MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF APPLIED SCIENCES

UNIVERSITY ORDINARY EXAMINATION

2017/2018 ACADEMIC YEAR

EXAMINATION FOR MASTER OF SCIENCE IN STATISTICS

AMS 605: STATISTICAL METHODS FOR SPATIAL DATA

DURATION: 3 HOURS

DATE: 17TH AUGUST, 2018

TIME: 9.00 – 12.00 NOON

Instructions to Candidates:

1. Answer **Any Four** questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

QUESTION ONE

a. Discuss any 6 areas of application of spatial statistics (14 marks)

b. Defining what a variogram $\gamma(h)$ is, show that it can be expressed in terms of the covariance function:

$$\gamma(h) = C(0)\left[1 - \frac{C(h)}{C(0)}\right]$$ (11 marks)

QUESTION TWO

a. Discuss any 6 types of kriging functions (12 marks)

b. Consider the spatial arrangement of the hypothetical dataset below:

ID	1	2	3	4	5	6	7	8	9
X_1	0	1	1	2	2	3	3	4	4
Y_1	0	0	1	2	3	3	4	4	5
Z_1	10	10	15	20	25	20	20	40	50

Letting $\hat{\gamma}_{ij}$ denote the variogram ordinates at distance h between points i and j, obtain:

i. $\hat{\gamma}_{ij}(2.83)$ (6 marks)

ii. $\hat{\gamma}_{ij}(3.61)$ (7 marks)

QUESTION THREE

a. Define the following terms:

i. Stationarity (3 marks)

ii. Isotropy (2 marks)

iii. Anisotropy (2 marks)

iv. Random effects (3 marks)

b. Suppose we have 3 points as given in the table below. We want to predict the value v at the new location $S_0 = (65E, 137N)$:

Sample	X	Y	v
1	61	139	477
2	63	140	696
3	64	120	227

Compute the covariances among all points and between each of the points to be predicted. Use the exponential covariance:

$$C(h)=\begin{cases} a+\left(\sigma^2-a\right) & if\ |h|=0 \\ \left(\sigma^2-a\right)\exp\left(\frac{-3|h|}{r}\right) & if\ h>0 \end{cases}$$

Assume the nugget effect a=0, the range=1 and sill, $\sigma^2 = 100$ (15 marks)

QUESTION FOUR

a. Spatial statistics ride on the advancement of computer algorithm for inference. Chief among these are the Markov chain Monte Carlo (McMC) and the Integrated Nested Laplace Approximation (INLA).

i. Discuss briefly the McMC method highlighting on the Metropolis Hastings and the Gibbs sampling methods, Burn in and convergence. (11 marks)

ii. Briefly outline the advantages of INLA over McMC (6 marks).

b. The following are choropleth maps obtained my mapping the prevalence of HIV in Kenya with the spatially varying effects of some selected covariates. Give a brief interpretation of the maps (attached). (8 marks)

QUESTION FIVE

a. Let $Y_i|\theta_i \sim Poisson(\theta_i E_i)$ show that the standardized mortality (or morbidity) rate SMR at region i is given by: $\hat{\theta}_i = \frac{y_i}{E_i}$ (12 marks)

b. Discuss the components of a spatial data (7 marks)

c. Define the following types of data.

i. Vector data (2 marks)

ii. Raster data (2 marks)

iii. Triangulated data (2 marks)