

THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
POST GRADUATE SECOND SEMESTER EXAMINATION
2011-2014

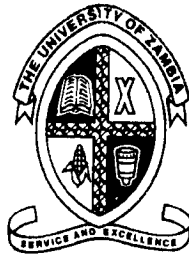
1. AGA 6122- Ruminant digestion and metabolism
2. AGA 6132- Vitamins and mineral nutrition
3. AGC 6111- Plant physiology
4. AGC 6112- Advanced plant physiology
5. AGC 6121- Physiology of yields
6. AGC 6125- Sustainable agriculture
7. AGC 6211- Plant breeding methods
8. AGC 6222- Molecular genetics and biotechnology
9. AGC 6322- Plant protection
10. AGC 6425- Horticulture
11. AGC 6432- Biometrical genetics and plant breeding
12. AGC 6431- Plant breeding methods
13. AGC 6452- Molecular genetics and biotechnology
14. AGC 6552
15. AGC 6612 Seed system
16. AGC 6820- Communication skills
17. AGE 6062- Production economics
18. AGE 6091- Institutional and behavioural economics
19. AGE 6122- Agricultural policy analysis
20. AGE 6222- International trade theory and policy
21. AGE 6311- Seed agribusiness management
22. AGG 6132- Soil plant water relations
23. AGG 6211- Biostatistics
24. AGG 6512- Soil plant water relations
25. AGG 6811- Biostatistics in agriculture
26. AGS 6141- Plant nutrition
27. AGS 6221- Applied soil chemistry

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- 28.AGS 6232- Soil amendments and fertilizer technology
- 29.AGS 6311- Applied soil physics
- 30.AGS 6411- Applied soil chemistry
- 31.AGS 6411- Soil microbiology
- 32.AGS 6431- Soil microbiology
- 33.AGS 6432- Soil amendments and fertilizer technology
- 34.AGS 6532- Soil conservation
- 35.AGS 6612- Soil and water conservation
- 36.AGS 6715- Agroclimatology.

AGA 6122 – RUMINANT DIGESTION AND METABOLISM



**UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
DEPARTMENT OF ANIMAL SCIENCE**

MASTER OF ANIMAL SCIENCE IN NUTRITION

COURSE: AGA 6132 VITAMINS AND MINERAL NUTRITION

FINAL EXAMINATION 11TH MAY 2011, 09:00 HOURS

Lecturers: Drinah Banda Nyirenda, PhD Senior Lecturer
Martha Musukwa, MSc. Lecturer

INSTRUCTIONS:

ANSWER PART I AND II IN SEPARATE ANSWER BOOKS

Time: 3 Hours

PART I VITAMIN NUTRITION

This section Accounts for 60 percent of the final examination.

Question I (15 points)

As the manager of a pig producing farm, you have just produced your own feed for growing pigs and after a week's feeding, the growth rate dropped by 40 percent and mortality rose by 5 percent. Upon laboratory analysis of the feed, it was discovered that the diet had 50% less B₁₂ (Cobalamin) and 50% less Niacin (B₃) as percent of daily requirement, respectively.

- (i) Briefly explain to your staff what the metabolic importance of the two vitamins are;
- (ii) In deficiency, explain the theoretical sequence of events leading to problems with each vitamin;
- (iii) Give two examples of biochemical functions of each vitamin to support your explanation and;
- (iv) What remedial action will you take?

Question 2 (10 points)

Using the chemistry of vitamin C (Ascorbic Acid) **OR** Biotin (**CHOOSE ONLY ONE**)

- (i) Briefly explain the importance of any one of the vitamins in animal metabolism;
- (ii) Give three biochemical functions;
- (iii) What are the anti-metabolites of the vitamin you selected and;
- (iv) How do they affect the metabolism of the vitamin and its function?

Question 3 (10 points)

- (a) Pick one vitamin of your choice and;
 - (i) Give three biochemical functions and;
 - (ii) Briefly explain their importance in animal overall metabolism and;
 - (iii) Give two specific deficiency symptoms that correlate to the biochemical functions of the selected vitamin.

OR

- (b) Briefly, provide a scientific analysis differentiating the water soluble vitamins from the fat soluble vitamins by their:
 - (i) General biochemical functions,
 - (ii) Active sites,
 - (iii) Deficiency symptoms and;
 - (iv) Occurrence in nature.

Question 4 (25 points)

(a) In the blood clotting mechanism;

- (i) At what point does vitamin K function?
- (ii) Name three antagonists of vitamin K and
- (iii) Illustrate how they affect the function(s) of vitamin K.

(10 points)

(b) In a flow chart;

- (i) Show the conversion of vitamin D to its active metabolites in the different tissue sites
- (ii) What are the main functions of each of these metabolites?
- (iii) How does vitamin D interact with hormones that regulate Calcium homeostasis in the body?

(15 points)

PART II: MINERAL NUTRITION

This section Accounts for 40 percent of the final examination.

Question 1(20 Points)

Explain the interrelationships in physiological function and homeostasis of sodium, potassium and chloride in the animal body.

Question 2 (10 points)

There are two classes of metal ion-requiring enzymes that are distinguished by the strengths of their ion-protein interactions.

- (i) What are the two classes of metal ion-requiring enzymes and what metals are involved in each class
- (ii) How do the metal ions participate in the catalytic function of metal ion-requiring enzymes?

Question 3 (10 Points)

Iron, Copper, Zinc, Selenium and Iodine are micro-minerals required by the animal body for normal metabolic function. For each of these minerals write on:

- (i) One biochemical function.
- (ii) One deficiency symptom.

END of EXAM

Question 4 (25 points)

(a) In the blood clotting mechanism;

- (i) At what point does vitamin K function?
- (ii) Name three antagonists of vitamin K and
- (iii) Illustrate how they affect the function(s) of vitamin K.

(10 points)

(b) In a flow chart;

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END of EXAM



UNIVERSITY OF ZAMBIA

School of Agricultural Sciences

DEPARTMENT OF PLANT SCIENCES

Masters of Science in Agronomy: Programme- First Semester Final Examinations

AGC 6111: PLANT PHYSIOLOGY

Date: 6th March 2014

Time: 09:00 to 12:00 hrs

- i. Answer any 4 questions
- ii. All questions carry equal marks

-
- 1) Describe the phytochrome and its role in plant development. [25 marks]
 - 2) Compare differentiation and pattern formation in plant development. [25 marks]
 - 3) Briefly describe 2 (two) nitrogen fixation systems and what are the factors that determine the productivity of the rhizobia nitrogen fixing system. [25 marks]
 - 4) Answer any 2 of the following;
 - a. Describe Leaf weight ratio and its importance in analysing crop performance.
 - b. Role of ethylene in plants.
 - c. How can plant physiology be used to enhance environmental stewardship? [25 marks]
 - 5) Describe the C₄ photosynthetic system. [25 marks]
-

END OF EXAMINATION



UNIVERSITY OF ZAMBIA

School of Agricultural Sciences DEPARTMENT OF CROP SCIENCES

Master of Science Agronomy Programme- Second Semester Final Examinations AGC 6112: ADVANCED PLANT PHYSIOLOGY

Date. May 2011

Time 14:00 to 16:30 hrs

INSTRUCTIONS

1. Answer ANY 4 (four) questions.
 2. Duration- 2.5 (two and half) hours.
-

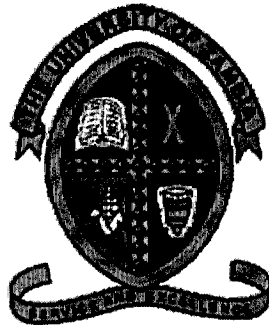
1. Write short notes on any 2 of the following

- i. Leaf area index;
- ii. Stress syndrome;
- iii. Leghemoglobin.

[25 marks]

2. Give detailed description of either Genetic OR Physiological approaches of improving yield. **[25 marks]**
 3. Distinguish between tropical and temperate nitrogen fixing organisms. In your answer include general host plants, growth characteristics and suitable environmental conditions. What are the environmental conditions that negatively impact nitrogen fixation? **[25 marks]**
 4. Contrast between Liebig type of limitations and Mitscherlitsch type of limitations and what are the implications on ability or ease of correcting each type of limitations. **[25 marks]**
 5. From a plant physiology point of view what is stress. Using water stress give the relative sensitivity of the following different plant processes to increasing stress- (respiration, carbon dioxide uptake, extension growth, stomata opening and sugar synthesis). **[25 marks]**
-

END OF EXAMINATION



UNIVERSITY OF ZAMBIA
School of Agricultural Sciences

DEPARTMENT OF PLANT SCIENCES
MSc Programmes- First Year, Final Examination

AGC 6121: PHYSIOLOGY OF YIELD
First Semester- 2012/2013

Date 20th November 2012

Time 09:00 to 12:00 hrs

INSTRUCTIONS

1. Answer **EACH SECTION IN A SEPARATE BOOKLET**
2. Duration- Three (3) Hours.

SECTION A

1. Briefly define each of the following terms **(20 marks)**
 - a) Kelvin temperature scale
 - b) Solar Constant
 - c) Heterosphere
 - d) Basal Heat Production
 - e) Kirchoff's Law
2. There has been significant level of consensus amongst scientists that there has been a global precipitation change on Earth. What are these agreed changes according to IPCC (2001)? **(20 marks)**

3. Given the following meteorological data measured this year for Mount Makulu , Chilanga (28°15' E, 15°33' S and altitude 1213 m): **(20 marks)**

Tmax	25.9°C
Tmin	11.7°C
RHmean	44 %
RHmin	26 %
Sunshine duration	9.40 hours
Wind speed at 10m height	227 km day ⁻¹
Estimated extraterrestrial radiation	358.788 W m ⁻²
Solar declination angle	0.233 radians

$$1.0 \text{ MJ m}^{-2} \text{ day}^{-1} = 11.6 \text{ W m}^{-2}$$

Determine:

- Wind speed in **metres per second**
- The day and month of this measurement
- Actual saturation vapour pressure in **radians**
- Solar radiation in **$\text{MJ m}^{-2} \text{ d}^{-1}$**
- Sunset hour angle **in degrees**

SECTION B

- With reference to subtropical environment on any 2;
 - What is Quantum Yield
 - Light extinction coefficient.
 - Briefly describe 3 strategies of improving food security. **(20 marks)**
- Give an overview of the different ways of describing yield and give a structure showing fixed and variable factors that limit yield? **(20 marks)**

END OF EXAMINATION



UNIVERSITY OF ZAMBIA
School of Agricultural Sciences
Department of Plant Science
MSc Programmes Final Examinations 2013/2014
AGC 6125: SUSTAINABLE AGRICULTURE

Date: 22nd July, 2014

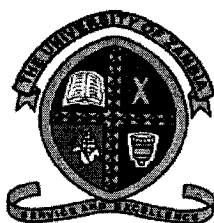
Time: 09:00-12:00h

Venue: VLT 3

INSTRUCTIONS:

- i. Answer ANY 4 (four) questions.
 - ii. Duration- Three (3) Hours.
-
- 1) Enumerate 5 ways of ensuring sustainable food production. **[25 marks]**
 - 2) What is urban agriculture and how can you overcome potential conflict with urban planning regulations. **[25 marks]**
 - 3) Briefly describe any 2 of the following
 - i. Best Management Practices and their effectiveness in dealing unsustainable agro practices.
 - ii. Role of industry in ensuring sustainable agriculture.
 - iii. Conservation farming. **[25 marks]**
 - 4) Discuss either Soil Health **OR** Soil Erosion under the following headings; General description of the problem; Components, National Quality Assessment Criteria and Assessment Tools.
 - 5) Discuss Livelihoods with reference to sustainable natural resource management. **[25 marks]**

END OF EXAMINATION



THE UNIVERSITY OF ZAMBIA

SCHOOL OF AGRICULTURAL SCIENCES

University Examinations

Examinations for Master of Science in Plant Breeding and Seed Systems

AGC 6211: PLANT BREEDING METHODS

Monday February 24th 2014,

AM.

Answer five questions. All questions carry equal marks.

(20 Marks)

1.0 Write short notes on the following:

- Show how scaling test C, $[C = 4F_2 - 2F_1 - P_1 - P_2]$ was derived
- Selection Differential
- The use of Species re-synthesis in Plant Breeding
- Dissociation of the chimera
- Merits and demerits of The Bulk Population Selection Method

ANSWER QUESTION 2.0, A COMPULSORY QUESTION

- 2.0 Plant Physiologists have established that Absciscic Acid (ABA) is a drought signal in plants. ABA is produced in the roots at the onset of water stress. It is transported via the xylem from roots to the leaves and detected by stomatal guard cells which effect stomatal adjustment (or closure of the stomata) to reduce moisture loss from the plant through transpiration. ABA, hence acts as a signal from the roots to alert the rest of the plant, that “there is danger of drought looming on the horizon” for the plant to prepare itself by reducing moisture loss through closure of the stomata.

It has been reported that a drought tolerant plant will speedily produce more ABA in response to moisture stress and thereby conserve water by closing the stomata compared to a drought susceptible plant.

