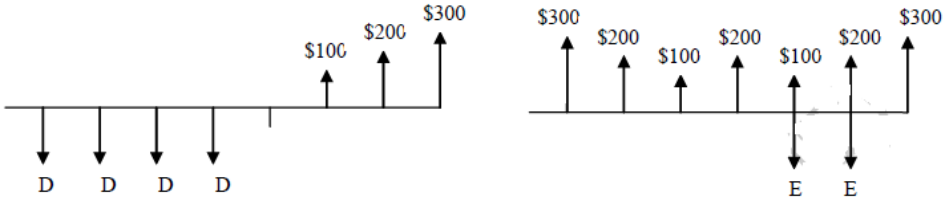
# نموذج الاجابة المادة :اقتصاد هندسى م 1482
## الفرقة الرابعة ميكانيكا
## التاريخ الأربعاء 29 مايو 2019
أستاذ المادة : د. محمد عبد اللطيف الشرنوبى

**Benha University**
**College of engineering at Benha .**
**Questions For Final Examination**
**Subject: Engineerin Economy M 1482 29/5/2019**
**Spec. 4th year All mechanic. Time :120 min.**
**Examiner:Dr.Mohamed Elsharnoby**

**Note: Attempt all Questions , Number of Questions = 6 , Number of Pages = 2**

1. Compute the value of D&E in the diagram, At an interest rate of 10%. (8 points)




2. Three mutually exclusive alternatives are being considered. (12 points)

| Year | A | B | C |
|---|---|---|---|
| 0 | -$2500 | -$6000 | -$10000 |
| 1 | $750 | $1700 | $2700 |
| 2 | $800 | $1750 | $2750 |
| 3 | $7 50 | $1800 | $2800 |
| 4 | $900 | $1850 | $2850 |
| 5 | $950 | $19 00 | $2900 |

If the minimum attractive rate of return is 8%, which alternative should be selected? Solve the problem by
(a) Present worth analysis
(b) Annual cash flow analysis
(c) Incremental ROR analysis

3) A shipping firm is considering the purchase of a machine handling system for unloading ships at the dock. The firm has reduced its choice to four different systems, all of whichn are expected to provide the same unloading speed . The initial costs and operating costs estimated for each system are described below: (14 points)

| System | A | B | C | D |
|---|---|---|---|---|
| Initial cost | $650,000 | 780,000 | 600,000 | 720,000 |
| Annual operating expenses | $ 91,810 | 73,000 | 100,000 | 78,000 |

The life of each system is estimated to be 5 years, and the firm's MARR is 15%. If the firm must select one of the material handling systems, which one is the most desirable?

i) Solve using the total investment approach.
ii) Solve using an incremental approach.
iii) Assuming the cost estimates are in constant dollars and the Annual inflation rate is expected to be 9%, which system is preferred (use NPW for part iii)

4)-A large heat treating oven (with appurtenances) for powder-coating automobile frames and large pieces of furniture was purchased for $60,000.The estimated operating costs, maintenance costs, and salvage values are shown below. (10 points)

| Year | Operating Cost,$ | Maintenance Cost,$ | Salvage Value, $ |
|---|---|---|---|
| 1 | --15,000 | -3000 | 35.000 |
| 2 | -17,000 | -3000 | 30.000 |
| 3 | -19,000 | -3000 | 25.0000 |
| 4 | -21,000 | -3000 | 20,000 |
| 5 | -23,000 | -3000 | 15,000 |

Assuming the interest rate is 10%, determine:

i) The economic service life and the associated annual worth
ii) Determine the marginal total cost of the oven.

