CE 377K: Final<br>Monday , May 18<br>9:00 AM - 12:00 Noon

Name

## Instructions:

- SHOW ALL WORK unless instructed otherwise. No shown work means no partial credit!
- If you require additional space, you may use the back of each sheet and/or staple additional pages to the end of the exam.
- If you need to make any additional assumptions, state them clearly.
- You may use two regular-sized sheets of notes; please turn in the notes with your exam. No additional resources are permitted.
- The number of points associated with each part of each problem is indicated.

| Problem | Points | Possible |
| :---: | :---: | :---: |
| 1 |  | 15 |
| 2 |  | 25 |
| 3 |  | 25 |
| 4 |  | 25 |
| 5 |  | 10 |
| TOTAL |  | 100 |

Problem 1. (15 points). Solve the following nonlinear program, showing all of your work:

$$
\begin{array}{cl}
\min _{x} & e^{x}+e^{-x-2} \\
\text { s.t. } & x \geq 0
\end{array}
$$

Problem 2. ( 25 points). Consider the network shown below, where the node labels on the left panel. indicate the amount of the commodity produced or consumed at that node (a positive number indicates production, and a negative number consumption). The arc labels in the left panel show the arc costs, and the arc labels in the right panel show the arc capacities. Identify the minimum-cost link flow ssatisfying the demand and capacities, showing all of your work.


Problem 3. ( 25 points.) During the simplex method, the following tableau is obtained:

| 1440 | 0 | 0 | 0 | 32 | -20 | 0 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 4 | 0 | 0 | 1 | $-4 / 5$ | 2 | 0 |
| 2 | 0 | 1 | 0 | $1 / 5$ | -1 | 0 |
| 8 | 1 | 0 | 0 | 0 | 1 | 0 |
| 4 | 0 | 0 | 0 | $-1 / 5$ | 1 | 1 |

1. (5) What is the current basis?
2. (5) What is the current solution and objective function value (report values of all variables)?
3. (5) How can we tell that the current solution is suboptimal?
4. (5) Perform one iteration of the simplex method. Report the new values of the decision variables and the objective function value.
5. (5) The cost coefficient for $x_{1}$ changes from $c_{1}$ to $c_{1}+\delta$. For what interval of $\delta$ will the new basis from part (d) remain optimal?

Problem 4. (25 points). A road is being constructed over hilly terrain; the figure below shows the landscape, and the proposed alignment for the road. Where the road lies above the terrain, soil needs to be filled in; where the road lies below the terrain, soil needs to be removed. Three sections need soil filled in; two sections need soil remoevd. The cost of moving soil from one section to another is $\$ 10$ per ton per mile (use the difference in mileposts shown in the table). Formulate an optimization problem for performing the groundwork with the smallest possible cost.


| Section | Soil needed (tons) | Milepost (mi) |
| :---: | :---: | :---: |
| 1 | +4 | 101 |
| 2 | -4 | 102 |
| 3 | +2 | 104 |
| 4 | -8 | 105 |
| 5 | +6 | 108 |

Problem 5. (10 points). Indicate whether the following statements are true or false. No work needs to be shown, and no partial credit will be given. Do not assume anything that is not given.

T F An iteration of the simplex method could potentially increase the objective function.
T F If $\mathbf{x}^{*}$ is an optimal solution to a linear program, it must be an extreme point of the feasible region.
T F Solving a nonlinear program with the line minimization rule is always faster than using the Armijo rule.
T F If $X$ is a convex set, then it must be the feasible region of some linear program.
T F The maximum flow problem is a special case of the minimum-cost flow problem.

