

ORDRE DES INGÉNIEURS DU QUÉBEC

NOVEMBER 2022 SESSION

Open-book examination
Calculators: only authorized models
Duration: 3 hours

14-EC-1 Engineering Economics

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| Question 1: | 20 |
| Question 2: | 20 |
| Question 3: | 20 |
| Question 4: | 20 |
| Question 5: | 20 |
| | |
| Total | 100 |

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| Question 1 (20 points) |
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For each of the statements below, please answer true or false and then justify your answer with a brief explanation.

- a) To estimate a project's minimum acceptable rate of return (MARR), the weighted average of the cost of each financing source must be computed. This calculation must exclude cash that the company has available through past retained earnings. (4 points)
- b) Depreciation does not enter in the pre-tax analysis of a project's financial profitability. (4 points)
- c) To compare two options which require different initial investments, one can use indifferently the net present value (NPV) or internal rate of return (IRR) criteria. (4 points)
- d) An increase in the rate of return expected by investors will increase the net present value of a project's cash flow. (4 points)
- e) The original cost of an equipment and its past repair and overhaul costs are factors entering in the decision to whether or not replace that equipment. (4 points)

Question 2 (20 points)

A company whose minimum acceptable rate of return (MARR) is 12% is asking you to assist it in choosing between the following four mutually exclusive options:

| Cash Flow (in \$ K) | | | | |
|----------------------------|---------------|----------|----------|----------|
| Year | Option | | | |
| | A | B | C | D |
| 0 | \$(100) | \$(750) | \$(300) | \$(400) |
| 1 | \$80 | \$500 | \$200 | \$200 |
| 2 | \$90 | \$400 | \$200 | \$200 |
| 3 | \$100 | \$400 | \$200 | \$300 |

- a) Find the missing data in the table below and then determine the best option. (15 points)

| | A | B | C | D |
|-------------------------------|----------|----------|----------|----------|
| Net present value (NPV) | 114 \$ | \$ | 80 \$ | |
| Internal rate of return (IRR) | 68,58% | 35,25% | | 30,47% |
| Payback period (years) | | 1,63 | 2,00 | 1,67 |

- b) Now, determine the best option on the basis of differential IRR. (5 points)

Note 1: For this question, assume that there is no inflation.

Note 2: For this question, assume that the degree of risk of all options is the same.

Note 3: For this question, assume that the given cash flow amounts are after tax.

Question 3 (20 points)

A municipal sewage treatment plant has hired an engineer to provide a recommendation on the type of motor to choose for a pump that will transfer sewage into a tailing pond. The pump's annual number of hours of operation depends in great part on the abundance of rainfall. To arrive at a recommendation the engineer has the following information:

- **OPTION A:** Purchase of an electric motor and installation of an electrical supply line at a total cost of \$50,000. The motor has a life span of 6 years after which its residual value would be \$3,000. Operating cost be \$8 per operating hour for electricity and \$4 per operating hour for maintenance.
- **OPTION B:** Purchase of a diesel engine, meeting environmental standards, for \$30,000. The life span of the engine is 6 years and it has no residual value. Operating costs are estimated at 20\$ per operating hour for fuel and oil. Maintenance costs are 6\$ per operating hour.

Unfortunately, the sewage treatment plant staff is not able to provide to the engineer the pump's average number of annual operating hours in time for the engineer's final presentation.

For how many annual operating hours would one of the options become preferable to the other one?

Use a 10% minimum acceptable rate of return (MARR).

Note 1: For this question, assume that there is no inflation.

Note 2: For this question, corporate income tax can be ignored.

Question 4 (20 points)

The ABC company is considering launching -a new line of organic dairy products. The project would require a \$ 12,000 K (**current dollars**) initial investment for new equipment. It forecasts sales of 3 000 tons per year, for 4 years, at an average price of \$5/kg (**constant dollars**).

Average variable production costs will be \$2/kg (**constant dollars**) and fixed costs will amount to 2,500 K\$ per year (**constant dollars**). In addition, the annual capital cost allowance (CCA) for tax purposes will use straight line method with no residual value and no half-year rule. The residual value is nonetheless estimated at \$ 3,000 K (**constant dollars**).

The average annual inflation rate for the next 4 years is forecast to be 8%.

If ABC's minimum acceptable rate of return (MARR) is 18,8% at current market rates and if its income tax rate is 25%, is this project financially acceptable under the net present value (NPV) criteria?

Note 1: Post-tax cash flow year by year is needed in the development of the solution.

Note 2: For this question, at your discretion, you can make the solution either in current dollars or in constant dollars.

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| Question 5 (20 points) |
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The MicroC company must prepare a quote for the supply of printed circuit boards to a maker of industrial robots. The following information is available:

- At current market price of comparable boards, revenues from this contract would amount to \$35,000 a year for the next 4 years;
- At this volume, annual operating costs would be \$27,000, excluding depreciation;
- In order to be able to manufacture the boards, the company would have to acquire \$16,000 in new equipment, with no residual value at the end of the contract;
Assume that the capital cost allowance (CCA) for tax purposes would be of \$4,000 per year (thus computed linearly with no half-year rule);
- The company will have to invest in working capital (WC) an amount equal to 20% of annual revenues. The investment in WC would have to be made at the beginning of the first year and entirely recovered at the end of the project.
- The company will finance its investment in part by contracting a \$5,000 loan at a 6% per year nominal rate, compounded monthly. Capital would be paid back, with interest, in 4 equal payments, due at the end of the next 4 years;
- The company's income tax rate is 25%;
- The minimum acceptable rate of return (MARR) of equity financing is 15%.

Should MicroC submit a quote to supply the boards at current market price? Use the net present value (NPV) decision rule.

Note 1: For this question, assume that there is no inflation.

Note 2: Post-tax cash flow year by year is needed in the development of the solution.