

**National Exams May 2019**  
**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

Silver Visa, Fast Card, and Mach Express are three credit card companies that charge different interest on overdue balances. Silver Visa charges 24% compounded daily, Fast Card charges 25% compounded weekly, and Mach Express charges 26% compounded monthly. (Hint: 1 year could be 365 or 52 weeks)

- a) What is the effective annual interest rate charged by each of the three credit cards? (8 Marks)
- b) What is the effective semi-annual interest rate charged by each of the three credit cards? (8 Marks)
- c) Which credit card would you prefer? (3 Marks)
- d) How much should the interest rate be for Silver Visa in order to break-even with Fast Card? (6 Marks)

### QUESTION 2

A major city in West of Canada is planning to build a new bridge to decrease the traffic load on the two old 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, 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. (10 Marks)
- c) Find the Future Worth of this project. (8 Marks)

### QUESTION 3

The following cash flows result from a potential engineering project for GoldBrick Engineering:

1. Receiving \$250,000 at the start of the project and \$600,000 at the end of the fourth year
2. Expending \$200,000 at the end of the first year and \$450,000 at the end of the second year
3. A net cash flow of \$0 at the end of the third year

- a) Draw a cash flow diagram for this project. (5 Marks)
- b) Using an appropriate rate of return method, for a MARR of 25%, should GoldBrick Engineering accept this project? (12 Marks)
- c) When comparing multiple projects, is it always the case for the alternative with the highest rate of return to be the economically best alternative? (4 Marks)
- d) Do both comparison methods worth-based and rate of return always yield the same results? (4 Marks)

### QUESTION 4

A medium-sized farm in Alberta 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 farm 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	5years	

- 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)

### QUESTION 5

An aluminum fabrication plant in Manitoba is studying a replacement decision for its old waterjet cutting machine, purchased 7 years ago at \$130,000, with a new more precise waterjet cutting machine. Based on market studies, the old waterjet cutting machine will have to be replaced some time before the end of the fourth year. The market value of the old waterjet cutting machine is currently estimated at \$49,000. Other related data for the old waterjet cutting machine are summarized in the table below. The MARR is 10%.

Remaining service life in years	Salvage value (\$)	Operating and maintenance cost (\$)
0	49,000	
1	31,500	17,000
2	19,875	21,320
3	15,656	26,806
4	6,742	33,774

- Determine the EAC (Equivalent Annual Cost) for the old waterjet cutting machine over one year, two years, three years and four years of remaining service life. (12 Marks)
- Determine the remaining economic life of the old waterjet cutting machine (5 Marks)
- If the EAC of the new waterjet cutting machine is \$35,000, should the plant replace the old machine with the new one now? (5 Marks)
- What could be considered as a "sunk cost" in this example? (Hint: no calculations are needed) (3 Marks)