COMAP ANNOUNCES THE FIRST ANNUAL

# HIGH SCHOOL MATHEMATICAL CONTEST IN MODELING

## FEBRUARY 22–26, 1999

# HiMCM 1999

**The contest offers students the opportunity to compete in a team setting using applied mathematics in the solving of real-world problems.**

**Major funding provided by the National Science Foundation.**

**NSF Project Award Number ESI-9708171**

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# HIGH SCHOOL MATHEMATICAL CONTEST IN MODELING

Dear Colleague,

Thank you so much for recently completing the High School Mathematical Contest in Modeling (HiMCM) Questionnaire. The purpose of this letter is to describe briefly the first contest to be held in Spring 1999, and to invite your school's participation.

Due to budget restrictions, we must limit the contest to about 50 schools, with each providing one 4-person student team. This year, we will test one of the models we described in the questionnaire:

**Model 1: One Examination – No Student Movement**

In this model, all competition would take place at the local high school with one 4-person student team per school. Their paper will be returned to the Consortium for Mathematics and its Applications (COMAP ) for centralized scoring.

Thanks again for participating in this exciting adventure! We sincerely hope you will join the first HiMCM by returning the enclosed registration card.

Best Wishes,

John Dossey
Frank R. Giordano
Project Directors

## The Ground Rules

### The Contest Problem

The modeling problem(s) in the contest will be similar to the enclosed sample problems. Problems are open ended. Typically, a situation is described that requires the students to restate the problem. Problems are unlikely to have a unique solution.

### Student Solutions

Attention must be paid to clarity, analysis, and design in attempting a solution. The narrative part of the solution papers must be typed and in English. Partial solutions are acceptable. Analysis expected of the students include:

- Restatement of the problem
- Define variables including units and reasonable domains
- Assumptions with justification
- Discuss model
- Proposed solution and "action taken"
- Model changes
- 1-page summary

These requirements as well as scoring criteria will be made clear to students when they open their HiMCM Problem Packet at the beginning of the contest.

### Resources Available

The competition allows students to use all resources currently available, but to disqualify any teams that discuss the problems with people in a position to supply them with information reflecting experience or professional expertise. The relevant issue is one of intent; each team of students is expected to develop all of its substantive analysis without the help of others. Participants may use computers, software packages, libraries, or any other inanimate sources. The HiMCM Problem Packet will provide requirements and suggested procedures.

All accommodations relative to learning conditions for individual students would follow the accommodations used as part of the local school program in an affected student's daily learning. If specialized staff are required, the school bears the responsibility for providing any specialized assistance as required by law. If such accommodations are required for a student participating, the school should detail them and the extent to which they were utilized as part of the HiMCM activities.

### The Faculty Advisor

The advisor is the key to the success of the HiMCM. The advisor alerts students to the competition and encourages the organization of a team of up to 4 enrolled students. It is both legitimate and desirable to coach or otherwise prepare the team. We are relying on the students and faculty advisors to ensure that the competition is fair and that all students understand and comply with the rules of the contest. In particular, we are counting on the faculty advisor to accomplish the following:

- Ensure that students participating have access to computers that enable students to word process, use a spreadsheet, and dynamically model both graphs and geometric relationships. In addition, students should have access to graphing calculators.
- Ensure that students and advisors sign an honor oath (to be provided in the HiMCM Problem Packet) that the solutions were done under the conditions laid out for the HiMCM competition.
- Ensure that all participating students and parents of students in the pilot and field tests sign release papers making their work available (with confidentiality assurance) for use in example and training materials for HiMCM professional development activities. These release papers will be provided as part of the HiMCM Problem Packet.

### Contest Date and Time

The HiMCM for 1999 must be completed at an individual school site during a specified consecutive 24-hour period between 8:00 A.M. local time on Monday, February 22, 1999 and 3:00 P.M. local time on Friday, February 26, 1999. For example, if the team began work at 8:00 A.M. on Tuesday, February 24, 1999, they would have to cease all work at 8:00 A.M. on Wednesday, February 25, 1999. Faculty advisors must ensure that no alterations of any type are made after the time cutoff. Papers must be collected from the students at this time and returned immediately to COMAP for scoring. **All papers must be received at COMAP by March 4, 1999.**

### Registration

Each school must register by returning the enclosed registration card by February 5, 1999. Team members do not need to register at this time. Faculty advisors are free to change team members up until the HiMCM packet is opened, signaling the beginning of the contest at your school.

**Note:** Each team will be assigned a control number that they will receive in an official control packet two weeks prior to the contest; If you have not received a control packet by **Friday, February 12, 1999**, call (781) 862-7878 extension 37 or email c.callahan@pop.comap.com.

