	100000	1200000	1100000
9	0	100000	1200000	1100000
10	0	100000	1200000	1100000
11	0	100000	1200000	1100000
12	0	100000	1200000	1100000
13	0	100000	1200000	1100000
14	0	100000	1200000	1100000
15	0	100000	1200000	1100000

Third we calculate the NPV by using this law:

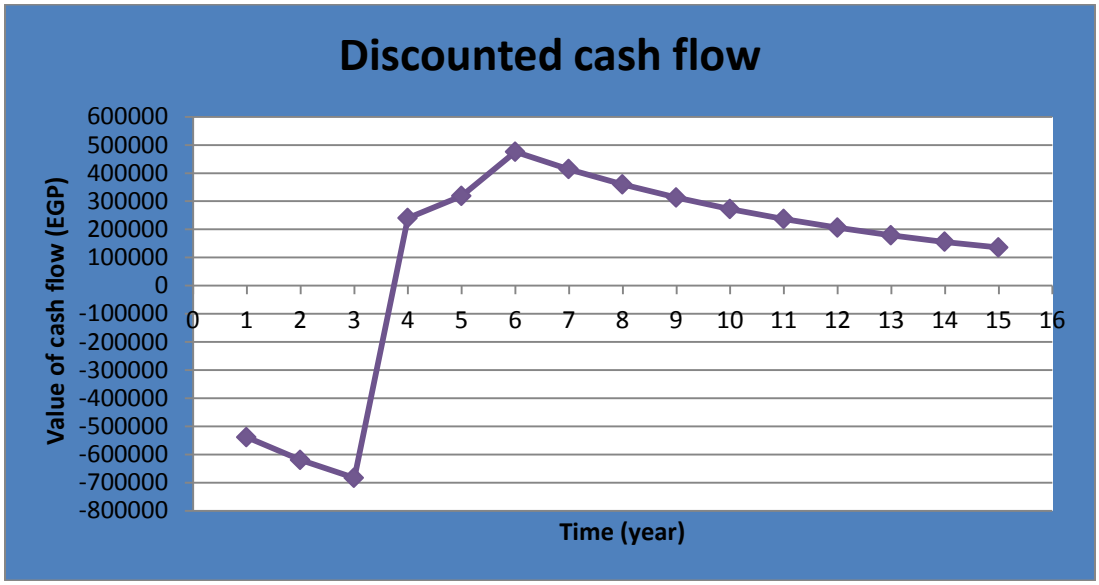
$NPV = \Sigma CF_n / (1 + i)^n$
Where

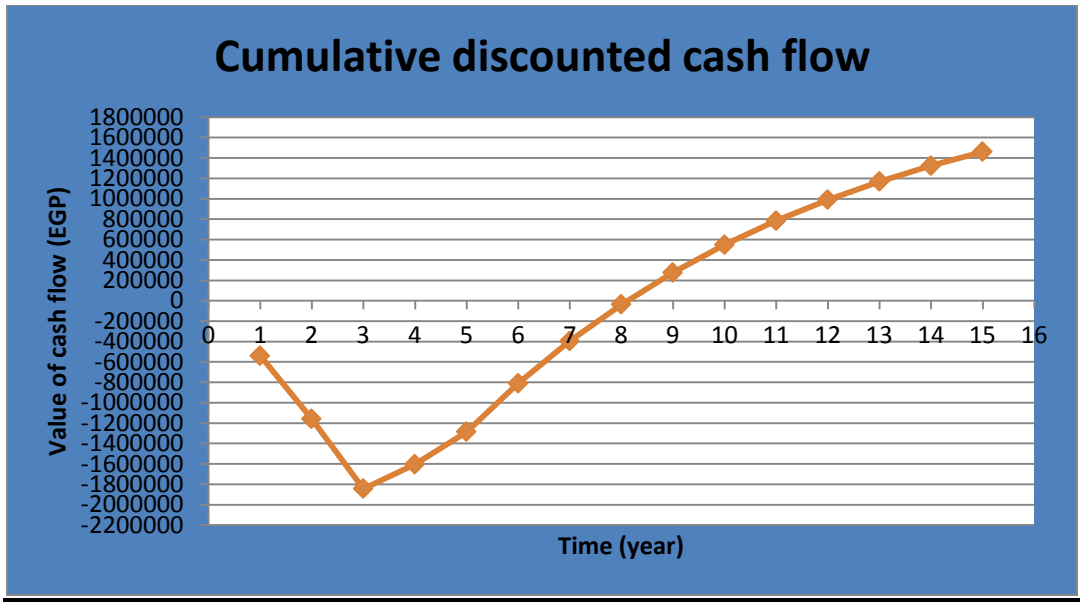
- NPV = Net Present Value
- CF_n = the cash flow in period n
- i = the discount rate=15 %

Year	Net	Cash flow	NPV	Cumulative Value
1	-620000	$-620000/(1+i)^1$	-539130.43	-539130
2	-820000	$-820000/(1+i)^2$	-620037.81	-1159168
3	-1040000	$-1040000/(1+i)^3$	-683816.88	-1842985
4	420000	$-420000/(1+i)^4$	240136.363	-1602849
5	640000	$640000/(1+i)^5$	318193.111	-1284656
6	1100000	$1100000/(1+i)^6$	475560.356	-809095
7	1100000	$1100000/(1+i)^7$	413530.744	-395565

8	1100000	$1100000/(1+i)^8$	359591.951	-35972.6
9	1100000	$1100000/(1+i)^9$	312688.653	276716.1
10	1100000	$1100000/(1+i)^{10}$	271903.177	548619.2
11	1100000	$1100000/(1+i)^{11}$	236437.545	785056.8
12	1100000	$1100000/(1+i)^{12}$	205597.865	990654.6
13	1100000	$1100000/(1+i)^{13}$	178780.752	1169435
14	1100000	$1100000/(1+i)^{14}$	155461.524	1324897
15	1100000	$1100000/(1+i)^{15}$	135183.934	1460081

Fourth we draw the cash flow diagram of the project between the NPV and time in years and between cumulative value and time in years





ii) At TRR; the NPV = 0, and if rate of return i is > TRR…..this means loss and if rate of return is < TRR… this means profit
So what we will do is that we will calculate TRR and compare it with rate of return given and see whether the project gains or losses.

NPW = $620000 / (1+i)^1 + 820000 / (1+i)^2 + 1040000 / (1+i)^3 + 420000 (1+i)^4 +$

$640000 / (1+i)^5 + 1100000 [(1+i)^{10}-1) / (i (1+i)^{10}] (1+i)^5 = 0$

Using trial and error;

i	NPW
0.1	2858.387602
0.11	2516.417683
0.12	2209.246031
0.13	1932.997527
0.14	1684.27198
0.15	1460.080851
0.16	1257.793033
0.17	1075.088313
0.18	909.917349

