

National Exams Dec 2018
11-CS-1, Engineering Economics
3 hours Duration

NOTES:

1. Assumptions could be made about questions that are not clear to the candidate, but that should be stated clearly.
2. Please answer the exam questions in the correct order.
3. Please start each question on a new page.
4. Candidates are urged to draw cash flow diagrams whenever applicable.
5. Any non-communicating calculator is permitted. This is an open book exam.
6. Any four out of the five questions constitute a complete exam paper. Only the first four questions, as they appear in the answer book, will be marked.
7. Each question is of equal value.

QUESTION 1

How much is accumulated in each of the following saving plans after 1 year?

- a) Saving \$100 at the end of each month for 12 months at 12% compounded monthly. (6 Marks)
- b) Saving \$100 at the end of each month for 12 months at 12% compounded quarterly. (6 Marks)
- c) Saving \$1,000 at the end of this month at 12% compounded continuously. (6 Marks)
- d) Saving \$60 at the end of this month, increasing by \$5 per month thereafter, at 12% compounded monthly. (7 Marks)

QUESTION 2

RCC is a tier 1 *Automotive Supplier*. They are choosing between two 3-D printing machines, A and B, of comparable specifications to help reduce the time needed in building prototypes for new parts and subassemblies. The company has a MARR (Minimum Acceptable Rate of Return) of 8%. Expected salvage value for each of the two 3-D printing machines at the end of their service lives is \$7,500. Answer the following questions using the information in the table below.

	3-D Printing Machine A	3-D Printing Machine B
Down payment	\$11,000	\$12,000
Running cost per year	\$1000	\$900
Maintenance cost	\$150 for the first year, increasing by \$110/year thereafter	\$160 for the first year, increasing by \$100/year thereafter
Service cost per year	\$3,000	\$2,800
Service Life	10 years	12 years

- a) State the necessary assumption for comparing mutually exclusive alternatives of different lives (4 Marks)
- b) Based on Annual Worth comparison, which alternative should be selected? (6 Marks)
- c) Based on Present Worth comparison, which alternative should be selected? (6 Marks)
- d) Do both methods (Present Worth and Annual Worth) always yield the same decision? (3 Marks)
- e) For a ten-year study period, what salvage value for Machine B would make it a better choice? (6 Marks)

QUESTION 3

The municipality of a major city in Quebec is planning to build a new bridge to decrease the traffic load on the existing bridges connecting both sides of the city across the river. Construction is to start in 2020 and is expected to take four years at a cost of \$25 million per year. After construction is completed, the cost of operation and maintenance is expected to be \$2.5 million for the first year, and to increase by 2.8% per year thereafter. The scrap/salvage value of the bridge at the end of year 2053 is estimated to be \$5 million. Consider the present to be the end of 2018/beginning of 2019 and the interest rate to be 8%.

- a) Draw a cash flow diagram for this project (from present till end of year 2053). (7 Marks)
- b) Find the Present Worth of this project. (12 Marks)
- c) Find the Future Worth of this project. (6 Marks)

QUESTION 4

Three investments are being evaluated by a local financial corporation in British Columbia. The table below summarizes expected cash flows for each of the three investments over the next seven years. Due to budget limitations, the corporation will only choose one investment out of the three investments. At a MARR (Minimum Acceptable Rate of Return) of 8%, answer the following.

Investment	Initial Cost	Expenses per Year	Return at end of year 7
1	\$100,000	\$40,000 for the first year, increasing by \$2,000 per year thereafter	\$600,000
2	\$360,000	\$85,000 for the first year, increasing by \$4,000 per year thereafter	\$1,600,000
3	\$185,000	\$55,000 for the first year, increasing by \$3,000 per year thereafter	\$850,000

- Determine the economically best investment for the corporation using a rate of return method. **(14 Marks)**
- Is it always the case for the alternative with the highest rate of return to be the economically best alternative? **(5 Marks)**
- Are you expecting different results if the comparison is based on Future Worth? (Hint: no calculations are needed). **(6 Marks)**

QUESTION 5

A medium-sized greenhouse in Southern Ontario is considering a new automated irrigation system that relies on advanced sensors and computer-based decisions as a replacement for the current human-based irrigation practices that relies on an experienced grower. The greenhouse has a MARR (Minimum Acceptable Rate of Return) of 7%. The table below summarizes the cost for keeping the experienced grower and the cost to acquire and run the automated irrigation system. Use the information in the table to answer the following questions.

	Human-Based System	Automated System
Purchase price of the automated system	-	\$135,000
System installation & first time programming cost	-	\$15,000
Salary/year for the experienced grower	\$40,000	-
Benefits/year for the experienced grower	\$3,000	-
Cost of system re-programming/maintenance	-	\$12,000
Planning horizon	5 years	

- If the automated irrigation system is to be re-programmed every year, is it an economic decision to replace the experienced grower with the automated system? (Use Present Worth). **(7 Marks)**
- If the automated system is to be re-programmed every 2 years, is it an economic decision to replace the experienced grower with the automated system? (Use Present Worth). **(7 Marks)**
- Redo part a) using Future Worth instead of Present Worth. **(6 Marks)**
- If the service life of the automated system is 10 years with zero salvage value, for a planning horizon of 10 years, do you expect a different decision for part b)? (Hint: no further calculations needed). **(5 Marks)**