Quiz 1 Your Name: Key

GENERAL INSTRUCTIONS

While the exam is being handed out:

1. Read all instructions on this page carefully.
2. You will find interest rate tables at the end of this quiz.
3. Do not look at the other exam pages and do not start to work yet. Wait until all students have an exam in hand and Kristen says you may proceed.
4. Write your name in the upper-right corner of this page.

Once you have been allowed to start:

5. Write your name in the upper right corner of pages 2 through 11. Read the exam all the way through before starting to write answers to questions. Pace yourself so you get to answer all questions. Partial credit will be given—**draw your cash flow diagrams**!
6. To receive full credit, your work must be neat, orderly, and easy to follow. Think before writing so as to make your points directly and concisely. State all assumptions.
7. Any answer requiring a calculation or rational process must show the method of arriving at the answer. The answer alone is not sufficient.
8. This is a closed-book examination but you are allowed to use a calculator.
9. If you do not have enough space for answering a question where space is provided, please continue on the back side of the page you were writing on. Write that you are doing so next to the question.
10. If you find it more convenient to take the staple out from this packet, go ahead and do so. When you turn in your exam, put all pages back in order and staple them back together (a stapler will be available).
11. In case you have questions for clarification you may ask Kristen or William privately. Raise your hand to call their attention; do not get up!
12. This quiz consists of pages 1 through 15, there are six (6) main problems and they have several parts. The total point value is 100. It is your responsibility to check that all pages are included and turned in, in the proper order and stapled together.

NAME: Key

Problem 1 (12 Points): Vocabulary

Define the following terms. Provide an example that is relevant to the Architecture-Engineering-Construction Industry.

1.1. Time Value of Money (4 points):

The notion that money is worth a different amount today than at some point in the future (or, for that matter, some time in the past).

AEC Example: If you need $100 M for a construction project in 5 years, you can invest less than $100M today and earn interest on it to pay for the project in the future.

1.2. Offer (as a part of a Contract) (4 points):

manifestation of interest or willingness to enter into a bargain made in such a way that the receiving party will realize that furnishing unqualified acceptance will seal the bargain.

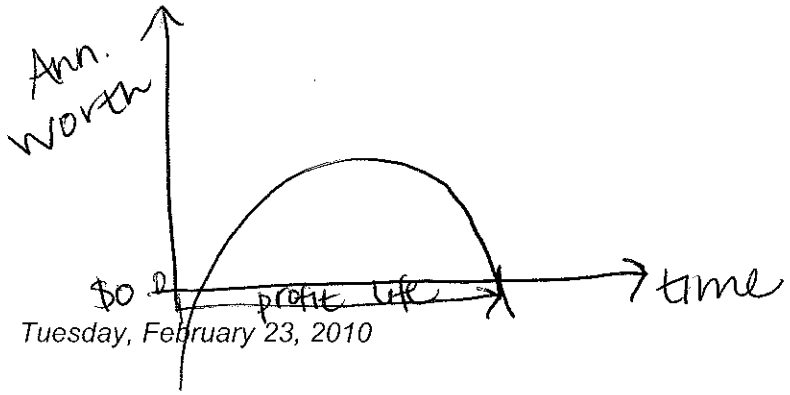
Accept: Offer is to express willingness to complete a specified scope of work for a specified sum of money.

Example: I will build a garage for your home from Jan 21 - Feb. 23 for a cost of $50,000. The garage will have room for 2 cars side-by-side and a single door.

1.3. Profit Life of an Asset (4 points):

The time over which an asset CAN earn a profit.

Example: A backhoe that has a lifetime of 10 years may be profitable for 7.



