

THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
2006 FIRST SEMESTER EXAMINATIONS

COURSE CODE		COURSE TITLE
AGA	211	Anatomy of farm Animals
AGA	351	Animals science for engineers
AGA	441	Introduction to Agriculture
AGA	511	Techniques in Animals Science
AGA	521	Applied Animal reproduction
AGA	531	Topics in Animal nutrition
AGC	411	Field crop production
AGC	431	Agricultural Entomology
AGC	531	Principles of weed management
AGE	211	Fundamentals of microeconomics
AGE	311	Rural sociology
AGE	411	Introduction to Agribusiness
AGE	421	Production Economics
AGE	431	Linear programming Applications for Agribusiness
AGE	511	Agricultural Organisation and Administration
AGE	531	International Agricultural markets, trade and Development
AGE	541	Agricultural project planning and appraisal
AGE	211	General microbiology (Theory paper)
AGE	211	General microbiology (Practical paper)
AGF	221	Computer Science
AGF	311	Chemical techniques in Food analysis (Theory Paper)
AEF	311	Chemical techniques in Food analysis (Practical paper)
AGF	321	Food chemistry (Theory Paper)
AGF	321	Food Chemistry (Practical paper)
AGF	341	Technical Thermodynamics
AGF	411	Food Engineering
AGF	421	Food Technology 1 (theory paper)

AGF	421	Food Technology I (Practical, Open book paper)
AGF	441	Water and Food waste treatments
AGF	511	Unit operations of food Engineering II
AGF	531	Technology of plant products I
AGF	541	Technology of Dairy and Egg Products
AGS	211	Fundamentals of soil science I
AGS	431	Soil mineralogy and macro morphology
AGS	441	Agricultural hydraulics and hydrology
AGS	511	Soil Chemistry
AGS	551	Planning and development of irrigation and drainage systems

THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
2006 ACADEMIC YEAR - FIRST SEMESTER FINAL EXAMINATIONS

AGA 211: ANATOMY OF FARM ANIMALS
TIME: THREE HOURS

INSTRUCTIONS: Answer Question 1, 2 and 3 and then choose one other question. Answer all parts of question 1 on the attached paper. Use back of page if need be. All questions carry 20 marks except question 1.

1. In the drawing provided next page, answer the following questions: (40 points)

- a. Name the animal indicated in the drawing.
- b. Label the sections and bones indicated as 1 to 20.
- c. Write the vertebral formula of this animal.
- d. Write the dental formula of this animal. How do you determine the age of this kind of animal?
- e. Indicate with an arrow on the diagram and label where the following organs should have been in the animal:
 - i. Heart
 - ii. Lungs
 - iii. Kidneys
 - iv. Uterus
 - v. Diaphragm
 - vi. Rumen
 - vii. Latissimus dorsi

2. Good management of animal reproduction is one of the most important aspects of animal farming because efficient reproduction leads to profitable farming. For this reason knowledge of reproduction can be used to obtain efficient production.

- a) With a diagram describe the internal features and products of the testis.
- b) With an illustration follow the movement of sperm in the female reproductive tract till implantation of the fertilized egg.
- c) Contrast between a pregnant and non pregnant goat uterus.

3. Write short notes on any 4 of the following topics:

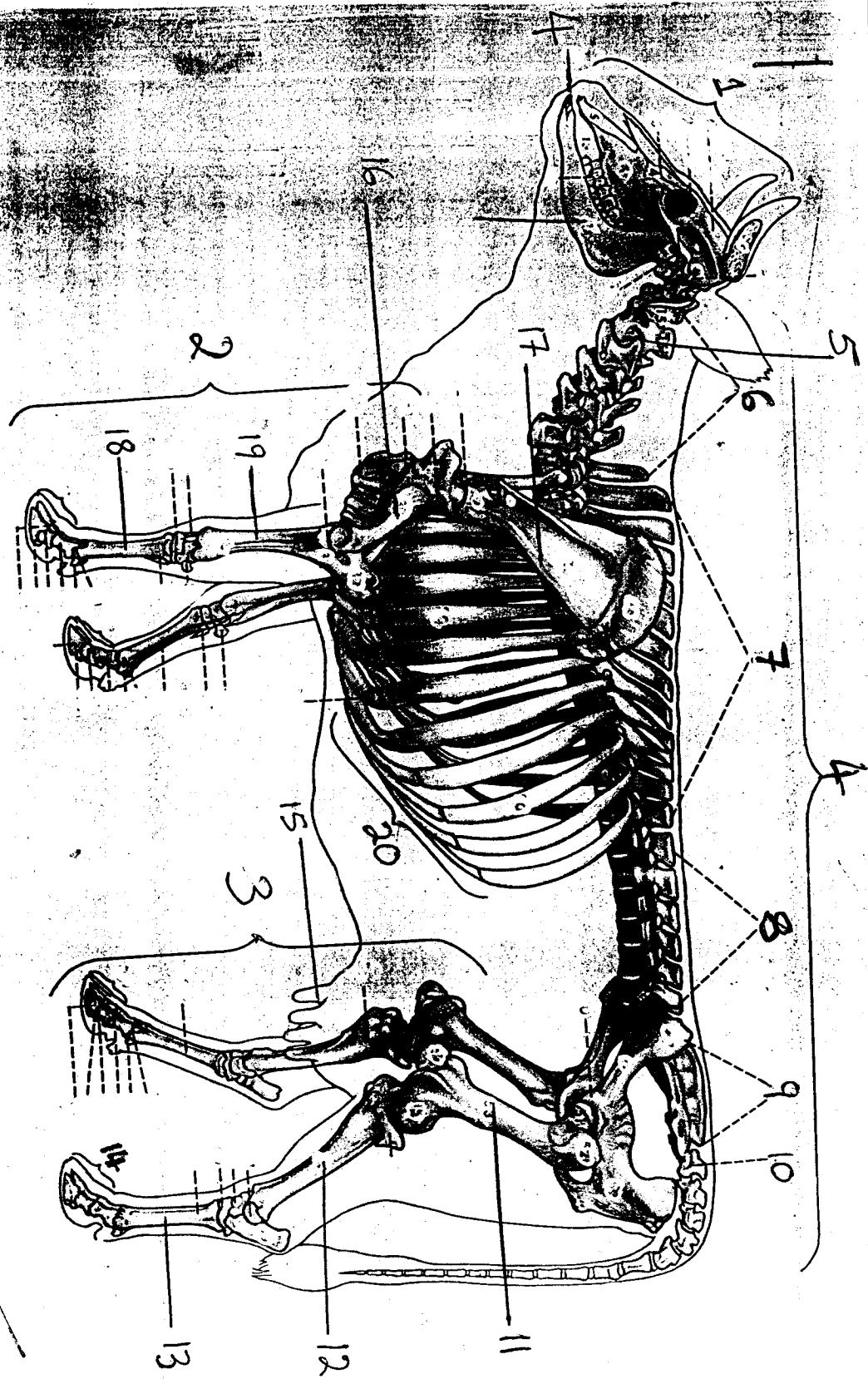
- a. Muscles of the heart
- b. Structure of cow mammary glands
- c. Portal system
- d. Structure of arteries and veins
- e. Epithelial tissue

4. The digestive system of domestic animals is different for various types of livestock:

- a) Differentiate between the digestive system of a goat and that of a pig.
- b) What purpose are these differences serving for the two species?
- c) What function does the liver play in digestion?

Q5. Endocrine and Nervous systems control all animal functions in the body.

- a) Classify the Nervous system.
- b) What do you understand by spinal and cranial nerves?
- c) Name the hormones produced by the anterior pituitary gland and functions.



THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES

2006 ACADEMIC YEAR FIRST SEMESTER
FINAL EXAMINATIONS

COURSE AGA 311: PRINCIPLES OF ANIMAL NUTRITION

TIME ALLOWED: THREE (3) HOURS

INSTRUCTIONS TO CANDIDATES:

- i. Answer any six (6) questions.**
 - ii. All questions carry equal marks**
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1. 'Proximate Analysis' procedures evaluate feed in terms of six (6) major chemical components.
 - i. List the chemical analyses that make up what are referred to as 'Proximate Analysis' procedures?
 - ii. Write briefly on the chemical basis of analysis or the principle used to determine five of the feed components evaluated using 'Proximate Analysis'.
 - iii. What is the significance of each of the feed components you have selected in (ii) above, in relation to animal nutrition.

2.
 - i. Define the terms polysaccharide, homopolysaccharide and heteropolysaccharide, giving two examples of each, in relation to the diet of farm animals. Name the enzymes that would be required to completely digest the food components you have given as examples.
 - ii. Glycolysis is the major metabolic pathway in animals for carbohydrate degradation for energy generation. With the aid of flow charts, where necessary, compare and contrast the aerobic and anaerobic production of energy from one glucose molecule via the Glycolytic pathway.

3. Essential fatty acids have to be provided in the diet of mammals because they cannot be synthesized by the body tissues.
 - i. Name the essential fatty acids.
 - ii. List their functions and deficiency symptoms in the animal body.
 - iii. Give an outline of fatty acid synthesis, from *de-novo* synthesis to elongation.
 - iv. Explain why essential fatty acids cannot be synthesized by mammalian body tissues.

4. In an experiment, a cow and a sow are both fed on a diet of crushed maize only. Compare and contrast the processes of digestion of the carbohydrates in the maize, and end products absorbed in each of the two animals, assuming this diet does not cause any digestive disturbances.

5. Excess amino acids above the levels required for the synthesis of proteins and other nitrogen-containing compounds, are not stored by the animal body. Nitrogen is removed from the amino acids and excreted, while the carbon skeleton is utilized for energy generation.
 - i. Explain in detail the biochemical processes involved in the removal of nitrogen from amino acids in preparation for excretion.
 - ii. Briefly describe any two methods of excretion of nitrogen in animals, giving examples of the types of animals using the selected methods of nitrogen excretion.
 - iii. Explain why some amino acids are said to be 'ketogenic' and others 'glucogenic'. Give three examples each, of glucogenic and ketogenic amino acids.

6. Write short notes on the following:
 - i. Interactions between nutrition and disease, as well as parasite infestations.
 - ii. The symbiotic relationship between rumen microorganisms and their hosts.
 - iii. Antinutritional factors found in legumes
 - iv. Heat increment of feeding.
 - v. Urea toxicity in ruminants.

7.
 - i) Production of hemoglobin requires the interaction of several vitamins and minerals. List any five of the micronutrients required in hemoglobin synthesis and give two other functions that the listed nutrients perform in the animal body.
 - ii) What are the common properties of water-soluble vitamins?
 - iii) What are the general functions of the Micro- and Macrominerals in the animal body?

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
2006 FIRST SEMESTER EXAMINATIONS

COURSE: AGA 351 ANIMAL SCIENCE FOR ENGINEERS
TIME: THREE (3) HOURS
INSTRUCTIONS: ATTEMPT ALL QUESTIONS
THE FIVE (5) QUESTIONS CARRY EQUAL MARKS

1. Describe the functioning of a compound stomach of a ruminant animal and explain its advantages over a simple stomach.

2. Discuss the enzymes of the small intestine indicating their sources and their functions.

3. Give an outline of the reproductive system of a hen and identify the functions of the various parts.

4. Briefly discuss the following:
 - a. Signs of estrus in a sow
 - b. Calf castration methods
 - c. Calf de-horning methods
 - d. Forced molting in layers

5. Discuss the various activities normally undertaken on a litter of piglets from farrowing to weaning.

END OF EXAMINATION

SECTION B

3. Write short notes on the following:
- Discuss the advantage of factorial experiments over single factor experiments
 - What experimental designs require the use of orthogonal polynomials in statistical analysis?
 - What information does the coefficient of determination (R^2) provide to the researcher in regression analysis?
 - Briefly state the difference between regression and correlation
4. It has been said that the problem of protein malnutrition among the people in Sub Saharan Africa can be solved if scientists in the continent can get back to basics and improve the productivity of small livestock available at village level. The village chicken has been identified as potentially the most available source of dietary protein.

The village chicken has been suggested because it is able to scrounge for food from the environment without the intervention of the farmer with any regular feeding using expensive commercial feeds. The village chicken is said to have very high protein utilization efficiency. However the main problem with village chickens is that they take too long to grow to slaughter weight.

It has been learnt that animal scientists at UNZA have managed to genetically characterize and identify **Five** most common and popular local village chicken breeds. Feeding trials are to begin in order to generate information that will improve the productivity of these village chicken breeds so that they can form a sustainable source of dietary protein for the rural poor.

Design an experiment **or** experiments to study the response of the Five identified village chicken breeds to different feed protein concentrations. The **Feed Protein** concentrations are as follows:

- Free range type (trace amounts as those found in the free range type of feed)
 - 25% of recommended protein concentration
 - 50% of recommended protein concentration
 - 75% of recommended protein concentration
 - 100% of recommended protein concentration
- Clearly explain the design of the experiment that will give you information on response of the village chickens to varying rates of feed protein concentrations
 - Your experiment should provide answers as to whether the feed response is dependent on the type of breed.
 - Explain how you will collect your data for analysis.
 - Will you need to include the improved breed as a check in this study?
 - Provide the form of the ANOVA table with the appropriate degrees of freedom.

SECTION C

5. A retired company executive decides to settle on his 10-hectare small holding in Lusaka West. Since you are the Animal Production Officer for the area, he comes to you for advice on how to establish a 20,000-bird broiler unit and a 2,000-bird egg laying chicken unit. Write on ten (10) factors that you consider important for designing this Poultry enterprise to ensure its successful operation.
6. Write briefly on the following:
- i. Any five (5) sampling plans you may use when taking a sample from a batch of feedstuff.
 - ii. Recommended feed sample storage conditions that will ensure minimal, or negligible change in the nutrient constituents of a stored sample.
 - iii. Define the term 'Feeding standards' and briefly explain any four (4) considerations you would make when applying feeding standards for lactation to dairy cows.

SECTION D

7. a) Define blood.
- b) Name the constituents of blood and indicate their functions.
- c) Mention and explain the methods of collecting blood from farm animals.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
UNIVERSITY FIRST SEMESTER EXAMINATIONS – SEPTEMBER,
2006
AGA 521 – APPLIED ANIMAL REPRODUCTION

TIME: **3 HOURS**

INSTRUCTIONS: **ANSWER QUESTION 1 AND TWO (2) OTHERS FROM SECTION A, AND TWO (2) FROM SECTION B, IN SEPARATE BOOKLETS.**

SECTION A

1. Read each question carefully! Answer as stated and related to this course.

For each of the phenomena listed, give the following information:

- a. Physiological status of the animal (e.g. estrual, metestrus I or II, pregnant, etc.)
 - b. Factors involved (e.g. hormones, anatomical structures, etc.)
 - c. Pathways involved (e.g. if the result involves two or more structures, show how).
- A. Immediately after natural mating a cow was observed to be streaming milk from the mammary gland. This gave confidence that another more directly reproductive feature occurred. Discuss the reproductive feature as outlined above.
- B. A blood sample from the cow was analyzed for hormone effect levels and the following was found:

Below Dominance

LH
Progesterone

Dominant

Estrogen
FSH
PGF_{2α}

- C. A blood sample from a cow showed LH to be the only really dominant hormone.
- D. The ovaries were removed from the cow and by general examination (no microscope), it was determined that the cow was cycling regularly and she would have been in heat 12 to 18 hours.

- (i) What structures did the observer see (name all and condition)?
 - (ii) What specific observations made the description of the cow's physiological status possible?
2. Give a basic physiological explanation for each of the following. Only one short explanation is needed, but be complete by following the events to completion, such as lack of ovulation was due to a lack of LH secretion by the anterior pituitary gland. It is important to demonstrate your depth of knowledge of endocrine and anatomical functions in each case.
- a. A cow with pyometra (uterus infection) has not been in heat for 60 days.
 - b. A sow showed heat 3 days after farrowing but did not conceive when mated.
 - c. A ewe did not show heat with the first ovulation at the start of the breeding season.
 - d. A mare cycled a month earlier in the breeding season than her contemporaries when exposed to a 10-minute increase in daily light beginning in May.
 - e. A group of sows had heat synchronized to a 5-day period after being injected with PMSG-HCG, but a group of cows did not.
3. a. Outline the process of fertilization to its completion i.e. formation of the zygote
- b. What are the sources of nutrition for the zygote from its formation to the fetal stage following implantation.
4. a. Discuss factors that affect the degree of fertility in sows.
- b. How many piglets would you expect a sow with 20 ovulations to have at farrowing? Show how you arrive at your answer.
 - c. What are the primary factors involved in low fertility experienced in mares?

SECTION B

5.
 - a). Outline the role of Artificial Insemination (A.I) in the Livestock industry in Zambia.
 - b) Name and explain 5 methods of semen collection in farm animals.

6.
 - a). Evaluation of semen is essential in order to ensure that only quality semen is used for Artificial Insemination (A.I). What are the points to consider when evaluating the semen?
 - b) After collection of semen from a bull, how do you process and store it so that it can be used in future?

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

THE SCHOOL OF AGRICULTURAL SCIENCES

2006 ACADEMIC YEAR – FIRST SEMESTER FINAL EXAMINATIONS

COURSE AGA 531 – TOPICS IN ANIMAL NUTRITION

TIME ALLOWED: THREE (3) HOURS ONLY

INSTRUCTIONS TO CANDIDATES:

- Question 1 carries 40 marks and the rest carry equal marks (20).
- Answer question 1 and three (3) others.
- Clearly show all the calculations.

Q.1 An emergent commercial broiler farmer wishes to compound stock-feeds on his farm by use of the locally available feed ingredients. The decision was made upon acquiring a hammer-mill. As a self-employed stock-feed consultant you are required to formulate a Broiler Ration for the first phase feeding in the three-phase feeding programme. The broiler ration should contain 2,800 Kcal/kg metabolisable energy (ME), 22% digestible crude protein (DCP), 1% Lysine, 0.6% Methionine, 3.5% Calcium, 0.85% Phosphorus, 1% Broiler Premix (vitamins and minerals) and 0.5% Salt.

The following feed ingredients are available:

Ingredient	Composition					
	ME (Kcal/kg)	CP%	LYS%	Met%	Ca%	P%
Maize Meal	3,350	8.8	0.24	0.20	0.02	0.28
Soya-bean Cake	2,230	44.0	2.93	0.63	0.29	0.65
Tallow	8,000	-	-	-	-	-
Di-calcium Phosphate	-	-	-	-	26.0	18.0
Limestone Flour	-	-	-	-	38.0	-

(40 Marks)

- Using the rapid formulation of forage and compound feed calculate the forage dry matter intake and the compound feed intake that should be provided to a 620 kg Friesian dairy cow in mid-lactation producing 27 kg milk per day containing 3.6% butterfat and 9% solids-not-fat given that only Maize Silage (containing 9 MJ ME/kg DM) and Dairy Meal or Compound Feed (containing 12.5 MJ ME/kg DM) are available.
 - If the Friesian cow in a) above was actually in early lactation calculate the forage dry matter intake and the compound feed intake requirements.
 - If the Friesian cow in a) above was actually producing the 27 kg milk at 2 weeks post-partum calculate the expected peak milk yield from the cow.

(20 Marks)

Q.3 The digestibility of forages affects the dry matter intake (DMI) of such forages by ruminants. However, the DMI of such forages determines the ruminant animals' productivity. Discuss the following:

- a) The methods that can be used on a farm to increase the digestibility of forages.
- b) The functions of micro-organisms in the ruminant stomach.
- c) The advantages of fore-stomach fermentation as opposed to hind-gut fermentation.

(20 Marks)

Q.4 a) Animal scientists rely use both chemical and biological methods of assessing the protein value of feeds of poultry and pig feeds. From the following data that was recently collected from the Animal Science Field Station calculate the True Biological Value of a protein supplement:

- ✓ Dry matter consumed daily (grams) = 8.50
- ✓ Percent nitrogen in the feed, dry matter basis (dmb) = 2.196
- ✓ Daily urinary output (mls) = 20.50; containing:
 - 0.00486 grams total nitrogen per ml, and
 - 0.0025 grams endogenous nitrogen per ml.
- ✓ Daily dry matter faecal output (grams) = 6.40; containing:
 - 3.82 mg total nitrogen per gram, and
 - 2.75 mg metabolic faecal nitrogen per gram, dmb.

b) How much is an Angoni steer weighing 375 kg expected to grow if it is fed on a daily ration consisting of the following feed-stuffs?

- ✓ 9.5 kg Sorghum Silage (300k/kg DM, 8.6 MJ ME/kg DM)
- ✓ 7.5 kg Maize meal (850 g/kg DM, 12.5 MJ ME/kg DM)
- ✓ 2.5 kg Cane Molasses (270 g/kg DM, 13.0 MJ ME/kg DM)

(20 Marks)

Q.5 Write notes on the following:

- a) Cyanogenetic glucosides and glucosinolates;
- b) The functions of micro-organisms in the ruminant stomach;
- c) The major poultry and pig protein feed ingredients available and used in Zambia; and
- d) Causes of acetonaemia the methods of preventing and treating the condition in cattle.

(20 Marks)

The following may be used to answer the questions:

- i. $EVI = 0.0386 BF + 0.0205 SNF - 0.236$
- ii. $Mm = 8.3 + 0.091 W$
- iii. $DMI = 0.025 W + 0.1 Y$
- iv. $Eg = \frac{MEP \times 0.0435 M/D}{1.05}$
- v. $LWG = \frac{Eg}{6.28 + 0.3 Eg + 0.0188 W}$
- vi. $FD = \frac{DMI (MC - M/D)}{(MC - MF)}$
- vii. $MI = \frac{EVI \times 1.05}{0.62}$
- viii. $KI = \frac{0.0435 M/D}{1.05}$ or $0.0414 M/D$



**UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
DEPARTMENT OF ANIMAL SCIENCE
MASTER OF SCIENCE IN NUTRITION**

AGA 6601 BIOCHEMICAL TECHNIQUES AND INSTRUMENTATION
SEMESTER I FINAL EXAMINATION
JUNE 2006

TIME: 3 Hours

TOTAL MARKS: 100

ANSWER ALL QUESTIONS

1. a. As Director of quality assurance in the livestock industry what are the six (6) reasons you might need to determine chemical characteristics of a food? What does AOAC refer to, what it does and what the *Official Method of Analysis* is?
(6 marks)
- b. What is mandatory and voluntary nutrition food labeling? Why is labeling important in animal nutrition?
(3 marks)
- c. Name critical considerations to be made in preparation of samples for analysis and what precautions are taken?
(3 marks)
- d. Define accuracy and precision and how are they measured?
(3 marks)
2. a. Why is the brix/acid ratio often used as an indicator of flavour quality for certain foods, rather than simply brix or acid alone?
(3 marks)
- b. As an analyst, you are given a sample of condensed brewer's grains to analyze and to determine if it is reduced to correct concentration. By gravimetric means, you find that the concentration is 26.54 percent solids. The laboratory standard reads 28.63 percent. If the starting volume was 1000 liters at 8.67 percent solids, and the weight is 8.5 kg per liter, how much more water should be removed?
(5 marks)
- c. Identify five factors that one would need to consider when choosing a moisture analysis method for a specific feed product. Why is standardized methodology needed for moisture determination?
(5 mark)

3. a. Differentiate low-temperature plasma ashing from conventional dry ashing with regards to principle and application.

(5 marks)

b. The following data were obtained on a sample of kitchen leftovers fed to pigs: sample wt, 2.034 g; wt after drying, 1.0781 g; wt after ether extraction, 0.4679 g; and wt of ash, 0.0223 g. What is the percentage ash on (i) a wet weight basis and (ii) a fat-free basis?

(5 marks)

c. What factors (i) should be considered in selecting a specific method for mineral analysis for a feed product? (ii) What analytical conditions may call for the use of a reagent blank?

