

MCS 494: Review for the Midterm Exam

The questions below are meant to stimulate the preparation of the exam. They cover some of the most important but not all topics of chapters 1 to 8. You must review all course materials : textbook, homework exercises, and lecture notes (also consult the course web site). A scientific calculator may be used.

1. Consider the quality loss function $L(X) = 48(X - 115)^2$. Use this function to evaluate two production processes with mean μ and standard deviation σ : A: $(\mu, \sigma) = (115, 5)$ and B: $(\mu, \sigma) = (114, 2)$. Which production process do you prefer: A or B? Justify your answer.
2. Suppose that on average, one out of ten car drivers is involved in a car accident every year.
 - (a) What is the chance of getting in two or more accidents?
 - (b) What is the chance of having no accident?
3. Assuming people are born on any given day in the week with equal probability, what is the chance that two or more students in the class (we are with 13) are born on the same day of the week?
4. Write pseudo code to simulate the traffic at a toll booth on a highway. The parameters are the number of toll booths, mean and standard deviation of processing time at the booth and of the arrival times of cars.
5. Find the z -transform of the signal $1, 2, 3, 2, 1, 2, 3, 2, 1, 3, 2, 1, \dots$
6. Solve the recursion $x_k = x_{k-1} + x_{k-2}$.
7. What is aliasing?
8. Show that the Discrete Fourier Transform turns convolutions in coordinate-wise products. Formally, we write $x * y \mapsto \hat{x} \cdot \hat{y}$. (*Hint*: translate the statement for frames of four elements and show the property for these frames.)
9. Formulate the major steps in designing a filter. State the major theorem that is applied here.
10. Minimize $x + 3y$ subject to $x \geq 2, y \geq 1, x + 2y \leq 8$ and $x + y \leq 6$. Graph the feasibility region.
11. Consider the data (x, y) given in the table

x	-2	-1	1	2	3
y	2	1	-1	0	2

Formulate the normal equations you need to solve to find the best fitting quadratic $y = ax^2 + bx + c$.

12. Assume you owe the government at the end of the year \$1,200 in taxes. Suppose \$100 is every month directly deducted from your salary.
 - (a) Using a discount rate of 5%, how much did you really pay after one year, or alternatively, how much should a fair government refund you?
 - (b) Using the same discount rate of 5%, figure out what your monthly deduction should be.
13. Suppose you have the choice between receiving \$1,000,000 now, or 30 installments of \$60,000 each year. Figure out the critical value of the discount rate which makes both options equally attractive and indicate which option is best when the discount rate is lower or higher than this critical value.
14. Formulate a concept of total wealth of a nation. What is the effect of taxes on this total wealth?

15. What is elasticity of demand?
16. Write one paragraph on what you learned from an unrelated project of another team.

This list of questions is by no means exhaustive, but illustrates the type of questions on the exam: short definitions, derivation of a result, a calculation, or a general open-ended question.

Questions of the Midterm Exam of Fall 2002

1. Suppose the quality loss function of a manufacturing process is $L(X) = 20(X - 12)^2$. What is the expected loss if the production methods yield a mean of 11 and a standard deviation of 2? /15
2. Find the z -transform of the signal $1, 2, 1, 2, 1, 2, \dots$ /15
3. What is the most important property of a linear, causal, and time-invariant filter? /15
4. Solve the following problem:
minimize $x_1 + 2x_2$
subject to
$$\begin{cases} 6x_1 + x_2 \geq 6 \\ x_1 + x_2 \geq 3 \\ 2x_1 + 5x_2 \geq 10 \end{cases}$$
 /20
5. Compute the present value of \$1,000 five years from now, using a discount rate of 5%. /10
6. Formulate the relation between elasticity of demand and the revenue of the producer.
Why is this relation so important? /15
7. Write one paragraph on you learned from an unrelated project of another team. /10