Plant physiologists have developed a rapid non-destructive invivo ABA assay method for cultivated crops which involves collecting plant sap from the xylem cells at the base of the stem of a plant using a syringe under suction pressure and quickly analyzing the sap for concentration of ABA.

Suppose you have just been appointed Maize Breeder to develop OPV and **hybrid** maize varieties that will have **high yield potential** and **drought tolerance** for Zambia using the ABA bio assay approach and applying the Recurrent Selection Breeding Method approach.

Clearly and comprehensively elaborate your Breeding Programme to develop OPV and Hybrid maize varieties with drought tolerance and high yield potential. **(20 Marks)**

3.0 In the first year of a population Improvement Breeding Program in Maize, there was a drought, and so the Breeder decided to select primarily for husk cover (length of husk extension beyond the tip of the ear) that season. The mean of the source population was **2.5 cm**. The Breeder selected the best families, which have a mean of **3.1 cm**. After recombining the selected families, he noted that the average for the improved population was now **2.8 cm**. Assuming that the initial population still has a mean of **2.5 cm** that year,

- a. What was the selection differential **(4 Marks)**
- b. What was the realized heritability for this trait? **(4 Marks)**
- c. What was the response to selection for husk cover in % per cycle? **(4 Marks)**
- d. Suppose what maize breeders consider to be a good response or gain to selection is **5%** and above, was the response to selection that this breeder obtained good or poor? **(4 Marks)**
- e. Would you expect the same, increasing or decreasing response per cycle as you advance in the number of selection cycles? **Give two reasons (4 Marks)**

4.0 Plant Breeders have come to value the exploitation of hybrid vigor or Heterosis in Crop improvement. This has led to the exploitation of hybrid vigor even in crops such as sunflower, wheat, rice and sorghum.

Clearly discuss the process involved in the Single Cross hybrid Varieties of Sorghum. **(20 Marks)**

5.0 The use of Doubled Haploids in Plant Breeding is becoming a very exciting Plant Breeding approach.

- a) Discuss its application in Self and Cross pollinated Crops. **(10 Marks)**
- b) What is the potential of the Doubled Haploid Method in Breeding of Vegetatively propagated Crops? **(10 Marks)**

6.0 A new graduate student in your department is taking an introductory plant breeding course and is having difficulty understanding the ideotype concept of Plant Breeding.

- a) How would you explain it to him? **(10 Marks)**
- b) **List** what you would suggest, with reasons, the ideotypes for **Pearl millet**, and **cowpeas** in Zambia. **(10 marks)**

7.0 It has been projected that by the year 2030, there will be 10 billion people on the face of the earth. This huge world population will put

tremendous pressure on food supply. It is said that the situation will be worse in countries south of the Sahara which are already facing food insecurity.

Clearly Discuss what you consider will be the role of the science of Plant Breeding in solving the problem of feeding 10 billion
(20 Marks)

-----END OF EXAMINATION-----



THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
DEPARTMENT OF PLANT SCIENCE

AGC 6222: Molecular Genetics and Biotechnology

2013/14 Final Examination

Date: 28th July, 2014

Time: 09:00 – 12:00 hrs

Venue: VLT3

Instructions:

Answer **both (2)** questions from Section A and **Any Three (3)** questions from Section B

You are required to answer a total of **Five (5)** questions

SECTION A (40 Marks): ANSWER BOTH QUESTIONS

Question 1. Write short notes on the following:

- a) Reverse and Forward Genetics **(4 marks)**
- b) Confined Field Trial **(4 marks)**
- c) Electrophoresis **(4marks)**
- d) Okazaki fragments **(4 marks)**

Question 2

- a) With the aid of an illustration describe the structure of an eukaryotic gene **(6 marks)**
- b) Explain three main concerns relating to biosafety issues on transgenic plants. **(6 marks)**
- c) You have been provided with four types of inbred lines and their reaction for resistance to *fusarium graminearum* a pathogen which causes cob rot in maize is described below:

Inbred line	A	B	C	D
Reaction to <i>F. graminearum</i>	HR	MR	MS	HS

HR-Highly resistance, *MR*- Moderate resistance, *MS*- Moderate Susceptible, *HS*- highly Susceptible

You have been tasked to map quantitative trait loci (QTL) associated with resistance to *F. graminearum*. Explain in detail how you can go about with the task of mapping **(12 marks)**

SECTION B (40 marks): ANSWER ANY THREE QUESTIONS

Question 3

Discuss the following important processes of the cell and how they can be applied in biotechnology :

- a) Translation (10 marks)
- b) Transcription (10 marks)

Question 4

- a) With the aid of illustrations explain any three types of mutation that can occur at DNA level and clearly highlight their effects on translation (12 marks)
- b) Discuss a dominant and co-dominant molecular marker and give one example of each. (8 marks)

Question 5

- a) Discuss how Polymerase chain reaction (PCR) works and its application in crop improvement. (12 marks)
- b) What are similarities and differences between Random Amplified Polymorphic DNA (RAPD) and Amplified Fragment Length Polymorphism (AFLP) molecular marker technique (8 marks)

Question 6

- a) Explain any four factors which should be taken into consideration when designing PCR primers. (8 marks)
- b) Describe the use of *Agro-bacterium* mediated gene transfer method in Genetic Engineering. What will be the effect of omitting a selectable marker gene on a DNA construct to be transferred to a crop specie? (12 marks)

END OF EXAMINATION



**The University of Zambia
School of Agricultural Sciences
Department of Plant Science
Examinations for the Master of Science in Agronomy
AGC 6322: Plant Protection**

Date: 25th July, 2014

Time: 09.00 – 12.00hrs

Venue: Vet LT3

Instructions:

- 1. Answer four questions**
- 2. All questions carry equal marks**

- Q1. (a) What are Semio-Chemicals?
(b) Name types of Semio-Chemical and describe how they are utilized in IPM programmes.
- Q2. (a) What is Biological Control?
(b) Describe the practices utilized in biological control programmes.
- Q3. (a) Define Insecticide Resistance.
(b) Describe types of Insecticide Resistance.
(c) Describe mechanisms of Insecticide Resistance.
- Q4. (a) Define the Economic Level Concepts and their relationship.
(b) What are the factors that influence the Economic Level Concepts?
- Q5. (a) What is Plant or Host Resistance?
(b) Describe the mechanisms of plant resistance to insects.
- Q6. (a) What is chemical Control?
(b) What are the advantages and disadvantages of Chemical Control?

END OF EXAMINATION



UNIVERSITY OF ZAMBIA

School of Agricultural Sciences

DEPARTMENT OF PLANT SCIENCES

Masters of Science in Agronomy Programme- First Semester Final Examinations

AGC 6425: HORTICULTURE

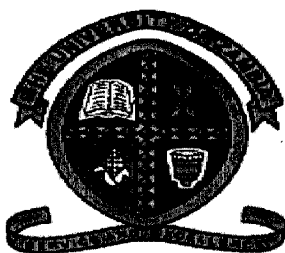
Date. 24th February 2014

Time 09:00 to 12:00 hrs

- i. Answer any 4 (four) questions.
- ii. All questions carry equal marks.

-
- 1) Explain the relevance of quality control to horticulture and outline the key elements of a quality control programme. **[25 marks]**
 - 2) What are the different methods for modification of horticultural plants? **[25 marks]**
 - 3) Describe the state of floriculture industry in Zambia; in your answer include the 2 important commodities and how production can be improved. **[25 marks]**
 - 4) Describe the role of ethylene in plants. In your answer distinguish between cellular and whole plant effects and ethylene interaction with other growth regulators. **[25 marks]**
 - 5) Choose any 2 popular vegetables in Zambia and explain briefly the main production areas, marketing and consumption patterns. **[25 marks]**
-

END OF EXAMINATION



UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
CROP SCIENCE DEPARTMENT
UNIVERSITY EXAMINATIONS

AGC 6432 BIOMETRICAL GENETICS AND PLANT BREEDING

MAY 2011

INSTRUCTIONS

Answer Question No. 1 and any other THREE. Points for each question are indicated in brackets.

TIME: 3 hours

Q.1 (a) Data from Diallel mating can be analyzed via two analytical approaches reviewed in class. Give a comprehensive outline of each and specify the types of genetic estimates that can be obtained from each. **(12 points)**.

(b) The following data (coded scores for smut) were obtained from a diallel mating from a new sorghum breeder who wanted to tackle the problem of smut in the crop for Western Province.

Parent	1	2	3	4	Total
1	X	87.01	90.50	114.95	
2		X	111.57	88.17	
3			X	100.65	
4				X	

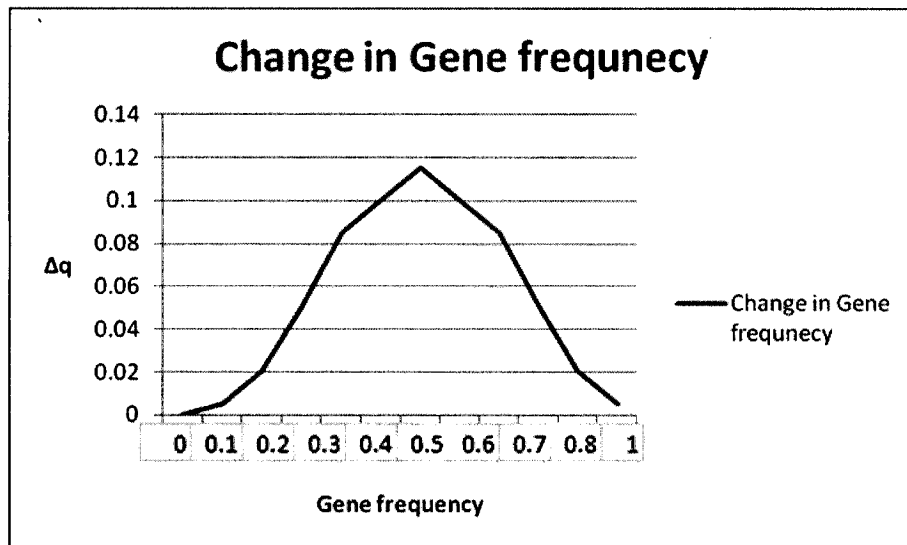
Tasks

1. What Method is appropriate to analyze these data? **(3 points)**.
2. Given the formulae for Sums of Squares (SS) for General Combining Ability (gca) and Specific Combining Ability (sca) on the separate sheet calculate the genetic components (additive and dominance genetic variance). Note: All essential steps must be shown **(25 points)**

Q. 2 Define selection **(5 points)**. Describe the five responses to selection you know and explain the underlining factors to the nature of the response **(15 points)**.

Q. 3 List four procedures that you know that are used in estimating stability parameters. **(5 points)**
Describe in details any one of them. Use an illustration. **(15 points)**

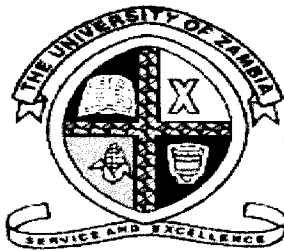
Q.4 Give a comprehensive explanation to the figure presented. What is it depicting with regards to effectiveness of selection? **(20 points)**



Q.5 Write short notes on the following: **(5 points each)**

- a. Environmental response and yield stability
- b. Improvement of gain from selection
- c. Main sources of genetic variation
- d. Differences and similarities between diallel mating and North Carolina Design II
- e. Homeostasis

END OF EXAMINATION



UNIVERSITY OF ZAMBIA

SCHOOL OF AGRICULTURAL SCIENCES

CROP SCIENCE DEPARTMENT

UNIVERSITY EXAMINATIONS

AGC 6432 BIOMETRICAL GENETICS AND PLANT BREEDING

JULY 2014

INSTRUCTIONS

Answer Question No. 1 and any other THREE. Points for each question are indicated in brackets.