(3 marks)

4. a. Explain the similarities and differences with regard to the principle involved and the procedures used between two (2) of the following methods in measuring reducing sugars: The Munson and Walker method, Lane-Eynon method and Nelson-Somogyi method.

(4 marks)

b. Distinguish chemically between monosaccharides, oligosaccharides, and polysaccharides (i), and (ii) explain how solubility characteristics can be used in an extraction procedure to separate monosaccharides and oligosaccharides from polysaccharides.

(6 marks)

5. a. Why is HPLC analysis of carbohydrates rapidly gaining favor over GC analysis?

(4 marks)

b. Differentiate (i) the solubility characteristics of pectic substances, hemicellulose, and cellulose, and (ii) explain how these characteristics can be used to help quantitate these structural polysaccharides.

(6 marks)

6. a. Compare (i) and (ii) contrast the AOAC method, the Englyst-Cummings methods, and the Theander-Marlett method for determination of total dietary fiber. (iii) Give the principle, procedures, applications, and advantages and disadvantages of each.

(5 marks)

b. The amount of dietary fiber in a cowpeas cultivar was determined by the Englyst-Cummings procedure. The following data were collected:

Item	Sample a	Sample b
Sample weight, mg	195.10	191.30
Neutral sugars, mg	26.36	25.74
Uronic acids, mg	8.74	8.64

(i) How much dietary fiber is in the beans? (ii) How would this value differ from crude fiber and why?

(5 marks)

7. a. (i) Itemize the procedures that may be required to prepare a food sample for accurate fat determination by a solvent extraction method (e.g., Soxhlet method). (ii) Explain why each of these procedures may be necessary.
(5 marks)
- b. To determine the fat content of semimoist feed by Soxhlet method, the feed was first vacuum oven dried. The moisture content of the dried feed was 25 percent. The fat in the dried feed was determined by Soxhlet method. The fat content of the dried feed was 12.5 percent. Calculate the fat content of the original semimoist feed product.

(5 marks)

8. Answer question (a) and either (b) or (c)

- a. Define and briefly describe the differences between the following assay procedures used in assessing protein quality:

- (i) PER versus NPR;
(ii) PER versus BV;
(iii) BV versus NPU;
(iv) Amino acid score versus amino acid index.

(5 marks)

- b. The Kjeldhal method of protein analysis consists of three major steps. (i) List these steps in order they are done, and (ii) describe what occurs in each step. (iii) Why is it that ml HCL can be used as an indirect measure of the protein content of a sample?

(5 marks)

- c. Cooked velvet bean was analyzed for crude protein content in duplicate using the Kjeldahl method. The following data were recorded:

Moisture content = 8.0%
Weight of sample no.1 = 1.015 g
Weight of sample no.2 = 1.025 g
Normality of HCL used for titration = 0.1142
mL HCL used for sample no.1 = 22.0 mL
mL HCL used for sample no.2 = 22.5 mL
mL HCL used for reagent blank = 0.2 mL

Calculate crude protein content of both the wet and dry weight basis of the velvet beans, assuming velvet beans protein contains 17.5 percent nitrogen.

(5 marks)

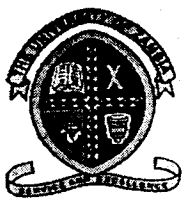
9. a. Explain why it is possible to use microorganisms to quantitate a particular vitamin in a feed product, and describe such a procedure.

(4 marks)

- b. Compare and contrast the principles and procedures for the Carr-Price method versus the HPLC method to quantitate Vitamin A.

(5 marks)

END OF EXAMINATION



**THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
DEPARTMENT OF CROP SCIENCE**

FIRST SEMESTER EXAMINATIONS, SEPTEMBER 2006

AGC 211: PRINCIPLES OF CROP PRODUCTION

TIME ALLOWED: 3HRS

INSTRUCTIONS

1. Answer all 5 questions
 2. Marks are as indicated
-

QUESTION 1 (20 Marks)

a) Briefly describe:

1. Conservation farming as practiced in Zambia.
2. Which Millennium Development Goal (s) is likely to be achieved with improvement in agricultural production?
3. How plants absorb nutrients from the soil.

b) i) Briefly describe factors which affect photosynthesis.

ii) What are C₄ plants?

iii) What is the significance of the phenomenon depicted in Figure 1 in the production of dry matter of plants?

QUESTION 2 (20 Marks)

a) What are the underlying principles in three of the methods used for measuring soil water content?

b) Given:

- i. The weight of the sampling can is 214 g.
- ii. The weight of the sampling can plus wet soil is 329g.
- iii. The weight of the sampling can plus dry soil is 314g..
- iv. The volume of the sampling can is 83.33 cm³.

Calculate:

- 1) The Gravimetric water content.
- 2) The Volumetric water content.

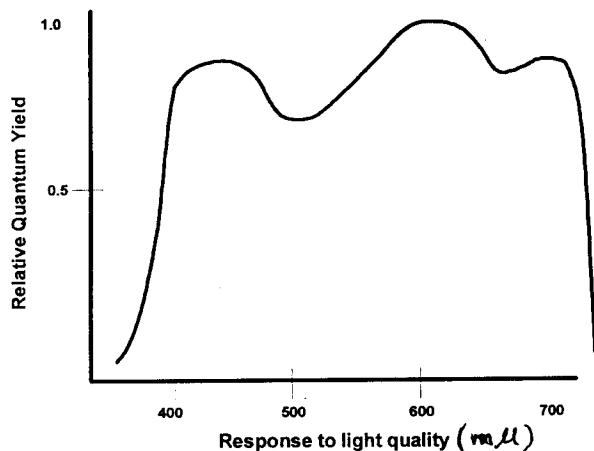


Figure 1

QUESTION 3 (20 Marks)

- a)
 - i) What is the role of K, P and B in plant nutrition and growth?
 - ii) What are the sources of these elements for crop production?
 - iii) How does pH affect plant nutrient uptake?
 - iv) Give an example of two of these elements whose uptake is greatly affected by soil pH.
- b)
 - i) What is Agroforestry?
 - ii) In which way does this technology improve the livelihoods of small scale farmers?

QUESTION 4 (20 Marks)

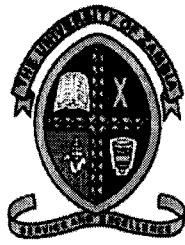
The growth and development of plants is influenced by external and endogenous factors.

- i) List these factors.
- ii) Describe the endogenous factors in terms of their role in regulating the intensity and direction of growth, differentiation of tissues and synchronisation of plant growth and development.
- iii) How are the external factors, for example, optimised for crop production at York Farm which you have visited?
- iv) What are the limitations for optimizing the same factors under small scale agriculture?

QUESTION 5 (20 Marks)

Given the families Poaceae, Fabaceae and Agavaceae:

- i) Give at least two members of each family.
- ii) Give their scientific names.
- iii) Describe their morphological characteristics.
- iv) What is the economic importance of these crops?



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DEPARTMENT OF CROP SCIENCE

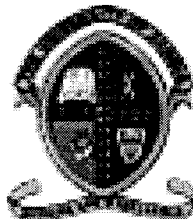
1ST SEMESTER EXAMINATIONS – JUNE 2006

AGC 411 – FIELD CROP PRODUCTION

INSTRUCTIONS:- 1. Answer all Questions.
2. Marks for each question are as indicated.

- Q1.** A group of youths have been allocated land in Mumbwa to grow sunflower. As a specialist, provide production recommendations in terms of when and how the crop is planted, harvested and the expected yields. Your answer should also give fertilizer recommendations. **(25 marks)**
- Q2.** a. Pulse crops are of economic importance to a nation. Discuss this statement.
b. Describe the soil and climatic requirements and techniques of planting cassava. **(25 marks)**
- Q3.** A farmer has observed the following in her fields:-
i. Stunted growth and yellowing in groundnuts.
ii. Swelling of roots in cowpeas.
As a pathologist/entomologist and for each case, identify the disease or pest giving a full description and possible remedial measures in each case. **(20 marks)**
- Q4.** Late harvesting in soyabeans results in loss of marketable yields. Discuss this statement in detail giving relevant examples on how yield can be maximized. Your answer should include expected yields. **(20 marks)**
- Q5.** Growing groundnuts in acid soils can reduce yields. As an agronomist, what advice would you give a Young Farmers Club to overcome this problem? **(10 marks)**

END OF EXAMINATION – AGC 411



**THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
DEPARTMENT OF CROP SCIENCE**

FIRST SEMESTER

FINAL EXAMINATIONS

JUNE 2006

AGC 431: AGRICULTURAL ENTOMOLOGY

TIME: 2½ HOURS

**INSTRUCTIONS: ANSWER ALL QUESTIONS,
ALL QUESTIONS CARRY EQUAL MARKS (20 Marks
each)**

- Q1.** Discuss the complications associated with insect identification and outline ways in which one may identify an insect.
- Q2.** Describe different forms of larvae and pupae in insects.
- Q3.** It is said that insects are beneficial to human beings. Discuss.
- Q4.** It is often stated that insects are probably the most successful organisms living on this earth. Discuss.
- Q5.** Write brief notes on the following:
- i. Open tracheal systems and closed tracheal systems
 - ii. Fossorial and scansorial leg adaptation
 - iii. Aristate and geniculate type of antenna
 - iv. Gregarious and solitary phases of locusts
 - v. Heterodynamic and homodynamic life cycle

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

**THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
JUNE/JULY 2006 EXAMINATIONS**

**AGC 511:
TIME ALLOWED:**

**ASPECTS OF CROP PRODUCTION
3 HOURS**

INSTRUCTIONS:

- 1. ANSWER ALL QUESTIONS**
 - 2. MARKS AS INDICATED**
-

Q1. With the help of diagrams, explain the differences between (15)
determinate and indeterminate plant nodules

Q2. Suppose you are given the following information for a maize crop:

(i)	Stover =	10,000kg/ha
(ii)	Grain =	5,000kg/ha
(iii)	Roots =	5,000kg/ha
(iv)	Total Yield @ 18% moisture =	20,000kg/ha
(v)	Total Energy Receipts =	20,243GJ/ha

Calculate the following:

- i. Yield at 13% moisture (5)
- ii. Ash content (5)
- iii. Respiratory losses (5)
- iv. Total energy produced by the maize crop/ha (5)
- v. Photosynthetic efficiency (ϵ) of the maize crop (5)

Q3 a. Explain the phenomenon and significance of Light Reflection (a) in crop production (10)

b. Cooperation (5)

c. Transpiration Coefficient (TC) (5)

Q4. Explain the effect of water stress on crop productivity and suggest (20)
copping strategies

- Q5 a. The light extinction co-efficient (k) is derived from the Beer-Lambert law presented in equation form as:

$$I = I_0 e^{-kx}$$

- (i) Explain the terms in the above equation (5)
- b. Yield of a given crop over a specified period of time is given by the equation:

$$Y = Q \times I \times \epsilon \times H$$

- (i) Define the components of the above equation (5)
- (ii) Explain the factors that influence the components of the above equation (10)

Good Luck

UNIVERSITY OF ZAMBIA

SCHOOL OF AGRICULTURAL SCIENCES
UNIVERSITY EXAMINATIONS

AGC 521 ADVANCED PLANT BREEDING AUGUST 2006

INSTRUCTIONS

Answer **Question #1 and any other THREE** questions. Marks for each question are indicated in brackets.

TIME: 3 HOURS

Q.1 (a) The Hardy-Weinberg Law is a proposition whose properties can be proved. State what this Law says and describe its properties. For each of the property show proof for its existence **(25 points)**

(b) Given the following data estimate the heritability for ear rot tolerance in maize **(15 points)**

Ear rot tolerance score in parent	Ear rot tolerance score in offspring
3.9	6.5
4.3	7.8
2.1	5.2
6.4	8.2
5.7	9.2
4.7	8.9
2.8	7.3
7.5	9.8
3.4	5.6
5.2	7.5

Q.2. Selection is the engine of crop improvement and justifies investments in plant breeding. What is selection? How can one improve it? Describe the responses to selection for the cross-pollinated populations. **(20 points)**

Q. 3. (a) What is heritability? List the methods used in estimating this important genetic parameter. **(8 points)**

(b) As a new plant breeder in a research unit of a seed company you are asked to give a seminar on “polyploidy in breeding”. Outline your presentation **(12 points)**.

Q.4. Write short notes on the following (**5 points each**):

- a) Neo-Darwinian Evolutionary Theory
- b) Methods of estimating Genetic parameters
- c) Fitness vs Coefficient of selection
- d) Importance of genetic conservation

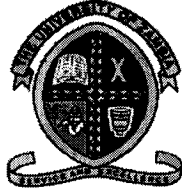
Q. 5. Respond to the following given the data in the table below:

Source	Df	SS
i^{th} epistasis	1	0.0699
$j + 1$ epistasis	9	0.5218
Total epistasis	10	0.5917
i^{th} epistasis x blocks	2	0.0350
$j + 1$ epistasis x blocks	18	0.6231
Total epistasis x blocks	20	0.6582

- a) How do you test for presence of epistasis?
- b) Is there evidence of epistasis?
- c) What follows in the presence/absence of epistasis i.e. what should you do in such a circumstance?

(20 points)

END OF EXAMINATION



**UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
FINAL EXAMINATION**

COURSE NAME: PRINCIPLES OF WEED MANAGEMENT

COURSE CODE: AGC531

TIME ALLOWED: THREE (3) HOURS 1400 – 1700 HOURS

DATE OFFERED: WEDNESDAY, 20TH SEPTEMBER 2006

INSTRUCTIONS

Answer question one (Q1) as it is **COMPULSORY**, and any other three questions. Points for each question are indicated.

Q1. (40 points)

- a) Why are weeds as a pest distinctly different from other agricultural pests?
- b) Discuss carbamates.
- c) Discuss the importance of competition in a weed-crop interaction.
- d) Define the following:
 - ❖ Preventive weed control
 - ❖ Weed
 - ❖ An aliphatic
 - ❖ An adjuvant

Q2. (20 points)

Discuss the factors that influence the activity of a herbicide when it comes into contact with a plant.

Q3. (20 points)

Discuss cultural weed control and its facets.

Q4. (20 points)

Discuss the economic importance of weeds.

Q5. (20 points)

Define formulation of herbicides, enumerate the different types and discuss their merits and demerits.

_____ **End of Exam** _____

THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
DEPARTMENT OF CROP SCIENCES

AGC 6121- AGROCLIMATOLOGY AND PHYSIOLOGY OF YIELD

Final Examination, June 2006

Instruction: *Answer all questions in the two sections; however answers to the sections should be in different booklets*

Section A

1. Write short notes on any two of the following:
 - a. Stem weight ratio
 - b. Genetic component of yield improvement
 - c. Sequential additivity

2. Give a detailed description and contrast of the two stress/yield concepts- Leibig law of minimum and Mitscherlich law of minimum

Section B

3. Briefly define each of the following terms used in Agroclimatology
 - a) Stefan-Boltzman Law
 - b) Solar constant
 - c) Psychometric constant
 - d) Climate
 - e) Tropopause

4. Earth's climates continually change and have done so for billion of years without any anthropogenic influence. In other words it has been hospitable over the past four billion years. What are the main natural causes of climate change?

5. Given the following meteorological data as measured on 4th February 2006 in Mbala (Northern Zambia) located at 08°51'S and at 1384 m above sea level:

Maximum temperature	28°C
Minimum temperature	24°C
Maximum relative humidity	80 %
Minimum relative humidity	68 %
Actual sunshine hours	4.9 hours
Sunset hour angle (ω_s)	1.527 radians
Extraterrestrial radiation (R_a)	50 MJ m ⁻² day ⁻¹

Based on the above climatic data, determine:

- a) Mean saturation vapour pressure (e_s)
- b) Actual vapour pressure (e_a)
- c) Solar radiation (R_s)
- d) Clear-sky solar radiation (R_{so})
- e) Net short wave radiation (R_{ns})

UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
UNIVERSITY SECOND SEMESTER EXAMINATIONS-JUNE, 2006

AGC 6132: PLANT-SOIL-WATER RELATIONS

Time: Three (3) Hours

Marks: 50

Instruction: Answer all Questions

1. Briefly define each of the following terms: **(10 marks)**
 - a) Relative saturation
 - b) Void ratio
 - c) Diffusivity
 - d) Sorptivity
 - e) pF scale

2. Briefly discuss the main principles of the each of the following soil water measurement methods: **(10 marks)**
 - a) Neutron scattering method
 - b) Time Domain Reflectometry method (TDR)

3. With a sketch, describe the different zones that can be identified during a vertical infiltration on a homogeneous soil profile with uniform moisture content. **(10 marks)**

4. An overhead (pivot) irrigation system for winter maize was set based on the following field data. **(20 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

- a) Determine the available water-holding capacity (AWC) of the soil profile to a depth of 1 meter (mm/m)
- b) Determine the depth of air in the entire profile if the water content is at field capacity
- c) If 50mm irrigation is applied, how deep with irrigation penetrate the soil profile
- d) What measures would you take in order to increase the available water-holding capacity of this soil

UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
UNIVERSITY SECOND SEMESTER EXAMINATIONS-JUNE, 2006

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UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
UNIVERSITY SECOND SEMESTER EXAMINATIONS-JUNE, 2006

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THE UNIVERSITY OF ZAMBIA
DIRECTORATE OF RESEARCH AND GRADUATE STUDIES
SCHOOL OF AGRICULTURAL SCIENCES

COURSE; AGRONOMY

NO	COMPUTER NO	NAME OF THE STUDENT	SIGNATURE
1	25550349	Rwiza Hildeus Ignath	
2	25550373	Makunde Godwill S	
3	25550381	Ndhlela Thokozile	
4	25550403	Kaonga K E Kesbell	
5	25550365	Mhike Xavier	
6	25550390	Simelani Victor B	
7	25550322	Siwale Jurius	
8	25547925	Chanda Richard	
9	25550331	Mbwanga Zabron	

INVIGILATOR.....SIGNATURE.....
DATE OF EXAMINATION.....
VENUE.....

THE UNIVERSITY OF ZAMBIA

MSC AGRONOMY FIRST SEMESTER EXAMINATIONS

AGC 6141 PLANT BREEDING

FINAL EXAM, DECEMBER 2005

Instructions:

1. Maximum time allowed = 3 hours
 2. Answer any five questions
 3. All questions carry equal marks
-

1.
 - a. Give a brief account of the effects of one physical and one chemical mutagen. [12 marks]
 - b. Describe how a transversion mutation causes changes in phenotypes. [8 marks]
 2. Write short notes on:
 - a. Cytoplasmic male sterility [4 marks]
 - b. Differences between mitosis and meiosis [6 marks]
 - c. Transposable genetic elements [3 marks]
 - d. Semiconservative replication of DNA [7 marks]
 3. Describe protein synthesis in plants, giving the flow of genetic information from mRNA to amino acids sequences. [20 marks]
 4. From a cross between individuals with the genotypes CcDdEe x ccddee, 1,000 offspring were produced. The class appearing C_D_ee included 351 individuals. Are the genes c, d, and e on the same or different chromosome pairs? Explain. [20 marks]
 5. A cross was carried out between grey-coloured and white coloured mice. In the first generation, all progeny were grey. From many litters, an F₂ was obtained with 396 grey and 144 white mice. If the grey-coloured F₂ mice were to be mated with the white-coloured parent, what would be the ratios that of the resulting phenotypes. [20 marks]
 6.
 - a. A maize seedling and a maize plant at maturity have the same genes. Why and how is it that their morphologies are different? [15 marks]
 - b. How do genes control the phenotypes of organisms? [5 marks]
-

End of exam. Have a blessed festive season, damsel and lads!



**THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES**

DEPARTMENT OF CROP SCIENCE

UNIVERSITY EXAMINATIONS – DECEMBER 2003

AGC 6421 PLANT CYTOGENETICS

ANSWER: **FIVE** QUESTIONS ONLY

TIME: **THREE** HOURS

ALL QUESTIONS CARRY EQUAL MARKS.

QUESTION	MARKS
-----------------	--------------

- | | | |
|-----|--|------|
| 1.0 | Write short notes on the following:
a) Types of recombination systems in plant species
b) What do you understand by these three terms:- genome, cytokinesis and idiogram
c) A cytogenetic condition that could cause gene dosage effects in plants
d) A chromosome inversion that will not cause any change in the chromosome arm lengths
e) Translocation heterozygotes in plants, their sources and their observational characteristics | [20] |
| 2.0 | A certain plant species has a haploid chromosome complement that consists of five chromosomes. Based on a simple karyotype analysis these chromosomes have been designated: I II III IV V in descending order of chromosome lengths.

Give the chromosome constitution of a somatic cell of a plant which happens to be:
a) Trisomic for II
b) Triploid
c) Monosomic for IV
d) Nullisomic for V
e) How many trisomic stocks can be obtained from this plant species? | [20] |

[20]

- 3.0 A plant cytogeneticist carried out an experiment in maize to illustrate the use of a **three-point test cross** in gene mapping. The genes; brown midrib (*bm*), red aleurone (*pr*), and virescent seedlings (*v*) are located on chromosome 5 of maize. Data obtained from a linkage study were as follows:

Parents: $\frac{+ + +}{+ + +} \times \frac{bm\ pr\ v}{bm\ pr\ v}$

Test-cross progeny were as follows;

$+ + +$	232
$bm\ pr\ v$	235
$+ pr\ v$	84
$bm + +$	77
$+ + v$	201
$bm\ pr +$	194
$+ pr +$	40
$bm + v$	46

- Calculate distances between genes
- Calculate Interference and coefficient of coincidence
- Show the linear order of these genes on chromosome 5 of maize, assuming they are located on the left arm of this chromosome

[20]

- 4.0 To a plant biologist the science of cytogenetics could be considered a tool for basic research, that is, only for the purpose of understanding the biological significance of chromosome behaviour in plant species. To a plant breeder however cytogenetics has a role as an applied science in crop improvement.

Discuss the application of plant cytogenetics to:

- Cereal crop improvement in general and with reference to the success story of the first "Man made" cereal crop called Triticale.
- To improving horticultural crops and its contribution to the agricultural industry in general

[20]

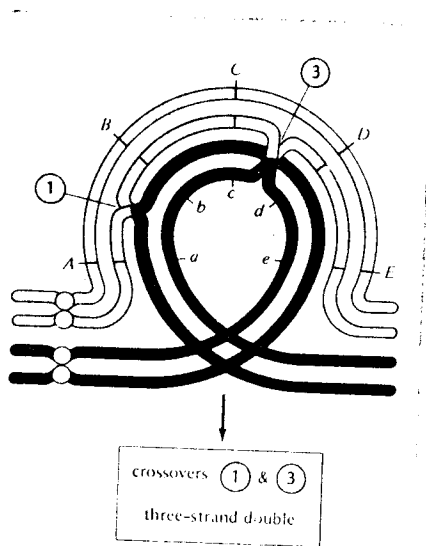
- 5.0 Plant breeders consider linkage as good and bad in crop improvement.
- Discuss when plant breeders value strong gene linkages and when they do not.
 - Discuss factors affecting crossing over and genetic recombinations in plants

6.0 In the course of several studies of plant populations, the following cytological pictures were taken of meiotic chromosome configurations in individual plants. In each case the somatic chromosome number was 24. Present a likely explanation for each picture: [20]

- Ten bivalents and a circle of four chromosomes at metaphase I
- Bridges and fragments in pollen mother cells at metaphase I
- Two tetravalents and eight bivalents at metaphase I in pollen mother cells
- Five trivalents, three bivalents and three univalents in the pollen mother cells at metaphase I
- Twelve bivalents, one of which shows a distinct buckle at the late prophase I of meiosis

7.0 Inversions are common in plant species. [20]

- Discuss causes and types of these chromosome aberrations in plant species.
- What are the phenotypic effects on plants that would lead a cytogeneticist to suspect presence of inversions for him or her to resort to cytological investigations.
- The figure shown below is an inversion heterozygote. State what type of inversion this is and also give and clearly label the meiotic products from three-strand double crossovers at positions 1 and 3 shown.



