

# MECH 431 - Engineering Economics: Midterm Examination 2020 Summer

Instructor: Mark Hollett

Name: \_\_\_\_\_

Duration: ~60-90 minutes

Student Number: \_\_\_\_\_

## Instructions:

1. You may complete the exam in this document and submit it, or you may submit a separate answer document. Acceptable document formats are Word (and equivalent open formats), PDF, or scanned images. **DO NOT SUBMIT SPREADSHEETS** – copy any tables into your document if needed.
2. Ensure your name and student number are clearly indicated on your submitted document.
3. Submit the completed exam through the “Exams” module on Canvas. The exam must be submitted before the indicated due date and time. **NO EXCEPTIONS WILL BE MADE.** Ensure you leave yourself sufficient time to deal with flakey wi-fi and technical challenges, as well as formatting your file for submission. Technical difficulties will not be accepted as an excuse for late submissions.
4. This examination consists of 15 questions for a total of 45 marks. Please check that your examination file is complete.
5. This is an open book exam. You may use any textbooks, resources, calculators, and software you wish to complete it.
6. Indicate your answers clearly and show all your work. Your numerical answers must be accurate to the nearest dollar, and must include the correct units (e.g. 496.3 Kg. \$1089).
7. Ensure your work is clear and readable. Severe readability issues may result in grade penalties.
8. The exam must be completed independently. Showing or discussing the exam with anybody is forbidden, including current and former students of this class. No discussion of exam questions will be permitted on Piazza. You may not post questions related to the exam on other discussion forums.
9. The following general UBC rules governing formal examinations will be in force:
  - a. You are not permitted to ask questions of the invigilators, except in cases of supposed errors or ambiguities in examination questions.
  - b. If you are suspected of any of the following, or similar, dishonest practices, you shall be immediately dismissed from the examination and shall be liable to disciplinary action:
    - i. having at the place of writing any books, papers or memoranda, calculators, computers, sound or image players/recorders/transmitters (including cameras and phones), or other memory aid devices, other than those authorized by the examiners;
    - ii. speaking or communicating with other candidates; and
    - iii. purposely viewing the written papers of other candidates or exposing written papers to the view of other candidates or imaging devices.

The plea of accident or forgetfulness shall not be received.

Name of Marker: \_\_\_\_\_

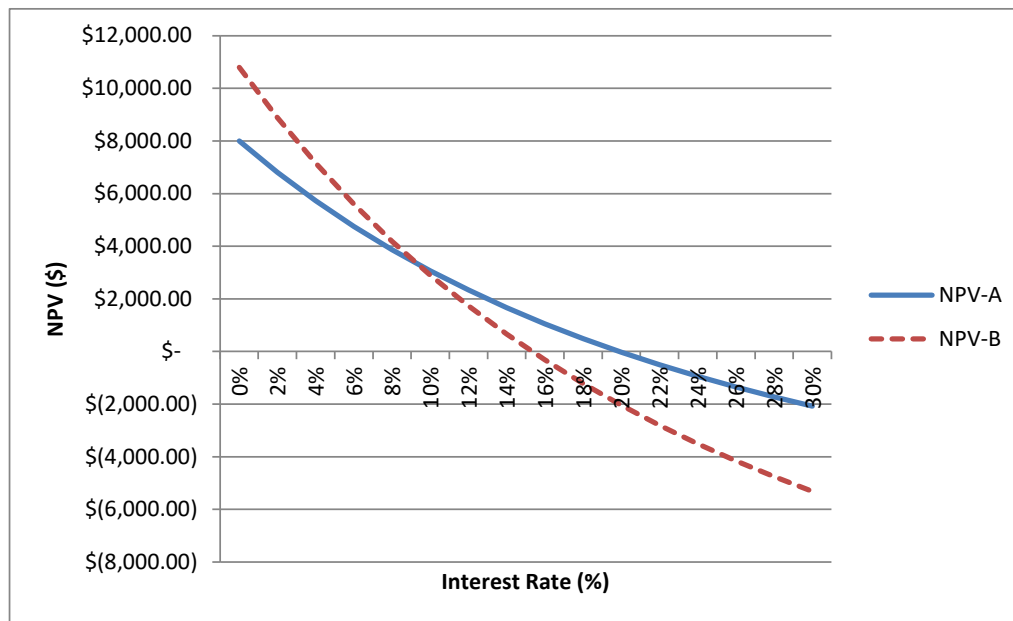
| Question                    | Possible Marks | Actual Marks |
|-----------------------------|----------------|--------------|
| <b>Short Answers (1-11)</b> | <b>15</b>      |              |
| <b>12</b>                   | <b>6</b>       |              |
| <b>13</b>                   | <b>6</b>       |              |
| <b>14</b>                   | <b>10</b>      |              |
| <b>15</b>                   | <b>8</b>       |              |
| <b>Total</b>                | <b>45</b>      |              |

