GEORGIA INSTITUTE OF TECHNOLOGY

The George W. Woodruff
School of Mechanical Engineering

Ph.D. Qualifiers Exam - Spring Quarter 1995

AUTOMATION IN MANUFACTURING
EXAM AREA

Assigned Number **(DO NOT SIGN YOUR NAME)**

-- Please sign your name on the back of this page --

AUTOMATION IN MANUFACTURING
Qualifier for Spring Quarter 1995

There are 3 questions. Try to allocate your time to each question so that no one question takes too much time. Clearly show your work so that your understanding can be evaluated. If you are stuck on one problem go to another. If a problem is ambiguous, please state your understanding of the question.

1. A. Write an assembly language program for MC68HC11 to measure the length of an input pulse applied to Input Capture 1. The measured time should be stored in a memory location.

   B. For an 8-bit Successive Approximation A/D converter:

      a. Determine the logic state of each bit if Vin = 2 volts and V_{ref} = 6 volts. Please use a chart to show how you arrived at your answer.

      b. What is the total voltage that the A/D converter sends to the computer?

2. Essentially all commercial products sold at retail have a bar code attached to the product. This called the Universal Product Code or UPC. The code is used most often at check out to allow a computer to know the identity of the item. List below the tangible, that is real, benefits of using the UPC for retail sales. Imagine a grocery store as an example. For each tangible benefit, try to compute the value of the UPC on a per item basis. That is, calculate the value in dollars for each can, box, etc. that is sold. (This will be a small fraction of a dollar.) You will make a very crude estimate. You are not being graded on the estimate itself but rather the method, approach, and reasonableness. Your are expected to make some very gross and inaccurate assumptions.

3. Consider a manufacturing workstation with two failure prone machine-tools M1 and M2. Each part that enters the workstation must be processed by both machines. You are asked to analyze and optimize the performance of this system. The following information is provided to you:

- The processing times and times between failures are memoryless with rates p_i and f_i for machine Mi, I=1,2, respectively. The set up and material handling times are negligible.
- Parts are always available for processing. They get processed by the first machine and then moved to the second machine if the second machine is free. Otherwise, they block the first machine. After processing at the second machine the part leaves the system. There can be no more than one part at a time in the system.
- When a machine fails, it is repaired and will resume processing the unfinished part. The repair time is also assumed to be memoryless with rate r_i for machine Mi, i=1,2.
- A machine that is not processing a part cannot fail. Thus blocked or starved machines do not fail.

First identify a suitable state space and develop a continuous-time Markov chain (CTMC) model for this process assuming M1 processes a part first. Compute the steady-state

- process throughput
- utilization of each machine

Based on the above information, answer the following questions:

a) How does the performance (throughput, and utilization) change if the machining sequence is reversed?

b) If more than one part is allowed in the system, how many states do you need to model the process? In your opinion, would this improve throughput and/or machine utilization?

c) Ignoring the machine failure, make an intellectual guess as to what the average throughput would be if more than one part at a time were allowed and compare it to the previous case.