-----END OF EXAMINATION. MERRY CHRISTMAS-----

UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS, DECEMBER 2003

AGC 6432 BIOMETRICAL GENETICS AND PLANT BREEDING

INSTRUCTIONS

Answer **QUESTION #1** and any other **THREE**.

Marks for each question are indicated in brackets

TIME: 3 hours

Q.1 Given the following data from a field experiment

Parent	1	2	3	4
1	X	87.01	90.50	114.95
2		X	11.57	88.17
3			X	100.65
4				X

NB: Assumed values of importance in the calculations are attached.

- (a) Calculate the variance due to general combining ability and specific combining ability
- (b) Compute the additive and dominance genetic variance
- (c) Compute Degree of dominance
- (d) Calculate heritability
- (e) Draw conclusions

(40 points)

Q. 2 As a newly recruited scientist in a breeding programme you are requested by your supervisor to give suggestions on how to improve the quality of the products from the programme. Specifically you should clearly outline how the selection methods being used can be made to be effective, that is, how can response to selection be improved. (20 points)

Q.3 Write short notes on the following (5 points each):

- a. Selection by truncation
- b. Change in gene frequency due to Selection
- c. Plasmatic variation as a source of genetic variation.
- d. Divergent selection

Q.4 The problems resulting from significant genotype by environment interactions in plant breeding gave rise to a number of statistical approaches, widely known as Stability Analyses, to reduce the effects. Describe TWO of these approaches and indicate the strengths and weaknesses of each (20 points)

Q.5 List the causes of asymmetry response to selection and discuss each briefly. (20 points)

THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
2006 ACADEMIC YEAR FIRST SEMESTER
DEFERRED EXAMINATIONS

AGE 211: Fundamentals of Micro-Economics
Time: Three (3) hours

Instructions:

Answer All Questions in Section A. Please tick or circle the correct answer.

In Section B: Questions 1 & 2 are compulsory. You can then answer any other two Questions for a total of four. Marks for each Question are indicated.

SECTION A

ANSWER ALL QUESTIONS (Multiple choice, each question carries 1 mark)

1. Capitalism is a system in which
 - (a) property is owned primarily by private individuals.
 - (b) economic decisions are made through the market
 - (c) wealth is evenly distributed by the market
 - (d) all of the above; or
 - (e) only (a) and (b)

2. Which of the following is a prerequisite for capital formation?
 - (a) wealth
 - (b) prosperity
 - (c) savings
 - (d) labour
 - (e) all of the above

3. Capital is
 - (a) the cash/money in one's possession
 - (b) plant, equipment and inventories
 - (c) mineral resources
 - (d) wealth or
 - (e) (a), (c) and (d)

4. When marginal utility is zero
 - (a) total utility is unchanged
 - (b) marginal utility equals average utility
 - (c) satisfaction is falling
 - (d) total utility is zero or
 - (e) none of the above

5. According to the principle of diminishing marginal utility, if consumption of a fourth glass of coke yields 8 utils of satisfaction, the sixth glass of coke will give
- (a) more than 8 utils of satisfaction
 - (b) exactly 8 utils of satisfaction
 - (c) less than 8 utils of satisfaction
 - (d) a market price of K8 or
 - (e) (b) and (d)
6. When the consumer is in equilibrium, then;
- (a) $MU_a/MU_b = P_a/P_b$
 - (b) all income is spent
 - (c) $MU_a/P_a = MU_b/P_b$
 - (d) all of the above are correct or
 - (e) only (b) and (c) are correct
7. If the demand for steaks shifts to the right, the most likely explanation is that
- (a) the price of cattle feed has fallen
 - (b) the price of steak has fallen
 - (c) cattle production has fallen
 - (d) consumer income has fallen or
 - (e) none of the above
8. Price elasticity of demand for a commodity tends to be greater
- (a) when it is more of a necessity
 - (b) when more substitutes are available for it
 - (c) over shorter time period
 - (d) when the price is lower, or
 - (e) (b), (c) and (d)
9. A demand curve is described as perfectly inelastic if -
- (a) neither price nor quantity ever changes
 - (b) the same price is charged regardless of quantity sold
 - (c) only quantity demanded can change, or
 - (d) the same is purchased regardless of price
 - (e) (b) and (d)
10. An income inelastic demand curve is one in which a 10% increase in income causes
- (a) sales to increase by 12%
 - (b) sales to increase by 16%
 - (c) production to increase by 16%
 - (d) all of the above or
 - (e) none of the above
11. Which of the following statements is incorrect? Under perfect competition
- (a) the market demand curve is downward sloping
 - (b) the individual firm aims to produce where AC is at a minimum

- (c) a firm may earn abnormal profits in the short-run
(d) the firm can sell as much as it wishes at the ruling market price
12. In long-run competitive equilibrium the theory predicts that
- (a) $TC=TR$
 - (b) firms operate at a minimum total average cost
 - (c) $MC=MR$
 - (d) there is no incentive for entry or exit of firms
 - (e) all of the above answers are satisfactory
 - (f) none of the above answers is satisfactory
13. In short-run competitive equilibrium, we predict that
- (a) marginal cost is rising
 - (b) $P=MC$
 - (c) there is no incentive for firms to enter the industry
 - (d) all of the above answers are satisfactory
 - (e) both (a) and (b) are satisfactory
 - (f) none of the above answers is satisfactory
14. Equilibrium of the monopolistic firm
- (a) occurs where $P=MC$
 - (b) occurs where $MR=MC$
 - (c) occurs where $P=MR$
 - (d) necessarily is profitable
 - (e) both (c) and (d) are satisfactory
 - (f) both (a) and (d) are satisfactory
 - (g) none of the above
15. Long-run profits are possible in an oligopolistic industry primarily because
- (a) firms can always set the profit maximising
 - (b) oligopolistic firms use the most efficient production methods
 - (c) the demand is typically quite elastic
 - (d) entry of new firms is difficult
16. Among the essential aspects of oligopoly is
- (a) excess capacity
 - (b) non-price competition
 - (c) a large number of firms
 - (d) mutual recognition of interdependence
 - (e) both (a) and (b) are satisfactory
 - (f) both (b) and (c) are satisfactory
 - (g) none of the above
17. A rise in unit costs is predicted to cause a
- (a) rise in price in monopoly, but not in competition
 - (b) rise in price in competition but not in monopoly
 - (c) rise in price of both competition and monopoly

- (d) none of the above answers is satisfactory
18. At the break even point,
- marginal cost equals price
 - average total cost equals price
 - average variable cost equals price
 - the firm is in equilibrium
19. The increase in total variable cost associated with an increase in one unit of output is called
- marginal product
 - marginal utility
 - marginal cost
 - average product
 - average variable cost
20. The long-run average cost curve declines because of
- the mathematics alone
 - the law of diminishing marginal utility
 - the law of diminishing returns
 - diseconomies of scale
 - economies of scale

END OF SECTION

SECTION B

**ANSWER FOUR (4) QUESTIONS FROM THIS SECTION.
QUESTION 1 & 2 ARE COMPULSORY. YOU CAN THEN ANSWER ANY
OTHER TWO QUESTIONS FROM THIS SECTION**

1. Given the following information in the consumption pattern and total utility for Banda.

Number of Purchases	Shirts		Food	
	TUs	Ps	TU	Pf
1	500	K20	80	K10
2	580	K20	130	K10
3	620	K20	170	K10
4	640	K20	200	K10
5	620	K20	190	K10

- What is the marginal utility of the fourth shirt?
- What is the total utility derived from the consumption of two units of food and two shirts?
- What would Banda buy at his equilibrium?
- How much money would Banda spend at his point of equilibrium?

2. The table below shows the output of a farmer producing bags of maize.

Land	Labour	TPP
50	0	0
50	1	1
50	2	3
50	3	8
50	4	16
50	5	22
50	6	26
50	7	28
50	8	29
50	9	27
50	10	23

- Calculate the MPP and APP from this table
 - Delimitate the three stages of the production function.
 - What are the values of MPP and APP when $MPP=APP$?
 - What is the value of TPP when MPP equal zero?
 - Why should a firm not produce in stage one of the production function?
3. A giffen good must be an inferior good, but an inferior good need not be a giffen good. Explain this statement fully, using the concepts of income and substitution effects.
4. A firm is employing 100hrs of labour and 50 tons of cement to produce 500 blocks. Labour costs K4 per hour and cement costs K12 per ton. For the quantities employed $MP_L=3$ and $MP_C=2$. Show this situation in an isoquant – isocost diagram. Explain and show in the diagram, how the firm can produce the same output at a lower total cost.
5. Explain what you understand by the following concepts.
- Isocost line
 - Opportunity cost
 - Consumer surplus -
 - Marginal rate of technical substitutes
 - Cartel

END OF EXAM

THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
2006 ACADEMIC YEAR FIRST SEMESTER
DEFERRED EXAMINATIONS

AGE 211: Fundamentals of Micro-Economics
Time: Three (3) hours

Instructions:

Answer All Questions in Section A. Please tick or circle the correct answer.

In Section B: Questions 1 & 2 are compulsory. You can then answer any other two Questions for a total of four. Marks for each Question are indicated.

SECTION A

ANSWER ALL QUESTIONS (Multiple choice, each question carries 1 mark)

1. Capitalism is a system in which
 - (a) property is owned primarily by private individuals.
 - (b) economic decisions are made through the market
 - (c) wealth is evenly distributed by the market
 - (d) all of the above; or
 - (e) only (a) and (b)

2. Which of the following is a prerequisite for capital formation?
 - (a) wealth
 - (b) prosperity
 - (c) savings
 - (d) labour
 - (e) all of the above

3. Capital is
 - (a) the cash/money in one's possession
 - (b) plant, equipment and inventories
 - (c) mineral resources
 - (d) wealth or
 - (e) (a), (c) and (d)

4. When marginal utility is zero
 - (a) total utility is unchanged
 - (b) marginal utility equals average utility
 - (c) satisfaction is falling
 - (d) total utility is zero or
 - (e) none of the above

5. According to the principle of diminishing marginal utility, if consumption of a fourth glass of coke yields 8 utils of satisfaction, the sixth glass of coke will give
- (a) more than 8 utils of satisfaction
 - (b) exactly 8 utils of satisfaction
 - (c) less than 8 utils of satisfaction
 - (d) a market price of K8 or
 - (e) (b) and (d)
6. When the consumer is in equilibrium, then;
- (a) $MU_a/MU_b = P_a/P_b$
 - (b) all income is spent
 - (c) $MU_a/P_a = MU_b/P_b$
 - (d) all of the above are correct or
 - (e) only (b) and (c) are correct
7. If the demand for steaks shifts to the right, the most likely explanation is that
- (a) the price of cattle feed has fallen
 - (b) the price of steak has fallen
 - (c) cattle production has fallen
 - (d) consumer income has fallen or
 - (e) none of the above
8. Price elasticity of demand for a commodity tends to be greater
- (a) when it is more of a necessity
 - (b) when more substitutes are available for it
 - (c) over shorter time period
 - (d) when the price is lower, or
 - (e) (b), (c) and (d)
9. A demand curve is described as perfectly inelastic if -
- (a) neither price nor quantity ever changes
 - (b) the same price is charged regardless of quantity sold
 - (c) only quantity demanded can change, or
 - (d) the same is purchased regardless of price
 - (e) (b) and (d)
10. An income inelastic demand curve is one in which a 10% increase in income causes
- (a) sales to increase by 12%
 - (b) sales to increase by 16%
 - (c) production to increase by 16%
 - (d) all of the above or
 - (e) none of the above
11. Which of the following statements is incorrect? Under perfect competition
- (a) the market demand curve is downward sloping
 - (b) the individual firm aims to produce where AC is at a minimum

- (c) a firm may earn abnormal profits in the short-run
(d) the firm can sell as much as it wishes at the ruling market price
12. In long-run competitive equilibrium the theory predicts that
- (a) $TC=TR$
 - (b) firms operate at a minimum total average cost
 - (c) $MC=MR$
 - (d) there is no incentive for entry or exit of firms
 - (e) all of the above answers are satisfactory
 - (f) none of the above answers is satisfactory
13. In short-run competitive equilibrium, we predict that
- (a) marginal cost is rising
 - (b) $P=MC$
 - (c) there is no incentive for firms to enter the industry
 - (d) all of the above answers are satisfactory
 - (e) both (a) and (b) are satisfactory
 - (f) none of the above answers is satisfactory
14. Equilibrium of the monopolistic firm
- (a) occurs where $P=MC$
 - (b) occurs where $MR=MC$
 - (c) occurs where $P=MR$
 - (d) necessarily is profitable
 - (e) both (c) and (d) are satisfactory
 - (f) both (a) and (d) are satisfactory
 - (g) none of the above
15. Long-run profits are possible in an oligopolistic industry primarily because
- (a) firms can always set the profit maximising
 - (b) oligopolistic firms use the most efficient production methods
 - (c) the demand is typically quite elastic
 - (d) entry of new firms is difficult
16. Among the essential aspects of oligopoly is
- (a) excess capacity
 - (b) none-price competition
 - (c) a large number of firms
 - (d) mutual recognition of interdependence
 - (e) both (a) and (b) are satisfactory
 - (f) both (b) and (c) are satisfactory
 - (g) none of the above
17. A rise in unit costs is predicted to cause a
- (a) rise in price in monopoly, but not in competition
 - (b) rise in price in competition but not in monopoly
 - (c) rise in price of both competition and monopoly

- (d) none of the above answers is satisfactory
18. At the break even point,
- marginal cost equals price
 - average total cost equals price
 - average variable cost equals price
 - the firm is in equilibrium
19. The increase in total variable cost associated with an increase in one unit of output is called
- marginal product
 - marginal utility
 - marginal cost
 - average product
 - average variable cost
20. The long-run average cost curve declines because of
- the mathematics alone
 - the law of diminishing marginal utility
 - the law of diminishing returns
 - diseconomies of scale
 - economies of scale

END OF SECTION

SECTION B

ANSWER FOUR (4) QUESTIONS FROM THIS SECTION.

QUESTION 1 & 2 ARE COMPULSORY. YOU CAN THEN ANSWER ANY OTHER TWO QUESTIONS FROM THIS SECTION

1. Given the following information in the consumption pattern and total utility for Banda.

Number of Purchases	Shirts		Food	
	TUs	Ps	TU	Pf
1	500	K20	80	K10
2	580	K20	130	K10
3	620	K20	170	K10
4	640	K20	200	K10
5	620	K20	190	K10

- What is the marginal utility of the fourth shirt?
- What is the total utility derived from the consumption of two units of food and two shirts?
- What would Banda buy at his equilibrium?
- How much money would Banda spend at his point of equilibrium?

2. The table below shows the output of a farmer producing bags of maize.

Land	Labour	TPP
50	0	0
50	1	1
50	2	3
50	3	8
50	4	16
50	5	22
50	6	26
50	7	28
50	8	29
50	9	27
50	10	23

- Calculate the MPP and APP from this table
 - Delimitate the three stages of the production function.
 - What are the values of MPP and APP when $MPP=APP$?
 - What is the value of TPP when MPP equal zero?
 - Why should a firm not produce in stage one of the production function?
3. A giffen good must be an inferior good, but an inferior good need not be a giffen good. Explain this statement fully, using the concepts of income and substitution effects.
4. A firm is employing 100hrs of labour and 50 tons of cement to produce 500 blocks. Labour costs K4 per hour and cement costs K12 per ton. For the quantities employed $MP_l=3$ and $MP_c=2$. Show this situation in an isoquant – isocost diagram. Explain and show in the diagram, how the firm can produce the same output at a lower total cost.
5. Explain what you understand by the following concepts.
- Isocost line
 - Opportunity cost
 - Consumer surplus
 - Marginal rate of technical substitutes
 - Cartel

END OF EXAM

THE UNIVERSITY OF ZAMBIA

SCHOOL OF AGRICULTURAL SCIENCES

2006 ACADEMIC YEAR FIRST SEMESTER DEFERRED EXAMINATION

AGE311: RURAL SOCIOLOGY

TIME: THREE HOURS

TOTAL MARKS: 100%

**INSTRUCTIONS: ANSWER ALL QUESTIONS IN SECTION A & B
ANSWER ANY TWO QUESTIONS FROM SECTION C**

SECTION: A

(Multiple Choices-Each Question carries 2 marks)

1. The spread of cultural traits from one group to another is called:
a) distribution, b) diffusion, c) extension, d) succession
2. A society which is receptive to change is likely to:
a) Stress the obedience of rituals, b) be critical of some aspects of its traditions, c) honor the wisdom of elders, d) both b and c
3. Most sociologists agree that with respect to values:
a) they should repress them, b) they can do research showing the relations between values, c) they have a right to express their values as citizens, d) both b and c
4. The concept of self is:
a) Is slowly realized under all circumstances, b) is innate, c) inhibits ego development, d) is socially learned
5. All but ONE of the following are included in the concept of culture:
A) Biological heredity, b) beliefs, c) law and customs, d) language
Sit in demonstrations is an example of:
~~a) Forceful coercion, b) political power, c) non-violent coercion, d) none of these~~
6. To sociologist the human trait of greatest importance is:
a) Human nature, b) intelligence, c) aggression, d) individualism
7. Alienation is closely associated with Karl Marx while anomie is associated with:
a) Weber M, b) Durkheim E c) Comte A, d) Herbert Spencer
8. Mobility refers to:

a) The incidence of disease in a population, b) the occupancy of deaths in a population, c) movement of people d) the permanent or semi permanent change of usual residence

9. What are the major functions of school?
a) School serves to keep youths out off the street, b) schools serve as occupation role socialization, c) schools serve as marriage partners, d) all these
10. Modernization theory argues that:
a) Fate is important in human progress, b) causal life is at the root of human progress, c) progress depends on human ability to control their own destiny, d) a anti-social behaviour is crucial to progress

SECTION B

(Short answers- Each question carries 4 marks)

1. Describe any two goals of socialization process.
2. Explain what a closed –non integrated type of a community is.
3. Distinguish clearly between sociology and rural sociology
4. Are role and status separate or two aspects of the same phenomena? Explain
5. Give your own understanding of the following concepts: role playing, Gemeinschaft, Ideology, Social change
6. Outline and describe two functions of religion which are significant to facilitating development activities
7. Why are primary groups cohesive?
8. How do you differentiate between organization and social system?
9. With specific examples explain the major agricultural barriers that gender tries to address
10. Compare and contrast traditional and charismatic leadership styles.

SECTION C

(Answer only two Essay questions- Each question carries 20 marks)

1. State at least FOUR major reasons that led to the establishment of a “World System” and, show case either its failure or success?
2. Identify **any one** development theory that explains how Zambia relates to the world system. Argue for and against such type of relations.

3. "A family is defined as one of the major institutions for enculturating its members. With at least four known functions of the family, state how this is done.
4. Critically discuss with practical examples the extent to which the traditional leadership has been selective and encourages rural inequality in agrarian societies.

END

**UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
2006 ACADEMIC YEAR FIRST SEMESTER
FINAL EXAMINATIONS**

**AGE 411: INTRODUCTION TO AGRIBUSINESS MANAGEMENT
TIME: THREE (3) HOURS**

INSTRUCTIONS: ANSWER FIVE QUESTIONS ONLY. (i.e. ANSWER QUESTION ONE, WHICH IS COMPULSORY AND THEN SELECT FOUR OTHERS FROM THE REMAINING QUESTIONS)

1 a) The following information is for Lubinda and Sons Ltd.

- i. Cash balance on 1 July 2006 is \$4,500;
- ii. Sales are \$15 per unit and cash is received three months after sales;
- iii. Production and sales are as follows:

2006	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 2007	FEB 2007
PRODUCTION	40	50	80	70	80	130	130	150	145	160	170	160
SALES	60	60	75	90	55	140	130	150	150	160	170	150

- iv. Raw materials cost \$4 per unit, and these are paid for, two months before being used in production;
- v. Wages are \$5 per unit and these are paid for in the same month as the units produced;
- vi. Running costs are \$4 per unit, 50% of the cost is paid in the same month of production, while the other 50% is paid in the next month;
- vii. Sundry expenses of \$50 are paid monthly;

REQUIRED

Prepare a cash flow budget for the six months July-December 2006 (15 marks)

1 b) The following information for Alpha Ltd and Omega Ltd has been provided:

	ALPHA Ltd (K' MILLION)	OMEGA Ltd (K' MILLION)
Turn Over	44.2	24.2
Gross Profit	24.0	12.5
Fixed Assets	60.0	40.0
Opening Stock	8.0	12.0
Closing Stock	12.0	10.0
Other Liquid Assets	20.0	18.0
Owner's Equity	10.0	8.0
Long term Liabilities	6.0	4.0
Current Liabilities	25.0	24.0

REQUIRED

Calculate the following ratios and for each ratio comment on the performance/health of the companies

- i. Gross Profit (2.5marks)
 - ii. Current Ratio (2.5marks)
 - iii. Debt to Equity ratio (2.5marks)
 - iv. Average Stock Turn Over period (2.5marks)
2. Discuss the factors that influence the choice of the best form of business organization suitable for an agribusiness. Use Sole proprietorship and Corporations as examples, and in the process contrast the two forms of business organization (15marks)
3. Employees of a company can exhibit a wide range of commitment and performance, ranging from the bare minimum necessary to remain employed to their maximum effort. It is the responsibility of the Human resource manager to gain employees cooperation and make sure that the company's objectives are achieved. The way a company remunerates its employees is critical for effective people management.

REQUIRED

Comment on the above statement and highlight the aim of a remuneration policy, and the types of rewards a human resource manager might use to remunerate his/her employees (15 marks)

4. Ungawanga milling company produces breakfast and roller meal. The following information has been given regarding its two product lines:

	BREAKFAST MEAL	ROLLER MEAL
	(K)	(K)
Selling Price per 25Kg bag	30,000	25,000
Total Variable Costs	40,000,000	30,000,000
Fixed Costs	25,000,000	25,000,000
25Kg bags produced	2,500	2,500

REQUIRED

- a) For each product calculate:
 - i. The break even volume in 25 kg bags (3marks)
 - ii. Gross profit margin percentage (3marks)
 - iii. Margin of safety (2marks)

- b) If Ungawanga proposed to increase its profit by K3, 000,000 (i.e. K1, 500,000 on each product). How many 25Kg of each product will it have to sell? **(4 marks)**
- c) Give four limitations of break even point analysis **(3marks)**
5. Quality management is a strategic issue. It is one of the performance characteristics that an agribusiness firm may choose to emphasize.

