

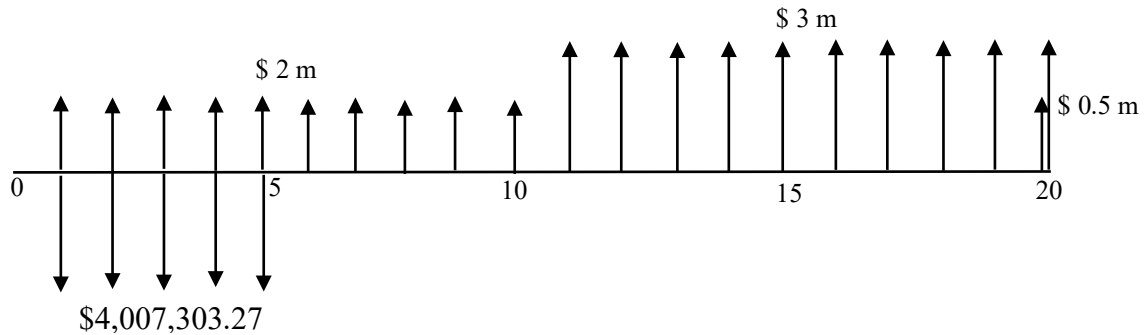
TIE2140 Engineering Economy Solutions to Assignment #2

(a)

$$\begin{aligned}
 \text{Annual repayment amount} &= 16,000,000 [A/P, 8\%, 5] \\
 &= 16,000,000 (0.250456455) \\
 &= \mathbf{\$ 4,007,303.27}
 \end{aligned}$$

(b)

Cash flow diagram:



(c)

$$\begin{aligned}
 PW(10\%) &= -4,007,303.27 [P/A, 10\%, 5] && // \text{Loan repayments} \\
 &+ 2,000,000 [P/A, 10\%, 10] && // \text{Profits for years 1 to 10} \\
 &+ 3,000,000 [P/A, 10\%, 10] [P/F, 10\%, 10] && // \text{Profit for years 11 to 20} \\
 &+ 500,000 [P/F, 10\%, 20] && // \text{SV at EoY 20} \\
 \\
 &= -4,007,303.27 (3.790786769) \\
 &+ 2,000,000 (6.144567106) \\
 &+ 3,000,000 (6.144567106) (0.385543289) \\
 &+ 500,000 (0.148643628) \\
 &= \mathbf{\$ 4,279,613.64} > 0
 \end{aligned}$$

The project is financially feasible.

(d)

The IRR is i such that

$$\begin{aligned}PW(i) &= -4,007,303.27 [P/A, i, 5] + 2,000,000 [P/A, i, 10] \\ &\quad + 3,000,000 [P/A, i, 10] [P/F, 10\%, 10] + 500,000 [P/F, i, 20] = 0 \\ &= -4,007,303.27 \left(\frac{1-(1+i)^{-5}}{i} \right) + 2,000,000 \left(\frac{1-(1+i)^{-10}}{i} \right) + 3,000,000 \left(\frac{1-(1+i)^{-10}}{i} \right) \left(\frac{1}{(1+i)^{10}} \right) + \\ &\quad 500,000 \left(\frac{1}{(1+i)^{20}} \right) = 0\end{aligned}$$

Using an equation solver: $i = 0.1570$

Hence IRR = **15.70 %**

(e)

Financing rate = 8%

Reinvestment rate = 10%?

$$\begin{aligned}|PW(-ve CF at 8\%)| &= (4,007,303.27 - 2,000,000) [P/A, 8\%, 5] \\ &= 2,007,303.27 (3.992710037) \\ &= \$ 8,014,579.93\end{aligned}$$

$$\begin{aligned}FW(+ve CF at 10\%) &= 2,000,000 [F/A, 10\%, 5] [F/P, 10\%, 10] \\ &\quad + 3,000,000 [F/A, 10\%, 10] \\ &\quad + 500,000 \\ &= 2,000,000 (6.1051) (2.59374246) \\ &\quad + 3,000,000 (15.93742460) \\ &\quad + 500,000 \\ &= \$79,982,387.99\end{aligned}$$

$$\begin{aligned}MIRR &= \sqrt[20]{\frac{79,982,387.99}{8,014,579.93}} - 1 = 0.1219 \\ &= \mathbf{12.19\%}\end{aligned}$$

(f)

$PW(10\%)$ of CF for the Years 1 to 13 =

$$\begin{aligned} & -2,007,303.27 [P/A, 10\%, 5] \\ & + 2,000,000 [P/A, 10\%, 5] [P/F, 10\%, 5] \\ & + 3,000,000 [P/A, 10\%, 3] [P/F, 10\%, 10] \\ = & -2,007,303.27 (3.79078677) \\ & + 2,000,000 (3.79078677) (0.62092132) \\ & + 3,000,000 (2.48685199) (0.38554329) \\ = & -\$25,330.73 < 0 \end{aligned}$$

$PW(10\%)$ of CF for the Years 1 to 14 =

$$\begin{aligned} & = PW(10\%) \text{ of CF for the Years 1 to 13} + 3,000,000 [P/F, 10\%, 14] \\ & = -25,330.73 + 3,000,000 (0.26333125) \\ & = -25,330.73 + 789,993.76 \\ & = \$ 764,663.04 > 0 \end{aligned}$$

Since $PW(10\%, 13 \text{ years}) < 0 < PW(10\%, 14 \text{ years})$, it follows that the discounted payoff period of the project is **14 years**.