



MACHAKOS UNIVERSITY

University Examinations for 2021/2022 Academic Year

SCHOOL OF AGRICULTURAL SCIENCES

DEPARTMENT OF AGRICULTURAL EDUCATION AND EXTENSION

SECOND YEAR FIRST SEMESTER EXAMINATION FOR

BACHALOR OF SCIENCE (AGRICULTURAL EDUCATION AND EXTENSION)

ANS 241: QUANTITATIVE GENETICS

DATE: 10/12/2021

TIME: 2.00-4.00 PM

INSTRUCTION TO CANDIDATES: Answer *ALL* questions from Section A and any other *TWO* from Section B

SECTION A: COMPULSORY: (30 MARKS)

QUESTION ONE (30 MARKS)

- a) Define the following terms as use in quantitative genetics (4 marks)
- i. Generation interval
 - ii. Intensity of selection
 - iii. Allele
 - iv. Gene
- b) Using equations, distinguish between heritability in the narrow and broad sense (2 marks)
- c) Explain why the genetic value of an individual is always different from its breeding value (2 marks)
- d) Explain the role of genotype by environment interaction in the design and analysis of breeding programmes (4 marks)

- e) Explain under what circumstances direct selection or indirect selection can be used for the genetic improvement of a trait (3 marks)
- f) Explain the relationship between selection differential and response to selection (3 marks)
- g) Explain the value of information from relatives in the estimation of breeding values (2 marks)
- h) Describe the three strategies of selection, giving reasons which determine the choice any strategy. (6 marks)
- i) Explain four conditions which must be met for the Hardy-Weinberg Law to hold (4 marks)

SECTION B: ANY OTHER TWO QUESTIONS (40 MARKS)

QUESTION TWO (20 MARKS)

- a) Assume that the average yearling weight in beef cattle is 300kg and has a heritability of 0.4. A bull X has a weight of 340 kg at one year. What is the expected mean value of his progeny if he is mated to:
 - i. A randomly selected cow (2 marks)
 - ii. A top cow with a yearling weight of 330kg (2 marks)
 - iii. A cow with a yearling weight of 280 kg (2 marks)
 - iv. Of the three scenarios above, which one would be the most appropriate for improvement of yearling weight and why? (2 marks)
- b) Consider a single locus with just two alleles segregating (A_1 and A_2). Assume genotype A_1A_1 to have the greatest merit, and genotype A_1A_2 to be better than the average of the two homozygotes-i.e. showing some dominance. The table below shows the values and frequencies for yearling weight in beef cattle:

Genotype	A_1A_1	A_1A_2	A_2A_2
Genotype mean merit	$g_{1,1}$	$g_{1,2}$	$g_{2,2}$
Mean	320	310	280
Frequency ($p=0.8$)	p^2 a	$2pq$ b	q^2 c
Genetic value G:	$g_{1,1}$ e	$g_{1,2}$ f	$g_{2,2}$ g

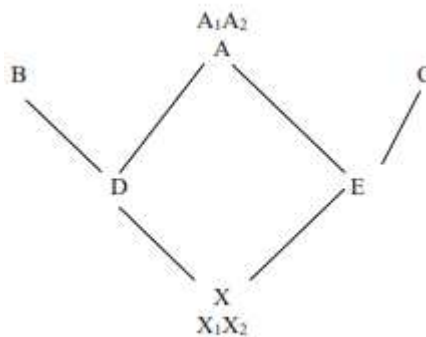
- i. What is the population mean merit? (3 marks)
- ii. Calculate the genotype frequencies of the three genotypes a , b and c (3 marks)
- iii. What are the genetic values e , f and g for the three genotypes? (3 marks)
- iv. Calculate the breeding values of each of the three genotypes (3 marks)

QUESTION THREE (20 MARKS)

- a) In an experiment to improve weight in Tilapia fish, a researcher find that the heritability of weight, $h^2=0.09$, and that of length is 0.16. The genetic correlation between body weight and length is 0.95.
- i. What is the direct response to selection for weight and length? (6 marks)
 - ii. Calculate the correlated response in body weight due to selection for body length? (4 marks)
 - iii. From the results you have obtained in part i & ii above, explain which one between direct and indirect selection leads to higher response in body weight. (5 marks)
- b) Explain five ways you would employ to increase response to selection (5 marks)

QUESTION FOUR (20 MARKS)

- a) Explain the three factors that lead to increase in inbreeding in livestock populations (6 marks)
- b) From the Figure below, calculate the inbreeding coefficient of Individual X (show all the pathways and computations) (6 marks)



- c) Describe four consequences of high inbreeding levels in breeding programmes (8 marks)

QUESTION FIVE (20 MARKS)

- a) Explain the two main breeding systems that are used in genetic improvement of livestock (4 marks)
- b) Explain the advantages of crossbreeding systems in livestock production. (6 marks)
- c) The average weaning weight of breed A is 206.4 kg and that of breed B is 201.8 kg. The average of the crossbreds resulting from the crossing of Breeds A and B is 213.2 kg. calculate the percent heterosis arising from this crossbreeding. (4 marks)
- d) Explain three benefits of genomic selection. (6 marks)