REQUIRED

Discuss the statement and in the process highlight ways by which higher quality management might improve the profits and competitive position of a firm **(15marks)**

6. i. What are the advantages and disadvantages of perpetual and periodic inventories as methods of tracking inventory? **(5marks)**
- ii. Define control and explain why it is an important management function **(5marks)**
- iii. Highlight the major unique features of Agribusiness products **(5marks)**

END OF EXAM

THE UNIVERSITY OF ZAMBIA

SCHOOL OF AGRICULTURAL SCIENCES

2006 ACADEMIC YEAR FIRST SEMESTER FINAL EXAMINATIONS

AGE 421: PRODUCTION ECONOMICS

TIME: THREE (3) HOURS

ANSWER: ALL QUESTIONS

MARKS: 100 TOTAL

1. Discuss and illustrate the concept of economic efficiency as it is related to factor-product and factor-factor relationships. (20 Marks)
2. a) Draw the classical production function, APP and MPP, and carefully describe the three stages of production. (10 marks)

b) Given the cost function:

$$TC = 100 + 6Y - 0.4 Y^2 + 0.02 Y^3$$

Calculate:

- i) Total Fixed Cost,
 - ii) Total Variable Cost and Marginal Cost when $Y = 2$
 - iii) Level of Y at Minimum AVC
- (10 Marks)

3. What do you understand by the following concepts:
 - a) Supplementary products
 - b) The law of diminishing returns
 - c) Equimarginal principle
 - d) Expansion path
 - e) Scale line

(20 Marks)

4. a) Define and explain the concept of opportunity cost. (4 Marks)

b) You, as a Manager for Liempe farm is in a planning situation and you are faced with the production functions of maize, wheat and sorghum as shown below. The maize, wheat and sorghum can be produced with five units of fertiliser and you can allocate them one unit at a time to any of the three crops. How will you allocate the five units of fertiliser to the three crops, if the price of maize is K1000 per bag, wheat is K2000 per bag and Sorghum is K2000 per bag? What is the profit from this allocation, if land is priceless and the price of one unit of fertiliser is K6500? (16 Marks)

Unit of fertiliser (X)	Bags of Maize (Ym)	Unit of fertiliser (X)	Bags of Wheat (Yw)	Unit of fertiliser (X)	Bags of Sorghum (Ys)
0	0	0	0	0	0
1	18	1	7	1	10
2	31	2	13	2	18
3	42	3	18	3	24
4	51	4	22	4	29
5	58	5	25	5	33

5. In May 2006, Mr. Kalibaliba harvested 100 bags of 50-kg maize. Meanwhile the Zambian government was paying K25, 000 per 50kg bag of maize. Mr. Kalibaliba strongly feels that the maize price per 50kg bag may rise to K60, 000 in December 2006. He is also aware that there is a slight chance that the prices in December 2006, may fall to K15, 000 per 50 kg bag. He estimates the likelihood for a price rise at 75%.
- What is the expected maximum utility if Mr. Kalibaliba sells his maize in May, 2006? (5 Marks)
 - What is the expected maximum utility if Mr. Kalibaliba sells his maize in December, 2006? (5 Marks)
 - What is the expected value of the perfect forecast? Interpret this value? (10 Marks).

END OF EXAMINATION

The University of Zambia
University First Semester Examinations – September 2006

AGE 431
Linear Programming Applications for Agribusiness

Instructions: Answer Question 1 in Section A; any one of the two questions in Section B; and any one of the two questions in Section C. Thus, you are expected to answer a total of three questions in this exam

Time: Three (3) hours

Section A (35 points)

Answer the only question (Question 1) in this section. It is worth 35 points.

1. Research is defined as “a systematic approach to obtaining new & reliable Knowledge” (Ethridge, 1995). Answer the following questions about research.
 - a) Why do agricultural economics students have to learn research methodology?
 - b) “A worthwhile science has internal validity and external worth.” (Gebremedhin and Tweeten, 1991). What do you think the authors meant?
 - c) Distinguish between deductive and inductive logic. Why does research need both?
 - d) What is a logical fallacy? List three examples of logical fallacies.
 - e) What would you do if your facts do not agree with theory?
 - f) Compare and contrast normative techniques and positive techniques. For each, give one example used by agricultural economists to answer empirical questions.

Section B (35 points)

There are two questions in this section (Questions 2 and 3). Answer any one of these two questions.

2. Use the attached Microsoft Excel Solver printout for a plant location problem (page 4) based on the tableau on page 5, where Y_i are binary variables.
 - a) What is the optimal value of the objective function? Explain what this value means.
 - b) How many (i) real activities and (ii) constraints does this model have?
 - c) What is the optimal shipment pattern suggested by the model?
 - d) Explain the optimal values of the three binary variables – Y_1 , Y_2 , and Y_3 . How do these values relate to the optimal shipment pattern referred to in c) above?
 - e) Write out the algebraic model from which this output comes

3. Mr. Kachisi, a medium-scale farmer at Mshekela Village in Chipata, is considering growing paprika and/or cotton with the goal to maximize total net returns. Paprika returns K400,000 per acre while cotton returns K200,000 per acre. The farmer has 240 hours of family labour and 40 acres of land. He has also just bought and delivered to his homestead 8,400 kg of fertilizer from a nearby depot. 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.
 - a) Express Mr. Kachisi's problem in an LP tableau format
 - b) Write out the syntax/code that you would use to solve this problem using the Generalized Algebraic Modeling System (GAMS)

Section C (30 points)

There are two questions in this section (Questions 4 and 5). Answer any one of these two questions.

4. A farm family has scarce resources of land, labour and fertilizer. They would like to determine how to allocate these resources between two competing crops – maize and wheat. They have 20 hectares of land, 72 units of labour, and 600 units of fertilizer. Maize requires four units of labour and 10 units of fertilizer per hectare. Wheat requires two units of labour and 40 units of fertilizer per hectare. Given expected prices, the family expects a gross margin of \$60 per hectare for maize and \$40 per hectare for wheat.
- Set up the algebraic linear programming problem.
 - Use the simplex method to solve the problem, completing all the necessary tableaux
 - Use the results from b) to answer the following questions:
 - What is the value of the objective function in the optimal solution?
 - What is the optimal quantity of each of the real activities?
 - What is the optimal quantity of each resource used and not used?
 - Explain the $z_j - c_j$ value (or shadow price) for land and fertilizer.
5. A farmer has 160 hectares of land and proposes to grow maize and tobacco. He has 65 man-days of December labour and 110 man-days of January labour available. He requires 0.5 man-days of December labour per hectare and no January labour for maize and needs 1 man-day of January labour for each hectare of tobacco. The net returns from each hectare of maize and tobacco are K320,000 and K160,000, respectively. The farmer seeks to maximize his total profits.
- Specify, algebraically, the primal LP model.
 - Solve the problem using the simplex method.
 - Determine the optimal values of the objective function, real activities, and slack activities.
 - Specify the dual to the problem in a).
 - What is the economic interpretation of the dual variables?

-----**END OF EXAM**-----

Happy holidays!

Section C (30 points)

There are two questions in this section (Questions 4 and 5). Answer any one of these two questions.

4. A farm family has scarce resources of land, labour and fertilizer. They would like to determine how to allocate these resources between two competing crops – maize and wheat. They have 20 hectares of land, 72 units of labour, and 600 units of fertilizer. Maize requires four units of labour and 10 units of fertilizer per hectare. Wheat requires two units of labour and 40 units of fertilizer per hectare. Given expected prices, the family expects a gross margin of \$60 per hectare for maize and \$40 per hectare for wheat.
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-----**END OF EXAM**-----

Happy holidays!

Microsoft Excel Solver Printout for Question 2

Microsoft Excel 11.0 Answer Report

Worksheet: [Plant location problem.xls]Sheet1

Report Created: 27/08/2006 12:47:25

Target Cell (Min)

Cell	Name	Original Value	Final Value
\$C\$4	Objective function equation	0	8,100,000

Adjustable Cells

Cell	Name	Original Value	Final Value
\$E\$3	CentEast	0	10.0
\$F\$3	CentLusa	0	30.0
\$G\$3	CentSout	0	0.0
\$H\$3	CentWest	0	30.0
\$I\$3	CopEast	0	0.0
\$J\$3	CopLusa	0	10.0
\$K\$3	CopSout	0	50.0
\$L\$3	CopWest	0	0.0
\$M\$3	NortEast	0	0.0
\$N\$3	NortLusa	0	0.0
\$O\$3	NortSout	0	0.0
\$P\$3	NortWest	0	0.0
\$Q\$3	Y1	0	1.0
\$R\$3	Y2	0	1.0
\$S\$3	Y3	0	0.0

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
\$C\$7	Central Province equation	-10	\$C\$7<=\$D\$7	Not Binding	10.0
\$C\$8	Copperbelt Province equation	0	\$C\$8<=\$D\$8	Binding	0.0
\$C\$9	Northwestern Province equation	0	\$C\$9<=\$D\$9	Binding	0.0
\$C\$12	Eastern Province equation	10	\$C\$12>=\$D\$12	Binding	0.0
\$C\$13	Lusaka Province equation	40	\$C\$13>=\$D\$13	Binding	0.0
\$C\$14	Southern Province equation	50	\$C\$14>=\$D\$14	Binding	0.0
\$C\$15	Western Province equation	30	\$C\$15>=\$D\$15	Binding	0.0
\$Q\$3	Y1	1	\$Q\$3=binary	Binding	0.0
\$R\$3	Y2	1	\$R\$3=binary	Binding	0.0
\$S\$3	Y3	0	\$S\$3=binary	Binding	0.0
\$E\$3	CentEast	10.0	\$E\$3>=0	Not Binding	10.0
\$F\$3	CentLusa	30.0	\$F\$3>=0	Not Binding	30.0
\$G\$3	CentSout	0.0	\$G\$3>=0	Binding	0.0
\$H\$3	CentWest	30.0	\$H\$3>=0	Not Binding	30.0
\$I\$3	CopEast	0.0	\$I\$3>=0	Binding	0.0
\$J\$3	CopLusa	10.0	\$J\$3>=0	Not Binding	10.0
\$K\$3	CopSout	50.0	\$K\$3>=0	Not Binding	50.0
\$L\$3	CopWest	0	\$L\$3>=0	Binding	0.0
\$M\$3	NortEast	0	\$M\$3>=0	Binding	0.0
\$N\$3	NortLusa	0	\$N\$3>=0	Binding	0.0
\$O\$3	NortSout	0	\$O\$3>=0	Binding	0.0
\$P\$3	NortWest	0	\$P\$3>=0	Binding	0

Row units	Rows	Equation values	RHS	CentEast	CentLusa	CentSout	CentWest	CopEast	CopLusa	CopSout	CopWest	NorthEast	NorthLusa	NorthSout	NorthWest	Y1	Y2	Y3	
ZK	Objective function	8,100,000		10.0	30.0	0.0	30.0	0.0	10.0	50.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	
Supply constraints (<=)																			
tonne	Central Province	-10	0	1	1	1	1									-80			
tonne	Copperbelt Province	0	0				1	1	1	1	1							-60	
tonne	Northwestern Provi	0	0									1	1	1	1				-20
Demand constraints (>=)																			
tonnes	Eastern Province	10	10	1			1					1							
tonnes	Lusaka Province	40	40		1				1				1						
tonnes	Southern Province	50	50			1				1				1					
tonnes	Western Province	30	30				1				1				1				

The University of Zambia
University Second Semester Examinations – December 2005

AGE 442
Agribusiness Statistics and Data Analysis

Instructions: There are three questions in this exam: two in Section A and one in Section B. Answer all.

Time: Three (3) hours

Section A (60 points)

1. Briefly, compare the following pairs of concepts
 - a) Type I error and Type II error
 - b) Estimator and estimate
 - c) Ordinary Least Squares Estimator and Maximum Likelihood Estimator
 - d) Asymptotic properties and small-sample properties
 - e) Classical statistical inference and Bayesian inference
 - f) Point estimation and interval estimation

2. Answer the following short-answer questions on the classical linear regression model
 - a) List the five assumptions of the classical linear regression model (CLRM)
 - b) If a researcher is correctly using an estimated generalized least squares (EGLS) estimator for a single equation model, which of the CLRM assumptions are violated?
 - c) How does the EGLS estimator correct for the problem in b)?
 - d) List four of the criteria used to evaluate estimators.
 - e) When OLS is incorrectly used instead of EGLS in a single equation model, what are the consequences in terms of the criteria for evaluating estimators?
 - f) If a researcher is correctly using three-stage least squares (3SLS), which of the CLRM assumptions is violated?

Section B (40 points)

3. Mr. JM, an Economist, was hired by ICRAF, Chipata, to help identify the factors that affect the effectiveness of farmer trainers. Based on discussions with ICRAF staff and other knowledgeable people, Mr. JM used the number of farmers trained by the trainer as a measure of the latter's effectiveness (Y). He conducted a survey of **45** farmer trainers in Chipata district and collected responses on Y and several demographic and technical characteristics (Xs) of the trainer. Using his knowledge of econometrics and the data thus collected, Mr. JM was able to measure the relationship between Y and several explanatory variables (Xs). Answer the following questions based on Mr. JM's work.
- a) During specification analysis, Mr. JM tested for heteroskedasticity and multicollinearity.
 - i) Why do you think he suspected these problems in his data?
 - ii) What are the consequences of using OLS in the presence of heteroskedasticity?
 - iii) Why should Mr. JM be concerned about multicollinearity?

 - b) In his analysis, Mr. JM found that the variance inflation factors (VIF) were as indicated in the attached computer printout. What conclusion can you draw from these results?

 - c) Using the Breusch-Pagan-Godfrey (BPG) test, Mr. JM found that heteroskedasticity was significant at $\alpha = 0.05$. Following this finding, Mr. JM used the EGLS estimator to obtain his parameter estimates. Answer the following questions based on the attached EGLS regression results.
 - i) Why did Mr. JM use the EGLS estimator?
 - ii) List the variables that are significant at $\alpha = 0.10$?
 - iii) For each of the significant variables in $c(i)$, state whether their signs are in agreement with your *a priori* expectations. Explain your answers.
 - iv) Test whether the explanatory variables included in the model collectively explain a significant proportion of the variation in Y.
 - v) What proportion of the variation in Y does the model explain?

Edited SPSS Computer Printout
(JM Model)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.808	.652	.586	1.67553

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	194.820	7	27.831	9.914	0.000
Residual	103.874	37	2.807		
Total	298.694	44			

Coefficients

Explanatory variable	Description of explanatory variable	Coefficients	Standard error	t	p-value	Collinearity Statistics	
						Tolerance	VIF
Contact	Intercept	8.119	19.487	.417	.679		
X ₁	Experience of the trainer in years	22.980	2.853	8.055	.000	.855	1.170
X ₂	Number of adult members in the trainer's household	-1.759	1.357	-1.296	.203	.810	1.235
X ₃	Age of the trainer in years	-.848	.447	-1.895	.066	.740	1.352
D ₁	Sex dummy, equal to 1 if trainer is male	1.941	5.501	.353	.726	.859	1.164
D ₃	Education dummy, equal to 1 if trainer reached secondary school	6.445	6.565	.982	.333	.746	1.341
D ₅	Support dummy, equal to 1 if trainer receives support from any organization	-11.307	5.530	-2.045	.048	.858	1.166
D ₇	Farm size dummy, equal to 1 if greater than 10 acres	6.722	8.472	.793	.433	.812	1.232

THE UNIVERSITY OF ZAMBIA

SCHOOL OF AGRICULTURAL SCIENCES

2006 ACADEMIC YEAR FIRST SEMESTER FINAL EXAMINATIONS

AGE 511

AGRICULTURAL ORGANIZATION AND ADMINISTRATION

INSTRUCTIONS: ANSWER QUESTION ONE AND ANY OTHER FOUR FOR A TOTAL OF FIVE QUESTIONS. EACH QUESTION IS WORTH 20%

TIME: 3 HOURS

1. (a) Explain and elaborate what management is. Clearly identify and define the five (5) major management functions? Cite one appropriate example of a specific activity related to performing each of the functions you have identified.

(b) Briefly outline the roles which managers typically play. Cite appropriate examples illustrating the roles played by managers
2. (a) Typical African Ministries of Agriculture are described as being bureaucratic entities. What are the major features of a bureaucratic organization as described by Max Weber?

(b) Briefly outline the principles of administration as advanced or articulated by Henri Fayol.
3. (a) Explain and elaborate Maslow's theory of human needs.

(b) As a Manager in an agribusiness firm, how would you apply Maslow's theory in motivating employees in the workplace? Cite relevant examples to explain your approach to motivating the employees.
4. (a) What is communication? Why is it important in management?

(b) Using relevant examples, clearly describe the communication process.

(c) What is a Management information System (MIS)? Citing relevant examples, explain how a MIS can be used to carry out 3 management functions

5. (a) What is leadership? Comment and elaborate on the bases of leadership power.
- (b) Explain what Theories X and Y are and elaborate the managerial implications of these theories.
6. Write brief notes explaining salient aspects of the following:
- a. Human resource planning
 - b. Power, Influence and Authority
 - c. Employee Assistance Programmes (EAP)
 - d. Matrix organization structure

END OF EXAMINATION

**UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
2006 ACADEMIC YEAR FIRS SEMESTER FINAL EXAMINATIONS**

AGE 521: INTRODUCTION TO FARM MANAGEMENT

TIME: THREE (3) HOURS

INSTRUCTIONS: ANSWER ALL FIVE (5) QUESTIONS

MARKS: 100 TOTAL (Each question carries 20 marks)

1. (a) Discuss the three functions of a farm manager **(9 marks)**
 - (b) A farm manager is a decision maker who has to make decisions under a risk and uncertain agricultural environment. List five examples of risk for farms in Zambia. Classify them as production, price, financial, legal or personal risk. **(5 marks)**
 - (c) Several decision rules have been developed to help choose the appropriate strategy when faced with a decision involving risk. Describe at least three of these. **(6 marks)**
2. (a) Give at least three reasons why farmers should keep records. **(3 marks)**
 - (b) Use the following 2006 annual records for a farm in Choma to compute the values for each of the items listed below.

Income from cash grain sales K34,000,000	Cash operating expenses K32,000,000
Income from cash vegetables K9,000,000	Ending accounts receivable K4,000,000
Beginning value of crops in storage K10,000,000	Ending value of crops in storage K15,000,000
Beginning accounts receivable K6,000,000	Ending value of market livestock K14,000,000
Beginning value of market livestock K15,000,000	Cash paid for new tractor K50,000,000
Cash interest paid K900,000	Beginning prepaid expenses K500,000
Machinery depreciation K900,000	Ending prepaid expenses K1,500,000

- i. Cash basis income statement **(6 marks)**
 - ii. Accrual basis income statement **(8 marks)**
 - iii. Net cash income **(1 mark)**
 - iv. Accrual expenses **(2 marks)**
3. (a) If a Katete farmer estimates that the total cost of production for his crop farm in the coming season will be K2, 400,000 and the expected price as K38, 000 per 50kg bag. What is the minimum number of bags that the farmer should get from the harvest to meet the cost of production. **(2 marks)**
 - (b) How does a partial budget differ from an enterprise budget? **(2 marks)**

- (c) The following table shows three (3) alternative crops that can be grown on 4 hectares of land, and three resource constraints; land, labor and capital.

Production alternatives

	Maize	Groundnuts	Cotton
Gross margin/ha	K1,000,000	K4,000,000	K5,000,000
Resource Available	Resource Requirements per unit		
Land (ha) 4	1	1	1
Labor (man days) 350	80	100	150
Capital (Kwacha) K30,000,000	2,000,000	6,000,000	8,000,000

- i. Identify the most limiting resource for each crop **(6 marks)**
 - ii. Assume land and labor were unlimited and all the capital is used on cotton. How much land and labor would you allocate to cotton? **(4 marks)**
 - iii. Assume that labor was the most limiting, what crop(s) can you grow and what would be the total gross margin realized from that? **(4 marks)**
 - iv. What resource(s) if any is in excess (not utilized) from producing such a crop(s) in part (iii)? **(2 marks)**
4. The following table shows an example of combinations of two competitive enterprises, maize and soybean that can be produced from a fixed amount of land. The price of maize is K280 per kg and soybean is K400 per kg.

<u>Combination 1</u>	<u>Maize (kgs)</u>	<u>Soybean (kgs)</u>
1	0	6,000
2	2,000	5,600
3	4,000	5,000
4	6,000	4,100
5	8,000	3,000
6	10,000	1,700
7	12,000	0

- (a) Calculate the output substitution and price ratio for each combination. **(8 marks)**
 - (b) What is the profit maximizing combination and the income that can be generated from combination? **(4 marks)**
 - (d) Explain the differences and similarities between supplementary and complementary enterprises. **(6 marks)**
 - (e) What does the principal of diminishing marginal return say? **(2 marks)**
5. Mr. Bwalya is faced with two Agricultural program choices A and B. Program A cost K150, 000,000 and is expected to produce a net cash revenues per year of

K45, 000,000 for 5 years. Program B costs K375, 000,000 and it is expected to produce net cash revenue of K115, 000,000 per year for 5 years. Both programs will have no value at the end of 5 years.

- (a) Calculate the payback period for each program. **(2 marks)**
- (b) What is the simple rate of return for each program and which program would you select? **(5 marks)**
- (c) Why is a financial feasibility analysis necessary in capital budgeting? **(5marks)**
- (d) Identify measures that can be taken for a profitable project whose feasibility analysis shows a negative cash flow in the first few years. **(5 marks)**
- (f) Identify at least three (3) ways in which income taxes affect the investments net cash revenue. **(3 marks)**

END OF EXAMINATION!

THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURE
DEPARTMENT OF AGRICULTURAL ECONOMICS
FIRST SEMESTER FINAL EXAMINATIONS- JUNE 2006
AGE 531: International Agricultural Trade

TIME: 3 HOURS

INSTRUCTIONS: Answer all five questions (20 marks each)

.....

1. A newly elected Minister of Agriculture and his deputy want to know whether subsidizing export crops using the export advalorem subsidy for the small country Zambia would improve the agriculture export sector or not. They approach you as a policy analyst for advice. Use the partial equilibrium framework to clearly and neatly show the effects of such a policy and advice them accordingly. Support your answer with convincing reasons or arguments. (20 marks)
2. The political economy of protection tries to explain the existence of protectionism. Explain using the median voter model suggested by Robert Baldwin why protectionism still exists in democratic governments in spite of possible benefits of free trade and why there is increased pressure for protection rather decreased protection. (20 marks)
3. Zambia being a small importing country, rather than reduce imports by the use of a tariff decides to increase imports by subsidizing them in order to support consumers. What would be the effects of imposing an import subsidy at the advalorem rate on important imported inputs such as fertilizers used in the agricultural sector in a small country like Zambia? Is it a good policy in the Zambian case? Support your answer. (20 marks)
4. a) State the Stolper Samuelson and Heckscher Ohlin theorem. Clearly give one example in each to support your answer. (8 marks)
b) Why has trade liberalization not necessarily produced the predictions of the Stolper Samuelson theorem in most LDCs. (12 marks)
5. a) Outline and assess the merits and demerits of a fixed, floating and managed exchange rate for less developed countries. (12 marks)
b) Outline and discuss the factors that have hindered developing countries from participating effectively in international trade. (8 marks)

**THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
2006 ACADEMIC YEAR FIRST SEMESTER FINAL EXAMINATIONS**

AGE 541: AGRICULTURAL PROJECT PLANNING AND APPRAISAL

TIME: THREE HOURS

INSTRUCTIONS:

- i) **Answer all questions**
- ii) **Leave the discount tables in the Examination Hall**

1.
 - a) Sometimes agricultural project analyses prove wrong because of project design and implementation. Briefly explain four problems that have been shown to be related to project design and implementation. (8 marks)
 - b) Describe and illustrate by use of diagrams the "With" and "Without" project comparisons obtaining in four different scenarios. (8 marks)
 - c) What is the difference between the "before" and "after" comparison as opposed to the "with" and "without" project comparison? (4 marks)

2. The following investment outlay, operation and maintenance costs (cash outflows) as well as gross benefits (cash inflows) are given for an agricultural project proposal.