So i which = 0 is i≈0.26

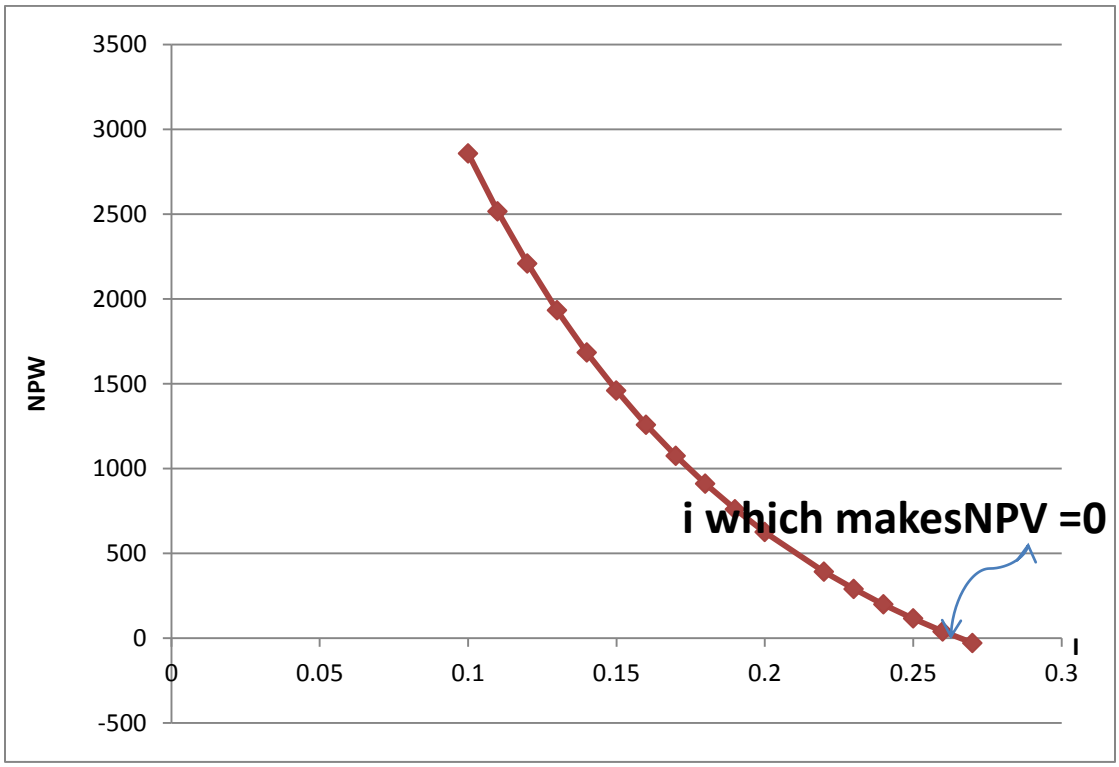
0.19	760.4671906
0.2	625.1315322
0.22	391.2608816
0.23	290.3318368
0.24	198.6931123
0.25	115.4479628
0.26	39.79493808
0.27	-28.98320837

makes this NPV (26%)

As seen in the next chart the value of the TRR is as follows:

TRR= 26.565 %

Since that the rate of return is 15 % and less than the TRR, the project is justified.



Question 5 (important)

i. A company has 2 alternatives which are being considered. Company policies dictate that a minimum annual return on the original investment of 15% after taxes must be predicted given the following data should be made by alternative analysis.

Profitability-evaluation methods of:

(a) Rate of return on initial investment

(b) Minimum payout period with no interest charge

(c) Net present worth (at i=15%)

(d) Capitalized cost (at i=15%)

Invest Number	If,$	Iw,$	Salvage value,$	Service life, years	Annual cash flow,$	Annual cash expanses,$
1	180,000	12,000	16,000	8	55,000	30,000
2	225,000	20,000	25,000	8	60,000	22,000

Solution

First we will calculate the Depreciation charges for both where:

D1= $\frac{180,000-16,000}{8}$ = 20,500 D2 = $\frac{225000-25000}{8}$ = 25,000

First we have to see if alternative 1 is valid or not and this is done by calculating ROI for alternative 1

ROI = $\frac{profit}{total\ investment}$ = $\frac{55,000-20,500}{192,000}$ = 0.179 = 17.9 %

Therefore alternative 1 is valid and now we will start comparing alternative 2 to 1 as follows:

ROII = $\frac{\text{annual savings}}{\text{additional cost}}$ = $\frac{\text{Net annual cash flow}-\text{depreciation}}{\text{total investment additional cost}}$

(a) $ROII_{1\text{-}2}$ = $\frac{(D1-D2)+(60,000-55,000)}{(225,000+20,000)-(180,000+12,000)}$ = 0.0094 = 0.94%

Therefore alternative 2 is refused and alternative 1 is chosen

(b) Min. payout $_1$ = $\frac{\text{fixed}}{\text{profit+depreciation}}$ = $\frac{180,000-16,000}{55,000}$ = 2.9 year

Min. payout $_2$ = $\frac{225,000-25,000}{60,000}$ = 3.33 year

N.B. Profit + depreciation = annual cash flow

Therefore alternative1 is accepted.

(c) Npw $_1$ = -180,000 - 12,000 + 55,000 * $\frac{(1+0.15)^8-1}{0.15(1.15)^8}$ + $\frac{12,000+16,000}{(1+0.15)^8}$ = EGP 63,955.9

Npw $_2$ = -245,000 + 60,000 * $\frac{(1.15)^8-1}{0.15(1.15)^8}$ + $\frac{20,000+25,000}{(1.15)^8}$ = EGP 38,949.87

Therefore 1 is accepted.

(d) Capitalized cost $_1$ = $\frac{180,000-16,000}{(1.15)^8-1}$ $(1.15)^8$ + 16,000 + $\frac{30,000}{0.15}$ + 12,000 = EGP 471649.4

Capitalized cost 2 = 200,000 $\frac{(1.15)^8}{(1.15)^8-1}$ + 25,000 + $\frac{22,000}{0.15}$ + 20,000 = EGP 488,800

Alternative 1 is chosen as it has lower capitalized cost.

ii. The following information applies to AZM company, Given date:

- Long term debt: EGP 3200
- Accounts payable: EGP 5000
- Cash in bank: EGP 10000
- Government bonds: EGP 12000
- Reserve for depreciation: EGP 1200
- Inventory: EGP 4000
- Debts due within one year: EGP 3000
- Machinery and equipment (at cost): EGP 40000
- Prepaid rent: EGP 600
- Social security taxes payable: EGP 680
- Reserve for expansion: EGP 2400
- Accounts receivable: EGP 6000

Determine the current ratio, cash ratio and working capital for company AZM at the given data.

Solution

Current assets = cash + government bonds + inventory + + accounts receivable = 10,000 + 12,000 + 4000 + 6000 = EGP 32000

Current liabilities = accounts payable + debts within 1 year + taxes = 5000 + 3000 + 680 = EGP 8680

Current ratio = $\frac{\text{current assets}}{\text{current liabilities}} = \frac{32,000}{8680} = 3.68$

Working capital = current assets - current liabilities = 32,000-8680 = EGP 23,320

Cash ratio= $\frac{\text{cash}}{\text{current liabilities}} = \frac{10,000+12,000}{8680} = 2.53$

June 2007

Question 1:

i- The total capital investment for a conventional chemical plant is $2000000 and the plant produce 3 million kg of a product annually. The selling price of the product is $1.5/kg. Working capital amounts to 15% of the total capital investment. Raw materials cost for the product is $0.1/kg, utilities$0.07/kg and packaging $0.008/kg. Labor costs $0.09/Kg.
Distribution costs are 5% of the total product cost. Plant overhead costs amount of 60% of the cost of operating labor, supervision and maintenance.

Estimate the following:

a- Manufacture cost per kg of product.
b- Total product cost per year.
c- Profit per kg of product before taxes.