5) An Engineering consulting firm can purchase a small electronic computer for $ 30,000. It is estimated that the life and salvage value of the computer will be 6 years and $4,000 respectively. Operating expenses are estimated to be $60 per day, and maintenance will be performed under contract for $3,000 per year. As an alternative sufficient computer time can be rented at an average cost of $140 per day. If the interest rate is 10%, how many days per year must the computer be needed to justify its purchase? (10 points)

6.. A **$15,000** investment will return annual benefits for **six years**, with no salvage value after six years. Assume straight line depreciation and a 40% income tax rate.
Find , for both before and after-tax ,rates of return for Case A, before tax rate of return for case B:

- ✓ ***Case A:*** *No inflation*. The annual benefits are constant at $3500/year.
- ✓ ***Case B:*** *Inflation of 5%:* The benefits from the investment is $3500/year and increase at the same inflation rate. (14 points)

- ***Single Payment formulas:***
  **Compound amount:** $F = P(1+i)^n = P(F/P,i,n)$
  **Present worth:** $P = F(1+i)^{-n} = F(P/F,i,n)$
- ***Uniform Series Formulas:***
  **Compound Amount:** $F = A\{[(1+i)^n - 1]/i\} = A(F/A,i,n)$
  **Sinking Fund:** $A = F\{i/[(1+i)^n - 1]\} = F(A/F,i,n)$
  **Capital Recovery** $A = P\{[i(1+i)^n]/[(1+i)^n - 1] = P(A/P,i,n)$
  **Present Worth:** $P = A\{[(1+i)^n - 1]/[i(1+i)^n]\} = A(P/A,i,n)$

- ***Arithmetic Gradient Formulas:***
  **Present Worth** $P = G\{[(1+i)^n - i\,n - 1]/[i^2(1+i)^n]\} = G(P/G,i,n)$
  **Uniform Series** $A = G\{[(1+i)^n - i\,n - 1]/[i(1+i)^n - i]\} = G(A/G,i,n)$

- ***Geometric Gradient Formulas:***
  **If** $i \neq g$, $P = A\{[1 - (1+g)^n(1+i)^{-n}]/(i-g)\} = A(P/A,g,i,n)$
  **If** $i = g$, $P = A[n(1+i)^{-1}] = A(P/A,g,i,n)$
- ***Nominal interest rate per year*, *r* : the annual interest rate without considering the effect of any compounding**

- **Effective interest rate per year, $i_a$:**
  $i_a = (1 + r/m)^m - 1 = (1+i)^m - 1$ with $i = r/m$
- ***Continuous compounding*, :**
  **r – one-period interest rate, n – number of periods**
  $(P/F,r,n)^{inf} = e^{-rn}$
  $(F/P,r,n)^{inf} = e^{rn}$

GOOD LUCK

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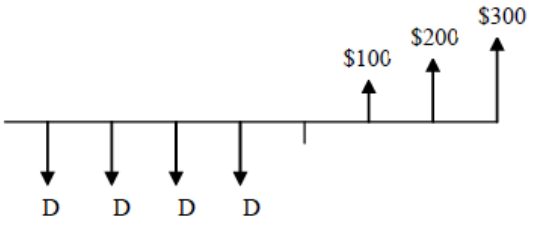
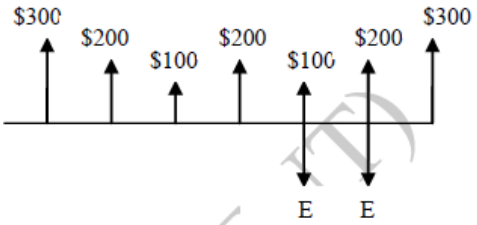
(12) Compute the value of D&E in the diagram, At an interest rate of 10%.



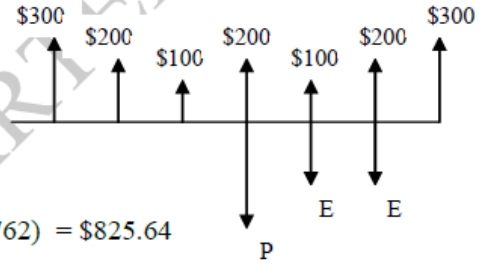




(A)-

P = $200 + $100 (P/A, 10%, 3) + $100 (P/G, 10%, 3) + $300 (F/P, 10%, 3) + $200 (F/P, 10%, 2) + $100 (F/P, 10%, 1)