Amounts in
K'million

Year	Investment Outlay	Operation and maintenance	Gross Benefit
0	900	0	0
1	0	18	218
2	0	20	320
3	0	30	430
4	0	40	540
5	0	50	550

- a) Compute the Net Present Value (NPV) if the opportunity cost of capital is 20%. On the basis of the NPV you obtain, would you recommend the project as good investment? Explain why? (8 marks)
 - b) Compute the Internal Rate of Return (IRR). On the basis of the IRR you obtain and given 20% as the opportunity cost of capital, would you recommend the project as good investment? Explain why? (8 marks)
 - c) What advantages do discounted measures of project worth have over undiscounted measures of project worth? (4 marks)
3. The foreign exchange component and the domestic currency component of a hypothetical ethanol production project are as given in the following table:

Year	Foreign Exchange Component (US\$'000)			Domestic Currency Component (K'million)	
	Value of Production	Investment Cost	Production Cost	Investment Cost	Production Cost
1	0	80	0	200	0
2	0	120	0	250	0
3	0	120	0	250	0
4	180	0	100	150	120
5	350	0	100	0	150
6	450	0	200	0	150
7	450	0	200	0	150
8	450	0	200	0	150
9	450	0	200	0	150
10	450	0	200	0	150

- a) If the opportunity cost of capital is 20%, compute the domestic resource cost (DRC). If the official exchange rate (OER) is K3, 500 to US\$1 and on the basis of the DRC you obtain, is the project favourable? Explain why? (12 marks)
- b) If there is a foreign exchange premium of 20%, what is the shadow exchange rate (SER)? In the light of the SER you obtain and on the basis of the DRC you obtained in a) above, would you say the project is favourable? Explain why? (4 marks)
- c) Explain why it is important to estimate the DRC and for what type of projects it should be applied? (4 marks)
4. a) Why is economic analysis carried out in project preparation? (4 marks)
- b) To carry out an economic analysis of a project, three steps are followed to convert financial prices to economic values. Explain what is involved in each step of adjusting financial prices to economic values. (12 marks)
- c) Briefly describe how to go about valuing land in economic analysis giving formulas and/or examples where appropriate. (4 marks)
5. A combine harvester is to be imported into the country for use at the University Farm. The c.i.f. price is US\$85,000; the import levy is 5% of the c.i.f. price; the handling and clearing charges amount to K10 million and the transportation to the project site is K5 million. The official exchange rate (OER) is K3, 500 to US\$1 and a foreign exchange premium of 20% is estimated. Calculate the economic import parity value at the farm gate or project boundary:
- Using the conversion factor approach. (8 marks)
 - Using the shadow exchange rate approach. (8 marks)
 - Why is it important to allow for a foreign exchange premium when calculating the economic import parity value? (4 marks)

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

FINAL EXAMINATION FIRST SEMESTER 2006

AGF 211 GENERAL MICROBIOLOGY

PRACTICAL PAPER

Duration: Three Hours

INSTRUCTIONS: Answer **ALL** questions

1. a) Briefly explain the principle behind direct staining and the importance of direct staining. What types of dyes are used in direct staining? (6 Points)
 - b) Briefly explain the principle behind negative staining and the importance of negative staining. What types of dyes are used in negative staining? (6 Points)
 - c) What microscopic technique gives a field similar in appearance to that seen in the negative stain (2 Points)
 - d) State and describe **two** different arrangements of each of the following;
Cocci
Bacilli
Spiral forms
(6 Points)
2. a) Explain in **detail** the steps of Gram staining technique (8 Points)
 - b) State why a gram stain is said to be a differential stain (2 Points)
 - c) Describe the differences between a Gram positive and a Gram negative cell wall (4 Points)
 - d) Describe a theory as to why Gram positive bacteria retain the crystal-iodine complex while Gram negative become decolourised (4 Points)
 - e) Describe two conditions that may result in a Gram positive organism staining Gram negative (2 Points)

3. a) State the components and function of enzymes (6 Points)
 - b) What factors influence enzymatic activities (6 Points)
 - c) Contrast endoenzymes and exoenzymes (4 Points)
 - d) In what types of bacteria is the enzyme catalase mostly found? What products result from the action of enzyme catalase (4 Points)
-
4. a) Explain how microbes are classified on the basis of oxygen requirements (10 Points)
 - b) Name any **two** types of media (2 Points)
 - c) Define osmotic pressure and Explain why bacteria are more likely to survive in a hypotonic environment than in a hypertonic environment (6 Points)
 - d) Name a food that is preserved with salt and a food preserved with sugar (2 Points)
-
5. a) Describe a method for the starch hydrolysis and state how to interpret the results (8 Points)
 - b) Describe a method for testing gelatin hydrolysis and state how to interpret the results (8 Points)
 - c) Name the general end products that may be formed as a result of the bacterial fermentation of sugars (2 Points)
 - d) Of what value is deamination to a microbe (2 Points)

**END OF THE EXAMINATION
GOOD LUCK!!!!**

THE UNIVERSITY OF ZAMBIA

SCHOOL OF AGRICULTURAL SCIENCES

2006 ACADEMIC YEAR FIRST SEMESTER FINAL EXAMINATIONS

AGF 311 CHEMICAL TECHNIQUES IN FOOD ANALYSIS PRACTICAL

TIME ALLOWED: THREE HOURS

INSTRUCTIONS

Answer both questions.

1. A food processing company has brought two food samples to your facility for titratable acid determination. The samples are labeled **M 01** and **Y 01**. Study the samples and develop and outline a plan on how you will proceed to determine what has been requested by the food company. [10 marks]

Your client wants you to carry out several analyses and report them (as well) including the average for each of the samples as per cent lactic acid (MM 90.08). You client also wants to know the pH of the food samples at various stages of your analysis.

2. Carry out the determination and write a detailed report to the company. [20marks]

END OF PRACTICAL EXAMINATION

UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
FOOD SCIENCE AND TECHNOLOGY DEPARTMENT
FIRST SEMESTER 2006 FINAL EXAMINATION
COURSE: FOOD CHEMISTRY THEORY- AGF321

TIME: THREE HOURS

INSTRUCTIONS: ALL QUESTIONS CARRY 20 MARKS
ANSWER ANY FIVE OUT OF THE SEVEN QUESTIONS

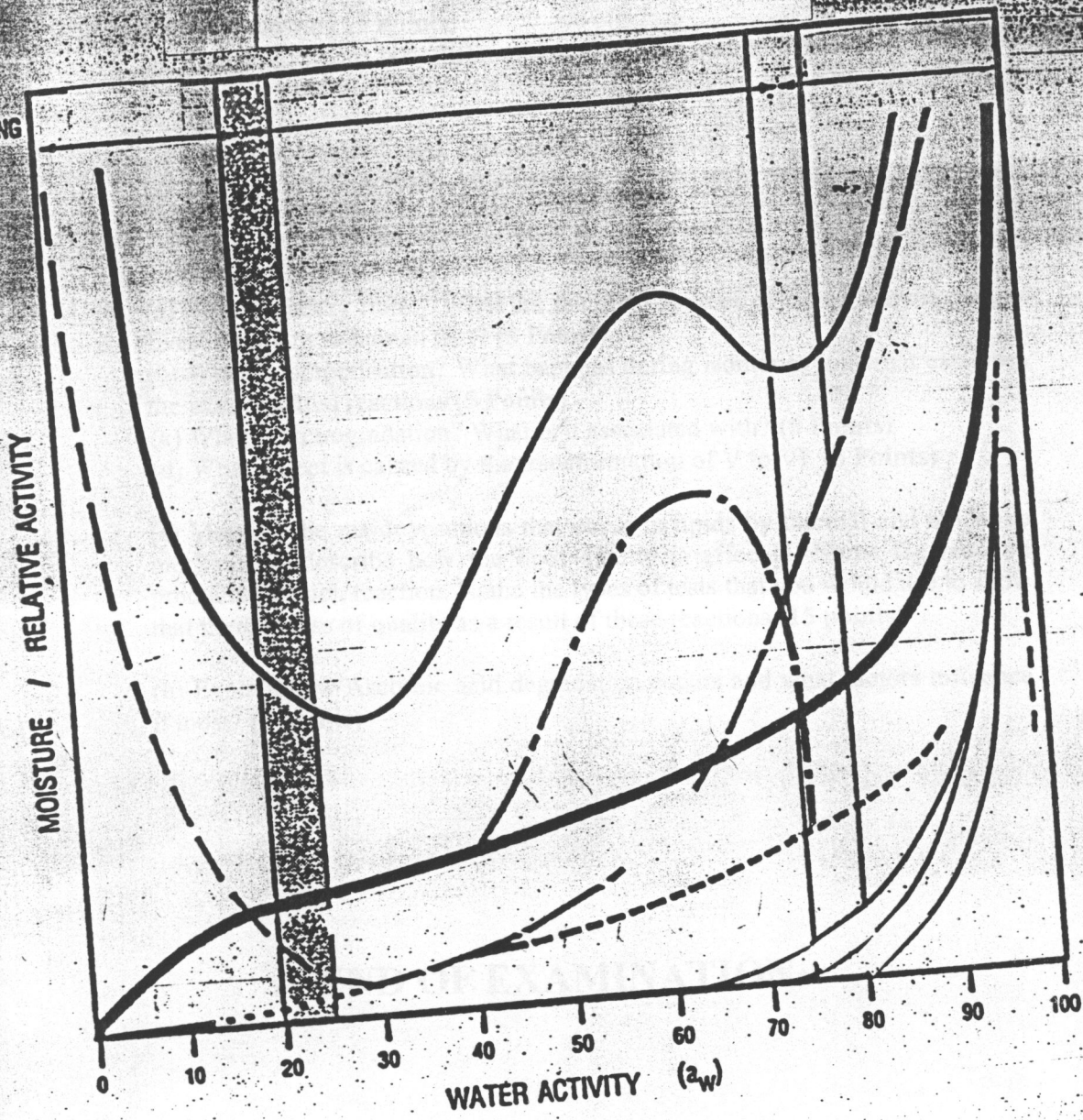
1. Define the following
 - (a) Latent enzymes What is significant about them in food processing (5 Points)
 - (b) Caramelisation what is it associated with? (5 Points)
 - (c) Food Enrichment in your answer give examples of two situations where this is done (5 Points)
 - (d) What are Amylases? Name and describe the two that have been studied in detail (5 points)

2. You have been given a bottle of peanut butter and upon opening it you realise that the peanut butter has two distinct layers describe what has gone wrong with the product. What advice would you give to the manufacturer in order to improve this product? Describe the way the better product should appear. (20 Points)

3. What is this figure about? And what is it usually called? **On it show the following (20 Points).**
 - a) The three regions showing types of water
 - b) Where the ionic bonding occurs, the solute and capillary location
 - c) Where the auto-oxidation reactions occur and the types of foods affected
 - d) Where the stability isotherm and sorption isotherm are located
 - e) The oxidation, enzyme and reactions are found
 - f) Where the yeasts, bacteria, chlorophyll and anthocyanins
 - g) The correct notation of water activity
 - h) Why are microorganisms not found at the same location on this figure?

4. You have been given 100,000 Litres of Crude Soya Bean Oil; explain in detail how you would make this oil fit for human consumption. Mention the statutory bodies in Zambia that would enable you to come up with oil good for human consumption. In the same vein explain what would happen to the oil if it were not subjected to what you explain as way of producing consumable oil. What technological and nutritional problems are you likely to encounter during processing this oil (20 Points)

QUESTION NUMBER 3 AGF 321



5. (a) Why is there no enzymatic browning in intact tissues (3 Points)
(b) What are the causes of mineral deficiencies in diets (2 points)
(c) What is the major difference between vitamins and mineral availability during processing (3 Points)
(d) What are dextrins how different are they from starch (2 Points)
(e) What is common to all oils affected by reversion name two such oils (3 Points)
(f) Name two non-reducing disaccharides (2 Points)
(g) When does protein putrefaction occur and mention 3 important putrefaction reactions (5 Points)
6. (a) What is dietary fibre? What are the good sources of fibre? Why is dietary fibre important to human diet? (5 Points)
(b) What is isomerization? What happens during isomerisation what catalyses the isomerisation reactions (5 Points)
(c) What is Retrogradation? What is it associated with? (5 Points)
(d) What defect is caused by the transformation of V to VI (5 Points)
7. (a) Mention the major reactions that occur in lipids by thermal and oxidative mechanisms describe how the lipid quality is affected. Name the reaction products for each reaction. Name the types of tests that you would use to show that there is loss of quality as a result of these reactions (15 points)
(b) Explain how Ascorbic acid degradation occurs and what factors influence it most? (5 points)

****END OF EXAMINATION****

UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
FOOD SCIENCE AND TECHNOLOGY DEPARTMENT
FIRST SEMESTER 2006 FINAL EXAMINATION
COURSE: FOOD CHEMISTRY AGF 321 PRACTICAL

TIME: THREE HOURS

INSTRUCTIONS: QUESTION ONE IS COMPULSARY. SECTION II ANSWER ANY FOUR OF YOUR CHOICE ALL QUESTIONS CARRY 20 POINTS

SECTION I 20 Points

1. (a) The Kjeldahl method of crude determination of protein is one method of determining crude protein. Is this the only method used for protein determination if not mention at least three other methods you know (5 Points).
 - (b) Name the three reagents added during sample digestion. Why are they added? (3 Points)
 - (c) If upon digestion for a long time no colour changed to the things you are digesting what possible things could have gone wrong. (4 Points)
 - (d) Why can distillation not proceed without the dilution step (3 Points)
 - (e) What reagent is added at the distillation stage and what is its function (2 Points)
 - (f) Explain what would happen if standardisation is omitted at the titration stage (3 Points)
-

SECTION II

2. If you were in charge of product development in a food company and you given a new food product explain how you would determine its moisture, fat and ash. How can this information be helpful in as far as this product is concerned (20 Points).
3. You are given two different samples of food products whose moisture content is 15%. One product is very stable at this moisture content while another is highly unstable explain how you will convince the person who gave you the sample that this is an expected phenomenon. What explanation tool which is scientific, would you use to make your answer convincing. (20 Points)
4. You have been given a sample with obvious signs of oxidative rancidity explain how you would explain this scientifically to the person who has given you. How would you classify this food product? What would be your advice on how to stop such type of loss of quality in foodstuffs? (20 Points)

5. Define the following

- (a) Refractive Index and what is its significance in food technology
- (b) Non protein Nitrogen What is its significance in protein determination
- (c) Iso-electric point of proteins what is crucial about this point name two proteins and their Isoelectric points.
- (d) Free Fatty Acid

END OF EXAMINATION!!

THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
2006 ACADEMIC YEAR FIRST SEMESTER FINAL EXAMINATION
AGF 341 – Technical Thermodynamics

Instructions: Answer any **Five (5)** questions.

Time allowed: Three (3) Hours

- Q.1 An ideal gas is one for which PV/T is a constant; regardless of the changes it undergoes such a gas has a volume of $0.02271\text{m}^3/\text{mol}$ at 0°C at 1bar. In the following problem, air may be considered an ideal gas with the constant heat capacities $C_v = (5/2)R$ and $C_p = (7/2)R$ where $R = 8.314\text{ J/mol.K}$.
- The initial conditions are 1 bar and 25°C . It is compressed to 5 bar and 25°C by two different mechanically reversible processes. Calculate the heat and work requirements and ΔU and ΔH of the air for each path
- Cooling at constant pressure followed heating at constant volume. **[10]**
 - Heating at constant volume followed by cooling at constant pressure. **[10]**
- Q.2 An ordinary egg can be approximated as a 5,5cm-diameter sphere. The egg is initially at temperature of 8°C and is dropped into boiling water at 97°C . Taking the properties of the egg to be $\rho = 1020\text{kg/m}^3$ and $c_p = 3,32\text{kJ}/(\text{kg K})$, determine:
- How much heat is transferred to the egg by the time the temperature of the egg rises to 70°C . **[10]**
 - The amount of entropy generation associated with this heat transfer process. **[10]**
- Q.3
- Air at 1 bar and 25°C entered the compressor at low velocity, discharges at 3bar and enters a nozzle in which it expands to a final velocity of 550m/s at the initial conditions of temperature and pressure. If the work of compression is 210kJ/kg air, how much heat must be removed during compression? **[10]**
 - A heat pump is used to heat a warehouse with bananas, which should be maintained at 28°C . In June, the average outdoor air temperature is 5°C and the warehouse is estimated to lose heat at a rate of 55,000kJ/h. Determine the minimum power required to operate this heat pump. **[10]**

Q.4

- a. Describe the ideal cycle for spark-ignition engine and its application in the food industry. **[10]**
- b. Steam at 3Mpa and 400°C enters an adiabatic nozzle steadily with a velocity of 40m/s and leaves at 2,5Mpa and 300m/s. Determine:
 - I. The exit temperature. **[5]**
 - II. The ratio of the inlet to exit area A_1/A_2 **[5]**

Q.5

- a. Explain and illustrate the Actual-Vapour Compression Refrigeration cycle. **[10]**
- b. How does the above-mentioned cycle relate to the Carnot cycle? **[6]**
- c. What factors are considered in selecting a refrigerant? **[4]**

Q.6

- Discuss the importance of refrigeration and freezing in the preservation of the quality of the following products:
- a. Fruits and vegetable **[8]**
 - b. Meat **[7]**
 - c. Poultry products. **[7]**

Data

$$Q = \Delta U + W$$

$$\text{COP} = Q_H / (Q_H - Q_L)$$

$$\text{COP} = Q_H / W$$

$$\Delta H = mc_p \Delta T$$

$$V = 4/3 \pi r^3$$

$$m = \rho v A$$

$$\theta = h + v^2/2 + gz$$

$$Q_{in} + W_{in} + \sum m_i \theta_i = Q_{out} + W_{out} + \sum m_e \theta_e$$

THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY
2006 ACADEMIC YEAR
FIRST SEMESTER FINAL EXAMINATIONS

AGF 411: FOOD ENGINEERING

TIME: THREE (3) HOURS

INSTRUCTIONS:

ANSWER ALL QUESTIONS.

ANSWER EACH QUESTION IN A SEPARATE ANSWER BOOKLET.

1. What are the differences between algebraic solution and dimensional analysis solution?

How does this apply to engineering problems?

Explain your answer and give an example.

(10pts)

2. The power consumption of an agitator (P) depend the size of the agitator, which is expressed by the diameter (D), the speed of the agitator (N) (in rpm), the density of the liquid (ρ) and the viscosity of the liquid (μ).
Find the relationship of the power consumption of the agitator and the other variables. What happens if the diameter doubles? What happens if the viscosity doubles?

(15pts)

3. Raw milk is transported to a dairy for processing and is fed through a centrifugal separator to remove the milk fat. The separator uses 3650 kg/hr of feed which has a composition of 85.5% water, 4.4 % Carbohydrate, 3.9% Fat, 3.4 % Protein, 0.8 % Minerals. The resulting products are a non-fat stream and a cream stream. The cream has a composition of 98 % fat and 2 % water. A portion of the cream stream is then added back to the non-fat stream to yield 2 % fat milk.
- a) Draw and label a schematic of the process
b) Determine the flow rate of the cream and non fat streams from the separator
c) Determine the amount of cream required to be added back to the non fat stream to yield 2% fat product.

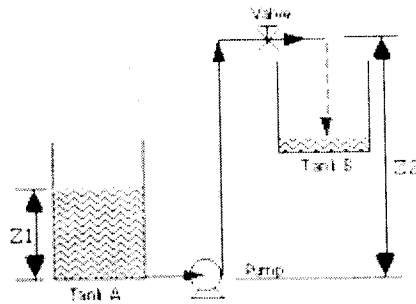
(20 pts)

4. A co-current flow heat exchanger is available to heat a liquid food (specific heat $4.02 \text{ kJ/kg}^\circ\text{C}$) from 5°C to 140°C . Steam enters at 475.8 kPa and exists as condensate at the same pressure. The overall heat transfer coefficient is $1000 \text{ W/m}^2 \text{ }^\circ\text{C}$. Internal diameter of the pipe is 10 cm and the length of the heat exchanger is 2 m .

- Sketch the heat exchanger and the temperature plot
- Determine the rate of heat transfer to the product
- Determine the product flow rate
- Would it be advantageous to run the system in a counter current mode? Why or why not?

(30 pts)

5. Water at standard conditions ($\rho = 1000 \text{ kg/m}^3$; $\mu = 1535 \times 10^{-6} \text{ Pa s}$) is being pumped at a mean velocity of 0.15 m/s from constant-level tank A to the top of tank B as shown. The pipe diameter is 0.02 m , there are 100 m of straight pipe, two 90° elbows (standard), the inlet from tank A, and one fully-open gate valve. Height $Z_1 = 1 \text{ m}$; height $Z_2 = 11 \text{ m}$. (Note: You may not need all of this information to answer these questions.)



Questions:

- Calculate Reynolds' number for this system.
- Is the flow laminar or turbulent?
- What is the value of α for Bernoulli' s equation?
- For a Reynolds' number of $2,000$ and a friction energy E_f of 0.0365 J/kg , calculate the pumping energy required using Bernoulli' s equation.

(25pts)

THE UNIVERSITY OF ZAMBIA

First Semester Examination September 2006

AGF 421 THEORY

FOOD TECHNOLOGY I

Answer question 1 and any other 5 questions, each question carries 10 marks

1. Discuss in five lines
 - fricke
 - mollier diagram
 - high quality life
 - IQF
 - freezer burn
2. What are the major aims of heat treatment in food processing?
3. How do the differences in D and Z values of nutrient and quality factors and those of microorganisms permit the optimization of heat treatment processes?
4. How does a multiple effect evaporator operate? Discuss the advantages of forward feeding over backward feeding.
5. What are the sources of radiation in the food industry? Discuss in detail.
6. Describe in detail the major causes of quality loss in frozen food.

7. Give the factors that determine the penetration of heat from a heating medium such as steam to the food.
8. Discuss and illustrate the following: Heat recuperation is a major issue in food technology.

GOOD LUCK !

THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY
2006 ACADEMIC YEAR
FIRST SEMESTER FINAL EXAMINATIONS

**AGF 431: FUNDAMENTALS OF BIOCHEMICAL
ENGINEERING**

TIME: THREE (3) HOURS

INSTRUCTIONS:

ANSWER ALL QUESTIONS.

ANSWER EACH QUESTION IN A SEPARATE ANSWER BOOKLET.

1. Derive the Michaelis-Menten rate equation, giving all the assumptions made. **(15pts)**
 - b) What are the commercial applications of enzymes? **(2pts)**
 - c) How do enzyme reactions differ from chemical reactions? **(3pts)**
2. Enzyme inhibition is an important phenomenon that has nutritional consequences as well. Discuss it and give two examples. **(20 pts)**
3. From a series of batch runs with a constant enzyme concentration, the following initial rate data were obtained as a function of initial substrate concentration

Substrate concentration mmol/l	Initial reaction rate mmol/l min
1	0.20
2	0.22
3	0.30
5	0.45
7	0.41
10	0.50
15	0.40
20	0.33

- a. Evaluate the Michaelis-Menten kinetic parameters by employing the Lineweaver-Burk plot and the Eadie-Hofstee plot. In evaluating the kinetic parameters, do not include data points, which deviate systematically from Michaelis-Menten model and explain the reason for the deviation.
- b. Discuss the strength and the weaknesses of each method.

(20 pts)

4. Derive the mass balance equations (feed, substrate, and biomass) in the case of 3 CSTF in series. Give also the yield at each stage. Why is it interesting to use fermenters in series?

(20pts)

5. A continuous fermenter is operated at a series of dilution rates but at constant (sterile) feed concentration, pH, aeration rate and temperature. The data given in the table below were obtained when the limiting substrate concentration was 1200mg/litre and the working volume of the fermenter was 9.8 litres. Estimate the kinetic constants K_m , μ_{max} and k_d as used in the modified Monod equation:

$$\mu = \frac{\mu_{max} S}{K_s + S} - k_d$$

(k_d is the cell maintenance term).

and also the growth yield coefficient Y .

