Problem 1

Initial capital cost	1,200,000
Annual benefit to users	500,000
Annual cost to users	50,000
Annual cost to government	125,000
Project life	35 years
Interest rage	10%

Given the table, let's calculate the conventional benefit-cost ratio,

PW(user benefit),

$$500000 \cdot \frac{1.1^{35}-1}{0.1 \cdot 1.1^{35}} - 50000 \cdot \frac{1.1^{35}-1}{0.1 \cdot 1.1^{35}} = 4822079.486 - 482207.9486 = 4339871.537$$

PW(sponsor cost),

$$1200000 + 125000 \cdot \frac{1.1^{35}-1}{0.1 \cdot 1.1^{35}} = 2405519.872$$

$$\text{conventional benefit-cost ratio} = \frac{4339871.527}{2405519.872} = 1.8$$

Now let's calculate the modified benefit-cost ratio, $PW(\text{user benefit})$, remains the same, we just need to get $PW(\text{sponsor capital cost})$ and $PW(\text{sponsor operating cost})$.

$$PW(\text{sponsor capital cost}) = 1200000$$

$$PW(\text{sponsor operating cost}) = 125000 \cdot \frac{1.1^{35}-1}{0.1 \cdot 1.1^{35}} = 1205519.872$$

$$\text{modified benefit-cost ratio} = \frac{4339871.527 - 1205519.872}{1200000} = 2.6$$

Problem 2

(Gravity Plan)

$$PW(\text{sponsor's cost}) = \text{Initial Investment} + PW(\text{operation, maintenance}) + PW(\text{annual power cost})$$

$$= 2800000 + 10000 \cdot \frac{1.07^{40}-1}{0.07 \cdot 1.07^{40}} = 2933317.088$$

$$PW(\text{user's benefits}) = 200000 \cdot \frac{1.07^{20}-1}{0.07 \cdot 1.07^{20}} + \frac{400000}{1.07^{20}} \cdot \frac{1.07^{20}-1}{0.07 \cdot 1.07^{20}} = 3213880.688$$

$$\text{conventional benefit-cost ratio} = \frac{3213880.688}{2933317.088} = 1.10$$

(**Pumping Plan**)

$$PW(\text{sponsor's cost}) = \text{Initial Investment} + PW(\text{operation, maintenance}) + PW(\text{annual power cost})$$

$$= 1500000 + 300000 \cdot \frac{1}{1.07^{10}} + 25000 \cdot \frac{1.07^{40}-1}{0.07 \cdot 1.07^{40}} + 70000 \cdot \frac{1.07^{10}-1}{0.07 \cdot 1.07^{10}} + \frac{100000}{1.07^{10}} \cdot \frac{1.07^{30}-1}{0.07 \cdot 1.07^{30}}$$
$$= 3108260.947$$

PW(user's benefits) is the same from the gravity plan, 3213880.688

Thus,

$$\text{conventional benefit-cost ratio} = \frac{3213880.688}{3108260.947} = 1.03$$

We can recommend the **Gravity Plan**, since it has a higher benefit-cost ratio.

Since the benefit of both projects are equal, it does not make sense to use incremental B/C analysis.

Problem 3

(a) The initial cost is \$7000 and by leasing for \$3000 a year, the annual saving compared to the other plan is \$2000/year.

$$\text{payback period} = \frac{\$7000}{\$2000/\text{year}} = 3.5\text{years}$$

(b) $i = 0.1$, and there is a salvage value of \$500 in six years.

$$\text{conventional benefit-cost ratio} = \frac{500 \cdot \frac{1}{1.1^6} + 2000 \cdot \frac{1.1^6-1}{0.1 \cdot 1.1^6}}{7000 + 3000 \cdot \frac{1.1^6-1}{0.1 \cdot 1.1^6}} = \frac{8992.758364}{20065.7821} = 0.45$$

Problem 4

(a) New Buses :

$$\text{conventional benefit-cost ratio} = \frac{18000000}{4500000 + 12000000} = 1.09$$

Road Improvement :

$$\text{conventional benefit-cost ratio} = \frac{26000000}{15000000 + 5000000 + 4000000} = 1.08$$

From the benefit-cost ratio, the **New Buses option** is better. And both projects are individually viable.

(b) Since both benefit-cost ratios are bigger than 1, we can use the incremental benefit-cost ratio, And because $C_{\text{Road Improvement}} > C_{\text{New Buses}}$,

$$\text{incremental benefit-cost ratio} = \frac{B_{\text{Road Improvement}} - B_{\text{New Buses}}}{C_{\text{Road Improvement}} - C_{\text{New Buses}}}$$

$$= \frac{26000000 - 18000000}{(15000000 + 5000000 + 4000000) - (12000000 + 4500000)} = 1.07$$

The better alternative is the **Road Improvement option** in this case.

(c)

$$PW(\text{New Buses}) = 18000000 - 12000000 - 4500000 = 1500000$$

$$PW(\text{Road Improvement}) = 26000000 - 15000000 - 5000000 - 4000000 = 2000000$$

The present worth analysis indicates that the **Road Improvement option** is better.

(d) By comparing the decisions above, for most analyses the **Road Improvement option** is better. Thus, we can see that the **Road Improvement option** is the best alternative.