

UNIVERSIDAD AUTÓNOMA DE NUEVO LEÓN  
Facultad de Ingeniería Mecánica y Eléctrica

Homework 1

Due date: Mon 02-Feb-2026 18:00

Course: **Selected Topics on Optimization**

Semester: Spring 2026

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**Answer each question.**

1. Formally define an optimization problem.

It is a mathematical problem where you aim to get the optimal solution by maximizing or minimizing the objective function by choosing the right inputs from the decision variables, while staying within the constraints.

2. Formally define a linear optimization problem (also called linear programming problem).

This is a specific type of optimization problem where the objective function and every constraint are strictly linear functions. Also there are no nonlinear terms such as exponents or variable products and the decision variables are real numbers allowing continuous and fractional values.

3. Formally define an integer optimization problem (also called integer programming problem).

An integer optimization problem is similar to linear programming but with the additional requirement that some or all of the decision variables must take whole-number values (integers). Fractional values are not allowed for those variables which makes these problems significantly harder to solve.

4. What is the method typically used for solving linear programming problems (of any size)?

The Simplex method.

5. What is the method typically used for solving integer programming problems?

The Branch and Bound method.

6. What is the main difference between a linear programming problem and an integer programming problem?

The main difference is the type of values the variables can take. Linear programming allows continuous values but integer programming restricts variables to discrete values like 0, 1, or 2. Even though this is a small change, it makes integer problems much harder to solve.

7. When do we say that an optimization problem is “easy” to solve?

An optimization problem is considered easy to solve if there exists an algorithm that can solve it in polynomial time.

8. When do we say that an optimization problem is “hard” to solve?

A problem is considered hard when it cannot be solved efficiently meaning no polynomial time algorithm is known and the solution time grows exponentially with the size of the problem.

9. What is a heuristic method for optimization problems?

A heuristic is essentially a smart "shortcut" or fast way to the answer. It is an algorithm designed to find a good solution very quickly, without guaranteeing that it is the mathematical best solution.

10. What is an exact method for optimization problems?

It is an algorithm that guarantees it will find the absolute best answer (most optimal). It does not stop until it can mathematically prove no better solution exists, which usually takes much longer than a heuristic.

11. What is a brute-force method for optimization problems?

It is when we check systematically every single possible solution one by one. It guarantees the right answer but it is extremely inefficient and only doable for very tiny problems.

12. What are the main reasons heuristic methods are used?

They are used when a problem is so complex or large that finding the perfect solution would take too long. In real life a good enough solution available now is often more useful than a perfect solution that arrives years later.

13. What is a combinatorial optimization problem?

Combinatorial optimization problems involve finding the best combination or arrangement of items from a finite set of discrete options. Typical examples include shipping goods from multiple supply points to multiple destinations or deciding the most efficient way to pack items into a container.