= $200 + $100 (2.487) + $100 (2.329) + $300 (1.331) + $200 (1.210) + $100 (1.100)

= $1,432.90



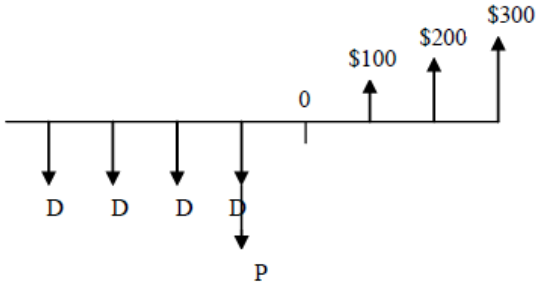

E = $1,432.90 (A/P, 10%, 2) = $1,432.90 (0.5762) = $825.64

(B)-

Present Worth of gradient series:

P = $100 (P/G, 10%, 4) = $100 (4.378)
= $437.80

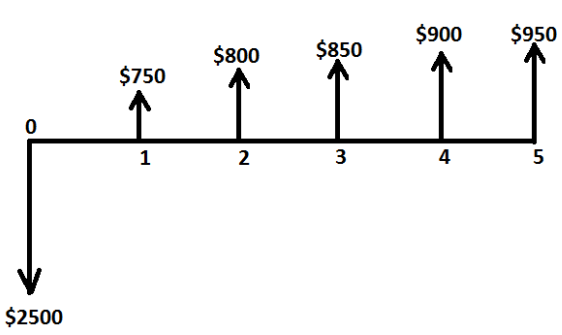
D = $437.80 (A/F, 10%, 4)
= $4.7.80 (0.2155)
= $94.35



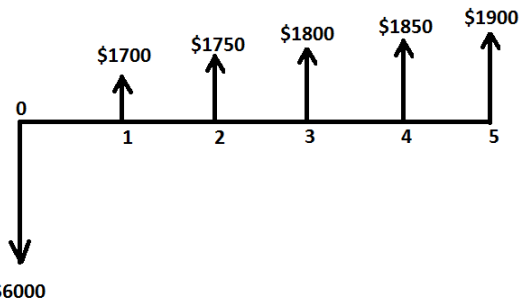



**Problem #1**

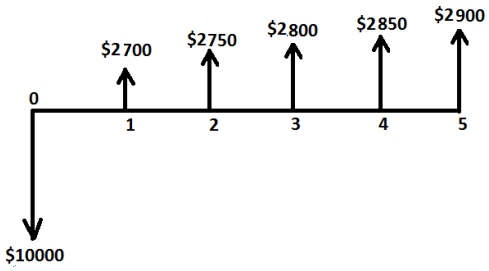
**(A)**




**(B)**



(C)




8.0%

| N | Single Payment: Compound Amount Factor (F/P,i,N) | Single Payment: Present Worth Factor (P/F,i,N) | Equal Payment Series: Compound Amount Factor (F/A,i,N) | Equal Payment Series: Sinking Fund Factor (A/F,i,N) | Equal Payment Series: Present Worth Factor (P/A,i,N) | Equal Payment Series: Capital Recovery Factor (A/P,i,N) | Gradient Series: Gradient Uniform Series (A/G,i,N) | Gradient Series: Gradient Present Worth (P/G,i,N) | N |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0800 | 0.9259 | 1.0000 | 1.0000 | 0.9259 | 1.0800 | 0.0000 | 0.0000 | 1 |
| 2 | 1.1664 | 0.8573 | 2.0800 | 0.4808 | 1.7833 | 0.5608 | 0.4808 | 0.8573 | 2 |
| 3 | 1.2597 | 0.7938 | 3.2464 | 0.3080 | 2.5771 | 0.3880 | 0.9487 | 2.4450 | 3 |
| 4 | 1.3605 | 0.7350 | 4.5061 | 0.2219 | 3.3121 | 0.3019 | 1.4040 | 4.6501 | 4 |
| 5 | 1.4693 | 0.6806 | 5.8666 | 0.1705 | 3.9927 | 0.2505 | 1.8465 | 7.3724 | 5 |

