# Problem I:

We consider four mutually exclusive design alternatives D1, D2, D3, D4 each with a useful life of 5 years. The MARR is 20%.

| | D1 | D2 | D3 | D4 |
|---|---|---|---|---|
| Initial Investment: | $100 | $300 | $150 | $200 |
| Annual Revenues: | $50 | $90 | $70 | $65 |
| Annual Expenses: | $20 | $15 | $15 | $20 |
| Salvage Value: | $30 | $100 | $50 | $50 |
| Useful Life: | 5 Year | 5 | 5 | 5 |

a) You are calculating the IRR of D1. You get PW (15%) = 15.5, and PW(25%) = -9.5 by trial and error. What is the approximated IRR using linear interpolation? Based on this approximated IRR, is D1 profitable? Explain the reason why?
b) Based on incremental rate of return analysis, which alternative should we select?

**Solution:**

(a) Investment alternative, because there are annual revenues.
(b) We claim that the design alternative D4 can be directly eliminated from the analysis. Why? Please explain the reason. **(4 Points)**

**Solution:**

(b) D4 has higher initial investment than D3 ($200 > $150), but D4 has lower net annual revenues less expenses than D3 ($45 < $55). D3 and D4 have the same Salvage Value $50, So D3 is a strictly better alternative than D4. So D4 can be directly eliminated.

**Solution:**

(c) By linear interpolation:
D1 is profitable.

**Circle exactly one solution for part (d) to (h) (20 Points)**

After eliminating D4, we can perform the incremental analysis procedure using IRR. The table we get is as follows,

| Increment Considered | △(D1 – DN) | (d) | (f) |
|---|---|---|---|
| △Capital Investment | $100 | $50 | $150 |
| △Annual Revenues Less Expenses | $30 | $25 | $20 |
| △Salvage Value | $30 | $20 | $50 |
| Useful life(Years) | 5 | 5 | 5 |
| $IRR_{\triangle}$ | 21.2% | 45.01% | 0.00% |
| Is increment justified by $IRR_{\triangle}$? | Yes | Yes | No |
| Which alternative will you select? | D1 | (e) | (g) |

(d) △(D1 – D3) / △(D2 – D3) / △(D3 – DN) / △(D3 – D1)

**Solution:**

(d) △(D3 – D1)
(e) D1 / D2 / D3 / DN
**Solution:**
(e) D3
(f) △(D2 – D3) / △(D3 – D2) / △(D3 – DN) / △(D3 – D1)
**Solution:**

(f) △(D2 – D3)
(g) D1 / D2 / D3 / DN
**Solution:**
(g) D3
(h) Which design alternative is the best?
D1 / D2 / D3 / D4
**Solution:**
(h) D3

## Problem II:

A corporation is considering spending $3 million for a new stamping machine that will save $550,000 per year (repairs, down time, etc.) over its seven-year life. At the end of its life, the machine could be sold for $1.8 million. An alternative is to spend $1 million on an overhaul of the existing machine. This would extend its life seven more years and save $175,000 per year. The value of the overhauled machine would be $750,000 at the end of its extended lifespan. Calculate the benefit-cost ratio for each alternative. Identify the best choice. The corporation MARR is 12% per year.

**Solution**

**Alternative A:** New machine, $P$ = $3 million, $A$ = $0.550 million, $n$ = 7, $S$ = $1.8 million.
B/C = PW of Benefits / PW of Costs = 0.550 (P/A, 12%, 7) / [3 – 1.8 (P/F, 12%, 7)]
= (0.550 × 4.564) / [3 – (1.8 × 0.4523)] = 2.510 / 2.1859 = 1.15.

**Alternative B:** $P$ = $1 Million, $A$ = $0.175 Million, $S$ = $0. 750 Million.
B/C = PW of Benefits/ PW of Costs = (0.175 x 4.564) / [1 – (0.75 x 0.4523)]
= 0.7987 / 0. 661 = 1.21.

Alternative B has a higher B/C ratio, but this information is not sufficient to choose the best economic alternative. Incremental analysis is required

| | A | B | A-B |
|---|---|---|---|
| ***P*** | -$3000 | -$1000 | -$2000 |
| ***A*** | 0.550 | 0.175 | 0.375 |
| ***S*** | 1.800 | 0.750 | 1.050 |

B/C of (A–B) = PW of Benefits/ PW of Costs= 0.375 x 4.564 / [2 - (1.05 x 0.4523]= 1 .7115/1.525 = 1.122; Pick A.