TIME: 3 hours

Section A: COMPULSORY

Q.1 Discuss the key features of the Triple Test Cross. What is the key difference with the North Carolina Design III (**12 marks**)

a) A legume program evaluated the general combining abilities (GCA) effects of a fixed set of 8 bean genotypes for resistance to fusarium solani a pathogen which causes root rot in beans and the results are as presented in the table below

Inbred line	A	B	C	D	E	F	G	H
GCA effect	-0.03	0.65	-0.10	-0.40	X	-0.70	0.48	0.13

- What is the importance of evaluating the GCA effects and calculate the GCA effect of inbred line E indicated as X above (**6 marks**)
- Which two inbred lines would you cross as male and female parents in generating a population with the greatest genetic variability with regards to root rot disease severity and why? Assuming that the GCA variance component is significant (**7 marks**)

Section B: Choose any three

Q.2 Write short notes on the following: (5 points each)

- Importance of GE interactions in Plant Breeding
- Approaches to germplasm conservation
- Sources of genetic variation in living organisms
- Homeostasis
- Definition of environment in a genetic sense

Q. 3 A plant breeder assessed the inheritance for the resistance trait to *Fusarium graminearum* cob rot in Maize using a 12 x 12 Full diallel method 1, fixed model. The progenies were evaluated and a partial ANOVA is shown below:

Source	DF	SS	MS	F-value
Rep	1			
Genotypes				
GCA	11	35.97		
SCA	66	25.08		
Reciprocal diff.		16.5		
Error			0.20	

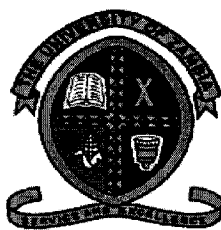
- Fill in the table and determine if the contributions of GCA, SCA and Reciprocal differences to the source of variance are significant (**5 marks**)
- Determine the type of gene action conditioning the trait for resistance to *F. graminearum*. (**8 marks**)
- Calculate the broad sense (BS) and narrow sense (NS) heritability for this trait. Which of the two (BS or NS) is of great significance to a plant breeder and why. (**7 marks**)
- What advice can be given to the Maize program with regards to selection for this trait? Take into account the aspect of reciprocal differences (**5 marks**)

Q. 4 Given the following information yield data which genotype do you pick as the most stable and why?

Genotype	Mean yield (ton/ha)	Genotypic variance across environments (T1)	b-value (T3)
Mimba	3.501	4.051	14
Mutu	3.819	2.091	105
Kwatu	3.719	2.700	2
Mendo	3.200	3.714	44

Q. 5 Define selection (**7 points**). How is selection measured? (**8 points**) How would you improve selection in breeding for disease resistance? (**10 points**)

END OF EXAMINATION



THE UNIVERSITY OF ZAMBIA

SCHOOL OF AGRICULTURAL SCIENCES

Examinations for Master of Science in Plant Breeding and Seed Systems

AGC 6451: PLANT BREEDING METHODS First Semester 2011/2012 Academic Year

DATE: Thursday November 15th 2012, AM. TIME: THREE HOURS

Answer five questions only. All Questions Carry Equal Marks

1.0 Write short notes on the following:

- a) Exsitu Conservation
- b) Somaclonal variation in Crop Improvement
- c) The value of Multilocation Trials
- d) Advantages and Disadvantages of the Single Seed Descent Method
- e) The top cross test

2.0 Discuss the Back Cross Breeding Method when it involves:

- a) Breeding for Disease Resistance and the resistance is governed by a recessive gene
- b) Converting a popular inbred line of sunflower into a male sterile line for use in hybrid variety development in Sunflower

ANSWER EITHER QUESTION 3.0 OR 4 COMPULSOY QUESTIONS

3.0 Maize (*Zea mays* L), unlike rice, does not tolerate water logging conditions for too long, or to put it in another way, **“It does not like to have its feet wet for prolonged periods”**. If maize is waterlogged for five days, its leaves turn yellow (i.e., senesce) and the plant dies.

The problem of frequent floods in Southern Africa has prompted the SADC Secretariat to advise Governments in the region to solve the challenge of water logging in maize production by developing maize varieties that can withstand water logging for a continuous period of a minimum of **21** days.

In response to this challenge, the Zambian Government has ordered all Public Plant Breeding programs to include Water logging tolerance in maize as a Breeding Objective.

Literature indicates that Scientist in India, have established that Water logging tolerance is a **quantitative** trait and that there is considerable variation for this trait in maize. However they have observed that water logging tolerant plants tend to be of a smaller plant type, with a less extensive root system compared to the normal, maize. As a result of the smaller plant type they report that water logging maize will tend to be lower yielding compared to the susceptible maize. However they suggest that the problem of low yields could be overcome if farmers used a relatively higher plant population density in their fields with the water logging Tolerant Varieties

Suppose You have just been appointed Maize Breeder by the Zambia Agricultural Research Institute (ZARI) to develop high yielding **Open Pollinated** and **Hybrid** maize varieties that will have Water logging tolerance to be able to withstand water logging conditions for a continuous period of a minimum of 21 days for Flood affected areas of Southern Africa.

- **Clearly Discuss a comprehensive** breeding program for achieving these objectives
- **List** any two critical facilities you would ask ZARI to provide for your program

4.0 Plant physiologists have established that it is possible to breed for Heat Tolerance in wheat (*Triticum aestivum* L). The mechanisms for heat tolerance which would form the basis for selection for this trait have yet to be fully established. However, a few publications have indicated that the traits, **Above Ground Biomass (AGBM)** and **Canopy Temperature Depression (CTD)** appear to be the most important traits in selecting for heat tolerance in wheat. The following are the reasons these traits have shown to control heat tolerance in wheat.

- **Above Ground Biomass:** Heat reduces the overall productivity of the wheat plant to the extent that under high ambient temperature regimes, the wheat plants tend to reduce plant height and the number of tillers, thus reducing the overall **AGBM**. However Heat Tolerant Varieties tend to maintain their AGBM compared to susceptible varieties.
- **Canopy Temperature Depression:** Heat Tolerant varieties have been reported to maintain a much lower canopy temperature when growing under high ambient temperature regimes compared to susceptible varieties. The canopy temperature is measured using an infra red thermometer.

Supposing you were promised a lucrative Plant breeding job by a Major American Seed Company Operating in Zambia on completion of your Mac in Plant Breeding and Seed Systems in 2014, on conditions that your MSC thesis research should investigate Breeding for Heat Tolerance in Wheat

- a) **List and Clearly explain** the objectives of your thesis research and the research investigations that you would carryout to realize your objectives
- b) **Present a clear outline** of your post 2014 Heat Tolerant Wheat Breeding Programme aimed at developing high yielding wheat varieties suitable for production in hot river valley areas of Zambia

5.0 Discuss some important achievements of plant introduction. Discuss the merits and demerits of Plant Introduction as a Breeding method

- 6.0** a) What is Inbreeding Depression and hybrid vigor?
b) Plant Breeders have come to value the exploitation of hybrid vigor or Heterosis in Crop improvement. Clearly discuss the process involved in the Single Cross hybrid Varieties of Sorghum.
- 7.0** a) The use of Doubled Haploids in Plant Breeding is becoming a very exciting Plant Breeding approach. Discuss its application in Self and Cross pollinated Crops.
b) What do you understand by the term "Dissociation of a chimera" when using induced mutations breeding method

-----**END OF EXAMINATION**-----



University of Zambia

Department of Plant Science

AGC 6452- Molecular Genetics and Biotechnology

Examination

INSTRUCTIONS

27th May 2013 AM

Answer **Both** questions from **section A** AND any **three (3)** from **section B**

Total marks: 100

Time allowed: 3 hours

SECTION A (40 marks): ANSWER BOTH QUESTIONS

Write short notes on the following:

Question 1 (16 marks)

- a) Palidriomic DNA sequence (**4 marks**)
- b) Confined Field Trial (**4 marks**)
- c) Okazaki fragments (**4 marks**)
- d) Application of Logarithm of Odds (LOD) score in QTL mapping (**4 marks**)

Question 2 (24 marks)

- a) Explain the concept of Biosafety. (**3 marks**)
- b) Explain any three conditions which should be met when designing a pair of primers to amplify a DNA segment of interest. (**6 marks**)
- c) Using suitable examples write an essay entitled, "The role and use of Genetic engineering in Agriculture" clearly elaborating how the technology is employed, its application and associated concerns. (**15 marks**)

SECTION B (60 MARKS): ANSWER ANY THREE QUESTIONS

Question 3 (20 marks)

Describe the following concepts and applications in plant and cell biology:

- a) Southern blotting and northern blotting. **(6 marks)**
- b) Restriction enzymes: What they are and how they can be used in plant science research. **(8 marks)**
- c) Application of plant tissue culture in crop improvement. **(6 marks)**

Question 4 (20 marks)

Discuss the following important processes of the cell and how they can be applied in biotechnology:

- a) Translation and its role in cell biology. **(10 marks)**
- b) Transcription and its role in cell biology. **(10 marks)**

Question 5 (20 marks)

- a) Discuss the four levels of protein structure, clearly elaborating the key differences among them. **(12 marks)**
- b) Explain the key differences and similarities between Cleaved Amplified Polymorphic Sequence (CAPS) and Simple Sequence Repeat (SSR) molecular marker techniques, utilized in crop improvement. **(8 marks)**

Question 6 (20 marks)

- a) With the aid of illustrations explain any three types of mutation that can occur at DNA level and clearly highlight their effects on the resulting translated protein. **(12 marks)**
- b) Describe the molecular structure of the eukaryotic gene. **(8 marks)**

Question 7 (20 marks)

- a) The legume improvement section at ZARI has received adequate funding from World Bank to help them employ marker assisted selection (MAS) for bean resistance to *Colletotrichum lindemuthianum* a pathogen which causes antracnose disease. They have a choice of employing either Restriction Fragment Length Polymorphism (RFLP) or Amplified Fragment Length Polymorphism (AFLP) molecular marker techniques in their breeding program. You have been approached for advice as an expert in Plant Breeding and Biotechnology. What sort of marker technique would you advise them to use? Clearly explain how these markers work and elaborate the reasons for the choice of your marker. **(15 marks)**
- b) List 5 components required to perform a Polymerase Chain Reaction (PCR). **(5 marks)**

END OF EXAMINATION



THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
DEPARTMENT OF CROP SCIENCES
SECOND SEMESTER EXAMINATION

AGC: 6552

INSTRUCTIONS:
ANSWER ALL QUESTIONS

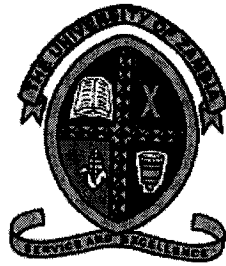
Date 26th May 2011

Time 09:00 to 12:00 Hrs

-
1. Briefly explain why weeds are undesirable in agricultural activities. (5 points)
 2. Describe two adaptive strategies of weeds. (2 points)
 3. List five characteristics of weeds that are related to success in disturbed environments. (5 points)
 4. Describe the soil weed seed bank and explain its significance in weed management. (2 points)
 5. What processes regulate weed seed entry and loss in the soil? (2 points)
 6. What is weed seed dormancy and its implication in weed management? (2 points)
 7. Describe two types of competition in plants. (2 points)
 8. Describe the additive and replacement approaches to studying plant interaction in mixed stand. (5 points)
 9. What are the limitation of additive experimentation approaches in studying plant? interaction in mixed stands. (5 points)
 10. Explain four possible outcomes of the interaction of two species when grown in a replacement series experiment. Please use figures to illustrate the outcomes. (4 points)
 11. Describe the relationship between weed density and crop yield using mathematical models. Explain why weed density is unreliable measure of competition? (5 points)
 12. Describe the concept of the critical weed free period and its implications in weed management. (2 points)

13. List three categories of herbicides based on modes of action. (3 points)
14. Describe the modes of action of the following herbicide categories: dinitroanilines, sulfonylureas, imidazolinones, and triazines. (4 points)
15. List three mechanisms by which weeds become resistant to herbicides. What is cross-resistance to herbicides? (5 points)
16. What are the risks and controversies surrounding herbicide resistant crops? (5 points).

END OF EXAM



University of Zambia

School of Agricultural Sciences
First Year Examination for Master of Science in Plant Breeding
and Seed Systems

AGC 6612 – Seed Systems
2013/14 Academic Year

Date: 17th July 2014..... **Time:** 09 00 hrs

Duration: 3 hours

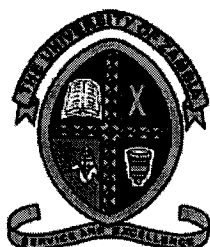
Total marks: 60

Instructions: Answer any six (6) questions

1	Define a seed system and contrast the two broad forms of a seed system. Discuss how each form can best serve a seed industry. [10 Marks]
2	<p>a) New varieties may be tested for Distinctness, Uniformity and Stability (DUS) and Value for Cultivation and Use (VCU) for the purpose of release. Explain these tests and distinguish the testing of the two. [5 marks]</p> <p>b) Seed certification may be based on minimum standards or truth in labelling. Contrast the two systems pointing out the advantages and disadvantages of each system. [5 Marks]</p>
3	There is interdependence between various components of the seed value chain because each component adds value to seed provision. What is the value of the following on the seed value chain: a) Plant breeding; b) Seed production; c) Seed quality control; d) Shelling of seed; e) Seed coating; f) Seed packing; g) Agronomist; h) Sealing of seed containers; i) Seed marketing, and; j) Farmer. [10 Marks]
4	A seed lot of a white maize variety was sampled for purity analysis at the seed testing laboratory. Purity analysis was conducted and you are requested to calculate the

	<p>percentage of pure seed, other seeds and inert matter. You were provided with the following information of the analysis. Show your working. (10 marks).</p> <ol style="list-style-type: none"> Weight of composite sample = 3kg Sample submitted to a laboratory for testing = 2 kg Prescribed working sample: 900g (tolerance of 5% allowed) Working sample drawn: 896g Results of analysis are as follows <ol style="list-style-type: none"> Full white maize =700g Stones =10g Full yellow maize =50g Live insects = 10g Shriveled white maize = 30g Immature white maize = 25g Leaves = 10g Broken white maize of size less than a half of grain size=10g Sand =10g Broken yellow maize more than half of grain size = 10g Sorghum=10g Chaff = 10g Dead insects = 5g
6	<ol style="list-style-type: none"> Zambia's seed certification is based on minimum standards. In order to multiply seed under this system, seed production is registered by the seed certification authority. Briefly explain why the registration of seed production is important. [5 Marks] The aim of the legislation on Plant Breeder's Rights (PBR) is to promote the development of new plant varieties for the benefit of man. What conditions must be met by an applicant for the grant of PBR. [5 Marks]
7	<p>What is the relevancy and procedure of conducting the following seed quality tests for seed certification.</p> <ol style="list-style-type: none"> Moisture content: Other seeds count Purity analysis Germination capacity Vigour <p>[10 Marks]</p>

