

BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR
B.E. 7TH SEMESTER (MinE) FINAL EXAMINATION, 2012
Elective I (Geostatistics) (MN 706/1)

Full Marks: 70

Time: 3 hrs

Answer any FIVE questions

Marks are indicated on the right margin of the questions

Students are allowed to use the charts and figures of Auxiliary functions and normal distribution

1. a) What are the causes of Nugget effect? How is it related with the size of sample?
- b) In practical Geostatistics how would you adjust lag distance and direction of orientation?
- c) Why semivariogram is considered as more powerful tool compared to covariogram to measure the relationship between sample values at different spatial locations?
- d) Establish the relation between semivariogram and covariogram. [3 $\frac{1}{2}$ \times 4 = 14]

2. Show that

i) $\sigma_w(h) = \bar{\sigma}(w; w_{+h})$ and

ii) $\gamma_w(h) = \bar{\gamma}(w; w_{+h}) - \bar{\gamma}(w; w)$

where, $\sigma_w(h)$ =regularized covariogram

$\bar{\sigma}(w; w_{+h})$ =average value of $\sigma(z'z'')$ where z' and z'' are any two points in $w(z)$ and $w(z+h)$ respectively

$\gamma_w(h)$ =regularized semivariogram

$\bar{\gamma}(w; w_{+h})$ =average value of the point semivariogram $\gamma(z'z'')$ where $z'z''$ is the vector distance between any two points z' in sample $w(z)$ and z'' in sample $w(z+h)$

$\bar{\gamma}(w; w)$ =average value of $\gamma(z'z'')$ where z' and z'' are any two points in the same sample w .

[10+4=14]

3. Enumerate Kriging error in terms of average semivariogram by taking two samples when mean grade is unknown, then generalize the relations. Show in a Matrix form also.

[14]

4. a) Define dispersion variance.
- b) What do you mean by 'variance additivity relationship'?
- c) A rectangular section of a bedded deposit has been sampled as shown in the following figure. The size of the section is 500 m \times 500 m, and 11 samples have been taken. Calculate the variance of the samples w in W_1 , where W_1 is of 500m \times 500m, 250m \times 500m and 250m \times 250m.

A ₁	A ₂	A ₃
o11	o19	o23
o10		
B ₁	B ₂	o16
		B ₃
o14	o11	
	o22	
o9	o20	
	o13	
C ₁	C ₂	C ₃

d) Show graphically the variance area relationship.

[1+2+7+4=14]

5. a) In a deposit of 10 million tones, it is found that the average grade of Cu is 0.30% and the cut off grade is 0.40% and the variance is $0.01(\%)^2$, find out the percentage and quantity of ore above cut-off grade in the deposit.

b) Consider an iron ore deposit which is known to follow a normal distribution with a mean of 48%Fe and a standard deviation of 5%Fe. This distribution has been established on samples small enough to be called 'points'. The deposit follows a point semi-variogram model which is spherical with a range of influence of 400 ft and sill 25 $(\%)^2$. If the cut-off grade is 44%Fe, how much of the deposit will be ore and what will be average grade of that ore?

c) In the above deposit if the block dimension is 100ft by 50ft what will be the standard deviation?

[4+7+3=14]

6. Consider a point semivariogram $\gamma(h)$ linear for $h \leq 2$ and reaching a sill $C=1$ at $h=2$. There is no nugget effect. Consider a square block W of size 3×3 and point sample w_1 and w_2 located in the centre and corner of W respectively.

a) Find out estimation variances $\sigma_e^2(w_1 \text{ to } W)$, $\sigma_e^2(w_2 \text{ to } W)$, $\sigma_e^2(w_s \text{ to } W)$, where $w_s = \{w_1, w_2\}$.

Given, $\bar{\gamma}(W;W)=0.683$; $\bar{\gamma}(w_1;W)=0.536$; $\bar{\gamma}(w_2;W)=0.882$.

b) Find also the estimation variances of the same parameters if the point semivariogram follows a spherical model with same sill and range as above.

[(2+2+3)×2=14]

7. Consider a disseminated nickel deposit in the late stages of development. On a particular underground level, the block of size 50m by 40 m needs to be estimated. This panel has been developed along two sides and the information available consists of (i) the average grade along the

50 m drive, g_1 and (ii) the average grade along the 40m drive, g_2 . If the average of these two grades are used to estimate the value inside the panel what will be the estimation variance? The deposit follows the spherical model of semivariogram with a range of influence of 60m and a sill of $0.75(\%)^2$.

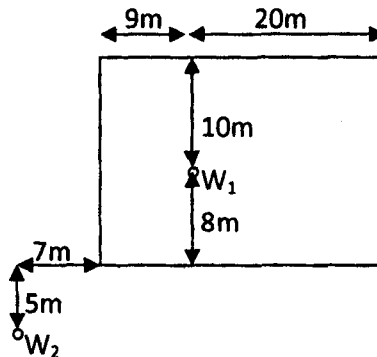
[14]

8. With the help of point Kriging method, find out the elevation of water table at an unknown point 'p' knowing the elevation at three specified points 1, 2 and 3. The following chart shows the three known wells and their elevation in meters. The unknown elevation point is labeled p.

Well	x-coordinate	y-coordinate	Water Table Elevation (m)
1	1	2	190
2	4	3	110
3	5	4	140
p	3	2	unknown

Use a linear semivariogram $\gamma(h)=4h$.

9. Consider a mineral deposit where the semivariogram follows an exponential model with sill $C=0.04(\%)^2$ and range $a=10m$. Calculate the Kriging estimator and Kriging variance for the block W (rectangular area) in the following figure with the help of the point samples w_1 (0.6%) and w_2 (1.0%).



[14]