Solution:

TCI = FCI+WCI

2,000,000 = FCI+0.15*2000, 000

FCI= $1,700,000

Variable cost= 0.1+0.07+0.008+ (0.1*0.08*1700000/3000000)

= $0.1825/kg

Fixed cost =0.09*(1+0.2) +
(1700000/3000000)*[0.15+0.01+0.08]+0.6*[(1.2*0.09)+0.08*1700000/3*10^6]=

$0.336/kg

a) Manufacturing cost = fixed cost+ variable cost

= 0.336+0.1825 = $0.5185/kg

b) Total production cost per kg = 1.2*(0.5185) = $0.6222/kg

Total production cost per year = 0.6222*3000000= $1866600

c) Profit per kg = 1.5-0.6222 = $0.8778/kg

ii- A power plant for generating electricity is one part of a plant design proposal. two alternatives power plants with necessary capacity have been suggested. One uses a boiler and steam turbine while the other uses a gas turbine. The following information applies to the two proposals:-

	Gas turbine	Boiler and steam turbine
Initial investment	$ 500,000	750,000
Fuel cost/yr	$ 26,000	18,000
Insurance	$ 17,000	24,000
Maintenance	$ 21,000	16,000
Service life	10	20
Salvage value	0	0
Depreciation	50,000	37,500

Where: Depreciation = (P+S)/N

Solution:

ROI I = (8000 – 7000 + 5000 + 12,500)/250,000 = 0.074 =7.4%

Since ROII is 7.4% < 10%, therefore the steam turbine is not accepted and Gas turbine is recommended

Question 2: (Important)

A plant is being designed in which 450,000 lb/day of caustic soda solution containing 5% by weight caustic soda must be concentrated to 40% by weight. A single effect or multiple effect evaporators will be used and a single effect evaporator of the required capacity requires an initial investment of $ 54,000. This same investment is required for each additional effect. The service life is estimated to be 10 years, and the salvage value of each effect at the end of the

service life is estimated to be $ 18,000. Fixed charges minus depreciation amount to 20% yearly based on the initial investment. Steam costs $ 1.8 per 1000 lb, and administration and labor costs are $ 120 per day, no matter how many evaporator effects are used. Where X is the number of evaporator effects, 0.9X is the amount of water evaporated / lb steam. There are 300 working days per year, 24 hours per day.

- If minimum ROII is 15%, how many effects are needed? (Alternative problem)
- How many effects should be used for giving the minimum total cost per year? (Optimization problem)

Solution for the alternative problem:

- Initial caustic = 0.05 * 450,000 = 22,500 lb /day
- The amount of caustic remains the same as only water evaporates, so the amount of caustic after evaporation is also 22,500 lb
- This amount = 40% from the total after evaporation
- Total amount = 22500/0.4 = 56,250 lb/day
- Amount of water evaporated per day = amount before evaporation – amount after evaporation = 450,000 – 56,250 = 393,750 lb/day
- Amount of steam / day = 1 * 393,750 / 0.9X = 437500 / X
- Cost of steam / day = (1.8 / 10000) * (437,500 / X) = 787.5 / X
- Fixed charges/ day = 0.2 * 54,000X/ 300 = 36X
- D = [(54000 – 18000) / (10 * 300)] * X = 12X

$$ROI_{1\text{-}2} = \frac{\left[\left(\frac{787.5}{1} - \frac{787.5}{2}\right) - 12*(2-1) - 36*(2-1)\right]*300}{54{,}000} = 1.92 = 192\%$$

$$ROI_{2\text{-}3} = \frac{\left[\left(\frac{787.5}{2} - \frac{787.5}{3}\right) - 12*(3-2) - 36*(3-2)\right]*300}{54{,}000} = 0.4625 = 46.25\%$$

$$ROI_{3\text{-}4} = \frac{\left[\left(\frac{787.5}{3} - \frac{787.5}{4}\right) - 12*(4-3) - 36*(4-3)\right]*300}{54{,}000} = 0.098 = 9.8\ \%$$

Number of effects is 3 effects

Solution for the optimization problem:

Here solution will be as following:

- Take X = 1
- Calculate the cost of the evaporator
- Calculate the fixed charges per year which amounts to certain percent from the evaporator cost and add to it depreciation charges
- Calculate the amount of water evaporated per year
- Calculate the amount of steam used per year
- Calculate the steam cost per year
- Calculate the total cost of fixed charges and operating charges
- Repeat the previous steps by putting X = 2, 3
- Choose the X which gives minimum total cost

X	Evaporator cost	Fixed cost + D Per year	Water evaporated Per year	Steam used per year	Steam cost Per year	Total cost
1	54,000	14,400 = (0.2*54,000 +3600)	393,750 * 300	(393750*300) /(0.9 *1)	236,250 = (amount of steam * 1.8/1000)	250,650
2	108,000	28,800	393,750 * 300	(393750*300) /(0.9 *2)	118,125	146,925
3	162,000	43,200	393,750 * 300	(393750*300) /(0.9 *3)	78,750	121,950
4	216,000	57,600	393,750 * 300	(393750*300) /(0.9 *4)	59,063	116,662.5
5	270,000	72,000	393,750 * 300	(393750*300) /(0.9 *5)	47,250	119,250

Therefore the optimum number of evaporators = 4 evaporators

Note: the alternative way says 3 while optimization says 4, any comments?

Question 3: (Important)

i) The total value of a new plant is $ 2 million. A certificate of necessity has been obtained permitting a write- off 60% of the initial value in 5 years. The balance of the plant requires a write –off period of 15 years.

Using the straight –line method and assuming negligible salvage and scrap value, determine the total depreciation cost during the first and the sixth year.

Solution:

Applying the straight line method to get the first depreciation charge

We want to save 60% of the equipment cost in 5 years

So total depreciation in the first 5 years = $0.6* 2*10^6$ = $1,200,000

By dividing this value on 5 years

$D_1 = D_2 = \ldots\ldots = D_5$ = $240,000

To get the deprecation charge in the sixth year

D_6= (V0-Vs)*(1/n)

D_6 = (2*10^6-0.6*2*10^6-0)*(1/10)

D_6 = $80,000

ii) An engineer in charge of the design of a plant must choose either a batch or a continuous system. The batch system offers a lower initial outlay, but owing to high labor requirements, it exhibits a higher operating cost.

The following table misses some values of cash flow and NPW

item		year	DCFRR	NPW @ 15%
	0	1:10		
batch system	$ -50,000	??	25%	??
continuous system	$ -70,000	??	25%	??

Find the value of cash flows and net present worth for two systems. If the company requires a minimum rate of return of 15%, which system should be chosen?

Solution:

First we will complete the missing spaces in the previous table

To get R, substitute in the NPW = 0 using DCFRR = 25%

$$0 = -P + R * \frac{[(1+i)^n - 1]}{i\ (1+i)^n}$$

Batch system

$$50{,}000 = R * \frac{[1.25^{10} - 1]}{0.25*(1.25)^{10}}$$

R=$14003.63

Continuous system

$$P = R * \frac{[(1+i)^n - 1]}{i\ (1+i)^n}$$

$$70{,}000 = R * \frac{[1.25^{10} - 1]}{0.25*(1.25)^{10}}$$

R=$19605.08

For the NPW at I = 15%:

Batch:

$$NPW = -50{,}000 + R * \frac{[(1+i)^n - 1]}{i\ (1+i)^n}$$

$$NPW = -50{,}000 + 14003.63 * \frac{[(1+0.15)^{10} - 1]}{0.15*(1+0.15)^{10}}$$

NPW = $20280.98

Continuous:

$$NPW = -70{,}000 + R * \frac{[(1+i)^n - 1]}{i\,(1+i)^n}$$

$$NPW = -70{,}000 + 19605.08 * \frac{[(1+0.15)^{10} - 1]}{0.15 * (1+0.15)^{10}}$$

NPW = $28393.36

Given ROII = 15%

Additional investment = $20,000

Savings = 19605.08 - 14003.63 = $5601.45

$$20{,}000 = 5601.45 * \frac{[(1+i)^{10} - 1]}{i\,(1+i)^{10}}$$

By trial and error processes

I = 0.25 = 25% > 15%

Continuous system is recommended

Question 4:

For the following project:

1-The construction of the project will be completed in 3 years. The project needs five years from the start till the full capacity stage (6th years till 15th years)

2- Date about the construction costs, operating costs and volume of sales during installation and operation stages are:

Year	Construction cost EGP 1000	Operating cost EGP 1000	Volume of sales 1000 tons
1 2 3	800 1000 1200	30 30 50	- - -

4	-	70	40
5	-	100	60
6-15	-	120	100

3-suggested selling price EGP 20 per ton, and the average interest cost is 15% present required

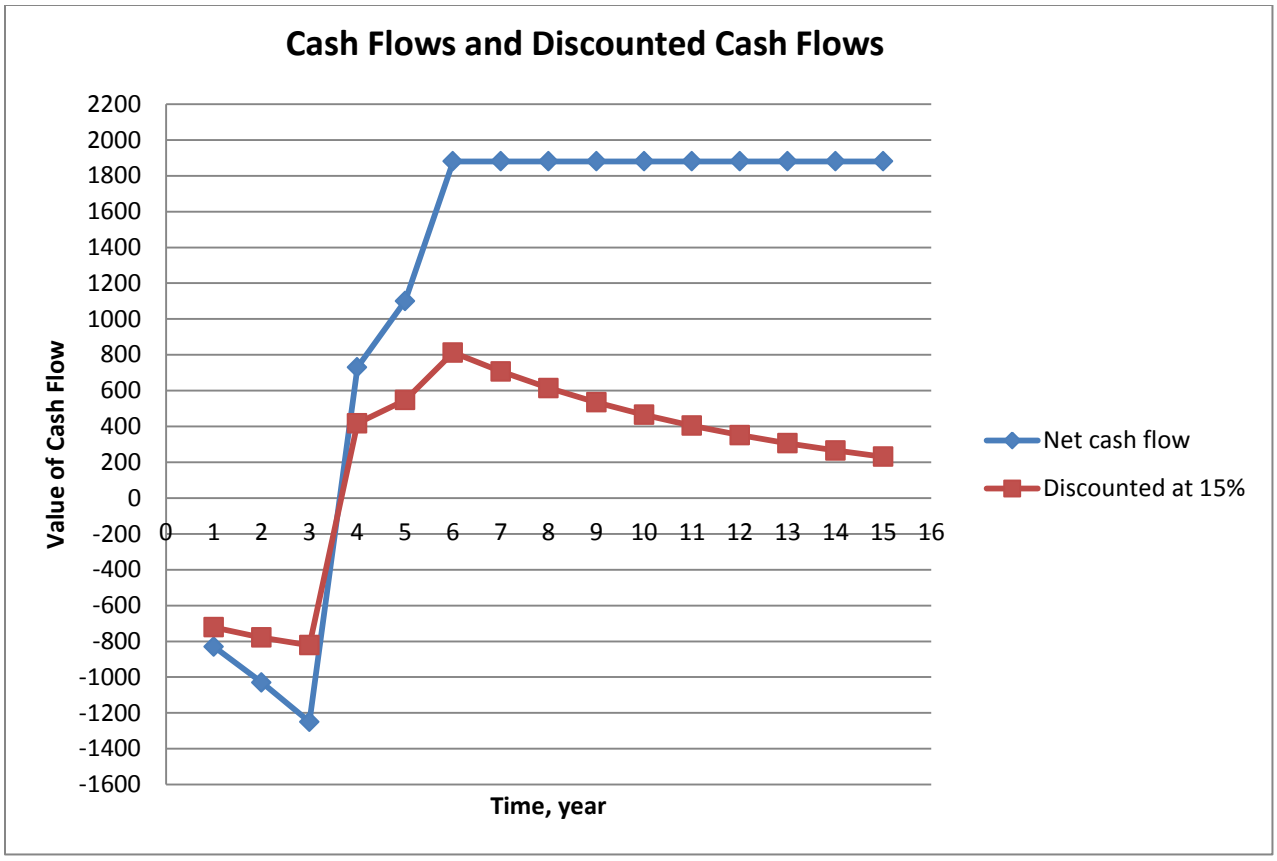
(i)Draw the cash flow diagram of the project

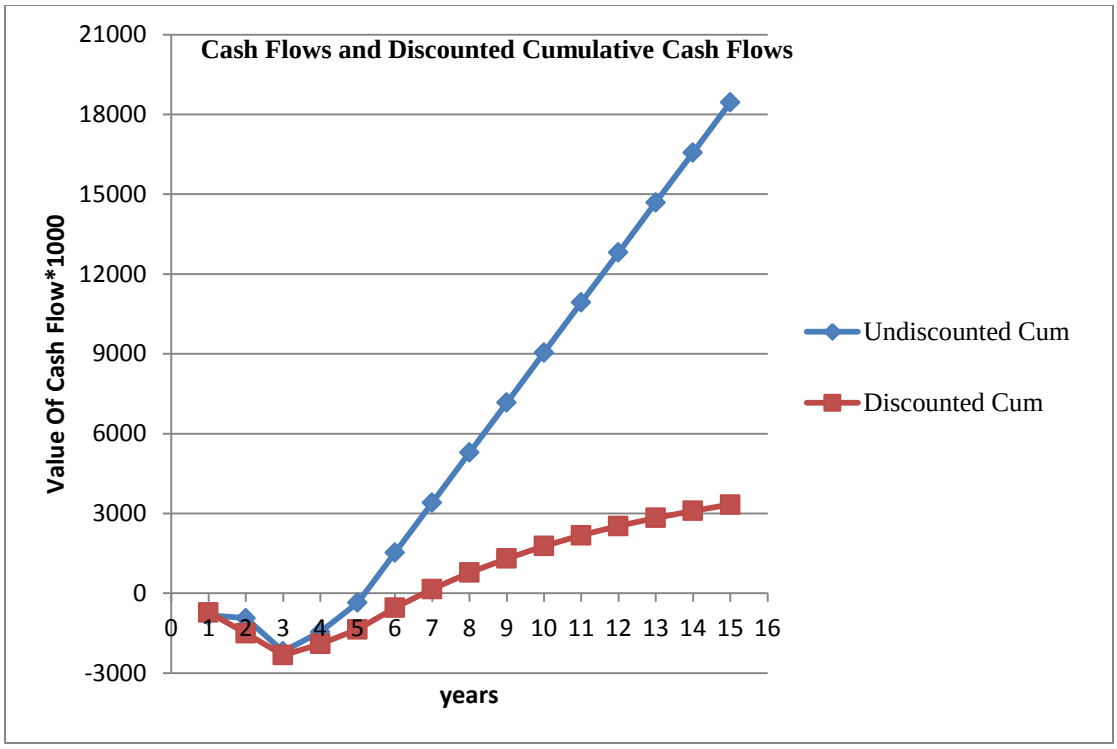
(ii) Project performance evaluation by TRR method.

(iii)Testing project sensitivity if the selling price is decreased from EGP 20 to EGP 15 per ton

Solution:

Year	Construction cost EGP 1000	Operating cost EGP 1000	Volume of sales 1000 tons	Volume of sales EGP1000	Net cash flow	npw	Comulative cash flow	Comulative npw
1	-800	-30	-	-	-830	-721.739	-830	-721.739
2	-1000	-30	-	-	-1030	-778.8	-1860	-1500.539
3	-1200	-50	-	-	-1250	-821.895	-3110	-2322.434
4	-	-70	40	800	730	417.38	-2380	-1905.054
5	-	-100	60	1200	1100	546.894	-1280	-1358.16
6-15	-	-120	100	2000	1880	.....	600	.....