Feed flow rate (l/h)	Exit substrate concentration (mg/l)	Dry weight cell density (mg/l)
0.79	36.9	487
1.03	49.1	490
1.31	64.4	489
1.78	93.4	482
2.39	138.8	466
2.68	164.2	465

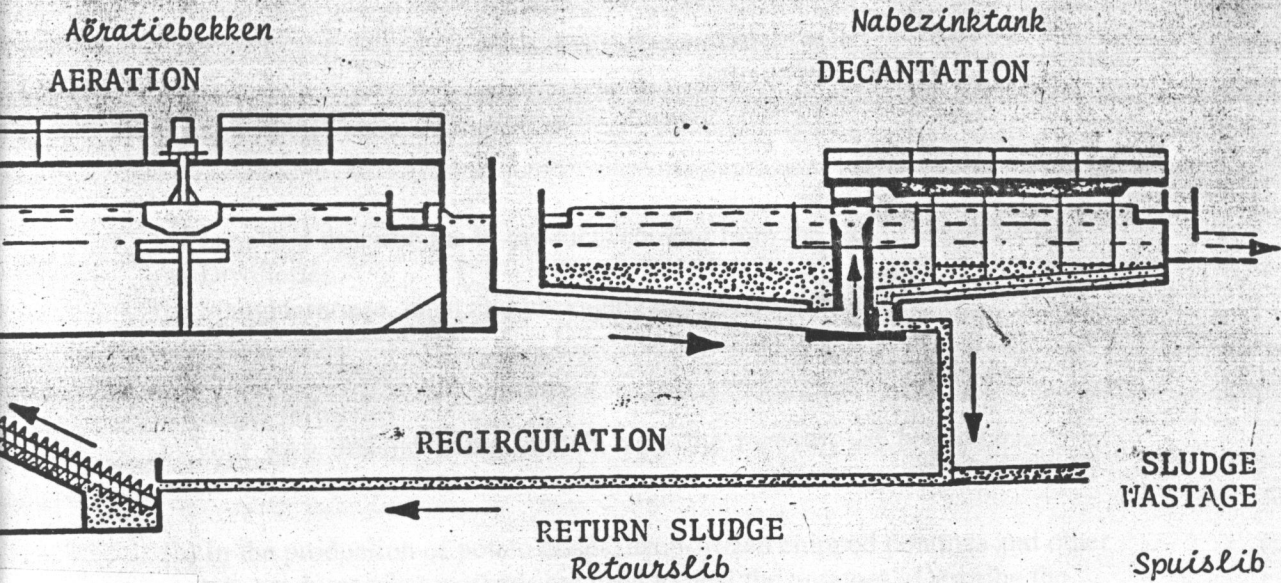
(20pts)

UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
FOOD SCIENCE AND TECHNOLOGY DEPARTMENT
FIRST SEMESTER 2006 FINAL EXAMINATION
COURSE: WATER AND FOOD WASTE TREATMENT
AGF441

TIME: THREE HOURS

**INSTRUCTIONS: ANSWER ANY FIVE QUESTIONS OF YOUR CHOICE
ALL QUESTIONS CARRY 20 POINTS.**

1. Why is stabilisation important in wastewater treatment? Explain in detail the system and stages used in stabilising wastewater. In your explanation explain the advantages and disadvantages of using this system. Explain how you would ascertain that this water is indeed stable
2. Mention and describe **4 recovery products** of activated sludges. What are the economical environmental and economic implications of each product?
3. (a) What species of flies cause most problems to trickling filters, What encourages them most? What causes most breakages to filters in developing countries?
(b) What is sludge age? Why is it important in sludge processes
(c) What causes the following conditions in waste management **ponding** and **sloughing off**? How can they be prevented?
(d) Describe how well formed flocs and malformed ones can be distinguished.
4. Describe with equations the Nitrification process. In your explanation include the microorganisms involved and their growth conditions. What is the significance of this process to waste water treatment?
5. (a) What role do microorganisms play in wastewater treatment? Describe the microbial community and their status in activated sludges.
(b) Name the **5 types** of bacteria found in activated sludges and describe the role played by each one of them.
(c) From the flow diagram given explain describe what happens at the inlet, Aeration, decantation and recirculation.
6. Describe in detail the water treatment process at Iolanda from the intake to the transmission and storage of the treated water. Highlight the significance of the physical and chemical treatment of the process. Also describe how the water quality is maintained.



Flow chart of activated sludge treatment

7. (a) Name and describe the bi-products coming from the following industries

(a) Distilleries

(b) Slaughterhouse, meat and packaging associated industries

(c) Dairy Industries

(d) Potato industries

(e) Sugar refineries

In your own understanding explain why the recovery of bi-products from waste water is important.

(b) In the production of potato crisps, deep-frozen chipped potatoes and other potato products what methods are used to peel the potatoes? Describe the Waste water coming from such an industry.

END OF EXAMINATION!!

THE UNIVERSITY OF ZAMBIA
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2006 ACADEMIC YEAR FIRST SEMESTER FINAL EXAMINATION

AGF 511 – Unit Operations in Food Engineering II

Instructions: Answer **Five (5) questions**; At **least two (2)** from each section and the **fifth (5th)** from either section. Answer **sections 1 and 2 in separate booklets**.

Time allowed: Three (3) Hours

SECTION 1

1. A mixture of 450kmol / hour of 60 mole percent of X (boiling point of 78°C) and 40 mole percent of Y (boiling point of 102°C) has to be distilled so that the final distillate contains 95 mole percent of X and the residue has 95 mole percent of Y.

The feed is preheated so that it enters the distillation column with a molar percentage vapour equal to the distillate – feed ratio. A reflux ratio of 3.5 moles to 1 mole of product is used.

Information for drawing the equilibrium line for this system is given in table 1:

Table 1: Data for equilibrium line

x	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
y	0.0	0.22	0.38	0.51	0.63	0.70	0.78	0.85	0.91	0.98	1.0

Calculate the following:

- a. The minimum number of stages **(5 Marks)**
- b. The minimum reflux ratio **(5 marks)**
- c. The number of stages for reflux when
 $R / R_{\min} = 1.3$ **(5 marks)**
- d. Position of feed plate **(5 Marks)**

2. A factory called Amai's Oil Refinery industry extracts oil from groundnut meal. The meal is fed into a cross current extraction unit. An amount of 240,000 kilograms of meal is treated in a 24-hour shift. The groundnut oil contains 25% of oil. The process extracts oil in each hour so that the final raffinate remains with a minimal of 5% of the compound.
- A pure hexane solvent is used and at each stage, the amount of feed = amount of solvent. For every 1 kg of solution, there is 1 kg of inert material.

Determine the following:

- a. Number of stages required (**4 marks**)
 - b. Total amount of extracted oil (**8 marks**)
 - c. Amount of raffinate obtained (**8 marks**)
3. Milk is to undergo UHT (ultra high temperature) processing using a concurrent tubular heat exchanger being used as a method of heating. UHT full fat (3.5%) milk is to be produced at 5000kg/hour with a desired time / temperature of 2 seconds at 150°C. Milk with an initial temperature of 15°C is fed to the heat exchanger and steam at 543.1KPa and of 100% quality is used as the heating media. Condensate at 155°C flows from the steam trap.
- The composition of the 3.5% full fat milk is given as 87.7% Moisture, 3.3% Protein, 3.5% Fat, 4.8% carbohydrates and the rest is ash.
- a. Construct and label a simple process flow chart showing the concurrent flow of the milk and steam (**5 marks**)
 - b. Determine the specific heat capacity (C_p) of the low fat milk using the data given (**5 marks**)
 - c. Write appropriate energy balance equations (i.e. incoming milk, outgoing milk, incoming stream of steam and also the outgoing stream of the condensate). Reference state: water at 0°C.
- With this information, solve for the amount of steam required to achieve processed UHT low fat milk at the given conditions (**10 marks**)
- Note that enthalpies of incoming components = enthalpies of leaving components.

- 4.
- a. Discuss the process of gas absorption and the design of absorption towers. **(10 marks)**
- b. Name and briefly describe three (3) types of trays used in gas absorption. **(10 marks)**
5. You are approached by a firm that manufactures a cooking oil brand X. However, the consumers of brand X are concerned about a yellow-greenish taint and an undesirable odour that is present in the oil.
- Describe and discuss a unit operation that can solve the firm's problem, including at least one equipment and other relevant materials required in this system (explain how the unit operation rids the oil of the unwanted impurities). **(20marks)**

SECTION 2: Answer at least 2 questions in a separate booklet.

1. A single-effect evaporator is concentrating a feed of 9000 kg/h of a 10% solution of NaOH in water to a product of 50% solids. The pressure of the saturated steam used is 42kPa (gauge) and the pressure in the vapour space of the evaporator is 20 kPa (absolute). The overall heat-transfer co-efficient is 1988 W/m² .K. Calculate the steam used, steam economy, and the area if the feed temperature of 15.6°C and when it is increased to 48.9°C. The heat capacity of the feed is 4.06kJ/kg.K **(20 marks)**
2. a) Discuss the difference between primary and secondary nucleation and name one type of crystallizer for each **(5 marks)**
- b) A feed solution of 2228 kg at 54.4°C containing 48.2kg MgSO₄/100 kg total water is cooled to 20 °C, where MgSO₄.7H₂O crystals are removed. The solubility of the salt is 35.5 kg MgSO₄/100 kg total water. The average heat capacity of the feed solution can be assumed as 2.93kJ/kg.K. The heat of the solution at 18 °C is -13.31x 10³kJ/kg.mol MgSO₄.7H₂O. Calculate the yield of

crystals obtained if 3% of original water in the system evaporates on cooling and determine the total heat absorbed **(15 marks)**

3. a) The sugar making process involves the concentration of clear sugar solution from 10 -13^o Brix to 40 - 60^o Brix. You are approached by Kafue sugar, who would like to know what equipment can be used for this operation? Justify your answer. **(7marks)**
- b) Explain the importance of supersaturation in crystallization and how it is achieved. How does it influence the design of crystallizers? **(6marks)**
- c) Determine the boiling temperature of the solution and the boiling-point rise for a 30% NaOH solution boiling in an evaporator at a pressure of 172.4 kPa. **(7marks)**

Data for the Examination

$$F = D + B$$

$$x_D / R_D + 1$$

$$R_m / R_m + 1 = (x_D - y') / (x_D - x')$$

$$R_m = (x_D - y') / (y' - x')$$

$$q = 1 - f$$

$$- q / 1 - q$$

$$q = 1 + \frac{C_{pL} (T_b - T_F)}{\lambda}$$

$$q = - \frac{C_{pV} (T_F - T_d)}{\lambda}$$

$$L_o + V_2 = L_1 + V_1 = M$$

$$x_s = p / (p + 1)$$

$$C_p = 1.424 m_c + 1.549 m_p + 1.675 m_f + 0.837 m_a + 4.187 m_m$$

$$C_p = 1.675 + 0.025 w$$

$$\Delta H = mc (T_2 - T_1)$$

$$\Delta H_s = m_s H_s \quad \text{or} \quad \Delta H_s = m_c H_c$$

From steam tables

$$H_{s,543.1} = 2746.5 \text{ kJ / kg}$$

$$H_{c,155} = 627 \text{ kJ / kg}$$

$$\Lambda = H_s - h_s$$

$$F = L + V$$

$$F x_F = L x_L$$

$$q = U A \Delta T$$

$$q = S(H_s - h_s) = S\Lambda$$

$$q = (H_2 + H_v) - H_1$$

molar weight

$$\text{MgSO}_4 = 120$$

$$\text{H} = 2$$

$$\text{O} = 16$$

THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
2006 ACADEMIC YEAR FIRST SEMESTER FINAL EXAMINATION
AGF 521 - Principles of Food Technology II

Instructions: Answer Question one (1) (Compulsory) and any other four (4) questions of your choice.

Time allowed: Three (3) Hours

1. You are the Product Development Manager of a firm and you have been given a task to formulate a liquid food product using the following ingredients.

Olive oil,	30% v/v
Water,	70% v/v
Basil, parsley	Plant herbs
Acetic acid	
Flavourant	
Flavour enhancers	
Colourants	
Monoacylglycerols	
Salt	
Xanthan gum	

In relation to the whole course of AGF 521, discuss the following

- a. Describe the type of emulsion that you expect from the combination of these ingredients.
 - b. Briefly describe at least two (2) types of colloidal interactions that could be effective in this type of system.
 - c. Explain two (2) major types of destabilization that could occur in this system and at least three (3) modes of stabilizing this kind of system (explaining precisely how the stability mechanism works).
 - d. Given the two (2) types of stabilising or emulsifying agents given for this formulation, explain what could happen if they are added in high and low concentrations in an emulsion (that is beyond their optimum or required amounts in the formulation).
- (20marks)**
- 2.
- a. Briefly discuss the Marangoni effect including its relationship with the LaPlace pressure. **(10 marks)**
 - b. A droplet of water with an average diameter of 200nm is placed on a flat surface. The vapour pressure above the flat surface is 2.34KPa. Determine the vapour pressure above the droplet given that the prevailing temperature condition is 20°C. **(10 marks)**

3. Aqueous solutions of a non-ionic surfactant at 20°C were experimentally found to have the following surface tensions.

C (mol/dm ³):	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.08	0.10
γ (mN/m):	72.6	64.6	60.0	56.8	54.3	51.9	49.8	46.0	43.0

C = Concentration

γ = Surface Tension

- a. Calculate the surface excess concentration, Γ , and the average surface area, Σ , available per mole of the surfactant at concentrations of -:
- 20mmole/dm³
 - 40mmole/dm³
- (15 marks)**
- b. Briefly describe the Gibbs law adsorption equation by way of a plot of surface tension versus natural logarithm of concentration. Clearly outline what is happening at every stage diagrammatically. **(5 marks)**
4. Discuss three (3) types of flow conditions that are prevalent during emulsification and outline how each of the flow rates is effective in bringing about droplet disruption. **(20 marks)**
- 5.
- a. Discuss and contrast slow and fast coagulation. **(10 marks)**
- b. Given that an emulsion of 10%v/v oil-in-water emulsion at 25°C has a half life of three (3) months and that the average diameter is 500nm. Calculate the following
- $t_{1/2}$, rapid
 - N_o
 - W
- (10 marks)**
6. A food company produces a product from milk by inoculating two strains of bacteria, *Lactobacillus bulgaricus* and *Streptococcus thermophilus*, into fresh pasteurized milk. The fluid milk is converted into a thick product which is later stirred to obtain a fluid like product that is thinner than the non stirred product. The stirred product is then packaged and ready for sale.
- Explain graphically the difference between the original product and the microbiologically transformed product in terms of viscosity and shear rates over time. **(5 marks)**
 - Explain what is happening during this transformation from the milk to the final product in terms of colloid science. **(5 marks)**
 - Differentiate Newtonian and non-Newtonian fluids giving an example of each. **(5 marks)**.

- iv. What category of non-Newtonian fluids does the stirred product belong to and why? (5 marks)
7. Figure 1 below shows the experimentally determined values of the electrophoretic mobility of a series of soybean oil emulsions in water. The aqueous phases contained 50, 100, 200 and 500 mM KCl.
- i. Estimate the zeta (ζ) potential of the emulsion droplets of the 100 and 200mM KCl solutions as a function of the electrolyte concentration using the Helmholtz-Smoluchowski equation (10 marks)
- ii. If the sample containing 10mM KCl is investigated by moving boundary electrophoresis. Over what distance will the boundary between the emulsion and dispersion media move within one (1) minute. The applied electric field is 2000V/m. (10 marks)

$T = 25\text{ }^{\circ}\text{C}$

$D = 78.55$

dielectric constant of the electrolyte solutions

$\eta = 0.89 \cdot 10^{-3}\text{ Pa}\cdot\text{s}$

viscosity of electrolyte

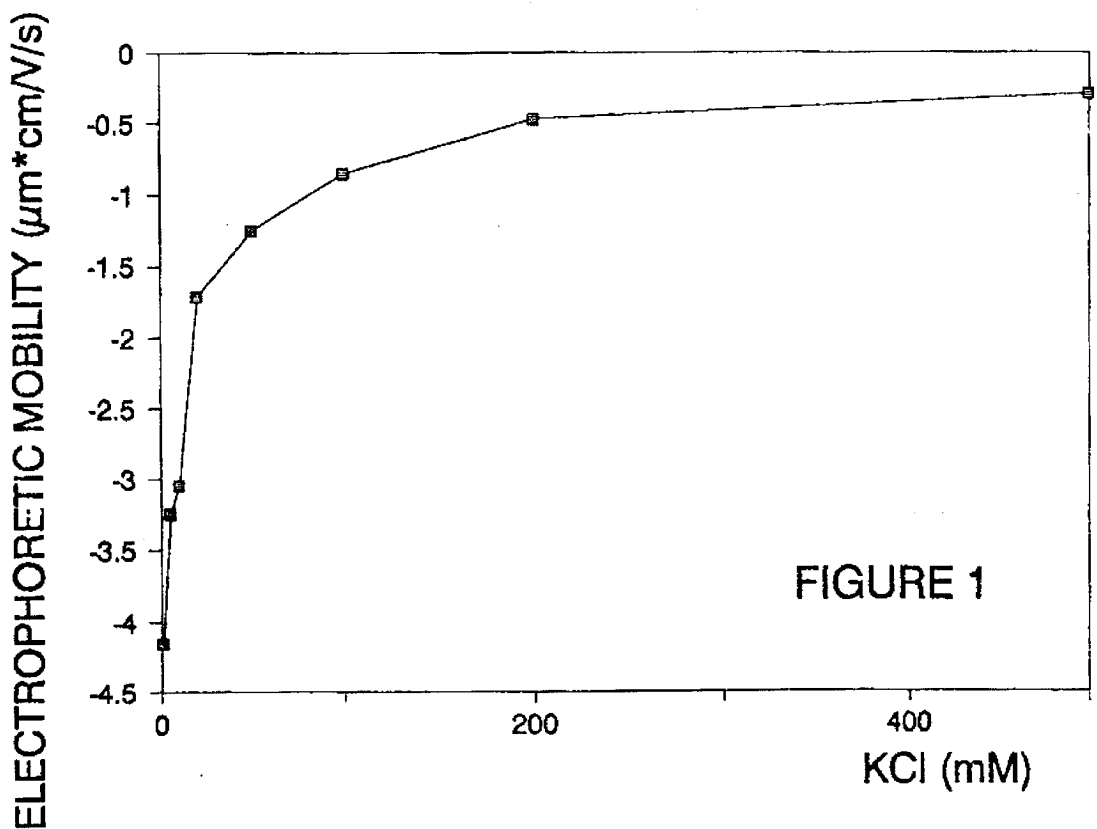


Figure1

8. Discuss two (2) applications and two (2) technological relevancies of electrophoresis in Colloid science (**20 marks**)

End of Exam

Formulae and constants for examination

$$\Gamma = -1 / (R^*T) * (d\gamma / d\ln C) = -C / R^*T * d\gamma / dC$$

$$\Sigma = 1 / \Gamma$$

$$\Delta P_L = 2 \gamma / r$$

$$\mu = \frac{\zeta * \epsilon}{1.5\eta}$$

$$\mu = \frac{\zeta * \epsilon}{\eta}$$

$$\mu = \frac{v}{E}$$

$$\kappa = \sqrt{(2 * Z^2 * F^2 * C_o / \epsilon RT)}$$

$$\kappa = \sqrt{(2 * Z^2 * e^2 * n_o / \epsilon kT)}$$

$$\kappa = 1.04 * 10^8 \sqrt{(C_o * Z^2)}$$

$$R^*T * \ln [P_{vr} / P_{vo}] = 2 * \gamma * M / \delta * r = 2 * \gamma * V_L / r$$

$$t_{1/2, \text{slow}} = W * t_{1/2, \text{fast}}$$

$$t_{1/2, \text{rapid}} = 3 * \eta / (4 * k * T * N_o) = 2 * 10^{17} / N_o$$

$$N_o = fv / [(\pi/6) * \phi^3]$$

$$F = 96485 \text{ C / Mole}$$

$$e = 1.602 * 10^{-19} \text{ C}$$

$$R = 8.314 \text{ J / (mole.K)}$$

$$\epsilon_o = 8.85 * 10^{-12} \text{ F/m}$$

$$k = 1.38 * 10^{-23} \text{ J/K}$$

$$D = 78.55$$

$$\eta_{H2O, 25^\circ C} = 0.89 * 10^{-3} \text{ Pa.s}$$

$$\eta_{H2O, 20^\circ C} = 1.00 * 10^{-3} \text{ Pa.s}$$

$$\gamma_{H2O, 20^\circ C} = 72 \text{ mN/m}$$

THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY
2006 ACADEMIC YEAR
FIRST SEMESTER FINAL EXAMINATIONS

AGF 531: TECHNOLOGY OF PLANT PRODUCTS I
TIME: THREE (3) HOURS

INSTRUCTIONS:

ANSWER ALL FIVE QUESTIONS.

ANSWER EACH QUESTION IN A SEPARATE ANSWER BOOKLET.

Question 1

During the wet milling of maize, the steeping stage makes one of the important steps. Describe in detail what, why and how is done in during this operation.

(20 Points)

Question 2

What is parboiling of rice and what are the advantages of processing rice using this technology.

(20 Points)

Question 3

Fractionation is one of the fat modification processes. As a consultant, you have been asked by Amanita Premium Oils on how their refined soy bean oil can be used in this procedure and consequently produce margarine. Show process flow diagrams.

(20 Points)

Question 4

Bleaching, in the refining of vegetable oils, is an important unit operation. Describe in detail the aim of this operation and how it is done.

(20 Points)

Question 5

Soy milk production and consumption in Zambia remains a challenge as it is associated with some undesirable quality properties. What are these undesirable quality properties and how can they be minimized during in soy milk processing.

(20 Points)

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
2006 ACADEMIC YEAR FIRST SEMESTER FINAL EXAMINATION
AGF 541 – Technology of Dairy and Egg Products

Instructions: Answer **Five (5)** questions; answer **Questions 1 & 2 and any other one from section one** and **two (2)** from section two. Answer the **two sections in separate booklets**.

Time allowed: Three (3) Hours

SECTION 1: Dairy Technology

1. Describe the yoghurt manufacturing process and explain differences between set and stirred yoghurt. How can the yield be increased? **(15 points)**
2. You are employed as a Quality Assurance Manager at Zammilk, how would you ensure the highest quality in your pasteurized and UHT milk lines from reception to final product? **(13 points)**
3. Discuss the three modes of formulation of casein products and support your answer by a flow diagram. **(12 points)**
4. Ice cream is a mixture of different constituents of differing characteristics (air bubbles, lactose crystals, ice crystals, MAGs, casein and fat micelles, etc). Discuss how these products maintain their integrity in this type of matrix. Include a diagram of ice cream in your explanation. **(12 points)**

SECTION 2: Technology of Eggs – Answer any two questions in a separate booklet.

1. Draw the egg and show its parts. From your diagram, show the part of the egg, which is **not** good as an emulsifier, why? Explain how egg porosity affects egg quality. Describe the other vital functional and nutritional properties of eggs **(10 Points)**

2. To meet both Legal, Regulation and Quality standards describe how eggs are classified, graded and defined. Describe also how and why egg examination is done . **(10 points)**

3. Egg processing and preservation is important in industry, why? Describe methods of egg preservation and the products produced. Explain in detail where these preservation products are used in industry. What processing methods should be avoided if the quality of eggs for future use is to be preserved? (**10 points**)

4. Explain how the following analyses in eggs are carried out for each question include how you would interpret the results **(10 Points)**
 - a. α -amylase why is its determination crucial
 - b. Free fatty acid in dried eggs

THE UNIVERSITY OF ZAMBIA

SCHOOL OF AGRICULTURAL SCIENCES

COURSE AGG 311 – EXPERIMENTAL DESIGNS AND STATISTICS

FIRST SEMESTER EXAMINATIONS - SEPTEMBER 2006

INSTRUCTIONS TO CANDIDATES:

1. Answer **five** questions only, however **question 4 is compulsory**.
2. All questions carry equal marks
3. Time: 3 Hours.

