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

- 2023 Midterm Examination -

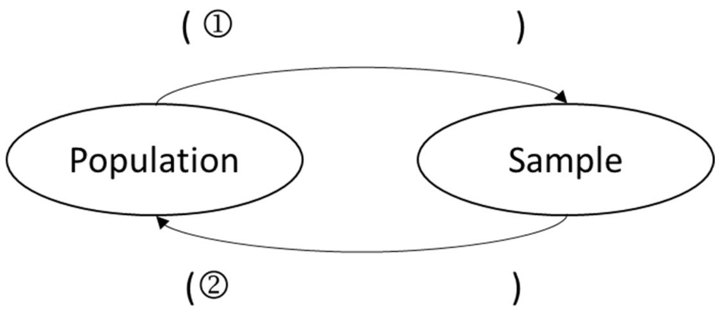
Student ID: **Name:**

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: 15:30~16:45, April 25, 2023.

Problem 1. [4 pts.]

Fill in two blanks ① and ②.



Problem 2. [4 pts.]

Provide the full name of each acronym:

2-1. BLUE [2 pts]

2-2. MVUE [2 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. [10 pts.]

There is an infinite population composed of nonnegative values of which the mean and variance are μ and σ^2, respectively. Explain why z^* tends to follow a log-normal distribution when z^* is the product of n data points sampled from the population.

Problem 5. [20 pts.]

For a sample dataset {5, 13, 3, 6, 45, -12, 36, 6, 9, 12},

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

5-2. Draw a boxplot, including the minimum, 1st quartile, 2nd quartile, 3rd quartile, maximum, and IQR [10 pts.]

Problem 6. [20 pts.]

6-1. Show your work that proves E(z) = (a + b)/2 and Var(z) = (b - a)^2/12 for a uniform distribution f(z; a, b). [10 pts.]

$$f(z;a,b)=\begin{cases}\dfrac{1}{b-a}, & if\ a\le z\le b\\ 0, & otherwise\end{cases}$$

$$F(z;a,b)=\begin{cases}0, & if\ z<a\\ \dfrac{z-a}{b-a}, & if\ a\le z\le b\\ 1, & if\ z>b\end{cases}$$

6-2. Show your work that proves both mean and standard deviation of exponential pdf are equal to 1/a when f(z; a) = ae^{-az}. [10 pts]

$$f(z;a)=\begin{cases}0, & if\ z<0\\ ae^{-az}, & if\ z\ge 0,\ a>0\end{cases}$$

$$F(z;a)=\begin{cases}0, & if\ z<0\\ 1-e^{-az}, & if\ z\ge 0\end{cases}$$

Problem 7. [10 pts.]

Show the mathematical expression of each scheme:

7-1. Weak second order stationarity

7-2. Intrinsic hypothesis

Problem 8. [20 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 $\gamma(h)$ values in the case of the separation distance h = 2 ft, 4 ft, and 6 ft. All Cov(h) and $\gamma(h)$ values **MUST** be calculated to the second decimal place.

Depth	z_i	$h = 2$	$h = 4$	$h = 6$
(ft)	(md)	z_{i+2}	z_{i+4}	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
$\gamma(h)$		⑧	⑨	⑩

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