**(a) $NPW_A$ = -$ 2500 +$750(P/A,8%,5) +$ 50(P/G,8%,5)**
**= -$ 2500 +$750x3.9927+$ 50x7.3724 = $ 863**
**$NPW_B$ = -$ 6000 +$1700(P/A,8%,5) +$ 50(P/G,8%,5)**
**= -$ 6000 +$1700x3.9927+$ 5 $EUAB_A$ = 750 +50(P/G<8%,5)*(A/P,8%,5)**
**= 750 + 50*7.3724*0.2505 = $ 842.34**
**$EUAW_A$ =-626.25+842.34 =$ 216**
**0x7.3724 = $ 1156**
**$NPW_C$ = -$ 10000 +$2700(P/A,8%,5) +$ 50(P/G,8%,5)**
**= -$ 10000 +$2700x3.9927+$ 50x7.3724 = $ 1149**
**Chose B**

**b) $EUAC_A$ = 2500x0.2505 = $626.25**
**$EUAB_A$ = 750 +50(P/G,8%,5)*(A/P,8%,5)**
**= 750 + 50*7.3724*0.2505 = $ 842.34**
**$EUAW_A$ =-626.25+842.34 =$ 216**

**$EUAC_B$ = 6000x0.2505 = $1503**
**$EUAB_B$ = 1700 +50(P/G,8%,5)*(A/P,8%,5)**
**=1700 + 50*7.3724*0.2505 = $ 1792.34**
**$EUAW_B$ =-1503+1792.34 =$ 289.34**

**$EUAC_C$ = 10000x0.2505 = $2505**
**$EUAB_C$ = 2700 +50(P/G,8%,5)*(A/P,8%,5)**
**= 2700+ 50*7.3724*0.2505 = $ 2792.34**
**$EUAW_C$ =-2505+2792.34 =$ 287.34**
**CHHOSE B**
**C- Incremental analysis**
**B-A**
**$NPW_{B-A}$ = -$ 3500 +$950(P/A,8%,5) = -$3500 + $ 950*3.9927 = $ 293**
**Choose B**
**C-B**
**$NPW_{C-B}$ = -$4000 + 1000x3.9927 = - $7.3**
**Choose B**

**3- $NPW_A$ = -$ 650,000 -$ 91,810(P/A,15%,5)**
**= -$ 650,000 -$ 91,810x3.3522 = - $ 957,765.5**
**$NPW_B$ = -$ 780,000 -$ 73,000(P/A,15%,5)**
**= -$ 780,000 -$ 73,000x3.3522 = - $ 1024,710.6**
**$NPW_C$ = -$ 600,000 -$ 100,000(P/A,15%,5)**
**= -$ 600,000 -$ 100,000x3.3522 = - $ 935,220**
**$NPW_D$ = -$ 720,000 -$ 78,000(P/A,15%,5)**
**= -$ 720,000 -$ 78,000x3.3522 = - $ 981,471.6**
**Choose C minimum cost**
**ii)Use incremental approach**
**$NPW_{A-C}$ = -50000 + $ 8190x(P/A,15%,5) = - $ 22545.5**
**Choose C**
**$NPW_{D-C}$ = -120,000 + $ 22,000x(P/A,15%,5) = - $ 46,251.6**
**Choose C**
**$NPW_{B-C}$ = -180000 + $ 27000x(P/A,15%,5) = - $ 89,490.6**
**Choose C**
**C is the best**
**iii) With Constant dollar**
**i'=(i-f)/(1+f) = 0.06/1.09=0.0550458 5.50458%**
**(P/A,i' ,5) = 4.2697529**