NAME: Key

Problem 2 (20 points): Comparison of Alternatives

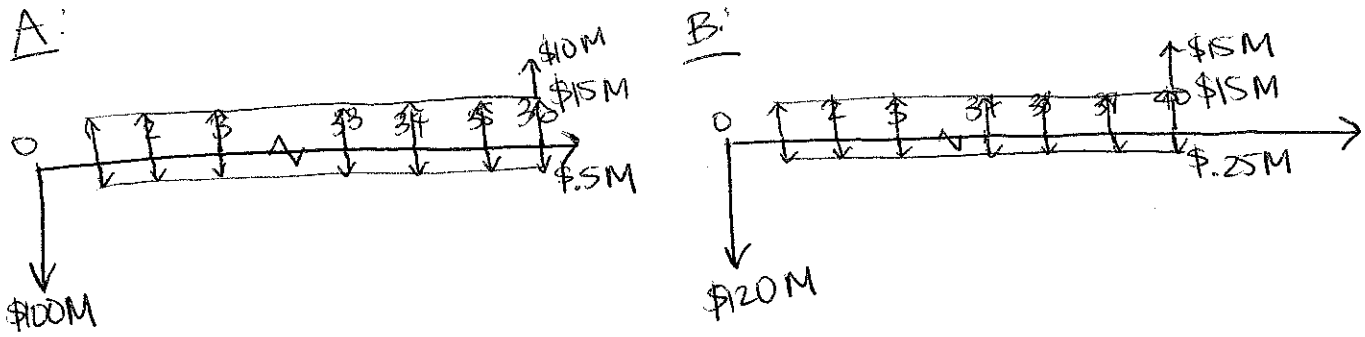
A university is considering two new classroom buildings, each with the following costs:

	Classroom Building A	Classroom Building B
Initial Cost	\$100 million	\$120 million
Annual Operating Cost	\$0.5 million	\$0.25 million
Annual Benefit (room for more students, able to attract better faculty)	\$15 million	\$15 million
Lifetime	36 years	40 years
Salvage Value	\$10 million	\$15 million

Assume the MARR is 10%.

As a design consultant working with the university, they have asked you to help them determine which building project to fund.

2.1. Draw the cash flow diagrams for each alternative. You may show the first three years of the cash flow diagram and the last three years of the cash flow diagram (6 points):



2.2. Due to changes in the building technology over the buildings' lifetimes, you determine that the data presented above is NOT repeatable. What study period, reported as n years, do you suggest we use for our analysis and why (4 points)?

n = 36. We can estimate the salvage value of Building B at this point, but we have no information about a Building to replace A, so we do not want to consider a study period, n, greater than 36 years. Accept: any $1 \le n \le 36$

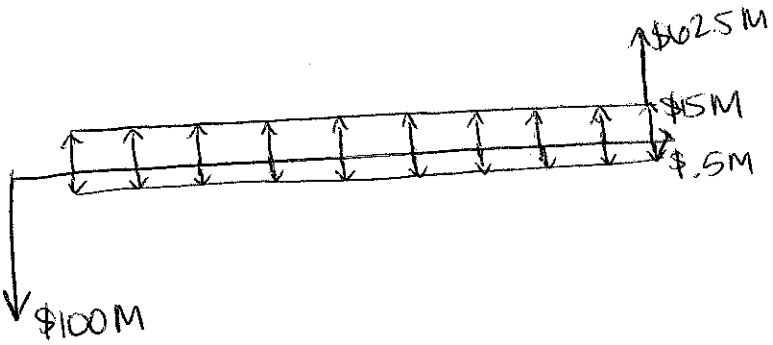
NAME: Key

2.3. You explain your approach for comparing the alternatives over the study period of *n* years (found in 2.2), but the university informs you they have their own methodology for comparing alternatives. They perform *present worth analysis* considering a *10-year lifetime* (10 years is their near-term planning horizon). They provide you the following information about the salvage values of each project after 10 years:

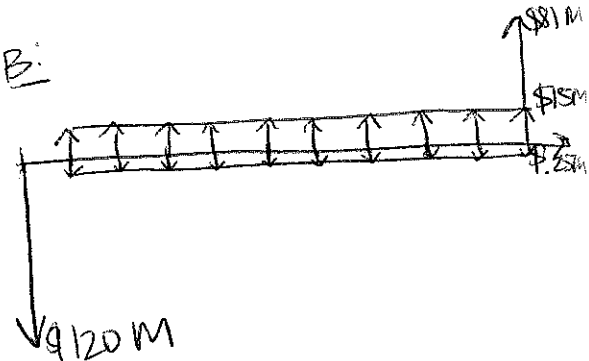
	Salvage Value at 10 years
Classroom Building A	\$62.5 million
Classroom Building B	\$81 million

Show your present worth analysis, state which project you advise the university to fund, and state your rationale (10 points):

A:



B:



