CE167: Engineering Project Management Spring 2007
Professor William Ibbs

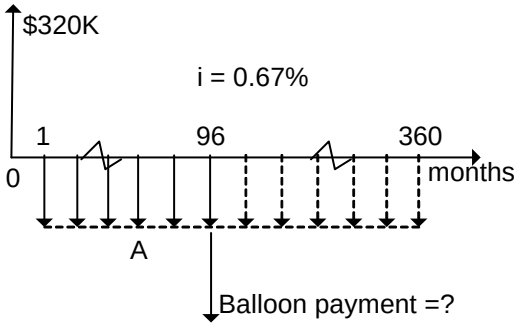
MIDTERM 1 SOLUTIONS Date: February 27, 2007

1. [15 points]
1.a. [3 points] A project is a **temporary** endeavor undertaken to create a **unique** product or service.
Two characteristics make projects differ from operations:
[1 points] Temporary vs. ongoing
[1 points] Unique vs. repetitive

1.b. [4 points] Third-party beneficiary relationship: when **each of two** or more separate entities has a **valid contract** with a **common third entity**, they may be third-party beneficiaries of the contract between the "common" entity and the other noncommon entities.

1.c. [6 points] Give at least three of the following assumptions [2 points per assumption]:
1. Cash flows are known
2. Cash flows are in constant-value currency (dollars); that is, we ignore the effect of inflation and we assume technological stability
3. Interest rate is known. The rate of return i required by an organization is a function of its cost of capital, attitude toward risk, and investment policy.
4. Comparisons are made with before-tax cash flows
5. Comparisons do not include intangible considerations
6. Comparisons do not include consideration of the availability of funds to implement alternatives.

2. [20 points] (Note: Students can use the effective interest rate per year = $(1 + \frac{0.08}{12})^{12} - 1 =$ 0.083 = 8.3%)
[3 points] The amount of the mortgage: P = \$400K x 0.8 = \$320K
[3 points] Effective interest rate per month: $i = \frac{8}{12} = 0.67\% = 0.0067$
Number of monthly payments: 30 years x 12 months/year = 360 months



Cash flow diagram [3 points]

[5 points] Equal monthly payments: A = \$320K x (A/P, i%, n) = \$320K x $\frac{i(1+i)^n}{(1+i)^n - 1}$

$$A = \$320K \times \frac{0.0067(1 + 0.0067)^{360}}{(1 + 0.0067)^{360} - 1} = \$320K \times 0.0737 = \$2,357$$

Solution 1: [6 points] The balloon payment at year 8 = Present value of the monthly payments for the remaining years (22 years x 12 months/year = 264 months)

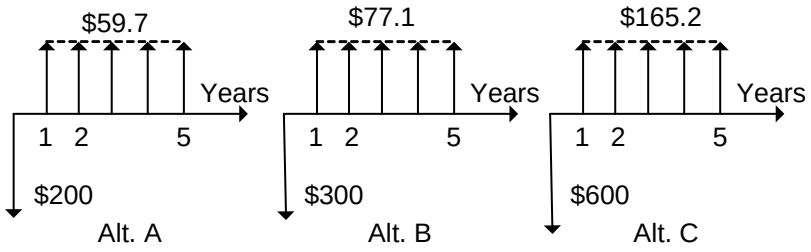
$$= \$2.357K \times (P/A, i\%, n) = \$2.357K \times \frac{(1 + 0.0067)^{264} - 1}{0.0067(1 + 0.0067)^{264}} = \mathbf{\$291.44K}$$

Solution 2: [6 points] The balloon payment at year 8 = Future value (at year 8) of the mortgage – Future value (at year 8) of the monthly payments for last 8 years (8 years x 12 months/year = 96 months)

$$= \$320K \times (F/P, i\%, n) - \$2.357K \times (F/A, i\%, n) = \$320K \times (1 + i)^n - \$2.357K \times \frac{(1 + i)^n - 1}{i}$$

$$= \$320K \times 1.0067^{96} - \$2.357K \times \frac{1.0067^{96} - 1}{0.0067} = \$607.51K - \$316.08K = \mathbf{\$291.43K}$$

3. [25 points]



Cash flow diagram [3 points]

Step 1: Find IRR for each alternative

[1 point] $NPV_A = -\$200 + \$59.7 \times (P/A, i\%, 5) = 0 \rightarrow (P/A, i\%, 5) = 3.3501$.