### HiMCM Results

Judging will be completed by March 28, 1999. The solutions will be recognized as Successful Participant, Honorable Mention, Meritorious, and Outstanding. The advisors and teams will be notified of the results in April, 1999. News releases will be prepared for local and national dissemination and there will be announcements in professional publications.

### Recognition

All successful participants will receive a certificate of participation. Outstanding teams will receive bronze plaques and their solution papers will be published in *The UMAP Journal*, among other places. Recognition information will also be sent to local newspapers and radio/television outlets.

## Sample Problems

### The Snowplow problem

The solid lines of the map (see **Figure 1**) represent paved two-lane county roads in a snow-removal district in Wicomico County, Maryland. The broken lines are state highways. After a snowfall, two plow-trucks are dispatched from a garage that is about 4 miles west of each of the two points (*) marked on the map. Find an efficient way to use two trucks to sweep snow from the county roads.

Assume that the trucks neither break down nor get stuck and that the road intersections require no special plowing techniques.

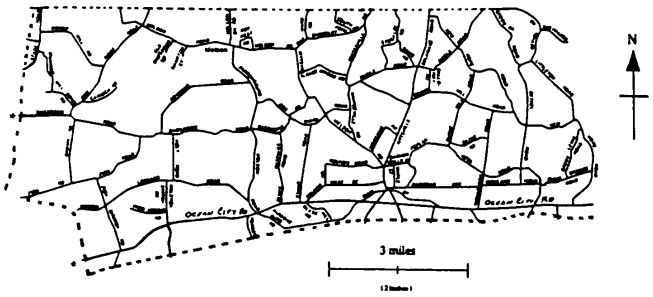


Figure 1. Roads in Wicomico County, MD. (A large map would be provided.)

### The Water Tank Problem

Some state water-right agencies require from communities data on the rate of water use, in gallons per hour, and the total amount of water used each day. Many communities do not have equipment to measure the flow of water in or out of the municipal tank. Instead, they can measure only the level of water in the tank, within 0.5% accuracy, every hour. More importantly, whenever the level in the tank drops below some minimum level $L$, a pump fills the tank up to the maximum level, $H$; however, there is no measurement of the pump flow, either. Thus, one cannot readily relate the level in the tank to the amount of water used while the pump is working, which occurs once or twice per day, for a couple of hours each time.

Estimate the flow out of the tank f(t) at all times, even when the pump is working, and estimate the total amount of water used during the day. **Table 1** gives real data, from an actual small town, for one day.

The table gives the time, in seconds, since the first measurement, and the level of water in the tank, in hundredths of a foot. For example, after 3316 seconds, the depth of water in the tank reached 31.10 feet. The tank is a vertical circular cylinder, with a height of 40 feet and a diameter of 57 feet. Usually, the pump starts filling the tank when the level drops to about 27.00 feet, and the pump stops when the level rises back to about 35.50 feet.

| Time | Level | Time | Level | Time | Level |
|---|---|---|---|---|---|
| 0 | 3175 | 35932 | pump on | 68535 | 2842 |
| 3316 | 3110 | 39332 | pump on | 71854 | 2767 |
| 6635 | 3054 | 39435 | 3550 | 75021 | 2697 |
| 10619 | 2994 | 43318 | 3445 | 79254 | pump on |
| 13937 | 2947 | 46636 | 3350 | 82649 | pump on |
| 17921 | 2892 | 49953 | 3260 | 85968 | 3475 |
| 21240 | 2850 | 53936 | 3167 | 89953 | 3397 |
| 25223 | 2797 | 57254 | 3087 | 93270 | 3340 |
| 28543 | 2752 | 60574 | 3012 | | |
| 32284 | 2697 | 64554 | 2927 | | |

Table 1.
Water-tank levels over a single day for a small town.
Time is in seconds and level is in 0.01 ft.

The Consortium for Mathematics and Its Applications (COMAP) is dedicated to the improvement of mathematics education. COMAP publishes a wide variety of innovative curriculum materials including printed modules, computer software, and video programs. For more information about COMAP products, call 1-800-77-COMAP (1-800-772-6627).

## 1999 High School Mathematical Contest in Modeling Advisor Registration Card

***To register, fill out entire card and return by February 5, 1999.***

HiMCM

(Please type or print clearly.)

School: _____

Advisor Name: _____

Street Address: _____

City, State, Zip Code: _____

Phone: _____

Fax: _____

Email: _____

Advisor Home Phone: _____

For COMAP Use:

(1)_____

**Note:** Each team will be assigned a control number that they will receive in an official control packet two weeks prior to the contest; If you have not received a control packet by **Friday, February 12, 1999**, call (781) 862-7878 extension 37 or email c.callahan@pop.comap.com.

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