**Short Answers Not necessary to show calculations/written work.**

1. [1 mark] Why does opportunity cost need to be considered when establishing a Minimum Acceptable Rate of Return?
2. [1 mark] What does marginal revenue represent? What are sunk costs?
3. [1 mark] Economies of scale suggests that generally, as you produce more of something, the average cost of production will go down. However, in some cases producing more output results in increased average costs. Give an example of why this might happen for a factory producing widgets
4. [1 mark] Create a cash flow diagram for the following: you take out a loan of \$50,000 that is charging 10% *simple interest*. For the next ten years, you pay only the interest payments. In the tenth year, you pay back the loan principal and the payments end.
5. [2 marks] Why does the formula for Geometric Gradient Annuity Factor change when  $i = g$ ? What is actually happening with a Geometric Gradient series of cashflows when  $i = g$ ?
6. [1 mark] Why are book costs not included in the cashflows when doing a cashflow analysis?
7. [1 mark] BC Hydro is building a small dam and want to capitalize the cost of operating and maintaining it. The estimated annual costs are \$50,000, and BC Hydro's interest rate is 10%. If the dam is expected to last forever, how much should BC Hydro invest to capitalize the operating and maintenance costs?
8. [2 marks] Determine the Internal Rate of Return for the following series of cashflows:

| Year | Cashflow        |
|------|-----------------|
| 0    | \$ (150,000.00) |
| 1    | \$ 400,000.00   |
| 2    | \$ (50,000.00)  |
| 3    | \$ (50,000.00)  |
| 4    | \$ (400,000.00) |
9. [1 mark] Why does the value of an investment decrease when interest rates increase?

10. [2 marks] You determine the NPV of a project with an analysis period of one year and an interest rate of 18%, and it is positive, indicating the project is financially worthwhile. If you were to determine the Equivalent Annual Uniform Cashflow (EAUC) for that project, would the EAUC be larger, smaller, or the same as the NPV? Why?
11. [2 marks] Below is a chart showing the NPV vs Interest Rate for two projects under consideration. Project A costs \$10,000. Project B costs \$18,000. What is the incremental rate of return on Project B (to the nearest percent)? If your MARR is 24%, which alternative (if any) should you select?



**Show ALL your work for questions 8-15.**

12. [6 marks] Calculate the Future Worth of these three sets of cashflows at the end of five years, with 9% interest, compounded semi-annually.

A: \$100 per month

B: \$100 in the first month, increasing \$2 per month thereafter

C: \$100 in the first month, increasing 1% per month thereafter

13. [6 marks] You are starting a small software company developing an application for unspecified nefarious purposes. Between yourself and two software developers, you have total monthly wages of \$15,000. Your small office in Hawaii costs \$2400 per month in rent and utilities.

You license your software to client companies at \$1,000 per month. You outsource your customer support, and based on expected volumes you estimate each client will cost you an average of \$300 per month in support costs.

A. [3 marks] Calculate how many clients you need to break-even on a monthly basis.

B. [3 marks] What is your average cost per client at the breakeven point? If you double the number of clients from there, what is the new average cost per client?

14. [10 marks] You are trying to decide between manufacturing a part using injection molding machine or using a 3D printer. The 3D printer option will cost \$3,000 in capital, has an annual operating cost of \$2,000, and annual benefits of \$4,000.

The Injection Molding machine will cost \$16,000 in capital, but have an annual operating cost of only \$750 and an annual benefit of \$4,000.

Your interest rate is 12% per year. The 3D printer has a useful life of 2 years, the Injection Molding Machine has a useful life of 10 years. Neither machine will have any salvage value after its life is up.

A: [8 marks] Which alternative should you select based on a Present Value analysis?

B: [2 marks] Suppose the specific 3D printer you have selected will be obsolete in two years' time, so you will not be able to replace it. But given the trajectory of 3D printing technology, you expect even better printers to be available for less cost. Discuss (no calculations or numbers needed) how this would (or would not) affect your previous analysis.

15. [4 marks] For both project option in the previous question, plot the NPV vs  $i$  for interest rates up to 25%.

[4 marks] What is the IRR for each option? What is the Incremental IRR? If your MARR is 12%, would your recommendation change from your Present Value analysis in question 14?