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UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2018

Program: B.Tech. Mining (Indian) **Semester – VI**
Subject (Course): Geostatistics **Max. Marks : 100**
Course Code : GSEG 327 **Duration : 3 Hrs**
No. of page/s: 03

<table>
<tr><td colspan="4">Attempt all questions from Section A (each carrying 4 marks); attempt all questions from Section B (each carrying 8 marks); attempt all questions from Section C (each carrying 20 marks).</td></tr>
<tr><td colspan="4">Section A
(Attempt all questions)</td></tr>
<tr><td>1.</td><td>In 256 sets of 12 tosses of a coin, in how many cases one can expect 8 heads and 4 tails.</td><td>[4]</td><td>CO1</td></tr>
<tr><td>2.</td><td>The two regression equations of the variables x and y are $x = 19.13 - 0.87y$ and $y = 11.64 - 0.50x$. Find the correlation coefficient between x and y.</td><td>[4]</td><td>CO1</td></tr>
<tr><td>3.</td><td>Let $z_1, z_2, \dots, z_n$ are measurements at n locations. An estimate for z at a point x_0 is required. Let $d_1, d_2, \dots, d_n$ are distance of the point x_0 from the other n locations. A variant of inverse distance interpolation technique is defined as

$$z(x_0) = \frac{w_1 z_1 + w_2 z_2 + \cdots + w_n z_n}{w_1 + w_2 + \cdots + w_n}$$

Where $w_i = \frac{1}{d_i^2}$.

Use this interpolation method to estimate the missing value $z(x_0)$ at x_0. Use the following information.
<table>
<tr><th></th><th>Distance from x_0</th><th>Value z_i</th></tr>
<tr><td>x_1</td><td>4</td><td>50</td></tr>
<tr><td>x_2</td><td>2</td><td>30</td></tr>
<tr><td>x_3</td><td>6</td><td>52</td></tr>
</table>
</td><td>[4]</td><td>CO2</td></tr>
<tr><td>4.</td><td>Write the definition of the anisotropic variogram.</td><td>[4]</td><td>CO3</td></tr>
<tr><td>5</td><td>Prove that the simple kriging is an exact estimator.</td><td>[4]</td><td>CO4</td></tr>
</table>

SECTION B
(Q6-Q9 are compulsory and Q10 has internal choice)

6. Find the mean and standard deviation of a normal distribution in which 7% of the items are under 35 and 89% are under 63. Given that, $P(Z \leq -1.48) = 0.07$ and $P(Z \leq 1.23) = 0.89$, where Z is a random variable following a standard normal distribution.

[8] **CO1**

7. Compute the variogram, $\gamma(h)$, for $h = 9$ in two directions (horizontally and vertically) separately for the data given below on a rectangular grid.

4	3	3	5	5	5
4	4	5	4	5	17
8	2	2	3	7	7
1	6	10	9	9	10
11	12	11	3	3	4

Each data is separated horizontally by 3 feet and vertically also by 3 feet.

[8] **CO3**

8.

h	$\gamma(h)$
0.07	3.09
0.24	6.09
0.38	7.9
0.53	9.25
0.69	10.73
0.84	12.31
1	12.28
1.12	14.28
1.29	13.92
1.44	14.25
1.58	14.48
1.74	13.4
1.89	12.51
2.04	12.8
2.19	11.71

For the data given above, use RMSE to suggest best variogram model among Spherical, Exponential and Gaussian models. Assume range as 1.5, sill as 14 and nugget as 0.

[8] **CO3**

9 Let $\gamma(x_i - x_j)$ represents the variogram between random variables $Z(x_i)$ and $Z(x_j)$ at two locations x_i and x_j, respectively. For a location x_0, establish the relation

$$\gamma(x_i - x_j) = \gamma(x_i - x_0) + \gamma(x_j - x_0) - Cov[Z(x_i) - Z(x_0), Z(x_i) - Z(x_0)]$$

[8] **CO4**

<table>
<tr><td>10.</td><td>Find the function to be optimized for computing the simple kriging weights.

OR
Find the function to be optimized for computing the ordinary kriging weights.</td><td>[8]</td><td>CO4</td></tr>
<tr><td colspan="4">SECTION C
(Q11 is compulsory and Q12A, Q12B have internal choice)</td></tr>
<tr><td>11.A</td><td>State and prove a necessary and sufficient condition for universal kriging estimator to be unbiased. Also show that, the un-biasedness conditions leads to $\sum_{i=1}^{n} \lambda_i = 1$.</td><td>[10]</td><td>CO4</td></tr>
<tr><td>11.B</td><td>Write the ordinary kriging system of equations in terms of the variogram function. Using the relationship between the variogram function and the covariogram function, transform the system of equations in terms of covariance functions.</td><td>[10]</td><td>CO4</td></tr>
<tr><td>12.A</td><td>
<table>
<tr><th></th><th>x</th><th>y</th><th>$Z(x_i)$</th></tr>
<tr><td>x_1</td><td>10</td><td>20</td><td>40</td></tr>
<tr><td>x_2</td><td>30</td><td>280</td><td>130</td></tr>
<tr><td>x_3</td><td>250</td><td>130</td><td>90</td></tr>
</table>

Use simple kriging to estimate the value of $Z(x_0)$ at $x_0 = (180, 120)$. Given $E[Z(x)] = 110$ and the covariance function as $2000 * \exp(\frac{-h}{250})$
OR
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<tr><td>12.B</td><td>(i) If the measurement is repeated at a location twice, then show that it is impossible to run kriging algorithm.
(ii) Find the optimum value of the function $f(x, y, z)$ subjected to condition $g(x, y, z) = 0$ and $h(x, y, z) = 0$.
OR

Find the simple kriging system of equations and use the solution to find the simple kriging estimation error variance.</td><td>[10]</td><td>CO4</td></tr>
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