1. Write short notes on the following:

- a) What are Type I and Type II errors in statistical test of significance?
- b) What design would suit a planting date experiment evaluating new maize varieties? Explain why this is so.
- c) The Duncan's Multiple Range Test.
- d) ANOVA break down for a 3^2 factorial experiment with 4 replications showing the array of all factor responses
- e) The mode and median of a set of observations

Marks 20

2. (a) The Analysis of Variance from a factorial experiment is shown as in the table below.

Source	df	SS	MS	EMS	F calc	F table
D_i	2	337.15	-----	$\sigma^2\epsilon + 18\sigma^2_R$	-----	-----
S_j	1	16.66	-----	$\sigma^2\epsilon + 9\sigma^2_{RS} + 27\sigma^2_S$	-----	-----
RS_{ij}	2	---	63.39	$\sigma^2\epsilon + 9\sigma^2_{RS}$	-----	-----
H_k	2	15.59	-----	$\sigma^2\epsilon + 6\sigma^2_{RH} + 18\sigma^2_H$	-----	-----
HS_{jk}	2	80.12	-----	$\sigma^2\epsilon + 3\sigma^2_{SRH} + 9\sigma^2_{HS}$	-----	-----
RH_{ik}	4	---	15.71	$\sigma^2\epsilon + 6\sigma^2_{RH}$	-----	-----
SRH_{ijk}	4	229.44	-----	$\sigma^2\epsilon + 3\sigma^2_{SRH}$	-----	-----
Error	36	200.00	-----	$\sigma^2\epsilon$	-----	-----
Total	53	1068.59				

- i) Complete the ANOVA and do a test of significance
- ii) Which of the factors are fixed and which are random?

Marks 10

2. (b) Members of a group of two migratory bird species were observed to distribute themselves as follows while feeding:

Species	HABITAT		
	In water	In wet mud	In dry mud
1	39	104	31
2	48	294	162

- a) Does the data show independence of habitat preference by the two bird species
 b) How can a vet surgeon use this information with regards to the danger of bird flu should there be worries that these migratory bird species could be carriers of this flu.

Marks 10

3. A Dairy cow breeding company wishing to increase its market share of semen sales of its improved breed in the SADC, set out to study whether or not the cash offer for its bulls varies with the characteristics of the sales agent. It selected one fine looking bull from its prime new breed for which cash offers were solicited from 24 big dairy Farmers in the SADC. Four sales agents were used in the study (denoted A, B, C, D) and each agent was sent to the six dairy farms selected at random from the 24 in the study. The cash offers equivalent to **millions of Zambian kwacha** was as presented in the table below.

DAIRY FARM	SALES AGENT			
	A	B	C	D
1	25	21	26	20
2	24	25	29	23
3	26	23	27	24
4	27	22	28	26
5	23	20	29	21
6	28	22	28	23

- a) Analyze the data and test whether or not cash offers vary for the four different sales agents. Use a level of significance of 0.05
 b) If sales agents A and D are males and B and C are females, examine differences in offers for male and female agents and also differences within each gender group

Marks 20

ANSWER QUESTION 4

4. There has been a surge of interest in aquaculture in Zambia. This appears to have arisen following the commissioning of a new canning factory in Lusaka which has opened up possibilities for processing fish and presenting it as a canned product to consumers.

The Fisheries department has commissioned a study to examine the comparative productivity of five local Tilapia species designated as **Sp1, Sp2, Sp3, Sp4, and Sp5**. A

fish biologist has advised that two variables could be a source of variation in fish yield and these are water temperature and sources of pelleted fish feed. He then suggested that the study should be done in aquariums in which water will be maintained at 15°C, 20°C, 25°C, 30°C, and 35°C. He also suggested that there is a need to source fish feed from a random sample of five feed manufacturers. The suggested range of water temperature regimes used in the study was for the purpose of simulating the probable temperature regimes the fish will be subjected to during commercial culture.

- Clearly explain how you will conduct such an experiment and state the design that you will use that will provide information to the Fisheries Department
- State the null and alternative hypotheses and clearly explain how you will analyze the data you will obtain from this experiment in the form of the ANOVA table.
- Comment on why you have chosen this type of design for this research trial.

Marks 20

5. Recent research findings from the International Plant Genetic Resources Institute (IPGRI) have shown that Livingstone Potatoes (known as Umumbu in Kapirimposhi) are very high in β carotene. This information has led the Government to decree that cultivation of this crop using scientific agronomic methods be started in Zambia right away.

Two factors are said to influence the β carotene content of Livingstone Potatoes and these are Genotype and soil Nitrogen. The genotype or factor A comprised of two local varieties and soil nitrogen or factor B were two rates; that is 50kg/ha N and 100kg/ha N. The response variable is β carotene concentrations in micro grams. Data is presented in the table below.

FACTORS		Treatment combinations	REPLICATIONS			
A	B		1	2	3	4
-	-	(1)	18.2	18.9	12.9	14.4
+	-	a	27.2	24.0	22.4	22.5
-	+	b	15.9	14.5	15.1	14.2
+	+	ab	41.0	43.9	36.1	39.2

- Analyze data from this experiment and interpret the results
- Draw the AB interaction plot and interpret this plot

Marks 20

6. A forage agronomist wishes to establish the relation ship between irrigation water supply and yield of Alfalfa of Lucern for his client. To do this he called on agronomists from the National Irrigation Research Station at Nanga in Mazabuka to furnish him with past research findings on this subject. The data he was given in tons per hectare is in the table below. Water applications are in millimeters.

Yield (y)	52.7	56.8	62.5	72.1	80.2	87.1	84.2
Water (x)	12.0	18.0	24.0	30.0	36.0	42.0	48.0

- a) Develop a prediction equation
- b) Comment on how a study of this nature can influence the efficacy of irrigation on forage production in alfalfa in a dairy farm setting.

Marks 20

7. It has been generally recommended that mortar for building requires a mixing formulation of seven (7) wheel barrow loads of building sand to be mixed with one 50kg packet of cement. However a lecturer in Agricultural Engineering teaching a Farm Structures course is of the opinion that you could use a modified formulation where you mix eight (8) wheel barrow loads of building sand with one 50kg packet of cement and get the same quality of mortar. To prove this he did a series of modified and unmodified mortar formulations with his class. He then determined the Tension Bond Strength of these mortar formulations. The Tension Bond Strengths in Kg/cm³ are shown in Table below.

Modified Mortar	Unmodified Mortar
16.85	17.50
16.40	17.63
17.21	18.25
16.35	18.00
16.52	17.86
17.04	17.75
16.96	18.22
17.15	17.90
16.59	17.96
16.57	18.15

- a) State the Null and Alternative hypotheses
- b) Are the claims of the lecturer correct?
[Use the t –test with $\alpha = 0.05$]

Marks 20

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

TABLE A.2.
Distribution of t^2

Degrees of Freedom	Probability of Obtaining a Value as Large or Larger					
	0.400	0.200	0.100	0.050	0.010	0.001
1	1.376	3.078	6.314	12.706	63.657	
2	1.061	1.886	2.920	4.303	9.925	31.598
3	0.978	1.638	2.353	3.182	5.841	12.941
4	0.941	1.533	2.132	2.776	4.604	8.610
5	0.920	1.476	2.015	2.571	4.032	6.859
6	0.906	1.440	1.943	2.447	3.707	5.959
7	0.895	1.415	1.895	2.365	3.499	5.405
8	0.889	1.397	1.860	2.306	3.355	5.041
9	0.883	1.383	1.833	2.262	3.250	4.781
10	0.879	1.372	1.812	2.228	3.169	4.587
11	0.876	1.363	1.796	2.201	3.106	4.437
12	0.873	1.356	1.782	2.179	3.055	4.318
13	0.870	1.350	1.771	2.160	3.012	4.221
14	0.868	1.345	1.761	2.145	2.977	4.140
15	0.866	1.341	1.753	2.131	2.947	4.073
16	0.865	1.337	1.746	2.120	2.921	4.015
17	0.863	1.333	1.740	2.110	2.898	3.965
18	0.862	1.330	1.734	2.101	2.878	3.922
19	0.861	1.328	1.729	2.093	2.861	3.883
20	0.860	1.325	1.725	2.086	2.845	3.850
21	0.859	1.323	1.721	2.080	2.831	3.819
22	0.858	1.321	1.717	2.074	2.819	3.792
23	0.858	1.319	1.714	2.069	2.807	3.767
24	0.857	1.318	1.711	2.064	2.797	3.745
25	0.856	1.316	1.708	2.060	2.787	3.725
26	0.856	1.315	1.706	2.056	2.779	3.707
27	0.855	1.314	1.703	2.052	2.771	3.690
28	0.855	1.313	1.701	2.048	2.763	3.674
29	0.854	1.311	1.699	2.045	2.756	3.659
30	0.854	1.310	1.697	2.042	2.750	3.646

TABLE A.2.
continued.

Degrees of Freedom	Probability of Obtaining a Value as Large or Larger					
	0.400	0.200	0.100	0.050	0.010	0.001
35	0.852	1.306	1.690	2.030	2.724	3.591
40	0.851	1.303	1.684	2.021	2.704	3.551
45	0.850	1.301	1.680	2.014	2.690	3.520
50	0.849	1.299	1.676	2.008	2.678	3.496
55	0.849	1.297	1.673	2.004	2.669	3.476
60	0.848	1.296	1.671	2.000	2.660	3.460
70	0.847	1.294	1.667	1.994	2.648	3.435
80	0.847	1.293	1.665	1.989	2.638	3.416
90	0.846	1.291	1.662	1.986	2.631	3.402
100	0.846	1.290	1.661	1.982	2.625	3.390
120	0.845	1.289	1.658	1.980	2.617	3.373
∞	0.8416	1.2816	1.6448	1.9600	2.5758	3.2905

Parts of this table are taken from Table III of Fisher and Yates: *Statistical Tables for Biological, Agricultural, and Medical Research*, published by Longman Group Ltd., London (previously published by Oliver & Boyd, Edinburgh), by permission of the authors and publishers. Other parts were calculated following Chen and Makowsky (see footnote to Table A.3).

TABLE A.3.
10%, 5% and 1% points for the F distribution.*

DF For Denom	Degrees of Freedom for Numrator (Greater Mean Square)																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
1	.10	39.86	49.50	53.59	55.83	57.24	58.20	58.91	59.44	59.86	60.19	60.47	60.71	60.90	61.07	61.22	61.35	61.46	61.57	61.66	61.74
	.05	161	200	216	225	230	234	237	239	241	242	243	244	245	245	246	246	247	247	248	248
	.01	4.052	4.999	5.403	5.625	5.764	5.859	5.928	5.981	6.022	6.056	6.083	6.106	6.126	6.143	6.157	6.170	6.181	6.191	6.201	6.209
2	.10	8.53	9.00	9.16	9.24	9.29	9.33	9.35	9.37	9.38	9.39	9.40	9.41	9.41	9.42	9.42	9.43	9.43	9.44	9.44	9.44
	.05	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38	19.40	19.40	19.41	19.42	19.42	19.43	19.43	19.44	19.44	19.44	19.45
	.01	98.50	99.00	99.17	99.25	99.30	99.33	99.36	99.37	99.39	99.40	99.41	99.42	99.42	99.43	99.43	99.44	99.44	99.44	99.45	99.45
3	.10	5.54	5.46	5.39	5.34	5.31	5.28	5.27	5.25	5.24	5.23	5.22	5.22	5.21	5.20	5.20	5.20	5.19	5.19	5.19	5.18
	.05	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.76	8.74	8.73	8.71	8.70	8.69	8.68	8.67	8.67	8.66
	.01	34.12	30.82	29.46	28.71	28.24	27.91	27.67	27.49	27.35	27.23	27.13	27.05	26.98	26.92	26.87	26.83	26.79	26.75	26.72	26.69
4	.10	4.54	4.32	4.19	4.11	4.05	4.01	3.98	3.95	3.94	3.92	3.91	3.90	3.89	3.88	3.87	3.86	3.86	3.85	3.85	3.84
	.05	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.94	5.91	5.89	5.87	5.86	5.84	5.83	5.82	5.81	5.80
	.01	21.20	18.00	16.69	15.98	15.52	15.21	14.98	14.80	14.66	14.55	14.45	14.37	14.31	14.25	14.20	14.15	14.11	14.08	14.05	14.02
5	.10	4.06	3.78	3.62	3.52	3.45	3.40	3.37	3.34	3.32	3.30	3.28	3.27	3.26	3.25	3.24	3.23	3.22	3.22	3.21	3.21
	.05	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.70	4.68	4.66	4.64	4.62	4.60	4.59	4.58	4.57	4.56
	.01	16.26	13.27	12.06	11.39	10.97	10.67	10.46	10.29	10.16	1.105	9.96	9.89	9.82	9.77	9.72	9.68	9.64	9.61	9.58	9.55
6	.10	3.78	3.46	3.29	3.18	3.11	3.05	3.01	2.98	2.96	2.94	2.92	2.90	2.89	2.88	2.87	2.86	2.85	2.85	2.84	2.84
	.05	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.03	4.00	3.98	3.96	3.94	3.92	3.91	3.90	3.88	3.87
	.01	13.75	10.92	9.78	9.15	8.75	8.47	8.26	8.10	7.98	.87	7.79	7.72	7.66	7.60	7.56	7.52	7.48	7.45	7.42	7.40

*The points of this table were calculated from Hubert J. Chen and A. B. Makowski. "On Approximations to the F-Distribution and Its Inverse." Report

Degrees of Freedom for Numerator (Greater Mean Square)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
3.59	3.26	3.07	2.96	2.88	2.83	2.78	2.75	2.72	2.70	2.68	2.67	2.65	2.64	2.63	2.62	2.61	2.61	2.60	2.59	
5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.60	3.57	3.55	3.53	3.51	3.49	3.48	3.47	3.46	3.44	
12.25	9.55	8.45	7.85	7.46	7.19	6.99	6.84	6.72	6.62	6.54	6.47	6.41	6.36	6.31	6.28	6.24	6.21	6.18	6.16	
3.46	3.11	2.92	2.81	2.73	2.67	2.62	2.59	2.56	2.54	2.52	2.50	2.49	2.48	2.46	2.45	2.45	2.44	2.43	2.42	
5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.31	3.28	3.26	3.24	3.22	3.20	3.19	3.17	3.16	3.15	
11.26	8.65	7.59	7.01	6.63	6.37	6.18	6.03	5.91	5.81	5.73	5.67	5.61	5.56	5.52	5.48	5.44	5.41	5.38	5.36	
3.36	3.01	2.81	2.69	2.61	2.55	2.51	2.47	2.44	2.42	2.40	2.38	2.36	2.35	2.34	2.33	2.32	2.31	2.30	2.30	
5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.10	3.07	3.05	3.03	3.01	2.99	2.97	2.96	2.95	2.94	
10.56	8.02	6.99	6.42	6.06	5.80	5.61	5.47	5.35	5.26	5.18	5.11	5.05	5.01	4.96	4.92	4.89	4.86	4.83	4.81	
3.29	2.92	2.73	2.61	2.52	2.46	2.41	2.38	2.35	2.32	2.30	2.28	2.27	2.26	2.24	2.23	2.22	2.22	2.21	2.20	
4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.94	2.91	2.89	2.86	2.85	2.83	2.81	2.80	2.79	2.77	
10.04	7.56	6.55	5.99	5.64	5.39	5.20	5.06	4.94	4.85	4.77	4.71	4.65	4.60	4.56	4.52	4.49	4.46	4.43	4.41	
3.23	2.86	2.66	2.54	2.45	2.39	2.34	2.30	2.27	2.25	2.23	2.21	2.19	2.18	2.17	2.16	2.15	2.14	2.13	2.12	
4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.82	2.79	2.76	2.74	2.72	2.70	2.69	2.67	2.66	2.65	
9.65	7.21	6.22	5.67	5.32	5.07	4.89	4.74	4.63	4.54	4.46	4.40	4.34	4.29	4.25	4.21	4.18	4.15	4.12	4.10	
3.18	2.81	2.61	2.48	2.39	2.33	2.28	2.24	2.21	2.19	2.17	2.15	2.13	2.12	2.10	2.09	2.08	2.08	2.07	2.06	
4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.72	2.69	2.66	2.64	2.62	2.60	2.58	2.57	2.56	2.54	
9.33	6.93	5.95	5.41	5.06	4.82	4.64	4.50	4.39	4.30	4.22	4.16	4.10	4.05	4.01	3.97	3.94	3.91	3.88	3.86	
3.14	2.76	2.56	2.43	2.35	2.28	2.23	2.20	2.16	2.14	2.12	2.10	2.08	2.07	2.05	2.04	2.03	2.02	2.01	2.01	
4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.63	2.60	2.58	2.55	2.53	2.51	2.50	2.48	2.47	2.46	
9.07	6.70	5.74	5.21	4.86	4.62	4.44	4.30	4.19	4.10	4.02	3.96	3.91	3.86	3.82	3.78	3.75	3.72	3.69	3.66	
3.10	2.73	2.52	2.39	2.31	2.24	2.19	2.15	2.12	2.10	2.07	2.05	2.04	2.02	2.01	2.00	1.99	1.98	1.97	1.96	
4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.57	2.53	2.51	2.48	2.46	2.44	2.43	2.41	2.40	2.39	
8.86	6.51	5.56	5.04	4.69	4.46	4.28	4.14	4.03	3.94	3.86	3.80	3.75	3.70	3.66	3.62	3.59	3.56	3.53	3.51	
3.07	2.70	2.49	2.36	2.27	2.21	2.16	2.12	2.09	2.06	2.04	2.02	2.00	1.99	1.97	1.96	1.95	1.94	1.93	1.92	
4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.51	2.48	2.45	2.42	2.40	2.38	2.37	2.35	2.34	2.33	
8.68	6.36	5.42	4.89	4.56	4.32	4.14	4.00	3.89	3.80	3.73	3.67	3.61	3.56	3.52	3.49	3.45	3.42	3.40	3.37	
3.05	2.67	2.46	2.33	2.24	2.18	2.13	2.09	2.06	2.03	2.01	1.99	1.97	1.95	1.94	1.93	1.92	1.91	1.90	1.89	
4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.46	2.42	2.40	2.37	2.35	2.33	2.32	2.30	2.29	2.28	
8.53	6.23	5.29	4.77	4.44	4.20	4.03	3.89	3.78	3.69	3.62	3.55	3.50	3.45	3.41	3.37	3.34	3.31	3.28	3.26	
3.03	2.64	2.44	2.31	2.22	2.15	2.10	2.06	2.03	2.00	1.98	1.96	1.94	1.93	1.91	1.90	1.89	1.88	1.87	1.86	
4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.41	2.38	2.35	2.33	2.31	2.29	2.27	2.26	2.24	2.23	
8.40	6.11	5.18	4.67	4.34	4.10	3.93	3.79	3.68	3.59	3.52	3.46	3.40	3.35	3.31	3.27	3.24	3.21	3.19	3.16	
3.01	2.62	2.42	2.29	2.20	2.13	2.08	2.04	2.00	1.98	1.95	1.93	1.92	1.90	1.89	1.87	1.86	1.85	1.84	1.84	
4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.37	2.34	2.31	2.29	2.27	2.25	2.23	2.22	2.20	2.19	
8.29	6.01	5.09	4.58	4.25	4.01	3.84	3.71	3.60	3.51	3.43	3.37	3.32	3.27	3.23	3.19	3.16	3.13	3.10	3.08	
2.99	2.61	2.40	2.27	2.18	2.11	2.06	2.02	1.98	1.96	1.93	1.91	1.89	1.88	1.86	1.85	1.84	1.83	1.82	1.81	
4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.34	2.31	2.28	2.26	2.23	2.21	2.20	2.18	2.17	2.16	
8.18	5.93	5.01	4.50	4.17	3.94	3.77	3.63	3.52	3.43	3.36	3.30	3.24	3.19	3.15	3.12	3.08	3.05	3.03	3.00	
2.97	2.59	2.38	2.25	2.16	2.09	2.04	2.00	1.96	1.94	1.91	1.89	1.87	1.86	1.84	1.83	1.82	1.81	1.80	1.79	
4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.31	2.28	2.25	2.22	2.20	2.18	2.17	2.15	2.14	2.12	
8.10	5.85	4.94	4.43	4.10	3.87	3.70	3.56	3.46	3.37	3.29	3.23	3.18	3.13	3.09	3.05	3.02	2.99	2.96	2.94	

Degrees of Freedom for Numerator (Greater Mean Square)

