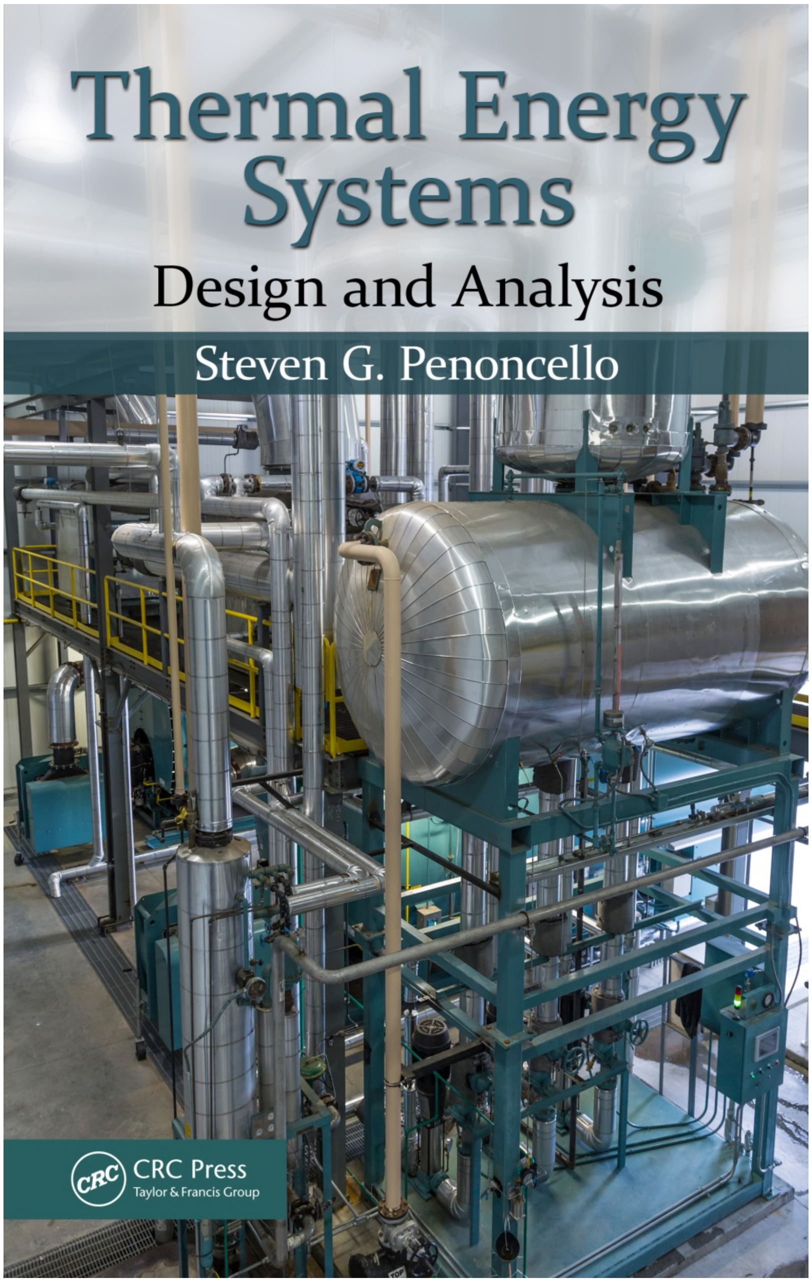
Solutions to Accompany



Chapter 2 – Engineering Economics

Engineering economy problems require the calculation of various interest factors listed in Table 2.2. An alternative is to create an EES function library that can be easily accessed to calculate these factors. An example of such a user-written function library is shown on pages 14 – 15. Subsequent problems in this chapter simply access the function library by calling the function name with the appropriate inputs.