-END-



University of Zambia

School of Agricultural Sciences

First Year Examination for Master of Science in Agronomy

AGC 6625 – Seed Science and Technology

2013/14 Academic Year

Date: 18 July 2014.....Time: 09 00 hrs

Duration: 3 hours

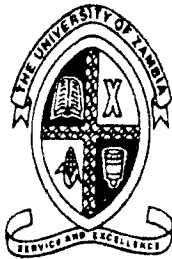
Total marks: 60

Instructions: Answer any six (6) questions

1. Contrast and highlight the importance of the following: **[10 marks]**
 - a) True and induced seed dormancy
 - b) Recalcitrant and orthodox seeds
 - c) Pre- and post control in seed certification
 - d) Distance and time isolation in seed production
 - e) Fresh and hard seeds in a germination test
2. a) Plants are limited in their mobility and can be in danger of becoming extinct as a result of adverse environmental conditions. What coping mechanisms do plants exhibit that enables them overcome such situations. **[5 marks]**

- b) Define dessication tolerance in seeds and explain its evolution, acquisition and importance. **[5 marks]**
3. Discuss fertilization and embryonic development up to maturity in flowering plants. **[10 marks]**
4. a). A maize breeder was evaluating maize landraces in various characteristics in a crop improvement program. At harvest one entry surprised him because all grains were shrivelled despite having grown the plants under optimal conditions. What do you think could have caused this. **[5 marks]**
- b) Mrs Chooye cultivated maize and guar on his farm in Mazabuka. The two crops matured almost at the same time and were left in the field to dry. One day during this period, light rains were received on the farm. A week later she noticed that some seeds of maize had started to germinate while those for guar did not. Discus reasons for this observation. **[5 marks]**
5. Seed is one of the most important inputs to crop production. How can you ensure the provision of seeds that are superior genetically, physically and physiologically. **[10 marks]**
6. A maize seed grower has just completed harvesting a 50ha maize seed crop. What would you advise the seed grower on the following follow-up practices which could promote seed longevity: **[10 marks]**
- a) Seed shelling
 - b) Seed treatment
 - c) Seed packaging
 - d) Seed storage
 - e) Seed handling
7. Provide reasons for the following practices: **[10 marks]**
- a) In a purity test a broken seed fraction that is more than half of its original size is considered to be pure
 - b) In determining moisture content of a maize seed lot, a working sample is ground prior to drying the same in the constant temperature oven
 - c) In evaluating a variety for distinctness uniformity and stability (DUS), genotypes are tested under optimal conditions
 - d) As part of seed processing a seed lot may be coated
 - e) A conductivity test may be used to determine the vigour of a soybean seed lot

END



THE UNIVERSITY OF ZAMBIA
School of Agricultural Sciences
Plant Science Department
Postgraduate Examination
Course AGC 6820: Communication Skills
Final Examination 2013/14

Date: Friday, 1st August, 2014

Time: 09:00-12:00Hours

Venue: VLT 3

Instructions: Answer five (5) questions only

1. Discuss the importance and characteristics of a good abstract in scientific and technical papers.
2. Discuss the nature and importance of agricultural Field Day to the organization and the surrounding communities. What are some of the challenges faced by organizers of such events?
3. What is communication? Using relevant examples differentiate between social and business communication.
4. Using a simplistic model show the basic communication process. What factors should be considered in selecting the channel of communication.
5. What do you understand by partnership? Discuss the advantages of partnership in research.
6. Using relevant examples distinguish between bilateral and multilateral donors, unrestricted and restricted grants with regard to research.

END OF EXAMINATION

The University of Zambia
School of Agricultural Sciences
2013/2014 Academic Year Second Semester
Final Examinations
AGE 6062: Production Economics
Time: Three (3) Hours

Instructions: There are four questions in this exam. Answer all.

1. Sally Street has a small business in which she clears red cedar from pasture land. She operates as a price taker. The prevailing price for clearing cedars is \$20 per acre. Her costs are given by

$$C(q) = 0.1q^2 + 10q + 50$$

where q is the number of acres Sally chooses to clear.

- a) Derive the average variable cost, fixed cost, and marginal cost functions [6 points]
- b) How many acres should Sally clear to maximize profit? [8 points]
- c) Calculate Sally's profit. [4 points]
- d) Derive her supply curve. [6 points]
- e) What is the price elasticity of her supply curve at equilibrium? [3 points]
- f) What is the minimum price of q at which she will operate in the short run? [3 points]

2. Given the following long-run cost function for each firm in a mature industry that supplies q .

$$C(q) = q^3 - 6q^2 + 11q$$

Firms will enter the industry if profits are positive and exit if profits are negative.

- (a) Derive the long-run supply function. [10 points]
- (b) Given that the aggregate demand function is

$$D(P) = 1000 - 50P$$

Derive the equilibrium price, aggregate quantity, and number of firms. [10 points]

3. Consider the following production function:

$$q(x_1, x_2) = 100x_1 - 2x_1^2 + 50x_2 - x_2^2$$

- a) Determine if the function is strictly concave. [6 points]
- b) Derive the expansion path. [4 points]
- c) Derive the factor demand for x_1 . [4 points]
- d) Use comparative statics to determine the following: [12 points]
 - i) the impact of changes in the price of x_1 on x_1 ,
 - ii) the impact of changes in the price of x_2 on x_1 , and
 - iii) the impact of changes in the price of output on x_1 .
- e) Derive the isoquant equation. [4 points]

4. Given the following:

Aggregate demand function: $Q_d = D(P) = 48 - 2P$

and aggregate supply function: $Q_s = S(P) = 3 + P$

- a) Solve for the equilibrium price and quantity. [4 points]
- b) Compute the elasticity of demand and the elasticity of supply evaluated at equilibrium. [4 points]
- c) Suppose the government imposes a specific tax \$3 per unit. Derive the price the customers will pay, the price the firms will receive, and the equilibrium quantity. [6 points]
- d) Compute the incidence of the tax. [4 points]
- e) How much tax will the government collect? [2 points]



THE UNIVERSITY OF ZAMBIA
DEPT. OF AGRICULTURAL ECONOMICS & EXTENSION
2014 ACADEMIC YEAR EXAMINATIONS
AGE 6091 INSTITUTIONAL AND BEHAVIOURAL ECONOMICS

TIME: THREE (3) HOURS

INSTRUCTIONS: INSTRUCTIONS: ANSWER ALL QUESTIONS.

Question 1

In light of the development challenges facing agriculture and agribusiness in Zambia, you are requested to illustrate the value of having an “institutional economics” perspective in finding real solutions to these challenges. In building your case, you should highlight the main technical and institutional challenges faced by smallholder farmers and how weak institutions affect market performance. Elaborate on the role and importance of institutional change in improving the performance of the economy in Zambia.

[25 Marks]

Question 2

Explain how the relaxation of the assumptions of neoclassical economics establishes a number of important schools of thought and/or developments of standard economic tools that are sometimes classified as part of the body of literature of New Institutional Economics (NIE). Elaborate with detail on which of these schools of thought you think are the most valuable for development work in trying to identify ways to improve the functioning of agricultural markets in Zambia

[25 Marks]

Question 3

Write brief notes to explain the salient aspects of the following. Use relevant examples from agriculture/rural development to illustrate the concepts:

- (i) Adverse Selection
- (ii) Moral Hazard
- (iii) Bounded Rationality
- (iv) Asset Specificity
- (v) Private Goods, Toll Goods, Public Goods, Merit Goods and Common Pool resources

[25 Marks]

Question 4

Smallholder farmers have just benefited from a redistributive land reform programme in Zambia. Explain the view you would hold about the role of the state or any other organization in protecting property rights. In this light you are also asked to contrast the concepts “property rights” and “land reform”. Are they reconcilable?

[25 Marks]

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
2014 ACADEMIC YEAR EXAMINATION
AGE 6122: AGRICULTURAL POLICY ANALYSIS
ANSWER: ALL QUESTIONS; MARKS: AS INDICATED; TIME 3 HOURS

1. (i) What is Policy Analysis Matrix (PAM)? 4 Marks
(ii) Discuss Nominal Protective Coefficiency, Effective Rate of Protection and Domestic Resource Cost as measures of Competitiveness (9 Marks).

(iii) Country **Azania** has a policy that allows some form of trade with other countries to occur. Tabulate a hypothetical **PAM** for Azania and use English to explain and interpret the various hypothetical figures in the PAM (17 Marks).
2. By using the Agricultural Policy of Zambia as an example, discuss the steps involved in a country's policy formulation process (20 Marks).
3. (i) Discuss the three (3) major broad objectives (and trade-offs) that governments are trying to further through interventions in the agricultural sector (9 Marks).

(ii) Discuss the three categories of constraints that limit the ability of policy-makers to realize all the three objectives discussed in 3a (9 Marks).

(ii) Discuss the differences between **monetary** and **fiscal** policies (7 Marks).
4. What is the role of monitoring policy impacts (MPI) in the cycle of policy formulation and implementation? Contrast MPI with policy evaluation (8 Marks).
5. What is **distributive policy**, contrast with **redistributive policy**? (4 Marks).
6. Define and contrast **Partial Equilibrium Framework** and **General Equilibrium Framework** for Policy analysis (8 Marks).
7. Explain and discuss in detail the **Gini Coefficient** as a measure of equity/inequality (5 Marks).

END OF EXAMINATION

The University of Zambia
School of Agricultural Sciences
2012/13 Academic Year First Semester
Final Examinations

AGE 6222: International Trade Theory and Policy

TIME: THREE HOURS

INSTRUCTIONS: ANSWER ALL QUESTIONS

1. Does trade theory suggest that trade liberalization by a small importing country will make everyone in the country better-off? Why or why not? Explain briefly.
2. In the United States where land is cheap, the ratio of land to labor used in cattle raising is higher than that of land used in wheat growing. But in more crowded countries, where land is expensive and labor is cheap, it is common to raise cows by using less land and more labor than Americans use to grow wheat. Can we still say that raising cattle is land intensive compared with farming wheat? Why or why not?
3. Consider a Ricardian model with two countries, England and Zambia, producing two goods, wine and maize. Suppose the unit-labor requirements in wine production are: $a_{L,W}^{Eng} = 1/3$ hour per liter, and $a_{L,W}^{Zam} = 1/2$ hour per liter, while the unit-labor requirements in maize are $a_{L,C}^{Eng} = 1/4$ hour per kg, and $a_{L,C}^{Zam} = 1/2$ hour per kg.
 - a) Which country has the absolute advantage in wine? ... in maize? Explain.
 - b) Which country has the comparative advantage in wine?... in maize? Explain.
 - c) According to Ricardo, state how these two countries would take advantage of the potential benefits of trade?
4. If the liberalization of agricultural markets proceeds in the future, many countries may eliminate export subsidies to farm products. Use a partial equilibrium (supply and demand) diagram to depict the price and welfare effects of export subsidy elimination for corn. Assume that the country is small in international markets.
5. Suppose there are only two countries, the US and China producing and consuming clothing. Suppose in free trade China exports clothing to the US.
 - a) At the free trade price, in which country is the supply of clothing greater than demand?
 - b) At the free trade price how does world supply compare with world demand for clothing? (i.e., greater, less, or equal)
 - c) If the US and China were in autarky rather than free trade, in which country would the price of clothing be higher?
 - d) In moving from autarky to free trade would the price of clothing rise, fall or stay the same in the US?
 - e) In moving from autarky to free trade would the price of clothing rise, fall or stay the same in China?
 - f) Starting from free trade, if the US places a tariff on imports of clothing, how would the price of clothing change in the US?
 - g) Starting from free trade, if the US places a tariff on imports of clothing, how would the price of clothing change in China?
 - h) How would a tariff on US imports of clothing affect the amount of clothing produced in the US?
 - i) How would a tariff on US imports of clothing affect the amount of clothing demanded in the US?

THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
2011 ACADEMIC YEAR SECOND SEMESTER EXAMINATIONS
AGE 6311: SEED AGRIBUSINESS MANAGEMENT

INSTRUCTIONS: ANSWER QUESTION 1 AND ANY THREE OF THE REMAINING FOUR QUESTIONS. WRITE QUESTION 1 IN ITS OWN SEPARATE ANSWER BOOK.