[2 points] Observe interest factor tables, $IRR_A \approx 15\%$

[1 point] $NPV_B = -\$300 + \$77.1 \times (P/A, i\%, 5) = 0 \rightarrow (P/A, i\%, 5) = 3.8911$.

[2 points] Observe interest factor tables, $IRR_B \approx 9\%$

[1 point] $NPV_C = -\$600 + \$165.2 \times (P/A, i\%, 5) = 0 \rightarrow (P/A, i\%, 5) = 3.6320$.

Observe interest factor tables, IRR_C is somewhere between 11% and 12%.

$NPV_C (11\%) = -\$600 + \$165.2 \times 3.6959 = \$10.56$

$NPV_C (12\%) = -\$600 + \$165.2 \times 3.6048 = -\$4.49$

[2 points] $\rightarrow IRR_C = 11\% + \frac{0 - \$10.56}{-\$4.49 - \$10.56} \times (12\% - 11\%) \approx 11.7\%$

[1 point] **Necessary condition**: $IRR_C \geq MARR \rightarrow MARR \leq 11.7\%$

Step 2: Find IRR's for investment increments (Note: since we just want to know when C is preferred, we do not have to find IRR_{B-A}. Of course, it is OK if you do that)

[1 point] $NPV_{C-B} = -\$300 + \$88.1 \times (P/A, i\%, 5) = 0 \rightarrow (P/A, i\%, 5) = 3.4052$.

Observe interest factor tables, IRR_{C-B} is somewhere between 12% and 15%.

[1 point] $NPV_{C-B} (12\%) = -\$300 + \$88.1 \times 3.6048 = \$17.58$

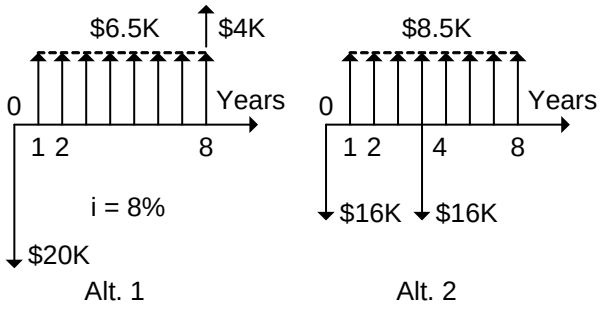
[1 point] $NPV_{C-B} (15\%) = -\$300 + \$88.1 \times 3.3522 = -\$4.67$

[1 point] $\rightarrow IRR_{C-B} = 12\% + \frac{0 - \$17.58}{-\$4.67 - \$17.58} \times (15\% - 12\%) \approx 14.37\%$

[1 point] $NPV_{C-A} = -\$400 + \$105.5 \times (P/A, i\%, 5) = 0 \rightarrow (P/A, i\%, 5) = 3.7915$.

[3 points] Observe interest factor tables, $IRR_{C-A} \approx 10\%$.
[2 points] **Sufficient condition**: $IRR_{C-B} \geq MARR$ and $IRR_{C-A} \geq MARR \rightarrow MARR \leq 10\%$
[2 points]→ **Necessary and sufficient conditions**: $MARR \leq 11.7\%$ and $MARR \leq 10\%$
→ **$MARR \leq 10\%$**.

4. [20 points]
The solutions are based on an eight-year analysis period and a replacement alternative 2 that is identical to the present alternative 2.

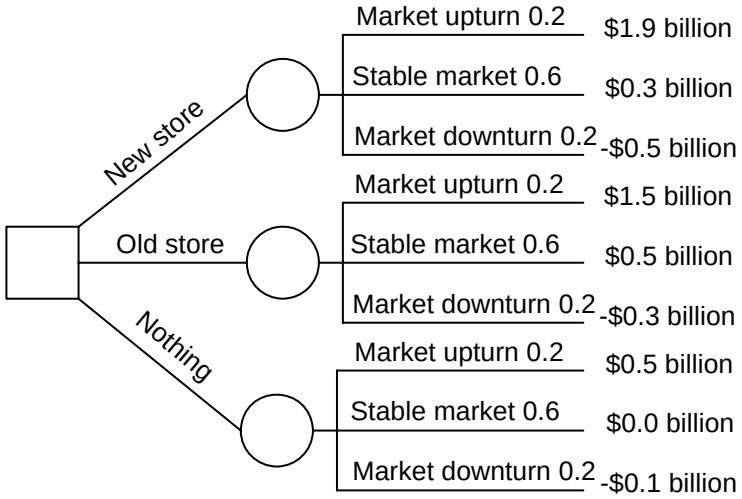


Cash flow diagram [4 points]

[4 points] $NPV_1 = -\$20K + \$6.5K \times (P/A, 8\%, 8) + \$4K \times (P/F, 8\%, 8)$
$= -\$20K + \$6.5K \times 5.7466 + \$4K \times 0.5403 = \$19.51K$
[4 points] $NPV_2 = -\$16K + \$8.5K \times (P/A, 8\%, 8) - \$16K \times (P/F, 8\%, 4)$
$= -\$16K + \$8.5K \times 5.7466 - \$16K \times 0.7350 = \$21.09K$
[2 points] $NPV_2 > NPV_1 > 0 \rightarrow$ Choose Alternative 2.