Cash Flows and Discounted Cash Flows
Value of Cash Flow
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
-800
-1000
-1200
-1400
-1600
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Time, year
Net cash flow
Discounted at 15%



(ii)

$$0 = \frac{-830}{(1+i)} + \frac{-1030}{(1+i)^2} + \frac{-1250}{(1+i)^3} + \frac{730}{(1+i)^4} + \frac{1100}{(1+i)^5} + 1880 * \frac{[(1+i)^{10} - 1]}{i * (1+i)^{10}} * \frac{1}{(1+i)^5}$$

By trial and error, TRR = 33.9 %

Since the average interest 15% is less than TRR, therefore the project is feasible

(iii)

Year	Construction cost EGP 1000	Operating cost EGP 1000	Volume of sales 1000 tons	Volume of sales EGP 1000	Net cash flow
1	-800	-30	-	-	-830
2	-1000	-30	-	-	-1030
3	-1200	-50	-	-	-1250
4	-	-70	40	600	530
5	-	-100	60	900	800
6-15	-	-120	100	1500	1380

$$0 = \frac{-830}{(1+i)} + \frac{-1030}{(1+i)^2} + \frac{-1250}{(1+i)^3} + \frac{530}{(1+i)^4} + \frac{800}{(1+i)^5} + 1380 * \frac{[(1+i)^{10}-1]}{i*(1+i)^{10}} * \frac{1}{(1+i)^5}$$

By trial and error, TRR = 26%

Since the average interest 15% is less than TRR, therefore the project is not sensitive.

i) Write short notes on each of the followings:

a- Added-value

b- Corporations

c- Stocks market

d- Planning in management functions

Solution:

a- **Added-value**: it is the difference between the value of the product and the value of what it Takes to produce it from raw materials, auxiliaries (water-electricity), chemicals added and so On and it is used to judge on the industrial efficiency.

b- **Corporations**: it does not belong to certain owner or some but it is ownership would be divided into shares of stocks.

c- **Stocks market**: it is the place where we buy and sell the stocks after the companies produce it there are two markets for the money:

1. Production market

2.سوق التداول

d- **Planning in management functions**: planning first is based on identifying the targets then choosing the systems and ways of working planning is mainly taking decisions as you have to choose between the all alternatives.

The planning responsibility can't be detached from the work of the other managers where all managers plan to work of the units that are under their responsibilities.

ii) The following information applies to AZM Company on - given date:

Terms	EGP
Long term debts	3,200
Accounts payable	5,000
Cash in bank	20,000
Government bonds	25,000
Reserve for depreciation	1500
Inventory	5000
Debts due within one year	3000
Machinery and equipment (at cost)	50,000
Prepaid rent	1000
Social security taxes payable	700
Reserve for expansion	2500
Accounts receivable	8000

Determine the current ratio, cash ratio, and working capital for company AZM at the given date

Solution:

Current assets = Cash in bank + Government bonds + Inventory
+ Accounts receivable

= 20,000 + 25,000 + 5,000 + 8,000

= EGP 58,000

Current liabilities = Accounts payable + Debts within 1 year + Social security taxes payable

= 5,000 + 3,000 + 700 = EGP 8,700

$$\text{Current ratio} = \frac{\text{Current assets}}{\text{Current liabilities}} = \frac{58{,}000}{8{,}700} = 6.66$$

$$\text{Cash ratio} = \frac{\text{Cash}}{\text{Current liabilities}} = \frac{20{,}000+25{,}000}{8700} = 5.17$$

Working capital = Current assets - Current liabilities
=58,000 – 8,700 = EGP 49,300

June 2008

Question (1):

i-The annual direct production cost for a plant operating at 70% capacity are $280,000 while the sum of the annual fixed charges, overhead costs and general expenses is $200,000.what is the break-even point in units of production per year if total annual sales are $560,000 and the product sells at $40 per unit? What are the annual gross earnings for this plant at 100% capacity? And if there are 22% taxes and 26% surtaxes on each profit above $25,000, estimate the net profit

Answer:

Profit = Sales - Variable cost - fixed cost

0 = (560000/0.7)*x – (280000/0.7)*x-200000

X=0.5 this means BEP occurs at capacity at 50%

Units at70%= total sales/price per unit=560000/40=14000 units

BEP in units of production = (50/70)*(14000) =10000 units

At 100% capacity

P=(560000/0.7) - (280000/0.7)- 200000=200000$

Net Profit=200000-(0.22*200000) - 0.26*(200000 - 250000) = $110500

ii- (Important) The cost of all purchased items of chemical engineering plant is $900,000 and 20 years of service life is estimated .calculate the %age of original paid off after 3 years of service life using the declining balance method for depreciating assets as compared to sum of years digits method

Solutions:

- P= $900,000
- S=0
- N=20 years

1 – Declining method

First year= P * (f / n) = (900,000)*(1/20) = $45,000

So = (900,000-45,000) = $855,000$

Second year= (855,000)*(1/20) = $ 42750

So= (855,000-42750) = $812250

Third year= (812250)*(1/20) =$ 40612.5

So = (812250-40612.5) = $771,637.5

% paid off in 3 years = (128,363/900,000) * 100 = 14.2625%

2-sum of years digits

Here we can get the three years together where:

$D_1 + D_2 + D_3$ = (20 + 19 + 18) / (1+2+3+4+----------+20) * 900,000= $244,286

D %=(244,286/900,000) = 27.14%

Question (2):

i-write short notes on each of the following:

a-Added value:

it is defined as the difference between the value of the product and the value of what it takes to produce it from raw materials, auxiliaries(water, electricity,…etc),chemical added and so on. And it is used to judge the industrial efficiency.

b-cost index:

as the value of money changes with time, what costed x the last year, would probably cost more than x this year. And it is used to obtain the price of certain item at the present time by knowing its price before.

Present cost = original cost*(index value at present time/index value at time original cost was estimated)

c- Declining balance method:

This method ignores the scrap value and depreciation is calculated as follows:

D1=f*(1/n)*cost

D2=f*(1/n)*remaining cost

n: number of years

f: 1(single) or 2(double) or 3(triple)

d-Capitalized cost:

It is defined as the original cost of the equipment plus the present value of the renewable perpetuity

K=Cv + (Cr/((1+i)^n)-1))

II-The following information applies to AZM Company on given date

Long term debts	3300
Accounts payable	6000
Cash in bank	40000
Government bonds	45000
Reserve for depreciation	2000
Inventory	6000
Debts within one year	3000
Machinery and equipment	60000
Prepaid rent	1500
Social security taxes payable	800
Reserve for expansion	3000
Accounts receivable	9000

Determine the current ratio, cash ratio and work capital for company AZM at the given data

Solution:

Current assets=40000+6000+45000+9000=100,000

Current liabilities=3000+6000+800=9800

Working capital=100,000-9800=90,200

Current ratio= (100000)/9800=10.2

Cash ratio= (40000+45000)/9800=8.6734

Question (3):

The overhead condenser of a distillation tower is to be designed to condense 12000 lbs of vapor/hr. The effective condensation temperature for the vapor is 225℉. The latent heat of condensation of vapor equals 245 Btu/lb, cooling water is available at 80℉. The cost of cooling water is $ 11*10E-6/lb. The overall heat transfer coefficient equals 160

Btu/hr ft^2℉. The cost of installed condenser is \$75/ft^2 of heat transfer area, and the annual fixed charges including maintenance and interest rate are 30% of the initial investment. The condenser is to operate 8000 hrs/year.