TIME: THREE (3) HOURS

1. Mr. Mbuiwamwambwa is a medium-scale farmer in Nangweshi, Senanga West. He is considering growing paprika and/or cotton. Paprika returns K400,000 per acre while cotton returns K200,000 per acre. He has 240 hours of family labour and 40 acres of land. He also has 8,400 kg of fertilizer. Cotton requires 8 hours of labour and 150 kg of fertilizer per acre. An acre of paprika requires 10 hours of labour and 400 kg of fertilizer. **(40 Marks)**
 - a) Use the simplex method to solve the problem
 - b) State the optimal objective function value and the optimal levels of all real and slack activities
 - c) Set up the dual problem algebraically
 - d) Mr. Mbuiwamwambwa's son, who lives in Chunda Ponde, Mpika, has just sent him some money. Should he hire additional labour if each hour costs K20, 000? Explain.
2. Running a successful agribusiness firm requires that you understand the environment you will be operating in and develop right marketing strategies to compete effectively. Choose a specific seed product and detail how you would strategically plan for it's the marketing **(20 Marks)**.
3.
 - a) Managing risk is one of the important decisions an agribusiness manager is faced with when planning for any business undertaking. You are proposing to venture into Vegetable seed agribusiness; what risks do you envisage and how do you hope to minimize them? **(10Marks)**
 - b) Discuss the forces influencing competition in an Agribusiness industry, and how these forces may be manipulated to expand the bean seed exports in the SADC market **(10 Marks)**
4. Mulenga Ltd produces a range of legume seed varieties for sale to farmers. As a result of increasing demand for the business's products, the directors have decided to expand production. The cost of acquiring new machinery and the increase in working capital requirements are planned to be financed by a mixture of long-term and short-term borrowing.
 - a) Discuss the major factors that should be taken into account when deciding on the appropriate mix of long-term and short-term borrowing necessary to finance the expansion programme **(10 marks)**

- b) Highlight the various options of long term and short term borrowing options available for the company **(10 Marks)**
- 5. Write short notes on the following
 - a) Argue out the case of human resource being the most important resource for the agribusiness enterprise**(5 Marks)**
 - b) You envisage starting an agribusiness in the near future and you choose to operate it as a private limited company. Carefully outline your considerations for selecting this particular business organization **(8 Marks)**
 - c) Outline the principles of total quality management and how they can be applied in managing quality in a seed company **(7 Marks)**

THE END



**THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
2014 ACADEMIC YEAR EXAMINATIONS
AGE 6311 AGRIBUSINESS MANAGEMENT**

TIME: THREE (3) HOURS

INSTRUCTIONS: ANSWER ALL QUESTIONS.

Question 1

- (a) Explain what management is. Elaborate by expounding on the functions of management in an agribusiness organization
- (b) It has been said that an effective manager is one who can change roles appropriately. What are the roles of a manager today?
- (c) Discuss the main advantages and disadvantages of the ideal-type of bureaucracy, as described by Weber.

[25 Marks]

Question 2

- (a) Business plans are essential for the success of an agribusiness firm. Explain what a business plan is. Elaborate by explaining the need for or benefits of a business plan from the perspectives of both internal and external users
- (b) List useful suggestions to follow in writing a business plan, and outline and briefly explain the contents of key or important sections of a business plan.

[25 Marks]

Question 3

As an agribusiness entrepreneur getting started, one has an option of establishing the type of business organization he/she is comfortable with such as a limited company; sole proprietorship or trading; partnership; and cooperative. Explain what each of these business organizations are and elaborate the advantages and disadvantages associated with each one of them

[25 Marks]

Question 4

- (a) What is involved in human resource or manpower planning? Why is human resource planning especially important to an organization in a period of change?
- (b) Comment briefly on each of the major elements normally included in the term "marketing mix".

[25 Marks]

END OF EXAMINATION

[Total - 100 Marks]

UNIVERSITY OF ZAMBIA

UNIVERSITY SECOND SEMESTER EXAMINATIONS-MAY 2011

AGG 6132: SOIL PLANT WATER RELATIONS

Time: Three (3) Hours

Marks: 85

Instruction: Answer all Questions

Non-programmable calculators are allowed

1. Briefly define each of the following terms (20 marks)
 - a) Aeration porosity
 - b) Midday Wilting
 - c) K_y -factor
 - d) Field capacity
 - e) Leaching requirement
2. With the aid of a diagram describe the different crop growth stages that are used in crop water requirement estimation for soil water management and relate to green canopy development. (15 marks)
3. A maize crop was grown under irrigation in a 50 ha field and a schedule developed based on the table below during the growth stages: (20 marks)

	I	II	III	IV
Days	25	30	30	38
ET _o	8.9	9.4	8.8	7.6
K _c	0.4	0.75	1.15	0.85
K _y	0.4	0.4	1.5	0.5

- a) Calculate the total seasonal water requirement of the crop in (i) mm and (ii) m³/ha
- b) Calculate the yield reduction if a 10% water stress is imposed during growth stage (I) and (III) and comment on the results
- c) Briefly define the Wageningen method for estimating maximum yield and its components

4. Given the following soil moisture and hydraulic head measurements using a neutron probe and tensiometers in an irrigated maize field at the University Farm, (20 marks)

	July 1		July 8	
Depth (cm)	H (cm)	θ_v (%)	H (cm)	θ_v (%)
10	-288.2	16.8	-458.2	7.5
30	-202.5	18.6	-275.5	15.9
50	-186.1	17.3	-205.0	16.2
70	-187.4	16.8	-202.5	16.7
90	-191.2	24.1	-206.2	24.2
110	-241.6	15.2	-242.8	15.5

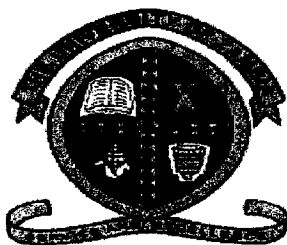
Based on the data above:

- Determine the plane of zero flux during the measured period (cm)
 - Determine the change in soil water storage during the measured period from the surface to the depth of 90cm (m^3/ha)
 - The amount of water loss in the profile through (i) soil surface and (ii) depth below 110 cm
5. The following soil profile data was obtained from a representative soil profile from a winter maize field irrigated with an overhead (pivot) irrigation system in Mukushi Farm Block, Northern Zambia. (15 marks)

Depth (cm)	Bulk Density (g cm^{-3})	Gravimetric Water Content (%)	
		Field Capacity	Wilting Point
0 – 10	1.71	17.3	4.4
10 – 23	1.67	14.4	2.4
23 - 63	1.58	13.2	3.4
63 - 100	1.52	19.9	5.3
100 - 183	1.59	14.2	4.0

- Determine the available water-holding capacity (AWC) of the soil profile to a depth of 1 meter (mm/m)
- Determine the depth of air in the entire profile when the soil water content is at field capacity
- If 50mm irrigation is applied at wilting point, how deep will the irrigation water penetrate the soil profile

End of Exam



UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
PLANT SCIENCE DEPARTMENT
UNIVERSITY EXAMINATIONS

AGG 6211 BIostatistics

NOVEMBER 2011

INSTRUCTIONS

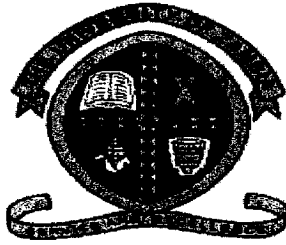
Answer Question No. 1 and any other THREE. Points for each question are indicated in brackets.

TIME: 3 hours

Q.1 (a). As a new recruited plant breeder in a new agricultural research institution you are to give a seminar on use of factorial experiments in scientific investigation. You have the following data from an experiment on animal nutrition for your presentation. The response variable is the thickness of back fat averaged over 6 pigs over a period of 14 weeks. Prepare a comprehensive presentation.

Mineral rate	Vitamin rate (mg/kg)	Block		
		I	II	III
Low (L)	1.5	4.20	4.94	4.45
	2.0	4.36	3.50	4.17
	2.5	5.40	4.55	5.75
	3.0	5.15	4.40	3.90
High (H)	1.5	2.82	3.14	3.80
	2.0	3.74	4.43	2.92
	2.5	4.82	3.90	4.50
	3.0	4.57	5.32	4.35

(25 points)



UNIVERSITY OF ZAMBIA
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PLANT SCIENCE DEPARTMENT
UNIVERSITY EXAMINATIONS

AGG 6211 BIOSTATISTICS

NOVEMBER 2011

INSTRUCTIONS

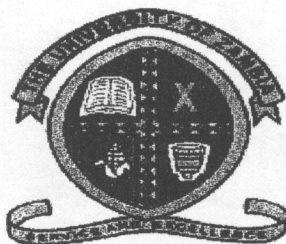
Answer Question No. 1 and any other THREE. Points for each question are indicated in brackets.

TIME: 3 hours

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Mineral rate	Vitamin rate (mg/kg)	Block		
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Low (L)	1.5	4.20	4.94	4.45
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(25 points)



UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
PLANT SCIENCE DEPARTMENT
UNIVERSITY EXAMINATIONS

AGG 6211 BIOSTATISTICS

NOVEMBER 2011

INSTRUCTIONS

Answer Question No. 1 and any other THREE. Points for each question are indicated in brackets.

TIME: 3 hours

Q.1 (a). As a new recruited plant breeder in a new agricultural research institution you are to give a seminar on use of factorial experiments in scientific investigation. You have the following data from an experiment on animal nutrition for your presentation. The response variable is the thickness of back fat averaged over 6 pigs over a period of 14 weeks. Prepare a **comprehensive** presentation.

Mineral rate	Vitamin rate (mg/kg)	Block		
		I	II	III
Low (L)	1.5	4.20	4.94	4.45
	2.0	4.36	3.50	4.17
	2.5	5.40	4.55	5.75
	3.0	5.15	4.40	3.90
High (H)	1.5	2.82	3.14	3.80
	2.0	3.74	4.43	2.92
	2.5	4.82	3.90	4.50
	3.0	4.57	5.32	4.35

(25 points)

Q.1 (b). You are given information/data on drought occurrence in the last two centuries as follows:

	Drought	No Drought
1801-1909	4	45
1910-2010	14	42

The question poised is, 'are the summers of the current century significantly more prone to drought than the previous one?' Establish the basis of responding to this question substantively **(15 points)**

Q.2 Write short notes on the following: **(4 points each)**

- Importance of clear definition of a problem in research and use of Problem Tree Analysis
- Randomization for the Latin Square Design.
- Sampling methods discussed in the course
- Formats of Research Proposal and Research Report.
- Derivation of totals for interactions for Split-Split-Plot Design for the three way interactions; Illustrate.

Q. 3 Given the following data from a factorial experiment on survival (%) of a bacteria (*Salmonella typhimurium*), test if the effect of sorbic acid on survival of the bacteria under the four regimes of water temperature is linear. The experiment was carried with 3 replications. **(20 points)**.

	Water Temperature (°F)			
Sorbic acid concentration (ppm)	98	94	90	86
0	24.89	19.60	17.99	15.42
100	23.02	19.22	16.07	14.09

The table below is to be used for the testing of linearity. Assume equal spaced treatments. Use the coefficients provided for n=4.

Mean Squares for use in testing significance of responses to water temperatures.

Source	df	MS
Sorbic acid (SA)	1	1.155
WaterT Linear (WTL)	1	a**
WaterT NonLinear (WTNL)	1	b**
SA x WTL	1	c**
SA x WTNL	1	d**
Error	9	0.024
** These values you have to be calculated		

Q. 4 In a study on productivity of potato the following data were obtained.

Fertilizer amount (NO_3 kg/ha)	Yield (tons/ha)
0	18.34
100	19.56
200	20.15
300	20.99

(20 points)

Answer the following questions about these data:

- How is yield of potato influenced by fertilizer?
- Is the effect of nitrogen fertilizer on yield of potato linear?
- How reliable is the relationship between these variables?

Q.5 List the assumptions that must hold for Analysis of Variance to be used **(8 points)**. For two of these illustrate how you would test for their validity. **(12 points)**

END OF EXAMINATION

Coefficients, divisors, and K values for fitting up to quartic curves to equally spaced data, and partitioning the sum of squares.

n: 3		4			5				6			
c_1	c_2	c_1	c_2	c_3	c_1	c_2	c_3	c_4	c_1	c_2	c_3	c_4
-1	1	-3	1	-1	-2	2	-1	1	-5	5	-5	1
0	-2	-1	-1	3	-1	-1	2	-4	-3	-1	7	-3
1	1	1	-1	-3	0	-2	0	6	-1	-4	4	2
		3	1	1	1	-1	-2	-4	1	-4	-4	2
					2	2	1	1	3	-1	-7	-3
									5	5	5	1
Divisors												
2	6	20	4	20	10	14	10	70	70	84	180	28
K_1	1/3			5/16				1/7				5/96
K_2	1/2			1/20				1/10				1/70
K_3				41/240				17/60				101/4320
K_4	1/2			1/16				1/14				1/224
K_5				1/48				1/12				1/864
K_6								1/24				1/768
K_7								31/168				95/2688
K_8								3/35				27/256



UNIVERSITY OF ZAMBIA
UNIVERSITY SECOND SEMESTER EXAMINATIONS-JULY, 2014

AGG 6512: SOIL PLANT WATER RELATIONS

Time: Three (3) Hours **Total Marks:** 100
Instruction: Answer all Questions
Non-programmable calculators are allowed

1. Briefly define each of the following terms (15 marks)
 - a) Yield response factor
 - b) Harvest Index
 - c) Field Capacity
 - d) Normalized Water Productivity
 - e) Available water-holding capacity
2. With the aid of a diagram briefly describe how canopy cover is related to partitioning of evaporation from evapotranspiration in a cropped field. (15 marks)
3. AquaCrop simulates the biomass and yield in response to water which is increasingly becoming one of the critical factors limiting crop production in Zambia. Describe the major calculation scheme of the AquaCrop model in simulating attainable yield of a fully irrigated crop. (20 marks)
4. The Maximum yield is determined by both genetic and environmental conditions, and can be determined using either the Wageningen Method or the Agro-ecological Zone Method. (30 marks)
 - a) What are the major differences between the two methods?
 - b) Why is it important to correct for net dry matter production when using the agro-ecological zone method?
 - c) Given the following data, Maximum actual incoming short wave radiation (R_{se}) = 299 cal/cm²/day, Gross dry matter production on a clear day (y_c) = 376 kg/ha/day, Gross dry matter production on an overcast day (y_0) = 197 kg/ha/day, ET_m = 6.0 mm/day, Vapour pressure deficit = 7 mbar, Measured sunshine duration (n) = 6 hr/day, Maximum sunshine hours (N) = 13 hrs/day, R_a = 925 cal/cm²/day.

