Spatial Information Modeling for Climate and Energy Systems
(기후에너지 공간정보모델링) (38541)

- 2024 Midterm Examination -

Student ID: **Name:**

Notice

- Fill your name below and write the whole sentence in your answer sheet:
  "I, _________________, swear I solve all problems by myself in this midterm examination. I will take any disadvantages if any dishonesty such as cheating is acted on my solution."
  5 points will be deducted from your total score if you do not fill in your name above.
- **You MUST solve each problem by hand.**
- Submission Deadline: 11:00~12:15, April 22, 2024.
- No late submission is accepted.

Problem 1. [4 pts.]

1-1. 지구통계학을 영어로 적으시오. [2 pts]

1-2. Provide the full name of BLUE [2 pts]

Problem 2. [10 pts.]

Statistically, you know the answer to 90% of the questions. When you answer the question correctly if the question is a multiple-choice problem with five choices, calculate the probability that you actually know the answer to this question up to the three decimal places. [10 pts.]

Problem 3. [12 pts.]

Suppose that there is a CO_2 storage formation of which the size is 5 km x 5 km x 100 m (height) in the *x*-, *y*-, and *z*-directions, respectively. A unit rock core sample has a diameter of 5 cm and a length of 20 cm (Here, $\pi = 3.14$).

3-1. How many core samples are required to do sampling of 0.001% of the total reservoir volume? [4 pts]

3-2. For problem 3-1, how much is the expected total cost where the unit sampling cost per core is $50.0? [4 pts]

3-3. Suppose that five vertical wells were drilled and 100 m-long core samples were collected from each well. Calculate the percentage of the total volume of the five core samples to the total reservoir volume. [4 pts]

Problem 4. [24 pts.]

Consider the following family of functions:

$z(x; u) = \sin(2\pi x + u)$,

where x is the spatial location (one-dimensional) and u is a random variable uniformly distributed between 0 and 2π. That is, the probability distribution of u is:

$$f(u) = \begin{cases} \frac{1}{2\pi}, & \text{if } 0 \leq u \leq 2\pi \\ 0, & \text{otherwise} \end{cases}$$

4-1. Compute the mean function $m(x)$. [4 pts.]

4-2. Compute the covariance function $R(x, x')$. [4 pts.]

4-3. Compute the variance function $R(x)$. [4 pts.]

4-4. Assume that you measure the value 0.5 for z at $x = 0$. Conditional on this information: What are the possible solutions for $z(x)$? What is the mean function? What is the covariance function? [12 pts.]

Problem 5. [20 pts.]

Given that a sample dataset Z = {4, 12, 3, 6, 50, 2, 32, 24, 5, 15},

5-1. Draw an ogive (i.e., empirical cumulative frequency curve) $f(Z)$, including cumulative probability to each sample data point [10 pts.].

5-2. Using the ogive, calculate a random variable Z when a cumulative probability of 0.23 is drawn. [10 pts.]

Problem 6. [10 pts.]

Calculate the mean and standard deviation of the exponential pdf (i.e., probability density function) where $f(x; k) = k \cdot \exp(-kx)$.

Problem 7. [10 pts.]

Show the mathematical expression of each scheme:

7-1. Weak second order stationarity [5 pts.]

7-2. Intrinsic hypothesis [5 pts.]

Problem 8. [10 pts.]

Fill out the circled numbers from ① to ⑩ in order to complete a below table for experimental auto-variogram Cov(h) and semi-variogram γ(h) values in the case of the separation distance h = 2 ft, 4 ft, and 6 ft. Note that all Cov(h) and γ(h) values **MUST** be calculated to the second decimal place.

Depth (ft)	z_i (md)	h=2 z_{i+2}	h=4 z_{i+4}	h=6 z_{i+6}
0.5	101.1			
1.5	116.5			
2.5	132.4			
3.5	108.1			
4.5	110.3			
5.5	101.3			
6.5	100			
7.5	87.8			
8.5	118.5			
9.5	99.9			
10.5	104.7			
11.5	113.2			
12.5	131.9			
13.5	55.1			
14.5	78.6			
15.5	44.7			
16.5	79.7			
17.5	92.5			
18.5	110.3			
19.5	35			
Number of data points	20			
Average	①	②	③	④
Cov(h)		⑤	⑥	⑦
γ(h)		⑧	⑨	⑩

-------------------- This is the End of the Midterm Examination --------------------