Determine

1. The outlet temperature of cooling water
2. Cooling water flow rate
3. The heat transfer area for optimum conditions

[Cp of cooling water = 1 Btu/lb℉]

Question (4): (important)

An engineer in charge of the design of a plant must choose either batch or a continuous system. The batch is to be installed at a cost of $ 60,000 and it is expected to operate for as long as 20 years. Two men operate this batch system at $4 per employee-hour. Utilities required for the batch unit cost $1,100 per month and annual fixed charges other then depreciation accounted to 10% of the initial cost.

The continuous system costs $40,000 and expenses for the monthly consumption of fuel and water amount to $2,100. Three working labors would be required for this unit per month at $1,600 each. Annual fixed cost excluding depreciation is 25% age of the purchased cost.

The plant is operated 24 hours, 365 days per year and both systems have a negligible salvage value. If the minimum return on any investment is 15%, determine the minimum service life for the continuous system to be accepted as an alternative to meet the incremental return.

Solution:

Batch:

P= $ 60,000

Salvage(S) = 0

N= 20 years

- Depreciation= (60,000-0)/20 = $3,000 / year
- Employees cost = 2*employee*($4/employee in hr)*(24 hr/day)*(365 day/year) = $70,080 / year
- Utilities cost = ($ 1,100/month)*(12/year) = $ 13,200 / year
- Annual fixed changes = 0.1*60,000 = $ 6,000

Continuous System:

- P = $ 40,000
- Utilities cost = ($ 2,100/month)*(12month/year) = $ 25,200
- Employees costs = 3*(employee/month)*($ 1,600/employee)*(12month/year) = $ 57,600
- Annual fixed cost excluding depreciation = 0.25*40,000 = $ 10,000

ROI = [(10,000-6,000) - (70,080-57,600) + (25,200-13,200) - (3,000-D)] / 20,000

D = $ 2,480

D = P / n

2480 = 40,000/n

n = 17 years

Question 5: (important)

The construction of the project will be completed in 3 years, the project needs 5 years from the start till full capacity stage (6th till 15th years)

Data about the construction costs, operating costs and volume of sales during installation and operation stages are: (values are in EGP1000)

Year	construction cost	operating cost	volume of sales (1000 ton)
1	-600	-20	-
2	-800	-20	-
3	-100	-40	-
4		-60	32
5		-80	48
6-15		-100	80
16		-120	60

Salvage value at end of service life=EGP 200,000

Suggested selling price EGP 15 per ton, and the average interest rate is 15 %.

Required:

(i) Project performance evaluation by DCFRR method.
(ii) Testing project sensitivity if the selling price is decreased from EGP 15 to 10 per ton, and both construction and operation costs is increased by 10 %

Solution:

i)Project performance evaluation by DCFRR technique

Item/year	1	2	3	4	5	6_15	16
Cash out flow Construction (1000 EGP) Operating cost (1000 EGP)	600 20	800 20	1000 40	– 60	– 80	– 100	– 120
out cash flow (1000 EGP)	(620)	(820)	(1040)	(60)	(80)	(100)	(120)
Cash in flow Sale price (1000 EGP)	– –	– –	– –	480	720	1200	900
N.C.F (1000 EGP)	(620)	(820)	(1040)	420	640	1100	780

Starting ω 15%

$\boldsymbol{Year}$	$\boldsymbol{Cas\square\ flow \times Coeff.of\ p.v.@\ 15\%}$
1	$-620 * \frac{1}{1.15} = -539.13$
2	$-820 * \frac{1}{(1.15)^2} = -620.04$
3	$-1040 * \frac{1}{(1.15)^3} = -683.82$
4	$420 * \frac{1}{(1.15)^4} = 240.14$
5	$640 * \frac{1}{(1.15)^5} = 318.19$
6-15	$\frac{1100 * ((1.15)^{10} - 1)}{0.15 * (1.15)^{10}} * \frac{1}{(1.15)^5} = 2744.74$
16	$780 * \frac{1}{(1.15)^{16}} = 83.35$

$NPV = +1543.43$

$NPV\ is\ positive$

$\therefore\ \%\ rate\ is\ more\ than\ 15\%$

$try\ 18\%$

$\boldsymbol{Year}$	$\boldsymbol{Cas\square\ flow * Coef.of\ P.V\ @18\%}$
1	$-620 * \frac{1}{(1.18)} = -525.42$
2	$-820 * \frac{1}{(1.18)^2} = -588.91$
3	$-1040 * \frac{1}{(1.18)^3} = -632.98$

4	$420 * \frac{1}{(1.18)^4} = 216.63$
5	$640 * \frac{1}{(1.18)^5} = 279.75$
6-15	$\frac{1100((1.18)^{10}-1)}{0.18(1.18)^{10}} * \frac{1}{(1.18)^5} = 2160.84$
16	$780 * \frac{1}{(1.18)^{16}} = 55.21$

$$NPV = +965.12$$

try 24%

$\boldsymbol{Year}$	$\boldsymbol{Cas\square\ flow * Coff.of\ P.V@24\%}$
1	$-620\frac{1}{1.24} = -500$
2	$-820\frac{1}{(1.24)^2} = -533.3$
3	$-1040\frac{1}{(1.24)^3} = -545.47$
4	$420\frac{1}{(1.24)^4} = 177.65$
5	$640\frac{1}{(1.24)^5} = 218.31$
6-15	$\frac{1100((1.24)^{10}-1)}{0.24*(1.24)^{10}} * \frac{1}{(1.24)^5} = 1381.5$
16	$780 * \frac{1}{(1.24)^{16}} = 24.97$

NPV=+223.66

Try 27%

$\boldsymbol{Year}$	**Cash flow** $*$ **Coeff. of P. V @27%**
1	$-620 * \frac{1}{1.27} = -488.19$
2	$-820 * \frac{1}{(1.27)^2} = -508.4$
3	$-1040 * \frac{1}{(1.27)^3} = -507.72$
4	$420 * \frac{1}{(1.27)^4} = 161.45$
5	$640 * \frac{1}{(1.27)^5} = 193.71$
6-15	$\frac{1100((1.27)^{10}-1)}{0.27*(1.27)^{10}} * \frac{1}{(1.27)^5} = 1120.16$

16	$780 * \frac{1}{(1.27)^{16}} = 17.03$

$$NPV = -11.9$$

$NPV\ is\ negative$

$\therefore$ DCFRR is between 15% and 27%

$$\therefore \text{DCFRR} = 15\% + \frac{1543.43 - 0}{1543.43 + 11.96} * (27 - 15)\% = 26.9\%$$

the project could be accepted economically becouse

DCFRR $= 26.9\%$ is greater than 15% avg cost of interest rate

ii)

	1	2	3	4	5	6-15	16
Construction	660	880	1100	-	-	-	-
Operating	22	22	44	66	88	110	132
Σ Out cash flow	(682)	(902)	(1144)	(66)	(88)	(110)	(132)
Sales price	-	-	-	320	480	800	600
Net cash flow	(682)	(902)	(1144)	254	392	690	468

Try 15%

Year	**Cash flow $*$ Coeff. of P. V @15%**
1	$-682 * \frac{1}{1.15} = -593.04$
2	$-902 * \frac{1}{(1.15)^2} = -682.04$
3	$-1144 * \frac{1}{(1.15)^3} = -752.2$
4	$254 * \frac{1}{(1.15)^4} = 145.23$
5	$392 * \frac{1}{(1.15)^5} = 194.89$
6-15	$\frac{690((1.15)^{10}-1)}{0.15*(1.15)^{10}} * \frac{1}{(1.15)^5} = 1721.7$
16	$468 * \frac{1}{(1.15)^{16}} = 50$