Given a wheat crop growing for 123 days with $K = 1.2$, $cH = 0.35$ and $cT = 0.6$ at an average temperature of 20°C , and the information above, calculate the following:

- i. The actual measured incoming radiation (R_s)
- ii. The fraction of the daytime the sky is clouded (F)
- iii. Gross dry matter production of a standard crop (Y_o)
- iv. The maximum expected yield (Y_{me})

5. Green maize is commonly grown under irrigation during the dry season by Commercial farmers near the Lusaka International Airport. The table below contain information on climatic data for Lusaka International Airport during the rainy season, and general crop data: (20 marks)

Month	Aug	Sept	Oct	Nov	Dec	Total
Growing period (days)	31	30	31	30	28	150
ET_o (mm/day)	8.06	7.11	7.92	6.67	5.00	
K_c	0.40	0.75	1.10	1.10	0.50	
K_y	0.40	1.10	0.95	0.80	0.40	1.05

Note: $ET_c = k_c * ET_o$; and $(1 - Y_a/Y_m) = k_y * (1 - ET_a/ET_c)$

Answer the following questions:

- a) Calculate the seasonal crop water requirement
 - (i) in mm,
 - (ii) in m^3/ha
- b) Calculate the yield reduction
 - (i) if the water supply is 10% less and equally spread over the total growing season,
 - (ii) If the water supply during the crop development stage in the month of September was 30% less than the water requirements of that month

End of Exam



UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES

FINAL EXAMINATIONS FIRST HALF OF 2013 ACADEMIC YEAR

COURSE: AGG 6811: BIOSTATISTICS IN AGRICULTURE
DURATION: THREE (3) HOURS
TOTAL MARKS 100

INSTRUCTIONS: ANSWER QUESTIONS IN SECTIONS ONE (1) AND TWO (2) IN SEPARATE ANSWER BOOKS.
ALL STATISTICAL TESTS SHOULD BE AT 5% SIGNIFICANCY LEVEL.

SECTION ONE: ANSWER THE COMPULSORY QUESTION AND ONE OF THE ELECTIVE QUESTIONS

COMPULSORY QUESTION

QUESTION 1

The following data (tons of fresh weight maize) were obtained from a field experiment at Liempe Farm in Lusaka. The study was aimed at finding out how varieties of pasture grasses respond to fertilizer (nitrogen) application.

		Blocks		
Variety	Fertilizer level	1	2	3
Kasumbi	High (H)	29.9	31.8	28.4
	Average (A)	24.7	20.2	17.1
Kuhu	High (H)	31.5	24.7	28.9
	Average (A)	25.7	17.5	18.8
Somba	High (H)	40.3	43.9	35.5
	Average (A)	22.2	17.0	19.2

- What design is this? (1 point)
- When would such a design be appropriate? (4 points)
- Give a comprehensive analysis of the above data with clear conclusions. (15 points)

ELECTIVE QUESTIONS

QUESTION 2.

- (a) In designing an experiment there are basic principles to adhere to. List five of these (**2.5 points**). For any **three** of them give the reasons why we should comply to their application (**7.5 points**)
- (b) What role do On-Farm experiments play in technology generation? (**5 points**). List five types of on-farm experiments commonly used in agriculture (**5 points**)

QUESTION 3

Write short notes on each of the following: (**5 points each**)

- a. Key components of a research proposal
- b. Characteristics of a Balanced Lattice design
- c. Applications of Crossover Design
- d. Deductive and inductive reasoning in agriculture

SECTION TWO: ANSWER THE TWO COMPULSORY QUESTIONS AND ONE OF THE ELECTIVE QUESTIONS

COMPULSORY QUESTIONS

QUESTION 4

- a) In what situations would you use: i) t-test; ii) chi-square test; and iii) F- test?
- b) Describe the three essential assumptions for Analysis of Variance?
- c) Distinguish among Analysis of Variance, Analysis of Covariance and Multivariate Analysis.
- d) Distinguish among Simple Correlation Analysis, Multiple Correlation Analysis and Partial Correlation Analysis.
- e) Distinguish among Simple Linear Regression and Multiple Linear Regression.

20 Points

QUESTION 5

In Katete, a researcher was investigating the influence of education level on yield of groundnuts. Farmers with grade 1 to grade 7 education were in group A, those with grade 8 to grade 9 education were in group B, those with grade 10 to grade 12 education were in group C and those with college education were in group D. Five farmers were randomly selected from each group and were requested to grow groundnuts (in one Lima) after attending a groundnuts growing course. Assuming that all the other sources of variation were controlled other than level of education and experimental error the researcher obtained the following data.

	Level of education			
	A	B	C	D
Yield (Kg)	24	21	25	25
	21	18	28	23
	18	15	28	20
	20	19	24	24
	23	20	23	27

- Write a fixed Linear Model which is appropriate for this data.
- Estimate the effects of education level on yield of groundnuts.
- Determine whether all the effects of education level are statistically not different from zero and make conclusion based on the results of your analysis.
- What experimental design do you think the researcher used?

20 Points

ELECTIVE QUESTIONS

QUESTION 6

An Agronomist reckoned that maize yield from a Lima can be predicted using the amount of a given fertilizer applied in a Lima. He therefore undertook a trial from which he obtained the following data.

Amount of fertilizer (Bags)	0.5	1	2	3	4	6
Maize Yield (Bags/Lima)	10	16	26	35	50	72

- Write a Linear model for this data.
- Determine the prediction function for this data.
- Determined whether the prediction function in b) is the best fit for this data.
- What conclusions can you make about the results of your analysis.

20 Points

QUESTION 7

A Masters Student, majoring in agronomy, measured both the plant height and grain yield on the same plant. The student was interested in finding whether there is a relationship between the two variables. Her data is given below:

Plant Height (cm)	100.1	99.4	97.9	98.6	101.4	102.6	99.0	98.6	101.1	98.0	100.5	99.3
Grain Yield (gm)	83	78	76	70	75	89	80	77	86	79	84	87

- If the student had to analyse this data would she find a significant relationship between the two variables?
- What kind of relationship would she find?
- What conclusions would she derive from this data?

20 Points

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
UNIVERSITY FIRST SEMESTER EXAMINATIONS – NOVEMBER 2012

AGS 6141
PLANT NUTRITION

TIME: 3 Hours

Marks: 90

INSTRUCTIONS: ANSWER ALL QUESTIONS AND WRITE LEGIBLY

1. Plant ion uptake selectivity is an important concept in plant nutrition. Discuss briefly how each of the following contribute to plant nutrient uptake selectivity:

- a. Plant uptake pathways [2 Marks]
- b. CEC in plants [2 Marks]
- c. Plant ion carriers [2 Marks]
- d. Electrogenic pumps [2 Marks]
- e. Hydration energy [2 Marks]

2. Interactions between ions of nutrients occur in different ways.

- a. Briefly explain the following ion interaction types:
 - i. Ion competition [2 Marks]
 - ii. Ion synergism [2 Marks]
 - iii. Cation anion relationship [2 Marks]
- b. Explain the role of pH in some of the ion interactions. [4 Marks]

3. Photosynthesis is an important process of converting light energy into chemical energy.

- a. Give two (2) forms of chemical energy that result from the process of photosynthesis. [4 Marks]
- b. Specify the energy type used in CO_2 fixation within the chloroplasts. [2 Marks]
- c. Describe briefly the two (2) CO_2 fixation pathways. [6 Marks]

4. Roots are important in plant nutrition studies.
- With the help of a diagram describe the cross section of a root of a plant. [10 Marks]
 - Explain the following terms:
 - Influx [2 Marks]
 - Efflux [2 Marks]
 - Net influx [2 Marks]
5. The understanding of how nutrients pass into the cytoplasm and vacuoles is important in plant nutrition.
- What is plasmalemma? [2 Marks]
 - Describe the structure of plasmalemma. [4 Marks]
 - Explain clearly what makes the element Ca important for the stability of membranes. In your explanation also consider the pH of the soil. [4 Marks]
 - Explain how ionophores are able to facilitate the movement of ions from one side of membrane to the other side. [4 Marks]
6. Discuss iron and manganese in terms of their occurrence in the soil, their functions in plant growth, identification of deficiencies and their excess/toxicity complications. [16 Marks]
7. Nutrient uptake has been compared to enzyme kinetics.
- What do you think is the reason(s) for this comparison? [4 Marks]
 - Describe the two absorption mechanisms that characterize uptake at different levels of nutrient concentration. [6 Marks]
 - What do you think is the role of water in plant nutrient uptake? [2 Marks]

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
UNIVERSITY FIRST ACADEMIC HALF EXAMINATIONS – FEBRUARY/MARCH
2014

AGS 6211
PLANT NUTRITION

TIME: 3 Hours

Marks: 100

INSTRUCTIONS: **ANSWER ALL QUESTIONS AND WRITE LEGIBLY**

1. There are sixteen (16) elements which are considered essential to plant growth.
 - a. What criteria are used to distinguish essential from non-essential elements?
[6 Marks]
 - b. The 16 elements are grouped into three (3) groups. What are these groups and what are the reasons given for each group? [6 Marks]
 - c. The elements Si, Co, I and Se are considered to be important for some functions of the plant development or for ~~some~~ other organisms. What are these functions and organisms? [4 Marks]
 - d. Explain how the age of a plant affects the mineral content of the plant.
[4 Marks]
2. The concept of selectivity is very important for the understanding of plant nutrient uptake.
 - a. Describe five (5) different mechanisms that contribute to ion selectivity by plants. [10 Marks]
 - b. Explain how plant nutrient uptake is similar to enzyme reactions? [5 Marks]
 - c. What are the five (5) factors that affect nutrient absorption per unit root surface area (influx). [5 Marks]
 - d. The nutrient uptake isotherms can be described with reference to mechanism I and Mechanism II depending upon the concentrations in the external solution. What is the difference between Mechanism I and Mechanism II? [4 Marks]
3. Knowledge of the interactions between ions is important for the understanding of nutrient uptake by plants.
 - a. Define competition as a type of interaction and give examples. [4 Marks]
 - b. What is synergism and how does this occur? [4 Marks]
 - c. What is cation-anion relationship and how does it take place? [4 Marks]
 - d. Explain how the cation-anion relationship affect the pH of the soil in which the plant may be growing and give examples. [4 Marks]
4. Discuss briefly the importance of the following to nutrient uptake:
 - a. Water. [8 Marks]
 - b. Roots. [4 Marks]
 - c. Photosynthesis. [4 Marks]

5. Potassium, phosphorus and iron are nutrient elements.
- a. What is the level of mobility of potassium in soils and in plants? **[2 Marks]**
 - b. Which leaves of plants would you expect to be first to show deficiency symptoms of potassium and explain why? **[2 Marks]**
 - c. What is luxury uptake of K and what is its main benefit to the plant?
[2 Mark]
 - d. Phosphorus levels in the soil solution are in general very low. Explain how plants end up with high amounts of P in their cells from soils containing such low concentrations? **[2 Marks]**
 - e. Name compounds in plants in which phosphate bonds act as an energy source.
[2 Marks]
 - f. What compounds are carriers of genetic information and need P as an essential component? **[2 Marks]**
 - g. What are the four (4) main functions of iron in the plant. **[4 Marks]**
 - h. Briefly discuss four (4) ways in which different plants may react to suboptimal levels of iron. **[8 Marks]**

END OF EXAMINATION



UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
DEPARTMENT OF SOIL SCIENCE

AGS 6221: APPLIED SOIL CHEMISTRY

EXAMINATIONS FOR 2013/2014 FIRST HALF ACADEMIC YEAR

February-March, 2014

MARKS: 100 MARKS

TIME: 3 HOURS

INSTRUCTIONS: Answer all questions legibly and as comprehensively as possible. Shorthand in text is not permitted and calculations must show all important steps