INTERESTFACTORS

Equations

Single Payment Compound Amount Factor

function $F/P\,(i,\ n)$

$$F/P = (1+i)^n$$

end

Present Worth Factor

function $P/F\,(i,\ n)$

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

end

Uniform Series Sinking Fund Factor

function $A/F\,(i,\ n)$

$$A/F = \frac{i}{(1+i)^n - 1}$$

end

Compound Amount Factor

function $F/A\,(i,\ n)$

$$F/A = \frac{(1+i)^n - 1}{i}$$

end

Capital Recovery Factor

function $A/P\,(i,\ n)$

$$A/P = i \cdot \frac{(1+i)^n}{(1+i)^n - 1}$$

end

Uniform Series Present Worth Factor

function $P/A\,(i,\ n)$

$$P/A = \frac{(1+i)^n - 1}{i \cdot (1+i)^n}$$

end

Gradient Present Worth Factor

function $P/G\,(i,\ n)$

$$P/G = \frac{(1+i)^n - 1}{(i^2 \cdot (1+i)^n)} - \frac{n}{i \cdot (1+i)^n}$$

end

PROBLEM 2.1

Interest Factor Calculator

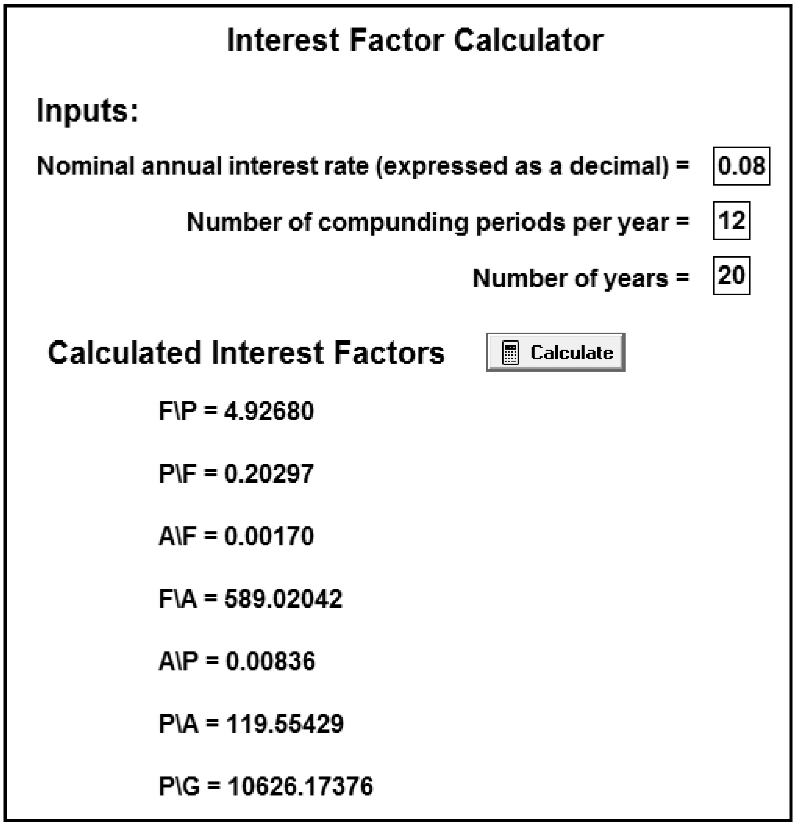
USER INPUTS	
7.00%	Nominal annual interest rate
4	Compounding periods per year
6	Number of years

i =	0.0175	Calculated interest per period
n =	24	Total number of periods

Interest Factors

P to F	F/P	1.516443
F to P	P/F	0.659438
F to A	A/F	0.033886
A to F	F/A	29.511016
P to A	A/P	0.051386
A to P	P/A	19.460686
G to P	P/G	207.667064

PROBLEM 2.02



Equations

Problem 2.2
Interest Factor Calculator using the EES Diagram Window for I/O

Input information

Calculations

These calculations access the user-written functions in InterestFactors.LIB

$F/P = FP\,(i/n_{yr},\ n \cdot n_{yr})$

$P/F = PF\,(i/n_{yr},\ n \cdot n_{yr})$

$A/F = AF\,(i/n_{yr},\ n \cdot n_{yr})$

$F/A = FA\,(i/n_{yr},\ n \cdot n_{yr})$

$A/P = AP\,(i/n_{yr},\ n \cdot n_{yr})$

$P/A = PA\,(i/n_{yr},\ n \cdot n_{yr})$

$P/G = PG\,(i/n_{yr},\ n \cdot n_{yr})$

PROBLEM 2.03

Equations

PROBLEM 2.3

GIVEN: A credit card advertising a nominal interest rate

$i = 0.125$

FIND: The effective rate

SOLUTION:

$$i_{eff} \cdot \left| 0.01 \ \frac{1}{\%} \right| = F/P - 1$$

Interest Factor

$$F/P = (1 + i/12)^{12}$$

Solution

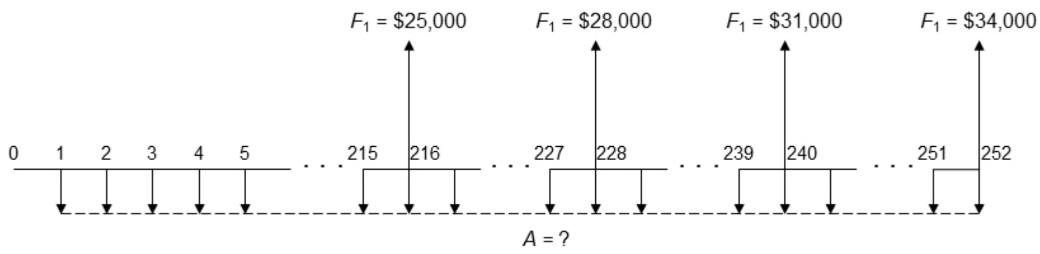
Variables in Main program

$F/P = 1.132 \quad i = 0.125 \quad i_{eff} = 13.24\,[\%]$

Key Variables

$i_{eff} = 13.24\,[\%]$ *effective annual rate*

PROBLEM 2.04



Equations

PROBLEM 2.4

GIVEN: College fund establishment

$i_{nom} = 0.04$

$F_1 = 25000$ [\$] Withdrawl for first year of college (age 18)

$F_2 = 28000$ [\$] Withdrawl for second year of college (age 19)

$F_3 = 31000$ [\$] Withdrawl for third year of college (age 20)

$F_4 = 34000$ [\$] Withdrawl for fourth year of college (age 21)

FIND: Monthly deposit required to obtain this goal

SOLUTION:

There are several ways to do this. In this solution, all money will be moved to time zero.

$$A \cdot P/A\,(i,\ n_{21}) = F_1 \cdot PF\,(i,\ n_{18}) + F_2 \cdot PF\,(i,\ n_{19}) + F_3 \cdot PF\,(i,\ n_{20}) + F_4 \cdot PF\,(i,\ n_{21})$$