NPV=+84.54

$NPV\ is\ positive$

Try 16%

$\boldsymbol{Year}$	$\textbf{Cash flow} * \textbf{Coeff. of P. V @16\%}$
1	$-682 * \frac{1}{1.16} = -587.9$
2	$-902 * \frac{1}{(1.16)^2} = -670.33$
3	$-1144 * \frac{1}{(1.16)^3} = -732.91$
4	$254 * \frac{1}{(1.16)^4} = 140.28$
5	$392 * \frac{1}{(1.16)^5} = 186.64$
6-15	$\frac{690((1.16)^{10}-1)}{0.16*(1.16)^{10}} * \frac{1}{(1.16)^5} = 1587.8$
16	$468 * \frac{1}{(1.16)^{16}} = 43.54$

NPV=-32.88

$NPV\ is\ negative$

$\therefore DCFRR\ is\ bet. 15\ \&\ 16\%$

$$DCFRR = 15 + \frac{84.54 - 0}{84.54 + 32.88} \times 1 = 15.7\%$$

Sensitivity analysis for decreased selling price and increase expenses:

DCFRR = 15.7 which is still greater than 15% not sensitive

June 2009

Question (1)

Estimate the manufacturing cost per kilo of product under the following conditions:
Fixed capital investment =*$10 million*.
Annual production output =*20 million Kg of product*.
Raw materials cost=*$0.25/kilo of product*.
Utilities:-

- Filtered and softened water =*20 gal/Kg of product ($2/1000gal)*.
- 100 psig steam=*80 Kg/Kg of product ($2.5/1000Kg)*.
- Purchased electrical power=*0.6 KWH/Kg of product ($0.2/KWH)*.

Operating labor=*20 men per shift at $20 per employee –hour*
Plant operates *300 (24-h) days per year*.
Corrosive liquids are involved. Shipments are in bulk car load lots.
A large amount of direct supervision is required.
There are no patent, royalty, interest, or rent charges.
Plant overhead costs amount to 50 % of the cost for operating labor, supervision, and maintenance.

Solution

F.C.I=$10 million.
Annual production output =20 million Kg of product.
Raw materials cost=$0.25/kilo of product.

$$\text{Utilities per Kg of product} = \frac{20 * 2}{1000} + \frac{80 * 2.5}{1000} + (0.6 * 0.2) = \$\ 0.36$$

$$\text{Labor per Kg of product} = \frac{20 * 3 * 8 * 20 * 300}{20 * 10^6} = \$\ 0.144$$

Plant Overhead =0.5 (labor + supervision + maintenance)
Maintenance per Kg of product = 0.1 F.C.I

$$= \frac{0.1 * 10 * 10^6}{20 * 10^6} = \$\ 0.05$$

Miscellaneous material = 0.1 maintenance = 0.1*0.05

Variable cost per Kg of product = 0.25+ 0.1* 0.05+ 0.36 = $ 0.615

Depreciation = 0.15 F.C.I

Insurance = 0.01 F.C.I
Fixed cost per Kg of product = 0.144 * (1+0.2) +
0.5*[(0.144 * (1+0.2)) +0.05] + 0.5 * (0.15+0.01) +0.05 =$ 0.4142

Manufacturing cost per Kg of product = Fixed cost + variable cost
= 0.4142+ 0.615 = $1.03

Question (2)

i- Write short notes on each of the followings:

a. Added value
b. Cost indexes
c. Sinking fund method
d. Corporation

(Important) ii- A plant is producing *20000 t/y* of a product. The overall yield is *70%* on a mass basis (kg of product per kg raw materials). The raw material costs *£20/t* and the product sell for *£50/t*. A process modification has been devised that will increase the yield to *80%*. The additional investment required is *£50000* and the additional costs are negligible.

Is the modification worth making?
Determine ROII and payback time?

Solution

i-

a. Added value:

Is defined as the difference between the value of the product & the value of what it takes to produce it from raw materials, auxiliaries (water , electricity…etc), chemicals added and so on , it's used to judge on the industrial efficiency.

b. Cost index:

As the value of money changes with time, what cost x the last year, would probably cost more than x this year.
Cost index is used to obtain the price of certain item at the present time by knowing its price at another time.

$$\text{present cost} = \frac{\text{originsl cost} * \text{index value}}{\text{index value at time original cost was estimated}}$$

There are several types of cost indices such as Marshall and Swift (Marshall and Stevens) and Lewis.

c. Sinking fund method:

It's a method used to calculate the yearly cost due to depreciation.

$$R = F * \frac{i}{(1+i)^n - 1}$$

d. Corporation:

Business doesn't belong to a certain owner, or some. Ownership is divided into shares of stokes.
Advantages:

- Limited liability to stakeholders.
- Ease of transferring ownership.
- Applicability to all sizes of firms.
- Ease of expansion.
- Perpetual life.

Disadvantages:

- Government regulations.
- Capital stock tax.
- Expense of organization.

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ii- $product_2$ = (80 * 20,000) / 70 = 22,857.14 t/y

Annual savings = (22,857.14 - 20,000) * 50 = £ 142,857

$$\text{ROII} = \frac{\text{annual savings}}{\text{additional investment}} = \frac{142{,}857}{50000} * 100 = 285.7\ \% > 15\%$$

Because *ROII > 15 %,* it means that this modification is worth to make

$$\text{pay back time} = \frac{\text{F. C. I.} - \text{salvage value}}{\text{Net cash flow}} = \frac{50000 - 0}{142857} = 0.35\ \text{year}$$

Note: this solution is based upon the idea that the plant will use the same amount of raw material and product will increase that's why we were concerned with the savings which results from extra product.

But if the plant would produce same amount of product and in this case if yield increases, it would use less raw material, in that case savings would be in cost of raw material.

What do you think is better?

Question (3)

i- Mention the most important steps in planning a new business.

(Important) ii- A company is considering the purchase and installation of a pump which will deliver oil at a faster rate than the pump already in use. The purchase and installation of the larger pump will require on immediate outlay of *$1600* but it will recover all the oil by the end of one year. The relevant of cash flows have been established as follows

	Year			DCFRR	NPW at 10 %
	0	1	2		
Install larger pump	-$ 1600	$ 20,000	0	?	?
Operating existing pump	0	$ 10,000	$ 10,000	?	?

Find the missing values in the above table for the discounted cash flow rate of retain and net present worth.
If the company requires a minimum rate of retain 10 %, which alternative should be chosen?

Solution

i-

1- Determine what profit you want from this business organizing the time you will give and the investment you will have.
2- Survey the market you plan to serve to as certain if necessary sales volume required to produce the profit called in step 1 is obtained.
3- Prepare a statement of assets to be used.
4- Prepare an opening day balance sheet.

5- Study the location and the specific site chosen in relation to specific characteristics.
6- Prepare a layout for the entire space to be used for business activity.
7- Choose your legal form of organization.
8- Review all aspects of your merchandising plan.
9- Analyze your estimated expenses in term of their fixed or variable nature.
10- Determine the firm's breakeven point.
11- Review the risks to which you are subjected and how you plan to cope with them.
12- Establish a personal policy at the outset.
13- Establish an adequate system for counting records.

