

National Exams May 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 in 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

- If you were to lend \$500 for three years at 12% per year simple interest, how much interest would you get at the end of the three years? **(6 Marks)**
- How much is accumulated over ten years on a deposit of \$1,000 today at 10% compounded annually? **(6 Marks)**
- If your credit card company charges a nominal 24% interest on the overdue accounts, compounded daily, what is the effective interest rate? (Assume 1 year is 365 days). **(6 Marks)**
- How long will it take any invested amount of money to double itself, with an 11% interest rate, compounded continuously? **(7 Marks)**

QUESTION 2

The city council of a fast growing city in the west of Canada is planning to construct a new tunnel to help improve the traffic flow in the city. Construction is to start in 2020 and is expected to last for four years at a cost of \$16 million per year. After construction is completed, the regular cost of operation and maintenance is expected at \$1 million for the first year, increasing by \$80,000 per year thereafter. To help the city recover the construction cost, the tunnel will operate for the first 25 years as a toll way (till end of 2048). Expected return from toll fees is estimated at \$8 million per year. Consider the present to be the end of 2018/beginning of 2019, the service life of the project to be till end of year 2058, and the interest rate to be 6%.

- Draw a cash flow diagram for this project. **(7 Marks)**
- What is the Present Worth of the project? **(8 Marks)**
- What is the Annual Worth of the project from 2018 till 2058? (Hint: make use of the PW calculated in part b)). **(7 Marks)**
- Is it a good investment for the city to make? **(3 Marks)**

QUESTION 3

A medium-sized food processing plant is considering re-designing one of its packaging operations. The operation is currently being performed by two labour workers. Due to the relative complexity of the task, full automation is not being considered. However, it is possible to replace one of the two labour workers with a collaborative robot that can work safely along with the other worker. The plant has a MARR (Minimum Acceptable Rate of Return) of 7%. The table below summarizes the cost for one labour worker and the cost for one collaborative robot. Use the information in the table to answer the following questions.

	Labour Worker	Collaborative Robot
Purchase price of the collaborative robot	-	\$135,000
Robot installation & first time programming cost	-	\$15,000
Labour worker salary/year	\$40,000	-
Benefits for labour/year	\$3,000	-
Cost of robot re-programming/maintenance	-	\$12,000
Planning horizon	5years	

- If the assembly operation is to be re-programmed every year, is it an economic decision to replace one labour worker with a collaborative robot? (Use Present Worth). **(7Marks)**
- If the assembly operation is to be re-programmed every 2 years, is it an economic decision to replace one labour worker with a collaborative robot? (Use Present Worth). **(7 Marks)**
- Redo part a) using Future Worth instead of Present Worth. **(6 Marks)**

- d) If the service life of the robot 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 are necessary). (5 Marks)

QUESTION 4

A fresh graduate who just started his new job is choosing between two commuting cars of comparable sizes. The first is a traditional **gasoline car** and the second is an **all-electric car**. The anticipated usage of the car is 20,000 km per year. The market value for both cars follows a Declining Balance Depreciation model. Given the data in the table below and assuming that paying will be in cash, answer the following at 0% interest rate.

	Gasoline car	All-electric car
Price	\$24,000	\$36,000
Consumption	6.5 liters per 100 km	12 kWh per 100 km
Fuel/Energy Price	\$0.85 per liter	\$0.20 per kWh
Depreciation Rate	12%	10%

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

QUESTION 5

An investor is currently studying four potential investments in the Great Toronto Area. The table below provides the first cost as well as the overall and incremental Internal Rate of Return (IRR) for the four investments that are currently being studied. Use the information in the table to answer the following. (Hint: for instance, the 11% in the table below could be interpreted as IRR_{B-A}).

Investment	First Cost	IRR on Overall Investment	IRR on Increments of Investment Compared With Project		
			A	B	C
A	\$1.1 m	19%			
B	\$1.7 m	15%	11%		
C	\$2.2 m	18%	17%	23%	
D	\$2.5 m	16%	12%	17%	13%

- a) If the four investments are independent, which projects should be selected at MARR of 16%? (5 Marks)
 b) If the four investments are mutually exclusive, which project should be selected at MARR of 14% (Note: do nothing is a possible alternative). (12 Marks)
 c) State the case(s) in which a rate of return method is recommended. (3 Marks)
 d) Is it always necessary for the alternative with the highest rate of return to be the best alternative? (5 Marks)