**3- $NPW_A$ = -$ 650,000 -$ 91,810(P/A,5.50458%,5)**
**= -$ 650,000 -$ 91,810x4.2697529= - $ 1,042,006**
**$NPW_B$ = -$ 780,000 -$ 73,000(P/A,5.50458%,5)**
**= -$ 780,000 -$ 73,000x 4.2697529= - $ 1,091,692**
**$NPW_C$ = -$ 600,000 -$ 100,000(P/A,5.50458%,5)**
**= -$ 600,000 -$ 100,000x 4.2697529= - $ 1,026,975**
**$NPW_D$ = -$ 720,000 -$ 78,000(P/A,5.50458%,5)**
**= -$ 720,000 -$ 78,000x 4.2697529= - $ 1,053,040**
**Choose C**

15.0%

| | Single Payment | | Equal Payment Series | | | | Gradient Series | | |
|---|---|---|---|---|---|---|---|---|---|
| *N* | Compound Amount Factor *(F/P,i,N)* | Present Worth Factor *(P/F,i,N)* | Compound Amount Factor *(F/A,i,N)* | Sinking Fund Factor *(A/F,i,N)* | Present Worth Factor *(P/A,i,N)* | Capital Recovery Factor *(A/P,i,N)* | Gradient Uniform Series *(A/G,i,N)* | Gradient Present Worth *(P/G,i,N)* | *N* |
| 1 | 1.1500 | 0.8696 | 1.0000 | 1.0000 | 0.8696 | 1.1500 | 0.0000 | 0.0000 | 1 |
| 2 | 1.3225 | 0.7561 | 2.1500 | 0.4651 | 1.6257 | 0.6151 | 0.4651 | 0.7561 | 2 |
| 3 | 1.5209 | 0.6575 | 3.4725 | 0.2880 | 2.2832 | 0.4380 | 0.9071 | 2.0712 | 3 |
| 4 | 1.7490 | 0.5718 | 4.9934 | 0.2003 | 2.8550 | 0.3503 | 1.3263 | 3.7864 | 4 |
| 5 | 2.0114 | 0.4972 | 6.7424 | 0.1483 | 3.3522 | 0.2983 | 1.7228 | 5.7751 | 5 |

## Problem 4

| Year | Market value | Loss in Market value | Foregone interest | Operating Cost,$ | Maintenance Cost,$ | Salvage Value, $ | Total Recovery Cost |
|---|---|---|---|---|---|---|---|
| 0 | $60000 | | | | | | |
| 1 | 35.000 | -$25000 | -$6000 | --15,000 | -3000 | 35.000 | -$49000 |
| 2 | 30.000 | -$5000 | -$3500 | -17,000 | -3000 | 30.000 | -$28500 |
| 3 | 25.0000 | -$5000 | -$3000 | -19,000 | -3000 | 25.0000 | --$30000 |
| 4 | 20,000 | -$5000 | -$2500 | -21,000 | -3000 | 20,000 | -$31500 |
| 5 | 15,000 | -$5000 | -$2000 | -23,000 | -3000 | 15,000 | --$33000 |

**The life cost of one year is 49000**

**The EUAC for two years is = (49000+28500/(1+i))*(A/P,10%,2)= (49000+28500/(1+i))*5762= (49000 +25909)*0.5762=-$43162.6**
**The EUAC for three years is = (49000+28500/(1+i)+30000*(1+i)$^{-2}$)* A/P,10%,3)= (49000 +25909+ 24793.3)*0.4021=-$40090.3**
**The EUAC for four years is = (49000+28500/(1+i)+30000*(1+i)$^{-2}$)*+31500*(1+i)$^{-3}$)( A/P,10%,4)= (49000 +25909+24793.3 +23666.3)*0.3155=-$38922**
**The EUAC for five years is = (49000+28500/(1+i)+30000*(1+i)$^{-2}$)*+31500*(1+i)$^{-3}$+33000*(1+i)$^{-4}$)( A/P,10%,5)= (49000 +25909+24793.3 +23666.3+22539.4)*0.2638=-$38409**
**Economic life is 5 years**

