COMPUTER PERFORMANCE EVALUATION Dr. Jozo Dujmović
Homework: Preparation for midterm exam

TOPICS FOR MIDTERM:

- Performance measurements
- Performance of processors
- Performance of memory
- Performance of disk units
- Single server models (M/M/c, GI/G/1)
- Random number generators
- Simulation

The following problems are selected from the above areas.

1. For a given processor bound workload the frequencies of instructions move (MOV), floating add (FADD), and floating multiply (FMUL), and the corresponding instruction run times, for a given processor are:

Instruction	MOV	FADD	FMUL	Others
Frequency [%]	30	10	10	50
Time [nanosec]	100	300	600	160

(a) What is the MIPS indicator of this processor?
(b) Faster memory chips reduce the MOV time by 50%, and all other times by 20%. What is now the value of the MIPS indicator?
(c) The floating point operation times can be reduced 3 times if we buy a floating point coprocessor whose cost is the same as the cost of faster memory. What would you buy: the coprocessor or the faster memory?

2. A disk has 900 cylinders and the capacity of 300 MB. The number of revolutions per minute is 7200 and the seek time (t) as a function of the number of cylinders traveled (x) is $t(x)=x^{1/2}$ [millisecond].
(a) Compute the average access time for a contiguous file whose size is 100 MB.
(b) Write a simulator that verifies the obtained analytic result.
(b) Compute the average access time if this disk uses a cache memory that has the capacity of 50 MB and the access time of 1 ms.

3. Develop a random number generator that generates two-digit decimal numbers where individual digits appear with the following probabilities:

digit	1	2	3	4
probability	0.1	0.2	0.3	0.4

For example, the number 43 (and 34) will be generated in 12% of cases, while 11 will appear only in 1% of cases.

4. Develop a random number generator for generating pseudorandom numbers having the probability density function $f_r(x) = a \sin x$, $0 < r < \pi$, a = constant . You have to determine the value of constant a.

5. Write a simple Lehmer random number generator $N_k = (aN_{k-1} + c) \bmod 256$ and adjust a and c so that it generates a random sequence of maximum length. Display the whole sequence. You may realize the modulo 256 operation using either the % operator, or the truncation of unsigned character variables.

6. Write a program for Monte Carlo computation of $A(x) = \int_0^x \exp(t)dt$. Use this program for computing e=1+A(1) with at least 3 accurate decimal digits. Use rand( ) function from stdlib.h.

7. A communication computer receives identical data packets that form a Poisson arrival process. The average arrival rate is X=10 sec^{-1}. The processing time per packet is constant: S=50 msec. What is the average time that packets spend in this computer? What is the maximum possible arrival rate? Solve the same problem if S is uniformly distributed from 40 to 60 msec.

8. A biprocessor system is described using the M/M/2 model. The average processor service time is 20 msec and the processor utilization is 40%.

(a) Compute the average response time.

(b) Compute the processor utilization and the average response time in the case where one processor is down.

9. Discuss the differences between machine dependent and machine independent random number generators. Write a half-page essay that is similar to the answer to theoretical questions used for the midterm exam.