The interest rate must be expressed on a monthly basis since interest is compounded monthly, but the analysis is considering years 18, 19, 20, and 21,

$i = i_{nom}/12$

The number of periods n_{18} ... n_{21} corresponds to the number of months before a withdrawl is taken

$n_{18} = 18 \cdot 12$

$n_{19} = 19 \cdot 12$

$n_{20} = 20 \cdot 12$

$n_{21} = 21 \cdot 12$

Solution

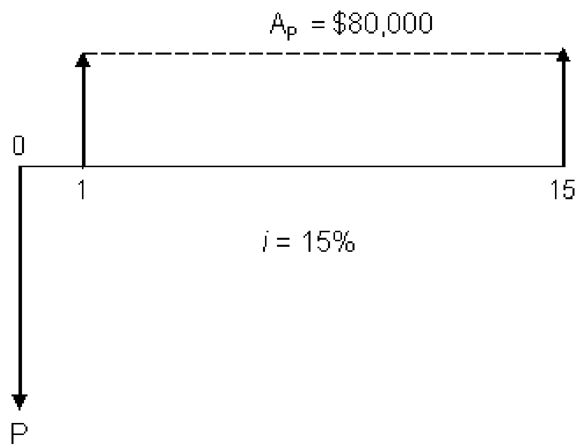
Variables in Main program

$A = 316.73$ [\$]	$F_1 = 25000$ [\$]	$F_2 = 28000$ [\$]
$F_3 = 31000$ [\$]	$F_4 = 34000$ [\$]	$i = 0.003333$
$i_{nom} = 0.04$	$n_{18} = 216$	$n_{19} = 228$
$n_{20} = 240$	$n_{21} = 252$	

Key Variables

$A = 316.73$ [\$] *monthly deposit required to meet goal*

PROBLEM 2.05



Equations

PROBLEM 2.5

GIVEN: A small scale silver mine

$A_P = 80000\ [\$]$

$n = 15$

$i = 0.15$

FIND: The amount of money that can be used to purchase the mine

SOLUTION:

Bringing all the mone back to the present,

$P = A_P \cdot P/A\,(i,\ n)$

Solution

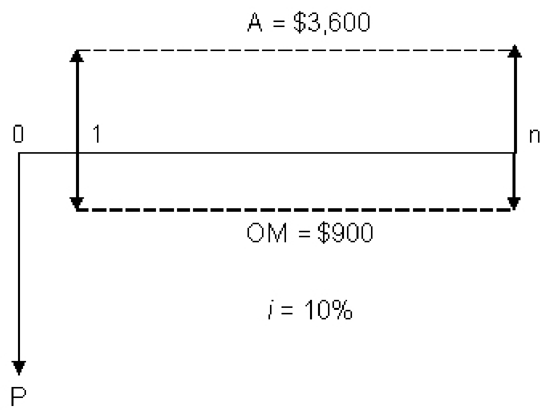
Variables in Main program

$A_P = 80000\,[\$]$ $\quad i = 0.15$ $\quad n = 15$
$P = 467790\,[\$]$

Key Variables

$P = 467790\,[\$]$ *Maximum bid to purchase the mine*

PROBLEM 2.06



Equations

PROBLEM 2.6

GIVEN: Analysis of a short-term storage facility

$P = 16000\ [\$]$

$OM = 900\ [\$]$

$A = 3600\ [\$]$

$i = 0.10$

FIND: How many years must the warehouse last?

SOLUTION:

There are several ways to solve this problem. Here, all costs will be converted to an annual series,

$P \cdot A/P\,(i,\ n) + OM = A$

Solution

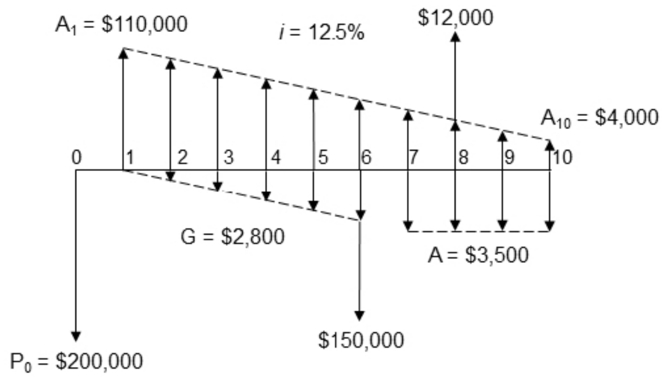
Variables in Main program

$A = 3600\,[\$]$	$i = 0.1$	$n = 9.421$
$OM = 900\,[\$]$	$P = 16000\,[\$]$	

Key Variables

$n = 9.421$ *Length of time the building must last (yrs)*

PROBLEM 2.07



Equations

PROBLEM 2.7

GIVEN: A cash flow diagram as shown

$P_0 = 200000$ [\$]

$G = 2800$ [\$]

$A = 3500$ [\$]

$A_1 = 110000$ [\$]

$A_{10} = 4000$ [\$]

$C_6 = 150000$ [\$] Cost at year 6

$I_8 = 12000$ [\$] Income at year 8

$i = 0.125$

$n = 10$

FIND: (a) the present value
(b) the future value
(c) the uniform annual value

SOLUTION:

Moving the cash flows to any point in the time line is relatively easy, except for the positive A values. They decrease linearly from 110,000 to 4,000. Calculating the gradient that causes this decrease,

$$G_A = \frac{A_1 - A_{10}}{n - 1}$$

Present value:

$$DEBITS_0 = P_0 + C_6 \cdot P/F\,(i,\ 6) + G \cdot PG\,(i,\ n) + A \cdot FA\,(i,\ 4) \cdot PF\,(i,\ 10)$$

$$INCOMES_0 = A_1 \cdot P/A\,(i,\ 10) - G_A \cdot PG\,(i,\ 10) + I_8 \cdot PF\,(i,\ 8)$$

$$PV = INCOMES_0 - DEBITS_0$$

Future value:

$$FV = PV \cdot F/P\,(i,\ 10)$$

Uniform annual value:

$$AV = PV \cdot A/P\,(i,\ 10)$$

Solution

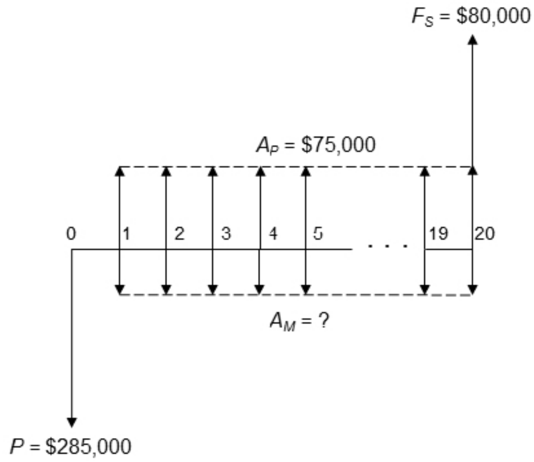
Variables in Main program

$A = 3500$ [$]	$AV = 8664$ [$]	$A_1 = 110000$ [$]
$A_{10} = 4000$ [$]	$C_6 = 150000$ [$]	$DEBITS_0 = 334216$ [$]
$FV = 155766$ [$]	$G = 2800$ [$]	$G_A = 11777.78$ [$]
$i = 0.125$	$INCOMES_0 = 382183$ [$]	$I_8 = 12000$ [$]
$n = 10$	$PV = 47967$ [$]	$P_0 = 200000$ [$]

Key Variables

$PV = 47967$ [$]	*equivalent present value (yr 0) of the cash flow diagram*
$FV = 155766$ [$]	*equivalent future value (yr 10) of the cash flow diagram*
$AV = 8664$ [$]	*equivalent uniform annual series value of the cash flow diagram*

PROBLEM 2.08



Equations

PROBLEM 2.8

GIVEN: Investment in a new machine for a production facility

$P = 285000\ [\$]$ Initial cost of the machine

$A_P = 75000\ [\$]$ Annual increase in profits

$F_S = 80000\ [\$]$ Salvage value of the machine

$i = 0.25$ Minimum required rate of return

$n = 20$ Life of the machine

FIND: The annual acceptable maintenance expenditures

SOLUTION:

There are several ways to solve this problem.
Converting all cash to an annual basis,

$P \cdot A/P\,(i,\ n) + A_{M,1} = F_S \cdot AF\,(i,\ n) + A_P$

Converting all the cash to a present value,

$P + A_{M,2} \cdot P/A\,(i,\ n) = A_P \cdot PA\,(i,\ n) + F_S \cdot PF\,(i,\ n)$

Converting all the cash to a future value,

$P \cdot F/P\,(i,\ n) + A_{M,3} \cdot FA\,(i,\ n) = A_P \cdot FA\,(i,\ n) + F_s$

Solution

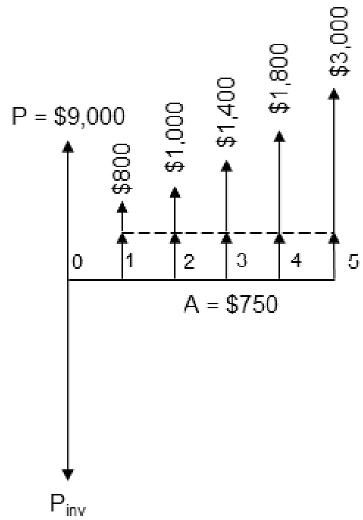
Variables in Main program

$A_{M,1} = 3152\,[\$]$	$A_{M,2} = 3152\,[\$]$	$A_{M,3} = 3152\,[\$]$
$A_P = 75000\,[\$]$	$F_S = 80000\,[\$]$	$i = 0.25$
$n = 20$	$P = 285000\,[\$]$	

Key Variables

$A_{M,3} = 3152\,[\$]$	*Converting to a future value*
$A_{M,1} = 3152\,[\$]$	*Converting to an annual series*
$A_{M,2} = 3152\,[\$]$	*Converting to a present value*

PROBLEM 2.09



Equations

PROBLEM 2.9

GIVEN: A machine with the following economic data

$P = 9000\ [\$]$

$O = 750\ [\$]$

$M_1 = 800\ [\$]$

$M_2 = 1000\ [\$]$

$M_3 = 1400\ [\$]$

$M_4 = 1800\ [\$]$

$M_5 = 3000\ [\$]$

$i = 0.06$

$n = 5$

FIND: The initial investment required to pay for the machine

SOLUTION:

Since the operating costs are given on an annual basis, and the compounding period is monthly, this problem can be solved on an annual basis using the effective interest rate

$i_{eff} = F/P\,(i/12,\ 12) - 1$

Moving all the cash to time zero ...

$$P_{inv} = P + O \cdot P/A\,(i_{eff},\ n) + M_1 \cdot PF\,(i_{eff},\ 1) + M_2 \cdot PF\,(i_{eff},\ 2)$$
$$+ M_3 \cdot P/F\,(i_{eff},\ 3) + M_4 \cdot PF\,(i_{eff},\ 4) + M_5 \cdot PF\,(i_{eff},\ 5)$$

Solution

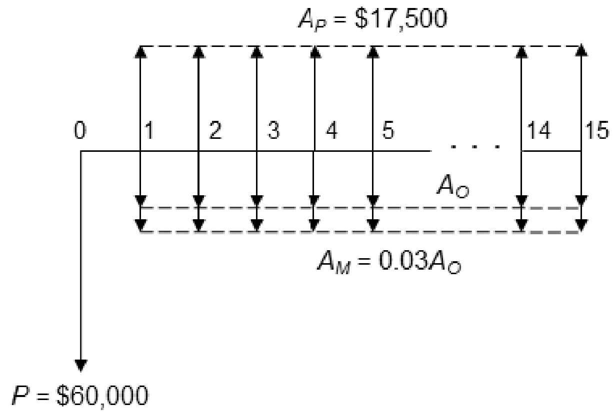
Variables in Main program

$i = 0.06$	$i_{eff} = 0.06168$	$M_1 = 800$ [$]
$M_2 = 1000$ [$]	$M_3 = 1400$ [$]	$M_4 = 1800$ [$]
$M_5 = 3000$ [$]	$n = 5$	$O = 750$ [$]
$P = 9000$ [$]	$P_{inv} = 18596$ [$]	

Key Variables

$P_{inv} = 18596$ [$] *Investment required to pay for the machine and its maintenance costs*

PROBLEM 2.10



Equations

PROBLEM 2.10

GIVEN: A chemical processing plant

$P = 60000$ [\$] Initial cost of the piping system

$A_P = 17500$ [\$] Profits realized by the piping system

$A_M = 0.03 \cdot A_O$ Annual maintenance costs

$C_e = 0.12$ [\$/kWh] Cost of energy to run the system

$n = 15$ Life of the system

$\rho = 48.5 \; [\mathrm{lbm/ft^3}]$ Density of the cyclohexane

$\Delta P = 6.4 \; [\psi]$ Pressure drop through the system

$\dot{Vol} = 1200$ [gpm] Volumetric flow rate of the cyclohexane

FIND: The rate of return

SOLUTION:

The annual cost of energy used to move the fluid through the system is,

$$\dot{W} = \left(\dot{m} \cdot \frac{\Delta P}{\rho}\right) \cdot \left| 5.42327 \times 10^{-5} \; \frac{\mathrm{kW}}{\psi \cdot \mathrm{ft^3/hr}} \right|$$

The mass flow rate of the cyclohexane through the system is,

$$\dot{m} = \rho \cdot \dot{Vol} \cdot \left| 8.02083379 \; \frac{\mathrm{ft^3/hr}}{\mathrm{gpm}} \right|$$

The total energy used per year is,

$$W = \dot{W} \cdot (24 \ [\text{hr/day}]) \cdot (7 \ [\text{day/week}]) \cdot (52 \ [\text{week}])$$

The annual cost of the energy is,

$$A_O = C_e \cdot W$$

Assuming annual compounding,

$$P \cdot A/P \left(i \cdot \left| 0.01 \ \frac{1}{\%} \right|, \ \text{n} \right) + A_O + A_M = A_P$$

Solution

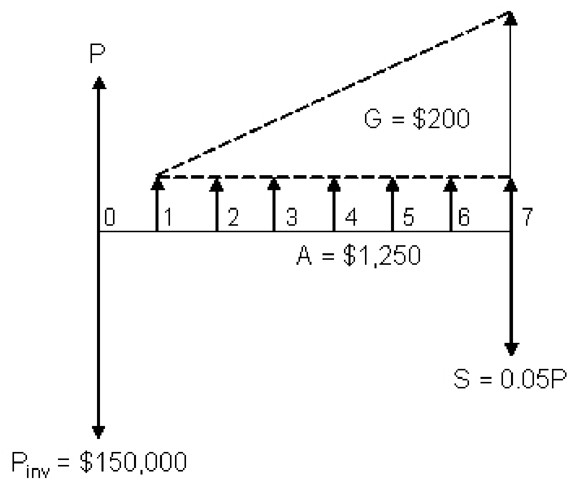
Variables in Main program

$A_M = 105.1\,[\$]$	$A_O = 3502\,[\$]$	$A_P = 17500\,[\$]$
$C_e = 0.12\,[\$/\text{kWh}]$	$\Delta P = 6.4\,[\text{psi}]$	$i = 21.98\,[\%]$
$\dot{m} = 466813\,[\text{lbm/hr}]$	$n = 15$	$P = 60000\,[\$]$
$\rho = 48.5\,\left[\text{lbm/ft}^3\right]$	$\dot{Vol} = 1200\,[\text{gpm}]$	$W = 29185\,[\text{kW-hr}]$
$\dot{W} = 3.341\,[\text{kW}]$		

Key Variables

$i = 21.98\,[\%]$ *Rate of return*

PROBLEM 2.11



Equations

PROBLEM 2.11

GIVEN: A machine with the following economic data

$P_{inv} = 150000\ [\$]$

$A = 1250\ [\$]$

$G = 200\ [\$]$

$S = 0.05 \cdot P$

$i = 0.08$

$n = 7$

FIND: The initial investment required to pay for the machine

SOLUTION:

The interest is compounded quarterly, but the gradient is on a yearly basis. Therefore, this problem will be solved by analyzing the cash flow diagram on a yearly basis but using the effective interest rate rather than the nominal interest rate.