[2 points] This decision would be reversed if $NPV'_1 \geq NPV_2$
[4 points] → $-\$20K + \$6.5K \times 5.7466 + SV \times 0.5403 \geq \$21.09K$
→ $SV \geq \dfrac{\$21.09K + \$20K - \$6.5K \times 5.7466}{0.5403} = \$6.92K$ → **Salvage value ≥ $6,920**

5. [20 points] 5.a.

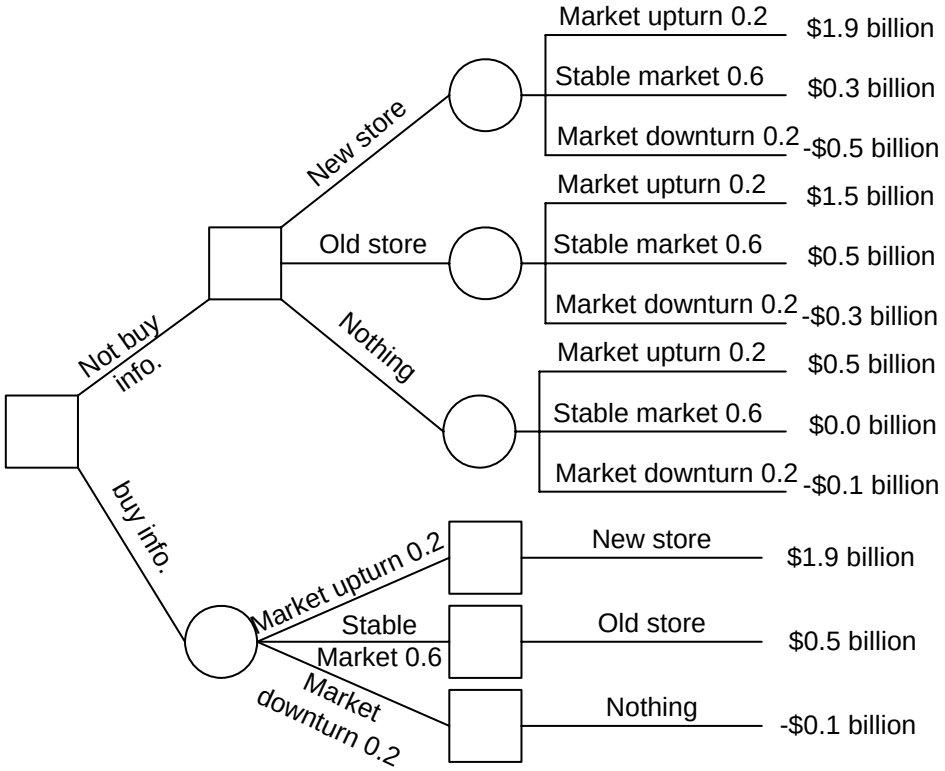


Decision tree [5 points]

5.b. [5 points]
[1.5 points] EV (Build new store) = 1.9x0.2 + 0.3x0.6 – 0.5x0.2 = $0.46 billion
[1.5 points] EV (Expand old store) = 1.5x0.2 + 0.5x0.6 – 0.3x0.2 = $0.54 billion
[1.5 points] EV (Do nothing) = 0.5x0.2 + 0.0x0.6 – 0.1x0.2 = $0.08 billion
[0.5 point]→ Expected net present value of "expand old store" is greatest → **Expand old store**.

5.c. [5 points]
Expected net present value (returns) of this optimal decision = $0.54 billion = $**540 million**

5.d. [5 points] Perfect information



New decision tree [1 point]

[2 points] EV (with perfect information) = 1.9x0.2 + 0.5x0.6 – 0.1x0.2 = $0.66 billion = **$660 million**
[2 points] EV (with perfect information) – EV (with no perfect information) = $660 million - $540 million = $120 million > $10 million → The building supply store should accept the ForSure's offer.

TOTAL: 100