

ORDRE DES INGÉNIEURS DU QUÉBEC

NOVEMBER 2024 SESSION

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Open-book examination

Calculators : only authorized models

Duration : 3 hours

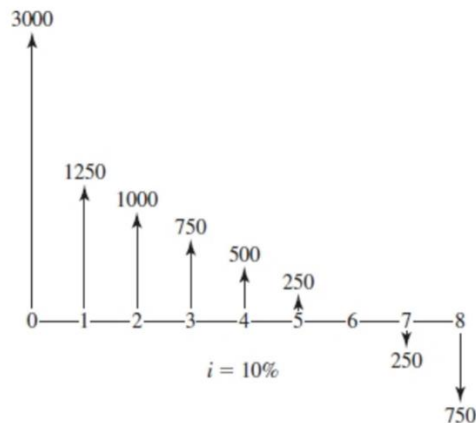
23-EC-1 ENGINEERING ECONOMICS

Question 1	18 points
Question 2	20 points
Question 3	15 points
Question 4	30 points
Question 5	17 points
Total	100 points

Note: Please, write your answers in a clear and legible manner

Question 1 (18 points): Answer the questions with all necessary calculations included.

1. A company makes a \$150,000 loan to finance its activities from a local bank that offers a rate of 6% compounded quarterly. If the loan is to be repaid in 4 equal annual payments,
 - a) (3 points) Calculate the annual effective rate
 - b) (3 points) Calculate the amount of each payment.
 - c) (6 points) Draw up a complete table of repayment (including interest and principal).
2. (6 points) Find the equivalent equal series, A (1 to 8) of the following cash flow at the effective rate of 10%:



Tip: First calculate the present worth and then find equivalent equal series (A)

Question 2 (20 points)

Note: Do all calculations specifying the formulas used

Nicole and Eric found a cottage that, due to a declining real estate market, costs only \$201,500. They will put \$22,000 down and finance the remainder with a 30-year mortgage loan from ABC Bank at an interest rate of 4.8% compounded monthly.

1. (3 points) Calculate the monthly interest rate
2. (4 points) How much are the monthly payments on their loan?

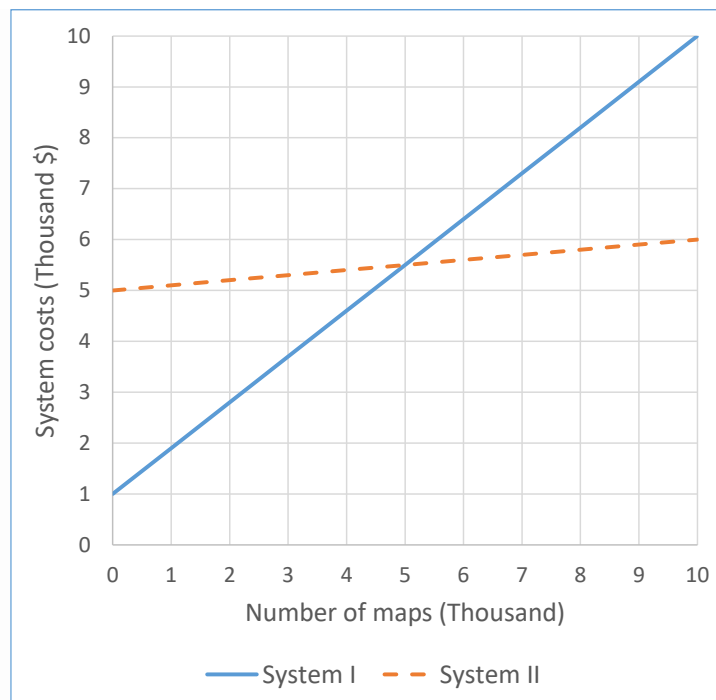
3. (4 points) How much interest will they pay in the second payment?
4. (7 points) They will also have the following expenses: \$2100 property taxes, \$1625 home insurance, and \$290 mortgage insurance (in case one of them dies before the loan is repaid, a requirement of the bank). These annual amounts are paid in 12 installments and added to the loan payment. What will be the full monthly cost of Nicole and Eric?