$P_{inv} + S \cdot P/F\,(i_{eff},\ n) = P + A \cdot PA\,(i_{eff},\ n) + G \cdot PG\,(i_{eff},\ n)$

$i_{eff} = F/P\,(i/4,\ 4) - 1$

Solution

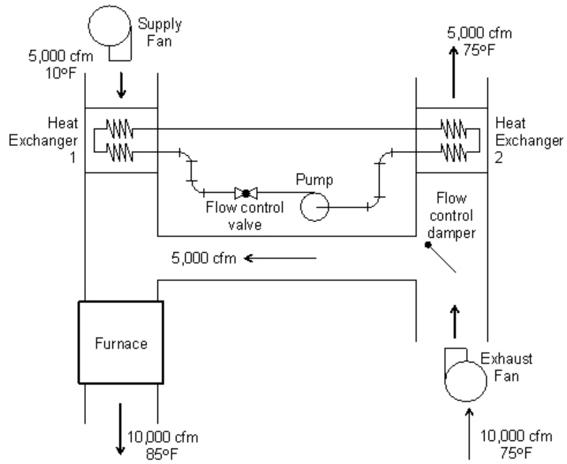
Variables in Main program

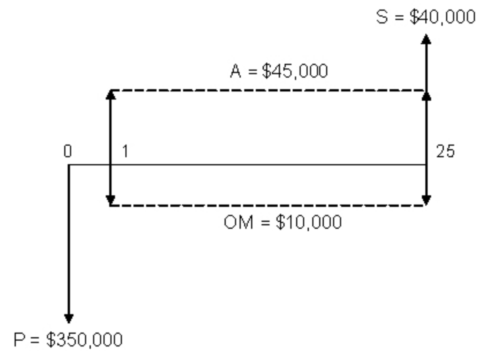
$A = 1250\,[\$]$	$G = 200\,[\$]$	$i = 0.08$
$i_{eff} = 0.08243$	$n = 7$	$P = 144936\,[\$]$
$P_{inv} = 150000\,[\$]$	$S = 7247\,[\$]$	

Key Variables

$P = 144936\,[\$]$ *Maximum amount of money that can be spent on the machine*

PROBLEM 2.12





Equations

PROBLEM 2.12

GIVEN: A proposed heat recovery system with the following economic parameters,

$P = 350000$ [$] Initial cost of the system

$OM = 10000$ [$] Annual operating and maintenance costs

$n = 25$ Economic life

$S = 40000$ [$] Salvage value

$A = 45000$ [$] Annual savings in fuel

$i_{mgmt} = 0.12$ minimum required rate of return

FIND: (a) the rate of return for this scenario
(b) if management requires a rate of return of 12%, how much can be spent on the heat recovery system?

SOLUTION:

(a) This problem can be solved in several ways. Converting all the funds to an annual series,

$$P \cdot A/P\left(i \cdot \left|0.01\ \frac{1}{\%}\right|,\ \text{n}\right) + OM = A + S \cdot AF\left(i \cdot \left|0.01\ \frac{1}{\%}\right|,\ \text{n}\right)$$

(b) The same equations from part (a) can be used ... substitute i_{mgmt} for i

$$P_b \cdot A/P\left(i_{mgmt},\ n\right) + OM = A + S \cdot AF\left(i_{mgmt},\ n\right)$$

Solution

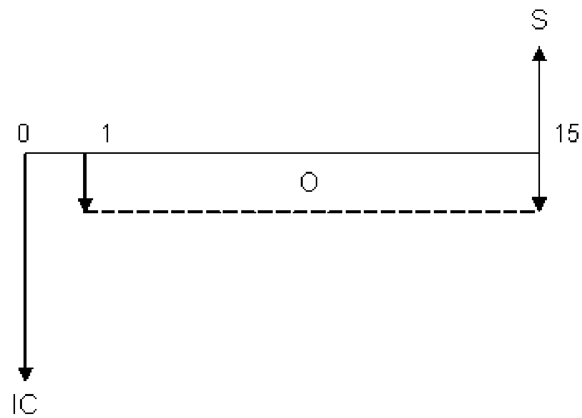
Variables in Main program

$A = 45000\,[\$]$	$i = 8.946\,[\%]$	$i_{mgmt} = 0.12$
$n = 25$	$OM = 10000\,[\$]$	$P = 350000\,[\$]$
$P_b = 276863\,[\$]$	$S = 40000\,[\$]$	

Key Variables

$i = 8.946\,[\%]$	*(a) rate of return for the heat recovery system*
$P_b = 276863\,[\$]$	*(b) Maximum that can be spent at time 0 for a rate of return of 12*

