

**National Exams Dec 2016**  
**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. Candidates are urged to draw cash flow diagrams whenever applicable.
3. Any non-communicating calculator is permitted. This is an open book exam.
4. 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.
5. Each question is of equal value.

## QUESTION 1

F1, F2 and F3 are three financial services companies that charge different interest rates on their loans. F1 charges **10%** compounded daily, F2 charges **10.1%** compounded quarterly, and F3 charges **10.2%** compounded semi-annually.

- What is the effective annual interest rate charged by each of the three companies? (Hint: An accuracy of at least 2 decimal digits is required). **(10 Marks)**
- Calculate the annual payment a borrower would have to pay to each company on a loan of \$400,000 over 7-year period? **(10 Marks)**
- Which financing company would you prefer? **(5 Marks)**

## QUESTION 2

The province of Ontario is planning to build a new wind farm at Niagara region. The construction of the wind farm will start by the beginning of 2022 and will take 3 years at a cost of \$200 million per year. The cost of maintenance and repairs, which is to start after project completion, is expected to be \$5 million for the first 6 years, and to increase by \$50,000 per year thereafter. The scrap value of the wind farm (mainly metal parts of the wind turbines) is estimated to be \$25 million at the end of its service life. The project is expected to save the province \$55 million per year in energy savings. Assuming the present to be the end of 2016/beginning of 2017, the life of the project is till the end of year 2059, and the interest rate to be 5%,

- Draw a cash flow diagram for this project (from present till 2059). **(7 Marks)**
- What is the Present Worth of the project? **(8 Marks)**
- What is the Future Worth of the project? **(7 Marks)**
- Is it a good investment for the province to make? **(3 Marks)**

## QUESTION 3

Two models of 4-door sedan cars are available for consumers in the Canadian market. The first car is a traditional **gasoline car** that is available at \$20,000, and the second car is an **all-electric car** that is available at \$30,000. A customer is choosing between the two car models. Estimated car usage by the customer is 20,000 km per year. The gasoline model has a fuel consumption rate of 6.5 liters per 100 km, while the all-electric model consumes 12 kWh per 100 km. The market value for both models decreases by 10% per year (Declining Balance Depreciation). Assuming a constant gasoline price per liter of \$0.85 and a constant electric energy price of \$0.14 per kWh and assuming the customer will pay in cash, answer the following at 0% interest rate.

- If the customer is going to resell the car after 3 years, which car model is more economic? **(7 Marks)**
- What gas price would justify the all-electric model if the customer will resell after 4 years? **(9 Marks)**
- How many years of usage will justify buying the all-electric model? (Hint: the answer could be a fraction value). **(9 Marks)**

### QUESTION 4

A medium size assembly plant is considering two solutions for one of its heavy lifting tasks. The plant is choosing between a **fully automated solution**, using a robotic arm, and a **semi-automated solution**, using human operated electric hoist. The plant has a MARR (Minimum Acceptable Rate of Return) of 7%. Use the information in the table below to answer the following questions.

	<b>Solution # 1: Robotic Arm</b>	<b>Solution # 2: Electric Hoist</b>
<b>Price</b>	\$145,000	\$9,000
<b>Human labor cost/year</b>	0	\$30,000
<b>Cost of maintenance and repairs</b>	\$3,000 per year for the first five years and \$5,000 per year thereafter	\$400 per year for the first three years and \$700 per year thereafter
<b>Salvage value</b>	\$5,000	\$1,000
<b>Life</b>	10 years	5 years

- What is the assumption made in comparing mutually exclusive alternatives of different lives? **(4 Marks)**
- Which solution is more economic based on Annual Worth comparison? **(6 Marks)**
- Which solution is more economic based on Present Worth comparison? **(6 Marks)**
- For a study period of 5 years and assuming a salvage value of \$25,000 for the robotic arm, which alternative is more economical? **(6 Marks)**
- Do both methods (Present Worth and Annual Worth) always lead to the same decision? **(3 Marks)**

### QUESTION 5

Four projects are being studied by RTC Inc. The table below provides the first cost as well as the overall and incremental Internal Rate of Return (IRR) for the four projects. Use the information in the table to answer the following. (Hint: for instance, the 9% in the table below could be interpreted as  $IRR_{2-1}$ ).

Project	First Cost	IRR on Overall Investment	IRR on Increments of Investment Compared With Project		
			1	2	3
<b>1</b>	\$100,000	19%			
<b>2</b>	175,000	15%	9%		
<b>3</b>	200,000	18%	17%	23%	
<b>4</b>	250,000	16%	12%	17%	13%

- If the four projects are independent, which projects should be selected at MARR of 17%? **(5 Marks)**
- If the four projects are mutually exclusive, which project should be selected at MARR of 15% (Note: do nothing is a possible alternative). **(12 Marks)**
- State the case(s) in which a rate of return method is recommended. **(3 Marks)**
- Is it always necessary for the alternative with the highest rate of return to be the best alternative? **(5 Marks)**