

# 1994 年美国大学生数学建模竞赛 MCM 试题

## 1994 MCM A: Concrete Slab Floors

The U.S. Dept. of Housing and Urban Development (HUD) is considering constructing dwellings of various sizes, ranging from individual houses to large apartment complexes. A principal concern is to minimize recurring costs to occupants, especially the costs of heating and cooling. The region in which the construction is to take place is temperate, with a moderate variation in temperature throughout the year.

Through special construction techniques, HUD engineers can build dwellings that do not need to rely on convection- that is, there is no need to rely on opening doors or windows to assist in temperature variation. The dwellings will be single-story, with concrete slab floors as the only foundation. You have been hired as a consultant to analyze the temperature variation in the concrete slab floor to determine if the temperature averaged over the floor surface can be maintained within a prescribed comfort zone throughout the year. If so, what size/shape of slabs will permit this?

Part 1, Floor Temperature: Consider the temperature variation in a concrete slab given that the ambient temperature varies daily within the ranges given Table 1. Assume that the high occurs at noon and the low at midnight. Determine if slabs can be designed to maintain a temperature averaged over the floor surface within the prescribed comfort zone considering radiation only. Initially, assume that the heat transfer into the dwelling is through the exposed perimeter of the slab and that the top and bottom of the slabs are insulated. Comment on the appropriateness and sensitivity of these assumptions. If you cannot find a solution that satisfies Table 1, can you find designs that satisfy a Table 1 that you propose?

Ambient	Temperature	Comfort Zone
High	85	76
Low	60	65

Part 2, Building Temperature: Analyze the practicality of the initial assumptions and extend the analysis to temperature variation within the single-story dwelling. Can the house be kept within the comfort zone?

Part 3, Cost of Construction: Suggest a design that considers HUD's objective of reducing or eliminating heating and cooling costs, considering construction restrictions and costs.

## 1994 MCM B: Network Design

In your company, information is shared among departments on a daily basis. This information includes the previous day's sales statistics and current production guidance. It is important to get this information out as quickly as possible. [Network diagram (with 5 nodes and 7 capacitated edges) omitted.]

We are interested in scheduling transfers in an optimal way to minimize the total time it takes to complete them all. This minimum total time is called the makespan. Consider the three following situations for your company: [Three more network diagrams (on roughly 20 nodes each) omitted.]