---

ii-

- <u>In case of installing larger pump</u>

Get DCFRR = i at NPW = 0

$$0 = -1600 + \frac{20000}{(1+i)} + \frac{0}{(1+i)^2}$$

i = 1150 %

NPW at 10 % i = 0.1

$$NPW = -1600 + \frac{20000}{(1+0.1)} + \frac{0}{(1+0.1)^2}$$

NPW = $ 16582

- <u>In case of operating the already existing pump</u>

Get DCFRR = i at NPW = 0

$$0 = 0 + \frac{10000}{(1+i)} + \frac{10000}{(1+i)^2}$$

i =∞

NPW at 10 % i = 0.1

$$NPW = 0 + \frac{10000}{(1+0.1)} + \frac{10000}{(1+0.1)^2}$$

NPW = $ 17356

Since that there is no construction cost in one of them so we cannot compare using ROI or DCFRR, so we will take the investment which has the higher NPW, so we will keep the already existing pump

Question (4)

i. Define DCFRR

ii. For the following project:

1- The construction of project will be completed in 3 years, the project needs five years from the start till full capacity stage.

2- Data about the construction costs, operating costs and volume of sales during installation and operation stages are:

Year	Construction costs (EGP 1000)	Operation costs (EGP 1000)	Volume of sales (1000 tons)
1	1200	40	—
2	1600	40	—
3	2000	80	—
4	—	120	64
5	—	160	96
6-15	—	200	160
16	—	240	120

3- Salvage value at end of the project = EGP 400000

4- Suggested selling price EGP 15 per ton, and the average interest rate is 15% percent

Required:

1- Project performance evaluation by DCFRR method.

2- Testing project sensitivity if the selling price is decreased from EGP 15 to EGP 10 per ton, and both construction and operating costs is increased by 10% percent.

Solution

i. DCFRR: (discounted cash flow rate of return)

At DCFRR or TRR (true rate of return) the NPW = 0 (present income = present investment), and if rate of return i is > DCFRR…..this means loss and if rate of return is < DCFRR… this means profit

So what we will do is that we will calculate TRR and compare it with rate of return given and see whether the project gains or lose. Also we can use DCFRR as a method for evaluation of different projects.

ii. 1-

Year	Construction Costs (EGP 1000)	Operating Costs (EGP 1000)	Sales (EGP 1000)	Net Cash Flow (EGP 1000)
1	-1200	-40	-	-1240
2	-1600	-40	-	-1640
3	-2000	-80	-	-2080
4	-	-120	64*15	840
5	-	-160	96*15	1280
6:15	-	-200	160*15	2200
16	-	-240	120*15	1560

$$0 = \frac{-1240}{(1+i)} - \frac{1640}{(1+i)^2} - \frac{2080}{(1+i)^3} + \frac{840}{(1+i)^4} + \frac{1280}{(1+i)^5} + 2200 \times \frac{[(1+i)^{10}-1]}{[i \times (1+i)^{10}} \times \frac{1}{(1+i)^5} + \frac{1560+400}{(1+i)^{16}}$$

By trial and error*:* *DCFRR = 26.88946 %*

Since that MARR (15%) is less than the DCFRR (26.88946%), therefore the project is feasible.

2-

Year	Construction Costs (EGP 1000)	Operating Costs (EGP 1000)	Sales (EGP 1000)	Net Cash Flow (EGP 1000)
1	-1320	-44	-	-1364
2	-1760	-44	-	-1804
3	-2200	-88	-	-2288
4	-	-132	640	508
5	-	-176	960	784
6:15	-	-220	1600	1380
16	-	-264	1200	936

- <u>Using the discounted cash flow rate of return technique:</u>

$$0 = \frac{-1364}{(1+\mathrm{i})} - \frac{1804}{(1+\mathrm{i})^2} - \frac{2288}{(1+\mathrm{i})^3} + \frac{508}{(1+\mathrm{i})^4} + \frac{784}{(1+\mathrm{i})^5} + 1380 \times \frac{[(1+\mathrm{i})^{10} - 1]}{[\mathrm{i} \times (1+\mathrm{i})^{10}]} \times \frac{1}{(1+\mathrm{i})^5} + \frac{936+400}{(1+\mathrm{i})^{16}}$$

By trial and error: *DCFRR = 19.54495 %*

Since that MARR (10%) is less than the DCFRR (19.54495%), therefore the project is not sensitive.

- Using the NPW technique:

$$\mathrm{NPW} = \frac{-1364}{(1+0.1)} - \frac{1804}{(1+0.1)^2} - \frac{2288}{(1+0.1)^3} + \frac{508}{(1+0.1)^4} + \frac{784}{(1+0.1)^5} + 1380 \times \frac{[(1+0.1)^{10} - 1]}{[0.1 \times (1+0.1)^{10}]} \times \frac{1}{(1+0.1)^5} + \frac{936+400}{(1+0.1)^{16}}$$

NPW = 4553.752974 (EGP 1000) = 4,553,752.974 EGP > 0, therefore the project is not sensitive.

Question (5) (Important)

An absorption tower containing wooden grids is to be used for absorbing SO_2 in a sodium sulfite solution. A mixture of air and SO_2 will enter the tower at a rate of *100,000 ft^3/min*, temperature of *260 ^0F*, and pressure of *1.2 atm*. The concentration of SO_2 in the entering gas is specified, and a given fraction of entering SO_2 must be removed in the absorption towers. The molecular weight of the entering gas mixture may be assumed to be *29.1*. Under the specified design conditions, the number of transfer units necessary varies with the superficial gas velocity as follows:

$$number\ of\ transfer\ units = 0.32G_S^{0.18}$$

Where G_S is the entering gas velocity at *lb/hr.ft^2* based on the cross sectional area of the empty tower. The height of the transfer unit is constant at *20 ft*. The cost for the installed tower is *\$ 1.5 / ft^3* of inside volume, and annual fixed charges amount to *20 percent* of the initial cost. Variable operating charges for the absorbent blower power, and pumping power are represented by the following relation:

$$Total\ variable\ operating\ costs\ are\ {}^{\$}/_{hr} = 1.5G_S^2 * 10^{-8} + \frac{81}{G_S} + \frac{4.8}{G_S^{0.8}}$$

The unit is to be operated *8000 hr/year*.

Determine the height and diameter of the absorption tower at conditions of minimum annual cost.

Solution:

- P M =ρ RT
- 1.5 * 29.1 = ρ * 0.082 * 400
- ρ = 1.33 g/L = (1.33 /453.6) * (12 * 2.54)^3 * (1/1000) = 0.083 lb/ft^3
- m = 0.083*v = 0.083 * 100,000 = 8300 lb/min
- $\text{number of transfer units} = 0.32G_S^{0.18}$
- Z = NTU * HTU = $0.32G_s^{0.18} * 20$
- Volume of the tower = Area * Z, area = m/G
- Volume of the tower = (8300 / G) * $0.32G_s^{0.18} * 20$
- Cost of the tower = 1.5 * (8300 / G) * $0.32G_s^{0.18} * 20$

= 79680* $G_s^{0.18}$

- Annual fixed charges/yr = 0.2 * 79680 * $G_s^{0.18}$ = 15936* $G_s^{0.18}$
- Operating charges/yr = ($1.5G_S^2 * 10^{-8} + \frac{81}{G_S} + \frac{4.8}{G_S^{0.8}}$) * 8000
- Total cost/yr = 15936 * $G_s^{0.18}$ + ($1.5G_S^2 * 10^{-8} + \frac{81}{G_S} + \frac{4.8}{G_S^{0.8}}$) * 8000
- Optimum G occurs at $\frac{dTotal\ coat/yr}{dG_S}$ = 0
- 2868.5 * $G_s^{-0.82}$ + [3 * 10^{-8} G_s - $\frac{81}{G_s^2}$ - $\frac{3.84}{G_s^{1.8}}$] * 8000 = 0
- Solve to get G