PROBLEM 2.13



Equations

PROBLEM 2.13

GIVEN: Three alternatives for a compressor drive

$Drive\$_{1..3} =$ 'Gasoline' , 'Diesel' , 'Electric'

$IC_{1..3} =_{10000\ [\$}\ ,\ 12000\ [\$]\ ,\ 18000\ [\$]]$

$S_{1..3} =_{3200\ [\$}\ ,\ 5800\ [\$]\ ,\ 2400\ [\$]]$

$FC_{1..3} =_{0.48\ [\mathrm{lbm/hp{\cdot}hr}}\ ,\ 0.36\ [\mathrm{lbm/hp \cdot hr}]\ ,\ 0]$

$Cost_{fuel,1..3} =_{3.28\ [\$/\mathrm{gal}}\ ,\ 3.89\ [\$/\mathrm{gal}]\ ,\ 0]$

$Cost_{elec,1..3} =_{0,\ 0,\ 0.11\ [\$/\mathrm{kWh}}]$

$\rho_{fuel,1..3} =_{43.7\ [\mathrm{lbm/ft^3}}\ ,\ 46.7\ \left[\mathrm{lbm/ft^3}\right]\ ,\ 1\ \left[\mathrm{lbm/ft^3}\right]]$

$elec_{1..3} =_{0,\ 0,\ 1}$ switch to specify non-electric (0) or electric (1) drive

$n = 15$

$i = 0.18$

$\dot{W} = 400\ [\mathrm{hp}]$

$time = 8\ [\mathrm{hr/day}] \cdot 270\ [\mathrm{day}]$ annual operation hours

FIND: Which drive is the best economic alternative

SOLUTION:

The lives are the same for all three alternatives. Therefore, the AC or PW method will work. Both soultions are shown here.

duplicate $k = 1,\ 3$

$$AC_k = -IC_k \cdot A/P\,(i,\ n) - O_{fuel,k} - O_{elec,k} + S_k \cdot AF\,(i,\ n) \qquad \text{Annual Cost}$$

$$PW_k = -IC_k - (O_{fuel,k} + O_{elec,k}) \cdot P/A\,(i,\ n) + S_k \cdot PF\,(i,\ n) \qquad \text{Present Worth}$$

$$O_{fuel,k} = gallons_k \cdot Cost_{fuel,k} \qquad \text{Annual operating cost - fuel}$$

$$O_{elec,k} = kWh_k \cdot Cost_{elec,k} \qquad \text{Annual operating cost - electricity}$$

$$gallons_k = \left(\dot{W} \cdot time \cdot \left(\frac{FC_k}{\rho_{fuel,k}}\right)\right) \cdot \left|7.48051945\ \frac{\text{gal}}{\text{ft}^3}\right| \qquad \text{gallons of fuel used per year}$$

$$kWh_k = \left(\dot{W} \cdot \left|0.7457\ \frac{\text{kW}}{\text{hp}}\right|\right) \cdot time \cdot elec_k \qquad \text{kWh used per year}$$

end

Solution

$i = 0.18 \qquad n = 15 \qquad time = 2160\ [\text{hr}]$
$\dot{W} = 400\ [\text{hp}]$

Arrays Table: $Main$

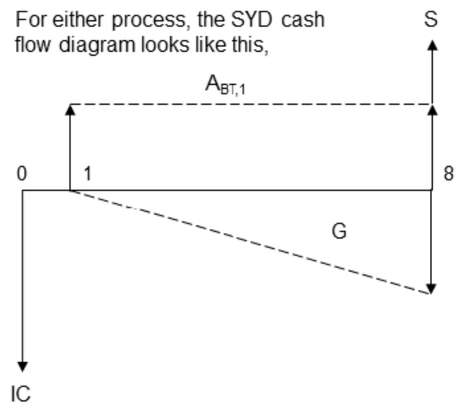
Row	$Drive\$_i$	$elec_i$	IC_i [\$]	S_i [\$]	FC_i [lbm/hp-hr]	$Cost_{fuel,i}$ [\$/gal]	$Cost_{elec,i}$ [\$/kWh]	$\rho_{fuel,i}$ [lbm/ft^3]	$gallons_i$ [gal]
1	Gasoline	0	10000	3200	0.48	3.28	0	43.7	70991
2	Diesel	0	12000	5800	0.36	3.89	0	46.7	49823
3	Electric	1	18000	2400	0	0	0.11	1	0

Row	kWh_i [kWh]	$O_{fuel,i}$ [\$]	$O_{elec,i}$ [\$]	AC_i [\$]	PW_i [\$]
1	0	232852	0	-234763	-1.195E6
2	0	193812	0	-196074	-998325
3	644285	0	70871	-74367	-378646

Report

The electric motor is the best economic alternative.

PROBLEM 2.14



Equations

Problem 2.14

GIVEN: Two possible heat treatment processes

Process [1]

$P_1 = 30000$ [$]

$A_{o,1} = 12000$ [$]

$A_{p,1} = 20000$ [$]

$F_1 = 10000$ [$]

Process [2]

$P_2 = 21000$ [$]

$A_{o,2} = 15000$ [$]

$A_{p,2} = 20000$ [$]

$F_2 = 7000$ [$]

Tax information

$N = 8$

$t = 0.52$

Depreciation is SYD

FIND: Which process should be selected based on the rate of return analysis?