| Year | Market value | EUAC of Capital recovery | Foregone interest | Operating Cost,$ | Maintenance Cost,$ | Salvage Value, $ | Total Recovery Cost |
|---|---|---|---|---|---|---|---|
| 0 | $60000 | | | | | | |
| 1 | 35.000 | -$25000 | -$6000 | --15,000 | -3000 | 35.000 | -$49000 |
| 2 | 30.000 | -$5000 | -$3500 | -17,000 | -3000 | 30.000 | -$28500 |
| 3 | 25.0000 | -$5000 | -$3000 | -19,000 | -3000 | 25.0000 | --$30000 |
| 4 | 20,000 | -$5000 | -$2500 | -21,000 | -3000 | 20,000 | -$31500 |
| 5 | 15,000 | -$5000 | -$2000 | -23,000 | -3000 | 15,000 | --$33000 |

**For one year**
**EUAC of Capital recovery for one year = -$60000*(A/P,10%,1) +$ 35000*(A/F,10%,1) =-$ 66000+$ 35000 =-$31000**
**EUAC of Capital recovery for two years =-$ 60000*(A/P,10%,2) + $ 30000*(A/F,10%,2)**

**=-$ 60000*0.5762 +$ 30000* 0.476 =-$ 20292**
**EUAC of Capital recovery for three years = -$60000*(A/P,10%,3) +$ 25000*(A/F,10%,3)**

**=-$ 60000*0.4021 +$25000* 0.3021=-$16573.5**
**EUAC of Capital recovery for four years =-$ 60000*(A/P,10%,4) +$ 20000*(A/F,10%,4) =-$ 60000*0.3155 +$20000* 0.2155=-$14620**

**EUAC of Capital recovery for five years =-$ 60000*(A/P,10%,5) +$ 15000*(A/F,10%,5) =-$ 60000*0..2638 +$15000* 0.1638 =-$13371**

| Year | Market value | EUAC of Capital recovery | Operating Cost,$ | Maintenance Cost,$ | Total EUAC |
|---|---|---|---|---|---|
| 0 | $60000 | | | | |
| 1 | 35.000 | -$31000 | --15,000 | -3000 | -$49000 |
| 2 | 30.000 | -$20292 | -17,000 | -3000 | -$40292 |
| 3 | 25.0000 | -$16573.5 | -19,000 | -3000 | --$38573 |
| 4 | 20,000 | -$14620 | -21,000 | -3000 | -$38620 |
| 5 | 15,000 | -$13371 | -23,000 | -3000 | --$39391 |

| Year | Market value | EUAC of Capital recovery | EUAC OP cost,$ | Maintenance Cost,$ | Total EUAC |
|---|---|---|---|---|---|
| 0 | $60000 | | | | |
| 1 | 35.000 | -$31000 | --15,000 | -3000 | -$49000 |
| 2 | 30.000 | -$20292 | -15,932.4 | -3000 | -$39224.4 |
| 3 | 25.0000 | -$16573.5 | -16873.2 | -3000 | --$36446.7 |
| 4 | 20,000 | -$14620 | -17636 | -3000 | -$35256 |
| 5 | 15,000 | -$13371 | -18620 | -3000 | --$34991 |

**Economic life is 5 years**

## Problem 5

Assume that the number of days per year for which the computer should be used is N
Annual cost for purchased computer if it works N days :
EUAC = P(A/P,10%,6) – SV(A/F,10%,6) + 60N + 3000
= 30,000x0.2297 – 4000.1296 + 60N + 3000
=60 N + 9,372.6
The AE should less or equal to the value for renting the computer for N days which is given by:
Renting Cost = 140 N
$\therefore 60N + 9372.6 \le 140N$