$PW(A) = -\$100M + (\$15M - \$.5M)(P/A, 10\%, 10) + \$62.5M(P/F, 10\%, 10)$

$= -\$100M + \$14.5M(6.144) + \$62.5M(.3855)$

$= \$13.2M$

$PW(B) = -\$120M + (\$15M - \$.25M)(P/A, 10\%, 10) + \$81M(P/F, 10\%, 10)$

$= -\$120 + \$14.75M(6.144) + \$81M(.3855)$

$= \$1.85M$

Select and fund project A, as $PW(A) > PW(B)$

NAME: Key

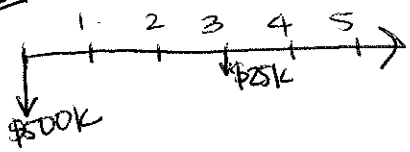
Problem 3 (20 points): Comparison of Alternatives, Sensitivity Analysis, and Internal Rate of Return (IRR)

A general contractor plans to buy one of two new cranes. The Picker costs $500,000 and has a lifetime of 5 years. At the end of 3 years, it will need a new operator elevator, which costs $25,000, though this value is somewhat uncertain. At the end of 5 years, the Picker is expected to have no salvage value. The Grabber costs $600,000 and also has a lifetime of 5 years. The original parts of the Grabber will last throughout its lifetime. The Grabber has a $75,000 salvage value at the end of its life.

Assume the MARR is 8%.

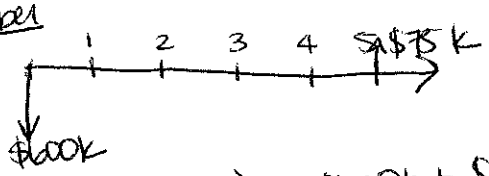
3.1. Which crane is preferred, the Picker or the Grabber? Why (5 points)?

Picker



PW(Pick) = -$500k + $25k(P/F, 8%, 3)
= -$500k - $25k(.7938)
≈ -$519k

Grabber



PW(Grabber) = -$600k + $75k(P/F, 8%, 5)
= -$600k + $75k(.6806)
≈ -$549k

Picker, PW(P) > PW(G)

3.2. What cost of operator elevator would reverse your decision from 3.1 (5 points)?

PW(Picker) = -$500k - Cost(P/F, 8%, 3)
= -$500k - .7938(Cost)

PW(Grabber) = -$549k

To reverse my decision, PW(Picker) < PW(Grabber):

-$500k - .7938(Cost) = -$549k

Cost ≈ $62k

If the cost was $61.73k or greater, I'd reverse my decision.

NAME: Key

Problem 4 (20 points): Annual Worth Comparison

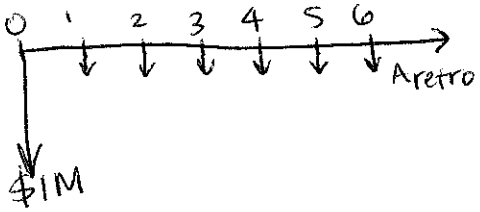
It costs $1 million to retrofit an operational ice arena for use in the Olympics. Fuel, water, and minor maintenance of the ice (e.g., smoothing ice with a Zamboni) are estimated to cost $350.00 for each day the arena is used. The operational costs of the arena are $75,000 every 300 days. Major repairs to the spectator seating after 600 days are expected to cost $400,000. The arena is expected to last 1800 days, after which it will have a salvage value of $300,000.

The owner expects the arena to be used 300 days/year.

Assume an interest rate of 15%.

4.1. Calculate the annual cost of the $1 million retrofit (5 points).

Lifetime to consider = 1800 days / 300 d/yr = 6 yr.



$A_{retro} = \$1M\,(A/P, 15\%, 6)$

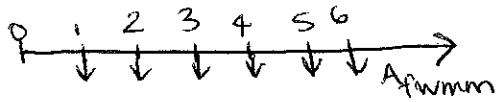
$= \$1M\,(.26424)$

$A_{retro} = \$.264\ M/yr.$

4.2. Calculate the annual cost of the fuel, water, and minor maintenance of the ice (5 points).

$A_{fwmm} = \$350.00/day\ (300 d/yr)$

$= \$105{,}000/yr$



$A_{fwmm} = \$.105\ M/yr.$

4.3. Calculate the annual worth of the salvage value (2 points).

$A_{salv} = \$300{,}000(A/F, 15\%, 6)$

$= \$.3M\,(.11424)$

$A_{salv} = \$.034\ M/yr.$

NAME: Key

3.3. If the Grabber produces an annual income of $140,000, what is the IRR of the Grabber (8 points)?

At MARR: $PW(Grabber) = -\$600K + \$140K(P/A, 8\%, 5) + \$75K(P/F, 8\%, 5)$

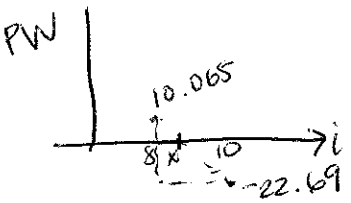
Generally: $PW(Grabber) = -\$600K + \$140K(P/A, i, 5) + \$75K(P/F, i, 5)$