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1.
 - a). Describe four (4) key soil management practices that define Integrated Soil fertility Management (ISFM). [4]
 - b). Since nutrient elements are principally absorbed in oxidized state, list the cultural practices that ensure good aeration of soil at all times. [3]
 - c). What fractions or pools of soil nutrients are considered plant available and why? [2]
2.
 - a). Define the term "colloid", give two of its most important characteristics and list soil colloids that control soil chemical properties. [6]
 - b). A hydrous iron oxide colloid (constant potential, or reversible surface) has a surface potential of 120 mV in an aquatic environment of pH 6:
 - i) Calculate the pzc of the colloidal particle [5]
 - ii). If the pH of the solution increased from 6 to 7, what effect would this have on the adsorption of anions and cations [3]
 - c). Twenty grams (20 g) of soil were extracted with 1.0 M neutral NH_4Aoc solution to exchange bases from the exchange complex and a second sample of 20 g was extracted with 1 M KCl to extract acid ions. The following cations were extracted: Ca = 0.02 g; Mg

= 0.006 g; K = 0.117 g; Al = 0.007 g and H = 0.00001 g. Calculate the ECEC, base saturation % and acid saturation %. [10]

3. a). Why might the growth of an acid-sensitive plant at low pH appear normal in an organic soil such as peat but completely fail in a mineral soil? [6]

b). An acid soil with a ECEC of 15 cmol (+) kg⁻¹ tested 0.35 cmol kg⁻¹ with respect to exchangeable Al³⁺. How much agricultural lime of only 60 % purity should be applied to replace all the Al³⁺ and ameliorate the soil acidity problem in the 15 cm deep layer per ha given that the soil has a bulk density of 1400 kg m⁻³? [6]

c). The critical limit of exchangeable K in soil by the ammonium acetate extraction procedure is 0.22 cmol kg⁻¹. Calculate the amounts of K and K₂O equivalent in the 20 cm- depth of soil layer per ha given that the soil bulk density is 1400 kg m⁻³. [5]

4. a). Explain the major differences between the treatment of ion adsorption according to the Langmuir and Freundlich models. [5]

b). The Langmuir model was developed for solid-gas adsorption. Explain the rationale for application of this model to solid-solution adsorption such as the soil system. [5]

5. a). Describe how climate as a soil-forming factor influences soil development. [6]

b) Why would a soil developed from limestone (alkaline) turn out to be acid when the soil is fully developed?

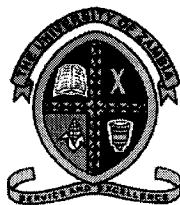
6. a). Explain the mechanisms of K and P fixation in soil [6]

b) Describe the implications of a). above on fertilizer application to soil [4]

7. In checking out an aerial application of ammonium sulphate fertilizer (21 % N) to a hectare of his field, a farmer collected 2.0g of fertilizer in an 8-inch diameter bucket placed in his field. Calculate the rate of N fertilizer (kg N ha⁻¹) that this application rate indicates. [10]

8. In a conservation farming system, crop rotation with legumes adds 5 ton of residue containing 3.5 % N of which 85 % is potentially mineralizable at the rate of 0.135 week⁻¹. Calculate the amount of N that would be mineralized during 120-day growing cycle of maize in Zambia. [10]

END



**UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES**

DEPARTMENT OF SOIL SCIENCE

UNIVERSITY EXAMINATIONS: JULY/AUGUST 2014

COURSE CODE: AGS 6232

SOIL AMENDMENTS AND FERTILIZER TECHNOLOGY

=====

INSTRUCTIONS:

ANSWER: ALL QUESTIONS

TIME: 3 HOURS

TOTAL MARKS: 100

Instructions: Answer ALL questions

1. a). What specific fertilizer formulation strategies are employed in order to ensure adequate supply of micronutrients to crops? [6]

b). Define the term nutrient-use efficiency in a quantitative and measurable way. [3]

c). Describe some fertilizer manufacturing strategies that are employed to enhance nutrient-use efficiency. [8]
2. a). Describe the specific reactions of gypsum in the amendment of a sodic soil [6]

b). Describe how H_2SO_4 acts as a soil amendment on a calcareous soil and calculate the quantity of the acid (tons) that would be equivalent to 1 ton of pure CaCO_3 . [6]
3. a). Show the reactions involved in the production of ammonia from methane through the Haber-Bosch process. [4]

b). Calculate the amounts of NH_3 that can be produced from one ton of CH_4 in the Haber-Bosch process. [6]

c). Explain the process of the manufacture of single superphosphate and triple super phosphate, clearly explaining the differences in the composition of the two fertilizers [6]
4. a). Discuss the merits and demerits of dry bulk blending of fertilizer compared to compound fertilizer [6]

b). Given that ammonium sulphate (21 % N), urea, Single super phosphate (16 % P_2O_5) and muriate of potash, KCl (60 % K_2O) can be compatibly be dry-blended, demonstrate how you could blend a fertilizer of grade 10 : 10 : 20. [10]
5. a). Describe important lime quality parameters that should form part of the lime quality guarantee standard. [6]

- b). Calculate the neutralizing value of calcium silicate, given the atomic weight of silicon as 28 g. [6]
- c). Calculate the amount of liquid lime comprising 48 % lime of 85 % purity, 50 % water and 2 % clay that would give the same rate as 3 ton ha⁻¹ of CCE as a powder. [6]
6. a). Define the term “fertilizer marketing chain” and describe what it entails . [6]
- b). Identify the weakest links in this chain for Zambia. [5]
- c). If you were appointed to lead a campaign to increase fertilizer use by farmers in Zambia, describe five specific suggestions you would advance. [10]

END



UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
DEPARTMENT OF SOIL SCIENCE

AGS 6311: APPLIED SOIL PHYSICS

EXAMINATIONS FOR 2013/2014 FIRST HALF ACADEMIC YEAR

ANSWER ALL QUESTIONS

TIME: 3 hours

ALL QUESTIONS:

=====

- Q1. a) Define what is implied by the term volumetric water content. How is it determined and what is it used for?
- b) Soil water has energy in different quantities and forms.
- Name two principal forms of energy which water is most likely to possess. Explain these energies.
- c) Explain what a soil moisture characteristic curve is and what it is used for. What is hysteresis and how does it influence soil moisture characteristic curve.

- Q2. The difference in soil water potential between two points in the soil leads to water movement.

Explain what total soil water potential is giving the equation which describes it. Explain what the components in the equation are explaining how they arise and their importance.

- Q3. Describe Darcy's law and equation. What does the law indicate? This law and equation is applicable to many cases of water flow. Explain the assumptions which must be satisfied for one to use this law and equation.

There are circumstances when Darcy's equation cannot on its own be used. State the conditions and explain what is done to solve the problem.

- Q4. Movement of different components of air in the soil may be by or via two mechanisms. The first is convective and the second is diffusion.

Explain each of these indications when it happens, the driving force and the process itself. How do they and when do they influence soil air?

Q5. Describe mulching in its various forms, why is it done.

Explain the conflicting results which are reported from studies with different mulch materials. Explain also what results you would expect when a black plastic and a transparent plastic material are used as mulch.

Q6. In studying salinity and how solutes move through the soil, three terms or processes are important and many occur during solute movement. These are breakthrough curve, miscible and immiscible displacement and piston flow. Explain what is meant by each.

END

UNIVERSITY OF ZAMBIA

UNIVERSITY FIRST SEMESTER EXAMINATIONS-NOVEMBER, 2012

AGS 6411: APPLIED SOIL CHEMISTRY

TIME: 3 Hours

MARKS: 100

INSTRUCTIONS: Answer all questions and write legibly. Shorthand and incomplete sentences in text are not allowed. Show all the logical steps in calculations.

1. a). Describe four (4) key management practices that constitute complete Integrated Soil Fertility Management (ISFM) [4]
- b). Calculate the amount of nitrogen that would be mineralized in one month in the top 20 cm of a soil containing 2.8 % organic matter with a C:N ratio of 15:1. Assume first order decomposition of organic matter at the rate of 0.143 week^{-1} and a soil bulk density of 1300 kg m^{-3} . [10]
2. a). A 5 ton ha^{-1} crop of maize transpired $3.2 \times 10^9 \text{ g}$ of water per season. If the P concentration in the soil solution was 0.1 mg dm^{-3} and adequate P content in the plant is 0.2 %, would mass flow supply enough P to meet the crop requirement? [6]
- b). Given that the diffusion coefficient of P in humid soil is $5.0 \times 10^{-9} \text{ cm}^2 \text{ s}^{-1}$, how far from the placed fertilizer granule would P have diffused after 6 hours? [4]
3. a). Define the term "colloid", give three examples of colloids in soil and list two important characteristics of colloids. [6]
- b). Demonstrate the mechanisms of charge development on the different soil colloidal surfaces. [6]
4. a). Why is pure water not a suitable extractant for plant available nutrients in soil? [4]
- b). List five characteristics of a good soil extractant for plant available nutrients [5]

- c). The iron precipitate, $\text{Fe}(\text{OH})_3 (s)$, controls Fe^{+++} concentration in the soil solution. Given that the solubility product of the compound in soil is $pK_s = 36$, calculate the concentration of Fe^{+++} at pH 8. [6]
5. a). List eight (8) natural causes of soil acidity and two (2) of salt accumulation in soil. [10]
- b). Explain the mechanisms of soil pH buffering in the acid range ($\text{pH} < 4.0$) and in the alkaline range ($\text{pH} > 7.0$). [6]
- c). Describe the reaction of agricultural lime in an acid soil. [7]
6. a). Explain the differences between the treatment of ion adsorption according the Langmuir and Freundlich models. [4]
- b). In the linear form of the Langmuir equation for the adsorption of a substance onto a surface, C_e/x_m is plotted against C_e . Given that C_e was measured in $\mu\text{g cm}^{-3}$ and m in grams, derive the units of the independent variable and of the constants b and k . [8]
7. a). Explain the rationale behind using activities () and rather than concentration [] in describing chemical equilibria. [6]
- b). Describe four (4) fundamental questions that the Laws of thermodynamics address. [4]
- c). A fertilizer company is desirous to produce ammonia ($\text{NH}_3 (g)$) from methane gas (CH_4): $7 \text{CH}_4 + 10\text{H}_2\text{O} + 8\text{N}_2 + 2\text{O}_2 = 16\text{NH}_3 + 7\text{CO}_2$
Determine whether or not the process is exothermic or endothermic. [10]

END



UNIVERSITY OF ZAMBIA

FIRST HALF EXAMINATIONS –FEBRUARY, 2014

AGS 6411: SOIL MICROBIOLOGY

Time: Three (3) Hours

Marks: 100

Instructions: Answer all Questions

1. Soil microorganisms are important in the cycling of phosphorus (P) and therefore play a significant role in mediating the availability of P to plants. Discuss in detail:
 - a. Three mechanisms by which microorganisms can enhance the capacity of plants to acquire P from soil [**15 marks**]
 - b. Two possible challenges (or reasons for inconsistent results) associated with the use of microbial products for P mobilization at farm level [**10 marks**]

2. In Conservation Farming Systems, residue retention and crop rotation are two of the practices recommended. Based on these practices and your knowledge of soil organic matter decomposition explain:
 - a. The predominant **TYPE** of organic matter in the soil immediately after the maize-cowpea and cowpea-maize rotation phases. [**5 marks**]
 - b. The kinds of enzymes and microorganisms that would be **most active** immediately after the cowpea-maize rotation phase. State the rationale for your answer [**15 marks**]

3. The establishment of the symbiosis between legumes and rhizobia is accomplished through a series of stages, mediated by a chronological cascade of physiological signals from both participants. Imagine you have access to 'state of the art' facilities that allow you to do detailed biochemical, morphological and molecular studies:
 - a. Explain how you would show a successful establishment of this relationship at any four (4) stages [**20 marks**]
 - b. Explain how you would show that the nodules are metabolizing N_2 and that the host plant is using the fixed N [**5 marks**]

4. From the plant and microorganism perspectives, explain why the formation of symbioses for biological nitrogen fixation or mycorrhizae would not be beneficial when soil conditions are 'favorable'. Give examples. **[15 marks]**
5. Explain why it is difficult to have only one view/ perspective on the effects on soil microorganisms of the following:
 - a. Climate change **[5 marks]**
 - b. Use of agricultural chemicals **[5 marks]**
 - c. Heavy metal pollution **[5 marks]**