Tip: Find the equivalent equal series per month that would give the total of the additional expenses over a year and add it to the monthly loan payment

5. (2 points) If they can afford \$1200 a month, can Nicole and Eric afford to buy that cottage?

Question 3 (15 points)

Two automatic systems for dispensing maps are currently being compared. The figure below compares these systems (System I and System II) and shows the total yearly costs for the number of maps dispensed per year. Answer the following questions:



1. (4 points) Give the equation of the total costs as a function of the number of maps for each system.

2. (2 points) What is the fixed cost of System I and the fixed cost of System II?
3. (1 point) What is the variable cost per map dispensed for System I?
4. (1 point) What is the variable cost per maps dispensed for System II?
5. (1 point) What is the breakeven point in terms of cards dispensed at which the two systems have equal annual costs?
6. (2 points) For what range of annual number of maps would you recommend System I or System II?
7. (4 points) At 3000 maps per year, what are the marginal costs and average map costs of each system?

Question 4 (30 points)

An investment firm has the choice between two projects and wonders about the most interesting project.

Project 1 is a wooden cutting board production plant. The cost of purchasing this facility would be \$300,000 with a salvage value, at the end of the 4-year project of \$50,000. Each year, the company would produce 5,000 boards sold for \$45 each in the first year. The company estimates that the price of these boards should increase by 5% thereafter. The cost of production materials (wood, glue, stain, oil, etc.) is estimated at 25% of revenues. Finally, the annual fixed costs are \$25,000 / year for electricity and heating as well as \$35,000 / year for all other fixed costs.

Project 2 consists of the purchase of office space that can be rented by third parties. The purchase and fitting out of the premises is estimated at \$200,000. The salvage value at the end of the 4-year analysis period is 5% of its purchase value. The company estimates that the traffic in this office space would generate \$150,000 in revenue per year. However, the cost of using these offices is \$40,000 per year and the fixed maintenance costs are estimated at \$15,000 per year. Finally, to modernize the office and remain competitive in

this market, the company will have to spend \$25,000 at the end of the 2nd year to make the space more attractive.

Considering that the MARR is 15%, Complete the table in **Question 4** (in the appendix) and answer the following questions:

1. (12 points) Determine the net cash flow of each option.
2. (6 points) What is the Present Worth (NPV) of each option? Which one is better?
3. (6 points) What is the IRR of each option?
4. (6 points) Confirm your investment choice by doing an analysis with the differential IRR method.

Question 5 (17 points)

Office equipment whose initial cost is \$100,000 has an estimated actual life of 4 years, with an estimated salvage value of \$25,000.

- Depreciation method: Declining-Balance with a percentage of $d = 30\%$ (using the half-year convention).
- The marginal tax rate of the company is $t = 35\%$.

Complete the table in **Question 5** (in the appendix) by answering the following questions:

1. (12 points) Make the table listing the annual depreciation amount and book value at the end of each year.
2. (5 points) Calculate the Tax Effect on Salvage value

Appendix – Question 4

1.

Project 1

Years	0	1	2	3	4
Price					
Quantity					
Total revenues					
Production costs					
Annual fixed costs					
Others fees					
Total costs					
Investment and Salvage					
Net cash flow					

Project 2

Years	0	1	2	3	4
Revenues					
User fees					
Maintenance costs					
Renovation (2nd year)					
Total costs					
Investment and Salvage					
Net cash flow					

Appendix – Question 5

1.

DA : Depreciation Amount

BV : Book Value

Calculation of DA and BV					
Year	0	1	2	3	4
Depreciation rate (d %)		15%	30%	30%	30%
Beginning Book Value (B_{n-1})					
Depreciation Amount (D_n)					
Ending Book Value (B_n)					

2.

Tax effect on Salvage Value		
S		
Book Value		
Gains (Losses)		
Gains (Losses) Tax		