At MARR: $PW(Grabber) = \$600K + \$140K(3.993) + \$75K(.6806)$

$= \$10.065K$

Try $i = 10\%$: $PW(Grabber) = -\$600K + \$140K(3.791) + \$75K(.6209)$

$= -\$22.69K$



So, $8\% < IRR < 10\%$: $\frac{10.065 - -22.69}{2} = \frac{10.065}{x}$

$x = .615 \rightarrow$ IRR = 8% + .615% = 8.615%

3.4. Would you purchase the Grabber? State your rationale (2 points).

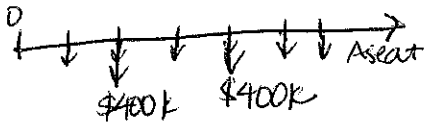
I would purchase the Grabber because the IRR > MARR

NAME: Key

4.4. What is the annual cost of operations for the ice arena (1 point)?

$75,000

4.5. Calculate the annual cost of the spectator seating repairs (5 points).



$A_{seat} = A_{seating,\ 2\ yr.} + A_{seating,\ 4\ yr.}$

$= [\$400k(P/F, 15\%, 2)](A/P, 15\%, 6) + [\$400k(P/F, 15\%, 4)](A/P, 15\%, 6)$

$= [\$400k(.7561)](.26424) + [\$400k(.5718)](.26424)$

$= \$79.92k + \$60.44k = \boxed{\$140.36k/yr.}$

4.6. How much should the owner of the ice arena charge, per day of use (2 points)?

~~Cost / d~~ Cost/day = Cost/yr $\left(\frac{1\ yr}{300d}\right)$

Cost/yr = $A_{retro} + A_{fwmm} + A_{oper} + A_{seat} - A_{salv}$

$= \$264k + \$105k + \$75k + \$140k - \$34k$

$= \$550k/yr$

Cost/day = $(\$550k/yr)\left(\frac{1\ yr}{300d}\right)$

$= \$1.83k/day$

$\boxed{\text{Cost} = \$1,830/day}$

NAME: Key

Problem 5 (8 points): Interest Rates

You are planning to open a new savings account at Bank A or Bank B. Bank A offers you a nominal interest rate of 12%, compounded semi-annually. Bank B offers you a nominal interest rate of 10%, compounded quarterly.

5.1. What is the effective interest rate at Bank A (4 points)?

$$1 + i_{eff} = \left(1 + \frac{i_{nom}}{\#per/yr}\right)^{\#periods/yr}$$

$$i_{eff} = \left(1 + \frac{i_{nom}}{\#periods/yr}\right)^{\#periods/yr} - 1$$

$$i_{eff} = \left(1 + \frac{.12}{2}\right)^2 - 1 = \boxed{12.4\%}$$

5.2. What is the effective interest rate at Bank B (4 points)?

$$i_{eff} = \left(1 + \frac{i_{nom}}{\#periods/yr}\right)^{\#periods/yr} - 1$$

$$= \left(1 + \frac{.10}{4}\right)^4 - 1$$

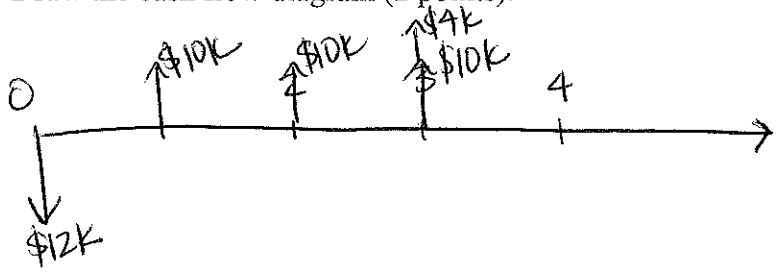
$$\boxed{i_{eff} = 10.4\%}$$

NAME: Key

Problem 6 (20 Points): MACRS Depreciation and Tax

A new tractor has a useful life of 3 years. This tractor costs $12,000. The tractor is expected to generate $10,000 in revenue each year for its 3-year life. At the end of its life, it will have a salvage value of $4,000. The company that would be purchasing this tractor expects to pay a 40% tax rate and has a MARR of 10%. Is this tractor worth buying?

