KENYATTA UNIVERSITY
UNIVERSITY EXAMINATIONS 2016/2017

SECOND SEMESTER EXAMINATION FOR THE DEGREE OF MASTER OF SCIENCE (ACTUARIAL SCIENCE)

SST 821: STATISTICAL GENETICS

DATE: Tuesday 16th May 2017 **TIME: 5.30p.m-8.30p.m**

INSTRUCTIONS:

Answer Question ONE and any other TWO questions

1. (a) Define the terms 'Natural and artificial selections' Give examples (4 marks)

(b) If $A_1, A_2 \ldots\ldots A_S$ denotes s alleles with genotype frequencies $h_{11}, h_{22} \ldots h_{12} \ldots\ldots h_{s-1,s}$ and fitness $w_{ii}, i = j$ and $w_{ij}, i \neq j$ i, j=12....s .Show that the effective population structure after selection in the first generation is given by

$$Q^1(r) = \sum\sum w_{ij} h_{ij} A_i A_j / \bar{w}$$

(6 marks)

(c) Three sets of data on the genotype frequencies of the MN blood group have been obtained by different investigators. If the mendelian ratios are 1:2:1 and these population exhibit heterozygote disadvantage with relative to fitness ϕ that is

MM	MN	NN
1	2ϕ	1

Where $0 < \phi < 1$.

Estimate ϕ. (6 marks)

(d) The MN blood group system in human is governed by a pair of co-dominant alleles L^M and L^N . A sample of 208 bedouins in the Syrian desert was tested for The presence of the M and N antigens and found to contain $119\ L^M L^M$, $76\ L^M L^N$ and $13\ L^N L^N$

Test the hypothesis that the population (i) exhibit heterozygote disadvantage.
(ii) is in equilibrium.

(8 marks)

(e) At what allelic frequency does the homozygous recessive genotype 'aa' becomes twice as frequent as the genotype 'Aa' in a Hardy-Weinberg equilibrium?

(6 marks)

2. (a) State Hardy-Weinberg equilibrium law with respect to multiple loci and Multiple alleles. (3 marks)

(b) Consider a population with a multiple autosomal loci $(\gamma_1, \gamma_2, ...\gamma_s)$ and multiple alleles $(g_1, g_2, ...g_s)$ respectively where $\sum_{i=1}^{s} g_i = 1$

Prove the Hardy-Weinberg equilibrium law.

(11 marks)

(c)In the human population, an index finger shorter than the ring finger is thought to be governed by a sex-influenced gene that appears to be dominant in males and receive in females. A sample of the males in this population was found to contain 120 short and 210 long index fingers. Calculate the expected frequencies of long and short index fingers in females in this population.

(6 marks)

3. (a) When is a population said to be in genetic equilibrium under selection? (2 mark)
(b) Stating the underlying assumptions, prove that the mean fitness increases in each successive generation until the stationary conditions are obtained. (8 marks)

(c) Given the following genotype pattern

Genotype	AA	Aa	aa
Probability	p^2	2pq	q^2
Relative Fitness	$1-c$	1	$1-\alpha c$

Show that the gene frequency at equilibrium is $q^* = \frac{1}{1+\alpha}$

(10 marks)

4. (a) State the conditions under which equilibrium is said to be stable. (2 marks)
(a) Stating the underlying assumptions, Prove that the necessary condition for equilibrium is that the mean fitness of the population attains an extremum. (8marks)
(b) Consider the following tetraploid population with a three loci.

The matrix of genotype frequencies and fitness are given respectively by

$$C = \begin{bmatrix} 0.16.....0.05.....0.07 \\ 0.05.....0.18....0.10 \\ 0.07.....0.10....0.22 \end{bmatrix} \qquad W = \begin{bmatrix} 1...2...3 \\ 2...1...2 \\ 2...2...1 \end{bmatrix}$$

(i) Calculate the gene frequencies in the initial population. (2marks)
(ii) Calculate the gene frequencies in the next two generations. (2marks)
(iii) Show that $\Delta W \geq 0$. (3marks)
(iv) Find the gene frequencies at equilibrium and determine whether this equilibrium is stable. (3marks)

END