$$\therefore N \ge \frac{9272.6}{80} \ge 117.15 \rightarrow \therefore N = 118$$

10.0%

| | Single Payment | | Equal Payment Series | | | | Gradient Series | | |
|---|---|---|---|---|---|---|---|---|---|
| N | Compound Amount Factor (F/P,i,N) | Present Worth Factor (P/F,i,N) | Compound Amount Factor (F/A,i,N) | Sinking Fund Factor (A/F,i,N) | Present Worth Factor (P/A,i,N) | Capital Recovery Factor (A/P,i,N) | Gradient Uniform Series (A/G,i,N) | Gradient Present Worth (P/G,i,N) | N |
| 1 | 1.1000 | 0.9091 | 1.0000 | 1.0000 | 0.9091 | 1.1000 | 0.0000 | 0.0000 | 1 |
| 2 | 1.2100 | 0.8264 | 2.1000 | 0.4762 | 1.7355 | 0.5762 | 0.4762 | 0.8264 | 2 |
| 3 | 1.3310 | 0.7513 | 3.3100 | 0.3021 | 2.4869 | 0.4021 | 0.9366 | 2.3291 | 3 |
| 4 | 1.4641 | 0.6830 | 4.6410 | 0.2155 | 3.1699 | 0.3155 | 1.3812 | 4.3781 | 4 |
| 5 | 1.6105 | 0.6209 | 6.1051 | 0.1638 | 3.7908 | 0.2638 | 1.8101 | 6.8618 | 5 |
| 6 | 1.7716 | 0.5645 | 7.7156 | 0.1296 | 4.3553 | 0.2296 | 2.2236 | 9.6842 | 6 |

**Problem** 6

# 6 For Before tax
NPW =Present worth of Benefits – Present worth of cost
= A*(P/A,I,6) – 12000 = 0
= 3500*(P/A,I,6) – 15000 =0
Required I
(P/A,I,6) = 4.2857 and (A/P,I,6) = 0.2333333
From Table $10\% \prec i \prec 11\%$
By interpolation i=10.75%

For After Tax Rate of return

| Year | CF before taxes | SL Depr. | Taxable Inc. | Tax (40%) | CF after taxes |
|---|---|---|---|---|---|
| | (a) | (b) | (c) = (a) – (b) | (d) = - 40%(c) | (a) + (d) |
| 0 | -$15,000 | | | | -$15,000 |
| 1 | 3500 | 2500 | 1000 | -400 | 3100 |
| 2 | 3500 | 2500 | 1000 | --400 | 3100 |
| 3 | 3500 | 2500 | 1000 | -400 | 3100 |
| 4 | 3500 | 2500 | 1000 | -400 | 3100 |
| 5 | 3500 | 2500 | 1000 | -400 | 3100 |
| 6 | 3500 | 2500 | 1000 | -400 | 3100 |

For After tax
NPW =Present worth of Benefits – Present worth of cost

= A*(P/A,I,6) – 15000 = 0
= 3100*(P/A,I,6) – 15000 =0

Required I
(P/A,I,6) = 4.8387and (A/P,I,6) = 0.206666
From Table
I = 6.5%

They continue to be the equivalent of $3500 in Year-0 based dollars.

| Year | Ann. Benefit for both situations, in year-0 based dollars | No Inflation, A$ received = R$ | 5% inflation factors | 5% inflation, A$ received (multiply $3500 by |
|---|---|---|---|---|
| 1 | $3500 | $3500 | $1.05^1$ | $3675 |
| 2 | $3500 | $3500 | $1.05^2$ | $3859 |
| 3 | $3500 | $3500 | $1.05^3$ | $4052 |
| 4 | $3500 | $3500 | $1.05^4$ | $4254 |
| 5 | $3500 | $3500 | $1.05^5$ | $4467 |
| 6 | $3500 | $3500 | $1.05^6$ | $4690 |

Before-tax ROR.

CFS (-15000,3500, 3500, …, 3500) for case A has ROR = 10.74%.

For case B, first convert the CFS (-12000,3064, 3217, …., 3910) into today's constant dollars, which just gives (-12000,2918, 2918, …., 2918).
Thus, its ROR for case B is also 10.75%.

| Situation | ROR`s before taxes | ROR`s after taxes |
|---|---|---|
| A) No inflation | 10.75% | 6.5% |
| B) 5% inflation | 10.75% | |