6.1. Draw the cash flow diagram (2 points).



6.2. The company accountant provides you with most of the depreciation charges, but forgets to give you the first year Depreciation Charges and the Book Values. Fill in the missing Depreciation Charges and Book Values in the table below (7 points):

Year	MACRS Double Declining Balance Depreciation Charge, DC_{DDB} $DC_i = BV_{i-1} * C/N$ where N = lifetime of asset, C = depreciation rate	MACRS Straight Line Depreciation Charge, DC_{SL} $DC_{i+1} = BV_i/(N-i+.5)$	Book Value, BV
0			$12,000
1	$4,000	$1,714	$8,000
2	$5,333	$3,200	$2667
3	$1,778	$1,778	$889
4	$296	$889	$0

$DC_{DDB,1} = \frac{1}{2}(\$12000)(2/3)$

$= \$4,000$

$DC_{SL,2} = \frac{BV_1}{3-1+.5}$

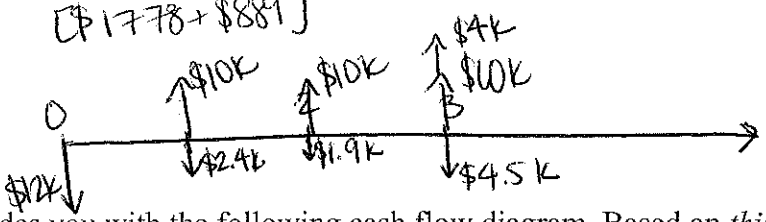
$= \frac{\$8,000}{2.5}$

$= \$3200$

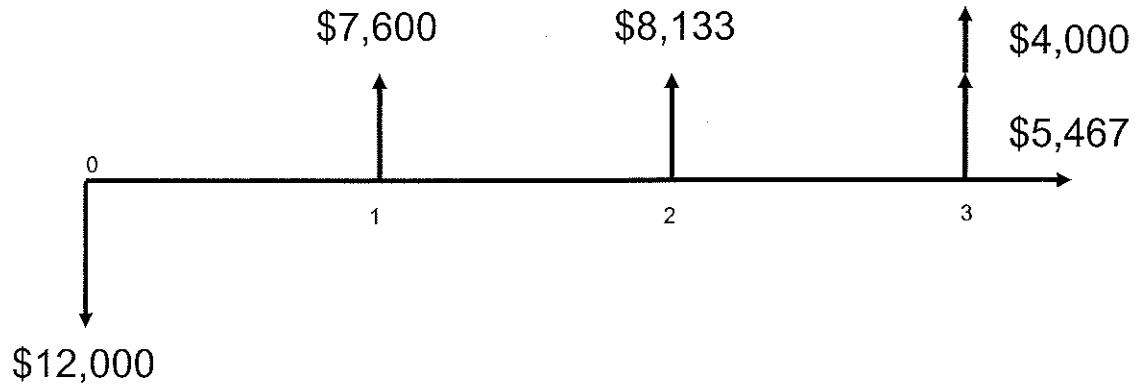
NAME: Key

6.3. Calculate the taxes you will need to pay each year and show these on your cash flow diagram. You may assume that Depreciation Charges accrued in Year 4 are treated as tax deductions in Year 3 (6 points).

Year	Revenue	Salvage	DC	Taxable	Taxes
			$4000	$6000	$2400
1	$10k				
2	$10 k		$5333	$4667	$1867
3	$10 k	$4k	$2667 [$1778+$889]	[$7333+$4,000]	$4533



6.4. The accountant provides you with the following cash flow diagram. Based on *this* cash flow diagram, would you recommend purchasing the tractor? Show your rationale (5 points).



$PW(\text{tractor}) = -\$12k + \$7.6k(P/F,10\%,1) + \$8.13k(P/F,10\%,2) + \$9.47k(P/F,10\%,3)$

$= -\$12k + \$7.6k(.9091) + \$8.13k(.8264) + \$9.47k(.7513)$

$PW(\text{tractor}) = \$8.74k$

Purchase tractor; its present worth > 0