- End -

UNIVERSITY SECOND SEMESTER EXAMINATIONS

MAY 2013

AGS 6431: SOIL MICROBIOLOGY

TIME: 3 HOURS

TOTAL MARKS: 100

ANSWER ALL QUESTIONS

1. The study of biota that inhabits the soil and the processes that they mediate requires a consideration of the environment in which they find themselves. What are the implications of the following soil conditions on soil microbes and/ or microbial processes?
 - a. Water logging and increased carbon dioxide levels in the 'soil atmosphere' [10 marks]
 - b. Increased soil temperature due to global warming [10 marks]
2. Explain why almost ALL attempts to isolate soil microorganisms from varied environments would include at least one isolate from the genus *Bacillus*? [10 Marks]
3. Explain how you would convince a group of scientists that *Bacillus thuringiensis* (Bt) toxin released from root exudates and biomass of Bt cotton has no apparent effect on soil microorganisms. Assume all resources you would require are available and unlimited. [25 marks].
4. Discuss five (5) general morphological and biochemical characteristics (features) of:
 - a. Actinomycetes [5 marks]
 - b. Bacteria [5 marks]
 - c. Fungi [5 marks]
5. Explain how the process of the formation of the symbiosis for nitrogen fixation would be affected if the following were deliberately excluded:
 - a. Indole acetic acid [5 marks]
 - b. Rhicadhesins [5marks]
 - c. Nod factors [5 marks]
 - d. Peribacteroid membrane [5 marks]
6. Mycorrhizae can be described as a symbiotic relationship between a fungus and a plant. Being a symbiotic relationship, explain its benefits to the plant, the fungi and the soil. [10 marks]

END

UNIVERSITY OF ZAMBIA
School of Agricultural Sciences

UNIVERSITY SECOND SEMESTER EXAMINATIONS – MAY 2011

AGS 6432: Soil Amendments and Fertilizer Technology

TIME: 3HOURS

MARKS: 100

INSTRUCTIONS

ANSWER ALL QUESTIONS AS COMPLETELY, CONCISELY AND LEGIBLY AS POSSIBLE

-
1.
 - a). Outline the chemical reactions in the production of ammonia (NH_3) from atmospheric nitrogen and hydrogen from coal. [5]
 - b). Show that the production of ammonia from using methane as feedstock is exothermic. [5]
 - c). Calculate the amount of ammonia that would be produced from one ton of coal with a purity of 58 % as feedstock? [4]
 - d). Why does the production of ammonia consume energy in spite of the reaction being exothermic (b above)? [3]
 2. A soil with a bulk density of 1.3 g cm^{-3} had a soil test of $0.15 \text{ cmol K kg}^{-1}$. If the target yield of maize on this soil was 5 ton ha^{-1} ,
 - a). Calculate the potassium deficit (kg ha^{-1}) if any that must be applied to compensate for the deficit [5]
 - b). How much (kg ha^{-1}) compound D fertilizer should be applied? [5]
 - c). The bumper harvest of the 2010/2011 season amounted to 2.8 million tons of maize. If the crop was adequately fertilized, calculate the amount of NPK that were removed in the harvest expressed as bags of compound D and urea fertilizers. [6]
 3.
 - a). Describe the constraints to plant growth associated with saline-sodic and calcareous-sodic soils. [6]
 - b). Describe the reactions of gypsum applied to a saline-sodic soil and explain how sulphur reacts in soil to ameliorate a calcareous-sodic soil. [5]
 - c). In the production of gypsum from the reaction of CaCO_3 with sulphuric acid, how many tons of sulphuric acid would be equivalent to 1 ton of pure $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$? [5]

4.
 - a). Describe specific ways soil acidity adversely affects plant growth? [6]
 - b). Plant breeders can develop crops tolerant or resistant to all plant physiological conditions of acid soils. Is this a certain means to eliminate the need for lime and fertilizer? [3]
 - c). An acid soil was adequately limed but it was observed that while the soil pH increased there was no improvement in plant growth . Explain the observation. [2]
5.
 - a). Explain the synergistic effect of organic and inorganic fertilizer on plant growth [5]
 - b). A soil contains 1.2 % organic matter and has a C : N ratio of 15 : 1. Calculate the total N (kg ha^{-1}) contained in the plough layer given a soil bulk density of 1400 kg m^{-3} . [5]
6. Acidulation of phosphate rock in P fertilizer production can be represented by the following reactions:

$$\text{Ca}_{10}(\text{PO}_4)_6\text{F}_2 + 7\text{H}_2\text{SO}_4 + 3\text{H}_2\text{O} \longrightarrow \text{Ca}(\text{H}_2\text{PO}_4)_2 \cdot \text{H}_2\text{O} + 7\text{CaSO}_4 \cdot 2\text{HF}$$

$$\text{Ca}_{10}(\text{PO}_4)_6\text{F}_2 + 14\text{H}_3\text{PO}_4 + 10\text{H}_2\text{O} \longrightarrow \text{Ca}(\text{H}_2\text{PO}_4)_2 + 2\text{HF}$$
 - a). Determine how much acid would be used in the production of 50 % and 25 % partially acidulated phosphate fertilizers. [5]
 - b). Calculate the percent P_2O_5 content of fertilizer products from the two reactions. [5]
7. Provided with Ammonium sulphate, ammonium nitrate, phosphoric acid and sulphate of potash, demonstrate how to make a fertilizer of grade 8: 6 : 4 [6]
8.
 - a). Explain the general ly observed low usage of fertilizer in sub Saharan Africa [4]
 - b). Outline specific strategies that would help convince smallholder farmers to buy and use increased amounts of fertilizer [4]
 - c). Discuss the options open to Zambia to develop a local NPK fertilizer industry. [6]

END

THE UNIVERSITY OF ZAMBIA
MSc. AGRONOMY – SOIL SCIENCE

UNIVERSITY SECOND SEMESTER EXAMINATIONS – MAY 2011

AGS 6532
SOIL CONSERVATION

TIME: 3 Hours

Marks: 90

INSTRUCTIONS: ANSWER ALL QUESTIONS AND WRITE LEGIBLY

1. Define soil conservation and the groups of technologies used in soil conservation.
[10 Marks]
2. Soil and water conservation require that policy analysis and assessment should be in place, what roles do the policy and strategies play? [10 Marks]
3. Briefly discuss how land management is affected by the following:
 - a. Access to markets [3 Marks]
 - b. Population [3 Marks]
 - c. Agricultural incentives [3 Marks]
 - d. Education [3 Marks]
 - e. Land tenure [3 Marks]
4. Discuss the main agronomic (vegetative) conservation measures and their effectiveness. [10 Marks]
5. Types of tillage methods are important in land management considerations.
 - a. Discuss why the No-Till technology has not been met with the same success in Zambia as in other countries notably Brazil and the USA. [5 Marks]
 - b. What positive roles can government play to facilitate adoption? [5 Marks]
6. Describe how you would carry out an assessment of:
 - a. Soil biological degradation [5 Marks]
 - b. Soil cover in the field [5 Marks]

7. Describe specific aspects of conventional agriculture that lead to the degradation of the soil. [10 Marks]
8. The annual soil loss from a field experiencing sheet erosion is estimated at, 20 metric tonnes per hectare. Given that the bulk density of the soil is 1.4 g cm^{-3} , determine:
- a. The equivalent depth of the soil lost annually in millimeters? [5 Marks]
 - b. How long it will take to lose an equivalent depth of 2.5 cm of soil at this rate. [5 Marks]
 - c. Given that the soil particles contain 15 ppm of adsorbed P, estimate the amount of P, expressed in terms of $\text{kg P}_2\text{O}_5$ per hectare that would be lost in 5 years at the above rate of erosion. [5 Marks]

END OF EXAMINATION



UNIVERSITY OF ZAMBIA
SECOND HALF EXAMINATIONS –JULY 2014
AGS 6612: SOIL AND WATER CONSERVATION

Time: Three (3) Hours

Marks: 100

Instructions: Answer all Questions

1. Chemical degradation is a serious challenge on most farms
 - a. Discuss how the determination and interpretation of soil pH and CEC may help to reveal different forms of chemical degradation **[10 marks]**
 - b. What measures would you recommend to a farmer who wants to minimize any five forms of chemical degradation **[10 marks]**
2. Biological degradation is the reduction in soil organic matter status, leading to a subsequent decline in soil biological activity and biodiversity
 - a. Explain why soil organic matter is at the center of biological fertility **[5 marks]**
 - a. Using an example of an 'ecological' approach, explain how biological fertility can be restored back to soils **[5 marks]**
 - b. Design an experiment that would elucidate the effects of toxic compounds on **at least two** activities mediated by soil microorganisms. **[10 marks]**
3. Erosion is a process of detachment, transportation and deposition of soil particles by erosive agents
 - a. Describe five reasons why erosion of surface soil is so detrimental to the environment **[10 marks]**
 - b. Describe the Universal Soil Loss Equation, its five factors and how it can be simplified for erodibility estimation **[7.5 marks]**
 - c. For wind erosion, briefly define the processes involved in the removal of soil particles **[7.5 marks]**
4. A runoff plot had a dimension of 25 m by 4 m with an installed runoff collection system capable of collecting 1% of the runoff. The total runoff collected after a 25 mm rainfall was 10 litres with a sediment load of 5 grams per litre, calculate: **[15 marks]**
 - a. Runoff depth in (i) mm and (ii) m^3/ha **[5 marks]**
 - b. Percentage of runoff (%) **[5 marks]**
 - c. Total soil lost from the (i) plot (kg/plot) and (ii) from 1 ha (ton/ha) **[5 marks]**

5. You are managing an agricultural development programme targeted at diversifying crop production in Zambia. Results of a Soil Survey below show the typical characteristic of the surface horizon of the dominant soil in your target area. [20 marks]

Table 1. Selected properties of the surface horizon of the dominant soils of the target area.

Depth (cm)	pH 0.01M CaCl_2	Org C (%)	Total N (%)	Bd (g/cm^3)	CEC pH 7	Exch Al	ECEC	Exch K	Avail-P
					-----($\text{cmol}/\text{kg soil}$)-----			(mg/kg)	
0-20	4.3	0.85	0.053	1.54	3.7	0.8	1.7	0.2	5.0

Answer the following questions. (20 marks)

- Give the agronomic interpretation of the pH value of this soil. [2.5 marks]
- How much organic matter is present in one Lima of this soil? [2.5 marks]
- Given that mineralization of nitrogen occurs in materials that have a C: N ratio of less than 20:1, would you expect the decomposition of organic matter in this soil to result in the mineralization of nitrogen? Show calculation to support your answer. [2.5 marks]
- The organic matter in this soil undergoes decomposition for 4 months (120 days) in a year and the amount of carbon lost as part of CO_2 gas per kilogram of soil after a given period t (in weeks) is given by the equation below:

$$C \left(\frac{\text{mgC}}{\text{kg}} \text{ soil} \right) = 545.0 * t^{0.454}$$

- How much organic carbon is lost from a Lima of the top layer of this soil every year? [4.0 marks]
 - How much compost (in kg) containing 50 % carbon should be applied per Lima to replace the carbon lost from the soil as CO_2 per year. [4.0 marks]
- e) How many 50 kg bags of the agricultural lime with a Neutralizing Value of 85 % are required to raise the pH of soils in a 2 Lima plot to 7.0? Assume that the lime is to be broadcast cross the whole field. [4.5 marks]

END OF EXAMINATION

UNIVERSITY OF ZAMBIA

SCHOOL OF AGRICULTURAL SCIENCES

UNIVERSITY FIRST SEMESTER EXAMINATIONS-MARCH, 2014

AGS 6715: AGROCLIMATOLOGY

Time: Three (3) Hours

Total Marks: 100

Instruction: Answer all Questions

1. Briefly define the following terms *(20 marks)*
 - a) Mesopause
 - b) Longwave radiation
 - c) Black body radiation
 - d) Return period
 - e) Thermal neutral zone
2. The depletion of the solar energy and associated processes in the earth's atmosphere results in a temperature profile around the earth: *(12 marks)*
 - a) What are the three distinct sources of heat energy warming the earth's atmosphere *(6 marks)*;
 - b) What are the constituents of the atmosphere that take a significant part in absorption of solar radiation *(6 marks)*
3. The earth's atmosphere is composed of distinct layers with unique sets of characteristics arranged around the Earth's surface. *(21 marks)*
 - a) With aid of a diagram describe the earth's heterosphere as characterized by spherical shells of atmospheric gases *(12 marks)*;
 - b) The continues to warm up in its 4.5 billion years, briefly describe the agreed temperature changes that have occurred according to the IPCC (2001) *(9 marks)*
4. Crop physiological development can be assessed through the heat that accumulates over a growing period. *(22 marks)*
 - a) Define (i) the growing degree day, and (ii) the crop heat unit *(6 marks)*
 - b) List the assumption made when applying of the growing degree day concept *(6 marks)*
 - c) What is the advantage of using crop heat unit over growing degree day? *(5 marks)*
 - d) List the equations that can be used to estimate the growing degree day and the crop heat unit *(5 marks)*

5. The following weather data were measured this year at Liempe Farm located in Chongwe (28°28' E, 15°23' S and altitude 1262 m): (25 marks)

Tmax	28.0°C
Tmin	17.3°C
Tdew	8.5°C
Solar Radiation (Rs)	251.72 W m ⁻²
Inverse relative Earth-Sun distance	1.011 radians

Note $1.0 \text{ MJ m}^{-2} \text{ day}^{-1} = 11.6 \text{ W m}^{-2}$

Determine:

- Day and month when these measurements were taken (5 marks)
- Sun-set hour angle *in degrees* (5 marks)
- Sun-rise and sun-set time for this day (4 marks)
- Mean saturation vapour on this day in *kPa* (5 marks)
- Actual saturation vapour pressure on this day in *kPa* (3 marks)
- The Relative humidity (%) (3 marks)

End of Exam