SOLUTION:

A DUPLICATE loop will be used to calculate the interest rate for each alternative

duplicate $k = 1,\ 2$

Calculation of the gradient

$$D_{1,k} = 2 \cdot (P_k - F_k) \cdot \frac{N - 1 + 1}{N \cdot (N + 1)}$$

$$D_{2,k} = 2 \cdot (P_k - F_k) \cdot \frac{N - 2 + 1}{N \cdot (N + 1)}$$

$$A_k = A_{p,k} - A_{o,k}$$

$$A_{AT,1,k} = A_k - t \cdot (A_k - D_{1,k})$$

$$A_{AT,2,k} = A_k - t \cdot (A_k - D_{2,k})$$

$$G_k = A_{AT,1,k} - A_{AT,2,k}$$

Determination of the interest rate

$$P_k = A_{AT,1,k} \cdot P/A\,(i_k,\ N) - G_k \cdot PG\,(i_k,\ N) + F_k \cdot PF\,(i_k,\ N)$$

end

Solution

$N = 8 \quad t = 0.52$

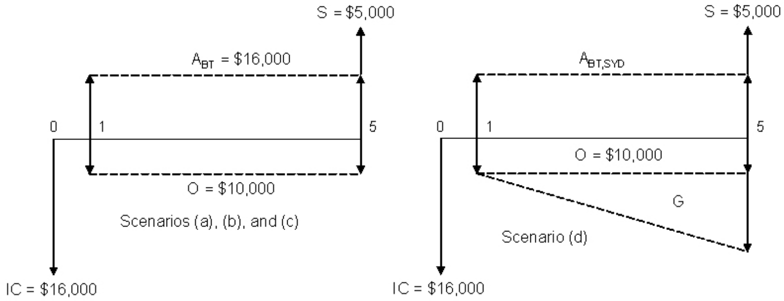
Arrays Table: $Main$

Row	P_i [$]	F_i [$]	$A_{o,i}$ [$]	$A_{p,i}$ [$]	A_i [$]	$D_{1,i}$ [$]	$D_{2,i}$ [$]	$A_{AT,1,i}$ [$]	$A_{AT,2,i}$ [$]	G_i [$]	i_i
1	30000	10000	12000	20000	8000	4444	3889	6151	5862	288.9	0.1237
2	21000	7000	15000	20000	5000	3111	2722	4018	3816	202.2	0.1055

Report

Based on this analysis, Process 1 has the higher rate of return. Therefore, select heat treatment process 1.

PROBLEM 2.15



Equations

PROBLEM 2.15

GIVEN: Purchase of a computer system

$IC = 18000$ [$]

$S = 5000$ [$]

$O = 10000$ [$]

$A_{BT} = 16000$ [$]

$n = 5$

$t = 0.50$

FIND: The rate of return (a) before taxes
(b) after taxes with no depreciation
(c) after taxes using SLD
(d) after taxes using SYD

SOLUTION:

Scenario

$Scenario\$_1$ = 'no tax'

$Scenario\$_2$ = 'after tax no depreciation'

$Scenario\$_3$ = 'after tax with SLD'

$Scenario\$_4$ = 'after tax with SYD'

Scenarios [1], [2], and [3]

duplicate $k = 1,\ 3$

$$IC = A_{AT,k} \cdot P/A\,(i_k,\ n) + S \cdot PF\,(i_k,\ n)$$

end

After tax cash flows

$A_{AT,1} = A_{BT} - O$

$A_{AT,2} = (A_{BT} - O) \cdot (1 - t)$

$A_{AT,3} = (A_{BT} - O) - t \cdot ((A_{BT} - O) - D_{SLD})$

Depreciation scheme - SLD

$D_{SLD} = \dfrac{IC - S}{n}$

Scenario [4]: SYD

$IC + G \cdot P/G\,(i_4,\ n) = A_{AT,4} \cdot PA\,(i_4,\ n) + S \cdot PF\,(i_4,\ n)$

Convert interest rates to percent

duplicate $k = 1,\ 4$

$i_{pct,k} = i_k \cdot |100\ \%|$

end

Calculated the gradient and after tax cash flow at year 1 using the first two years of the scenario

duplicate $k = 1,\ 2$

$D_k = 2 \cdot (IC - S) \cdot \dfrac{n - k + 1}{n \cdot (n + 1)}$

$A_{AT,SYD,k} = (A_{BT} - O) - t \cdot ((A_{BT} - O) - D_k)$

end

$G = A_{AT,SYD,1} - A_{AT,SYD,2}$

$A_{AT,4} = A_{AT,SYD,1}$

Solution

$A_{BT} = 16000$ [\$]	$D_{SLD} = 2600$ [\$]	$G = 433.3$ [\$]
$IC = 18000$ [\$]	$n = 5$	$O = 10000$ [\$]
$S = 5000$ [\$]	$t = 0.5$	

Arrays Table: $Main$

Row	$Scenario\$_i$	$A_{AT,i}$ [\$]	i_i	$i_{pct,i}$ [%]	D_i [\$]	$A_{AT,SYD,i}$ [\$]
1	no tax	6000	0.2444	24.44	4333	5167
2	after tax no depreciation	3000	0.0309	3.087	3467	4733
3	after tax with SLD	4300	0.1267	12.67		
4	after tax with SYD	5167	0.1345	13.45		