P	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
.10	2.96	2.57	2.36	2.23	2.14	2.08	2.02	1.98	1.95	1.92	1.90	1.87	1.86	1.84	1.83	1.81	1.80	1.79	1.78	1.78
.05	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.28	2.25	2.22	2.20	2.18	2.16	2.14	2.12	2.11	2.10
.01	8.02	5.78	4.87	4.37	4.04	3.81	3.64	3.51	3.40	3.31	3.24	3.17	3.12	3.07	3.03	2.99	2.96	2.93	2.90	2.88
.10	2.95	2.56	2.35	2.22	2.13	2.06	2.01	1.97	1.93	1.90	1.88	1.86	1.84	1.83	1.81	1.80	1.79	1.78	1.77	1.76
.05	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30	2.26	2.23	2.20	2.17	2.15	2.13	2.11	2.10	2.08	2.07
.01	7.95	5.72	4.82	4.31	3.99	3.76	3.59	3.45	3.35	3.26	3.18	3.12	3.07	3.02	2.98	2.94	2.91	2.88	2.85	2.83
.10	2.94	2.55	2.34	2.21	2.11	2.05	1.99	1.95	1.92	1.89	1.87	1.84	1.83	1.81	1.80	1.78	1.77	1.76	1.75	1.74
.05	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32	2.27	2.24	2.20	2.18	2.15	2.13	2.11	2.09	2.08	2.06	2.05
.01	7.88	5.66	4.76	4.26	3.94	3.71	3.54	3.41	3.30	3.21	3.14	3.07	3.02	2.97	2.93	2.89	2.86	2.83	2.80	2.78
.10	2.93	2.54	2.33	2.19	2.10	2.04	1.98	1.94	1.91	1.88	1.85	1.83	1.81	1.80	1.78	1.77	1.76	1.75	1.74	1.73
.05	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25	2.22	2.18	2.15	2.13	2.11	2.09	2.07	2.05	2.04	2.03
.01	7.82	5.61	4.72	4.22	3.90	3.67	3.50	3.36	3.26	3.17	3.09	3.03	2.98	2.93	2.89	2.85	2.82	2.79	2.76	2.74
.10	2.92	2.53	2.32	2.18	2.09	2.02	1.97	1.93	1.89	1.84	1.82	1.80	1.79	1.77	1.76	1.75	1.74	1.73	1.73	1.72
.05	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28	2.24	2.20	2.16	2.14	2.11	2.09	2.07	2.05	2.04	2.02	2.01
.01	7.77	5.57	4.68	4.18	3.85	3.63	3.46	3.32	3.22	3.13	3.06	2.99	2.94	2.89	2.85	2.81	2.78	2.75	2.72	2.70
.10	2.91	2.52	2.31	2.17	2.08	2.01	1.96	1.92	1.88	1.86	1.83	1.81	1.79	1.77	1.76	1.75	1.73	1.72	1.71	1.71
.05	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27	2.22	2.18	2.15	2.12	2.09	2.07	2.05	2.03	2.02	2.00	1.99
.01	7.72	5.53	4.64	4.14	3.82	3.59	3.42	3.29	3.18	3.09	3.02	2.96	2.90	2.86	2.81	2.78	2.75	2.72	2.69	2.68
.10	2.90	2.51	2.30	2.17	2.07	2.00	1.95	1.91	1.87	1.85	1.82	1.80	1.78	1.76	1.75	1.74	1.72	1.71	1.70	1.70
.05	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25	2.20	2.17	2.13	2.10	2.08	2.06	2.04	2.02	2.00	1.99	1.97
.01	7.68	5.49	4.60	4.11	3.78	3.56	3.39	3.26	3.15	3.06	2.99	2.93	2.87	2.82	2.78	2.75	2.71	2.68	2.66	2.63
.10	2.89	2.50	2.29	2.16	2.06	2.00	1.94	1.90	1.87	1.84	1.81	1.79	1.77	1.75	1.74	1.73	1.71	1.70	1.69	1.69
.05	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24	2.19	2.15	2.12	2.09	2.06	2.04	2.02	2.00	1.99	1.97	1.96
.01	7.64	5.45	4.57	4.07	3.75	3.53	3.36	3.23	3.12	3.03	2.96	2.90	2.84	2.79	2.75	2.72	2.68	2.65	2.63	2.60
.10	2.89	2.50	2.28	2.15	2.06	1.99	1.93	1.89	1.86	1.83	1.80	1.78	1.76	1.75	1.73	1.72	1.71	1.69	1.68	1.68
.05	4.18	3.33	2.93	2.70	2.55	2.43	2.35	2.28	2.22	2.18	2.14	2.10	2.08	2.05	2.03	2.01	1.99	1.97	1.96	1.94
.01	7.60	5.42	4.54	4.04	3.73	3.50	3.33	3.20	3.09	3.00	2.93	2.87	2.81	2.77	2.73	2.69	2.66	2.63	2.60	2.57
.10	2.88	2.49	2.28	2.14	2.05	1.98	1.93	1.88	1.85	1.82	1.79	1.77	1.75	1.74	1.72	1.71	1.70	1.69	1.68	1.67
.05	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.13	2.09	2.06	2.04	2.01	1.99	1.98	1.96	1.95	1.93
.01	7.56	5.39	4.51	4.02	3.70	3.47	3.30	3.17	3.07	2.98	2.91	2.84	2.79	2.74	2.70	2.66	2.63	2.60	2.57	2.55
.10	2.87	2.48	2.26	2.13	2.04	1.97	1.91	1.87	1.83	1.81	1.78	1.76	1.74	1.72	1.71	1.69	1.68	1.67	1.66	1.65
.05	4.15	3.29	2.90	2.67	2.51	2.40	2.31	2.24	2.19	2.14	2.10	2.07	2.04	2.01	1.99	1.97	1.95	1.94	1.92	1.91
.01	7.50	5.34	4.46	3.97	3.65	3.43	3.26	3.13	3.02	2.93	2.86	2.80	2.74	2.70	2.65	2.62	2.58	2.55	2.53	2.50
.10	2.86	2.47	2.25	2.12	2.02	1.96	1.90	1.86	1.82	1.79	1.77	1.75	1.73	1.71	1.69	1.68	1.67	1.66	1.65	1.64
.05	4.13	3.28	2.88	2.65	2.49	2.38	2.29	2.23	2.17	2.12	2.08	2.05	2.02	1.99	1.97	1.95	1.93	1.92	1.90	1.89
.01	7.44	5.29	4.42	3.93	3.61	3.39	3.22	3.09	2.98	2.89	2.82	2.76	2.70	2.66	2.61	2.58	2.54	2.51	2.49	2.46
.10	2.85	2.46	2.24	2.11	2.01	1.94	1.89	1.85	1.81	1.78	1.76	1.73	1.71	1.70	1.68	1.67	1.66	1.65	1.64	1.63
.05	4.11	3.26	2.87	2.63	2.48	2.36	2.28	2.21	2.15	2.11	2.07	2.03	2.00	1.98	1.95	1.93	1.92	1.90	1.88	1.87
.01	7.40	5.25	4.38	3.89	3.57	3.35	3.18	3.05	2.95	2.86	2.79	2.72	2.67	2.62	2.58	2.54	2.51	2.48	2.45	2.43
.10	2.84	2.45	2.23	2.10	2.01	1.94	1.88	1.84	1.80	1.77	1.75	1.72	1.70	1.69	1.67	1.66	1.65	1.63	1.62	1.61
.05	4.10	3.24	2.85	2.62	2.46	2.35	2.26	2.19	2.14	2.09	2.05	2.02	1.99	1.96	1.94	1.92	1.90	1.88	1.87	1.85
.01	7.35	5.21	4.34	3.86	3.54	3.32	3.15	3.02	2.92	2.83	2.75	2.69	2.64	2.59	2.55	2.51	2.48	2.45	2.42	2.40

A.3.
pd.

Degrees of Freedom for Numerator (Greater Mean Square)

P	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
.10	2.84	2.44	2.23	2.09	2.00	1.93	1.87	1.83	1.79	1.76	1.74	1.71	1.70	1.68	1.66	1.65	1.64	1.62	1.61	1.61
.05	4.08	3.23	2.84	2.81	2.45	2.34	2.25	2.18	2.12	2.08	2.04	2.00	1.97	1.95	1.92	1.90	1.89	1.87	1.85	1.84
.01	7.31	5.18	4.31	3.83	3.51	3.29	3.12	2.99	2.89	2.80	2.73	2.66	2.61	2.56	2.52	2.48	2.45	2.42	2.39	2.37
.10	2.83	2.43	2.22	2.08	1.99	1.92	1.86	1.82	1.78	1.75	1.73	1.71	1.69	1.67	1.65	1.64	1.63	1.62	1.61	1.60
.05	4.07	3.22	2.83	2.59	2.44	2.32	2.24	2.17	2.11	2.06	2.03	1.99	1.96	1.94	1.91	1.89	1.87	1.86	1.84	1.83
.01	7.28	5.15	4.29	3.80	3.49	3.27	3.10	2.97	2.86	2.78	2.70	2.64	2.59	2.54	2.50	2.46	2.43	2.40	2.37	2.34
.10	2.82	2.43	2.21	2.08	1.98	1.91	1.86	1.81	1.78	1.75	1.72	1.70	1.68	1.66	1.65	1.63	1.62	1.61	1.60	1.59
.05	4.06	3.21	2.82	2.58	2.43	2.31	2.23	2.16	2.10	2.05	2.01	1.98	1.95	1.92	1.90	1.88	1.86	1.84	1.83	1.81
.01	7.25	5.12	4.26	3.78	3.47	3.24	3.08	2.95	2.84	2.75	2.68	2.62	2.56	2.52	2.47	2.44	2.40	2.37	2.35	2.32
.10	2.82	2.42	2.21	2.07	1.98	1.91	1.85	1.81	1.77	1.74	1.71	1.69	1.67	1.65	1.64	1.63	1.61	1.60	1.59	1.58
.05	4.05	3.20	2.81	2.57	2.42	2.30	2.22	2.15	2.09	2.04	2.00	1.97	1.94	1.91	1.89	1.87	1.85	1.83	1.82	1.80
.01	7.22	5.10	4.24	3.76	3.44	3.22	3.06	2.93	2.82	2.73	2.66	2.60	2.54	2.50	2.45	2.42	2.38	2.35	2.33	2.30
.10	2.81	2.42	2.20	2.07	1.97	1.90	1.85	1.80	1.77	1.73	1.71	1.69	1.67	1.65	1.63	1.62	1.61	1.59	1.58	1.57
.05	4.04	3.19	2.80	2.57	2.41	2.29	2.21	2.14	2.08	2.03	1.99	1.96	1.93	1.90	1.88	1.86	1.84	1.82	1.81	1.79
.01	7.19	5.08	4.22	3.74	3.43	3.20	3.04	2.91	2.80	2.71	2.64	2.58	2.53	2.48	2.44	2.40	2.37	2.33	2.31	2.28
.10	2.81	2.41	2.20	2.06	1.97	1.90	1.84	1.80	1.76	1.73	1.70	1.68	1.66	1.64	1.63	1.61	1.60	1.59	1.58	1.57
.05	4.03	3.18	2.79	2.56	2.40	2.29	2.20	2.13	2.07	2.03	1.99	1.95	1.92	1.89	1.87	1.85	1.83	1.81	1.80	1.78
.01	7.17	5.06	4.20	3.72	3.41	3.19	3.02	2.89	2.78	2.70	2.63	2.56	2.51	2.46	2.42	2.38	2.35	2.32	2.29	2.27
.10	2.80	2.40	2.19	2.05	1.95	1.88	1.83	1.78	1.75	1.72	1.69	1.67	1.65	1.63	1.61	1.60	1.59	1.58	1.56	1.55
.05	4.02	3.16	2.77	2.54	2.38	2.27	2.18	2.11	2.06	2.01	1.97	1.93	1.90	1.88	1.85	1.83	1.81	1.79	1.78	1.76
.01	7.12	5.01	4.16	3.68	3.37	3.15	2.98	2.85	2.75	2.66	2.59	2.53	2.47	2.42	2.38	2.34	2.31	2.28	2.25	2.23
.10	2.79	2.39	2.18	2.04	1.95	1.87	1.82	1.77	1.74	1.71	1.68	1.66	1.64	1.62	1.60	1.59	1.58	1.56	1.55	1.54
.05	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99	1.95	1.92	1.89	1.86	1.84	1.82	1.80	1.78	1.76	1.75
.01	7.08	4.96	4.13	3.65	3.34	3.12	2.95	2.82	2.72	2.63	2.56	2.50	2.44	2.39	2.35	2.31	2.28	2.25	2.22	2.20
.10	2.78	2.39	2.17	2.03	1.94	1.87	1.81	1.77	1.73	1.70	1.67	1.65	1.63	1.61	1.59	1.58	1.57	1.55	1.54	1.53
.05	3.99	3.14	2.75	2.51	2.36	2.24	2.15	2.08	2.03	1.98	1.94	1.90	1.87	1.85	1.82	1.80	1.78	1.76	1.75	1.73
.01	7.04	4.95	4.10	3.62	3.31	3.09	2.93	2.80	2.69	2.61	2.53	2.47	2.42	2.37	2.33	2.29	2.26	2.23	2.20	2.17
.10	2.78	2.38	2.16	2.03	1.93	1.86	1.80	1.76	1.72	1.69	1.66	1.64	1.62	1.60	1.59	1.57	1.56	1.55	1.54	1.53
.05	3.98	3.13	2.74	2.50	2.35	2.23	2.14	2.07	2.02	1.97	1.93	1.89	1.86	1.84	1.81	1.79	1.77	1.75	1.74	1.72
.01	7.01	4.92	4.07	3.60	3.29	3.07	2.91	2.78	2.67	2.59	2.51	2.45	2.40	2.35	2.31	2.27	2.23	2.20	2.18	2.15
.10	2.77	2.37	2.15	2.02	1.92	1.85	1.79	1.75	1.71	1.68	1.65	1.63	1.61	1.59	1.57	1.56	1.55	1.53	1.52	1.51
.05	3.96	3.11	2.72	2.49	2.33	2.21	2.13	2.06	2.00	1.95	1.91	1.88	1.84	1.82	1.79	1.77	1.75	1.73	1.72	1.70
.01	6.96	4.88	4.04	3.56	3.26	3.04	2.87	2.74	2.64	2.55	2.48	2.42	2.36	2.31	2.27	2.23	2.20	2.17	2.14	2.12
.10	2.76	2.36	2.14	2.00	1.91	1.83	1.78	1.73	1.69	1.66	1.64	1.61	1.59	1.57	1.56	1.54	1.53	1.52	1.50	1.49
.05	3.94	3.09	2.70	2.46	2.31	2.19	2.10	2.03	1.97	1.93	1.89	1.85	1.82	1.79	1.77	1.75	1.73	1.71	1.69	1.68
.01	6.90	4.82	3.98	3.51	3.21	2.99	2.82	2.69	2.59	2.50	2.43	2.37	2.31	2.27	2.22	2.19	2.15	2.12	2.09	2.07
.10	2.75	2.35	2.13	1.99	1.90	1.82	1.77	1.72	1.68	1.65	1.63	1.60	1.58	1.56	1.55	1.53	1.52	1.50	1.49	1.48
.05	3.92	3.07	2.68	2.45	2.29	2.18	2.09	2.02	1.96	1.91	1.87	1.83	1.80	1.78	1.75	1.73	1.71	1.69	1.67	1.66
.01	6.85	4.79	3.95	3.48	3.17	2.96	2.79	2.66	2.56	2.47	2.40	2.34	2.28	2.23	2.19	2.15	2.12	2.09	2.06	2.03
.10	2.74	2.34	2.12	1.98	1.89	1.81	1.76	1.71	1.67	1.64	1.61	1.59	1.57	1.55	1.53	1.52	1.50	1.49	1.48	1.47
.05	3.90	3.06	2.66	2.43	2.27	2.16	2.07	2.00	1.94	1.89	1.85	1.82	1.79	1.76	1.73	1.71	1.69	1.67	1.66	1.64
.01	6.81	4.75	3.91	3.45	3.14	2.92	2.76	2.63	2.53	2.44	2.37	2.31	2.25	2.20	2.16	2.12	2.08	2.06	2.03	2.00

TABLE A.3.
Continued.

DF For Denom	P	Degrees of Freedom for Numerator (Greater Mean Square)																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
200	.10	2.73	2.33	2.11	1.97	1.88	1.80	1.75	1.70	1.66	1.63	1.60	1.58	1.56	1.54	1.52	1.51	1.49	1.48	1.47	1.46
	.05	3.89	3.01	2.65	2.42	2.26	2.14	2.06	1.98	1.93	1.88	1.84	1.80	1.77	1.74	1.72	1.69	1.67	1.66	1.64	1.62
	.01	6.76	4.71	3.88	3.41	3.11	2.89	2.73	2.60	2.50	2.41	2.34	2.27	2.22	2.17	2.13	2.09	2.06	2.03	2.00	1.97
400	.10	2.72	2.32	2.10	1.96	1.86	1.79	1.73	1.69	1.65	1.61	1.59	1.56	1.54	1.52	1.50	1.49	1.47	1.46	1.45	1.44
	.05	3.86	3.02	2.63	2.39	2.24	2.12	2.03	1.96	1.90	1.85	1.81	1.78	1.74	1.72	1.69	1.67	1.65	1.63	1.61	1.60
	.01	6.70	4.66	3.83	3.37	3.06	2.85	2.68	2.56	2.45	2.37	2.29	2.23	2.17	2.13	2.08	2.05	2.01	1.98	1.95	1.92
1000	.10	2.71	2.31	2.09	1.95	1.85	1.78	1.72	1.68	1.64	1.61	1.58	1.55	1.53	1.51	1.49	1.48	1.46	1.45	1.44	1.43
	.05	3.85	3.00	2.61	2.38	2.22	2.11	2.02	1.95	1.89	1.84	1.80	1.76	1.73	1.70	1.68	1.65	1.63	1.61	1.60	1.58
	.01	6.66	4.63	3.80	3.34	3.04	2.82	2.66	2.53	2.43	2.34	2.27	2.20	2.15	2.10	2.06	2.02	1.98	1.95	1.92	1.90
∞	.10	2.71	2.30	2.08	1.94	1.85	1.77	1.72	1.67	1.63	1.60	1.57	1.55	1.52	1.50	1.49	1.47	1.45	1.44	1.43	1.42
	.05	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83	1.79	1.75	1.72	1.69	1.67	1.64	1.62	1.60	1.58	1.57
	.01	6.63	4.61	3.78	3.32	3.02	2.80	2.64	2.51	2.41	2.32	2.25	2.18	2.13	2.08	2.04	1.99	1.96	1.93	1.90	1.88

TABLE A.4
 Significant studentized factors (R) to multiply by LSD for testing means at various ranges (p), 5% level; n = degrees of freedom for error

n	p:																			
	2	3	4	5	6	7	8	9	10	12	14	16	18	20	50	100				
4	1.00	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02				
5	1.00	1.03	1.04	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05				
6	1.00	1.03	1.05	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06				
7	1.00	1.04	1.06	1.07	1.07	1.07	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08				
8	1.00	1.04	1.06	1.08	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09				
9	1.00	1.04	1.07	1.08	1.09	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10				
10	1.00	1.05	1.07	1.09	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10				
11	1.00	1.05	1.08	1.09	1.10	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11				
12	1.00	1.05	1.08	1.09	1.10	1.11	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12				
13	1.00	1.05	1.08	1.09	1.10	1.11	1.12	1.12	1.12	1.13	1.13	1.13	1.13	1.13	1.13	1.13				
14	1.00	1.05	1.08	1.10	1.11	1.12	1.12	1.13	1.13	1.14	1.14	1.14	1.14	1.14	1.14	1.14				
15	1.00	1.05	1.08	1.10	1.12	1.12	1.13	1.13	1.14	1.14	1.15	1.15	1.15	1.15	1.15	1.15				
16	1.00	1.05	1.08	1.10	1.12	1.13	1.13	1.14	1.14	1.15	1.15	1.16	1.16	1.16	1.16	1.16				
17	1.00	1.05	1.08	1.10	1.12	1.13	1.13	1.14	1.15	1.15	1.16	1.16	1.17	1.17	1.17	1.17				
18	1.00	1.05	1.08	1.10	1.12	1.13	1.13	1.14	1.15	1.15	1.16	1.16	1.17	1.17	1.17	1.17				
19	1.00	1.05	1.08	1.10	1.12	1.13	1.14	1.14	1.15	1.15	1.16	1.17	1.17	1.18	1.18	1.18				
20	1.00	1.05	1.08	1.10	1.12	1.13	1.14	1.15	1.15	1.16	1.16	1.17	1.18	1.18	1.18	1.18				
22	1.00	1.05	1.08	1.10	1.12	1.13	1.14	1.15	1.16	1.16	1.17	1.17	1.18	1.18	1.18	1.18				
24	1.00	1.05	1.08	1.10	1.12	1.13	1.14	1.15	1.16	1.16	1.17	1.18	1.18	1.19	1.19	1.19				
26	1.00	1.05	1.08	1.10	1.12	1.13	1.14	1.15	1.16	1.16	1.17	1.18	1.19	1.19	1.19	1.19				
28	1.00	1.05	1.08	1.10	1.12	1.13	1.14	1.15	1.16	1.16	1.17	1.18	1.19	1.19	1.19	1.19				
30	1.00	1.05	1.08	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.17	1.18	1.19	1.20	1.20	1.20				
40	1.00	1.05	1.08	1.11	1.13	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.20	1.20	1.20				
60	1.00	1.05	1.09	1.11	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21	1.21	1.21	1.23				
100	1.00	1.05	1.09	1.11	1.14	1.15	1.16	1.18	1.18	1.19	1.20	1.21	1.22	1.23	1.23	1.23				
∞	1.00	1.05	1.09	1.12	1.14	1.15	1.17	1.18	1.19	1.20	1.21	1.22	1.23	1.24	1.26	1.26				

TABLE A.5.
 Significant studentized factors (R) to multiply by LSD for testing means at various ranges (p), 1% level; n = degrees of freedom for "error".

n	p:																			
	2	3	4	5	6	7	8	9	10	12	14	16	18	20	50	100				
3	1.00	1.03	1.04	1.05	1.07	1.08	1.08	1.09	1.09	1.09	1.10	1.11	1.13	1.13	1.13	1.13				
4	1.00	1.04	1.06	1.08	1.09	1.09	1.11	1.11	1.12	1.12	1.14	1.14	1.15	1.15	1.15	1.15				
5	1.00	1.05	1.07	1.08	1.10	1.11	1.12	1.13	1.14	1.16	1.16	1.18	1.18	1.19	1.19	1.19				
6	1.00	1.05	1.08	1.09	1.11	1.12	1.14	1.15	1.15	1.16	1.18	1.18	1.20	1.20	1.20	1.20				
7	1.00	1.05	1.08	1.10	1.12	1.13	1.15	1.16	1.17	1.17	1.19	1.19	1.21	1.21	1.21	1.21				
8	1.00	1.05	1.08	1.10	1.12	1.14	1.15	1.16	1.17	1.18	1.20	1.20	1.22	1.22	1.22	1.22				
9	1.00	1.06	1.08	1.10	1.12	1.14	1.16	1.17	1.17	1.19	1.21	1.22	1.24	1.24	1.24	1.24				
10	1.00	1.06	1.09	1.11	1.13	1.15	1.16	1.17	1.18	1.20	1.21	1.22	1.24	1.24	1.24	1.24				
11	1.00	1.05	1.09	1.11	1.13	1.14	1.15	1.17	1.17	1.19	1.20	1.22	1.23	1.23	1.23	1.23				
12	1.00	1.05	1.08	1.10	1.12	1.14	1.15	1.17	1.17	1.19	1.20	1.21	1.22	1.22	1.22	1.22				
13	1.00	1.05	1.08	1.10	1.12	1.14	1.15	1.17	1.17	1.18	1.19	1.20	1.21	1.21	1.21	1.21				
14	1.00	1.05	1.08	1.10	1.12	1.14	1.15	1.17	1.17	1.18	1.19	1.20	1.20	1.20	1.20	1.20				
15	1.00	1.05	1.08	1.10	1.11	1.13	1.14	1.16	1.16	1.18	1.18	1.19	1.20	1.20	1.20	1.20				
16	1.00	1.05	1.08	1.10	1.11	1.13	1.14	1.16	1.16	1.17	1.18	1.19	1.19	1.19	1.19	1.19				
17	1.00	1.05	1.08	1.10	1.11	1.13	1.14	1.16	1.16	1.17	1.18	1.19	1.19	1.19	1.19	1.19				
18	1.00	1.05	1.08	1.10	1.11	1.13	1.14	1.15	1.16	1.17	1.18	1.18	1.19	1.19	1.19	1.19				
19	1.00	1.05	1.07	1.09	1.11	1.13	1.14	1.15	1.16	1.17	1.18	1.18	1.19	1.19	1.19	1.19				
20	1.00	1.05	1.07	1.09	1.11	1.13	1.14	1.15	1.15	1.17	1.18	1.18	1.19	1.19	1.19	1.19				
22	1.00	1.05	1.07	1.09	1.11	1.12	1.14	1.15	1.15	1.17	1.17	1.18	1.19	1.19	1.19	1.19				
24	1.00	1.05	1.07	1.09	1.11	1.12	1.13	1.15	1.15	1.17	1.17	1.18	1.19	1.19	1.19	1.19				
26	1.00	1.05	1.07	1.09	1.11	1.12	1.13	1.15	1.15	1.17	1.18	1.18	1.19	1.19	1.19	1.19				
28	1.00	1.04	1.07	1.09	1.11	1.12	1.13	1.14	1.15	1.17	1.18	1.18	1.19	1.19	1.19	1.19				
30	1.00	1.04	1.07	1.09	1.11	1.12	1.13	1.14	1.15	1.17	1.18	1.18	1.19	1.19	1.19	1.19				
40	1.00	1.04	1.07	1.09	1.11	1.12	1.14	1.14	1.15	1.17	1.18	1.19	1.20	1.20	1.20	1.20				
60	1.00	1.04	1.07	1.09	1.11	1.12	1.14	1.15	1.15	1.17	1.18	1.19	1.20	1.20	1.20	1.20				
100	1.00	1.04	1.07	1.09	1.11	1.12	1.14	1.15	1.15	1.17	1.18	1.19	1.20	1.20	1.20	1.20				
∞	1.00	1.04	1.07	1.09	1.11	1.12	1.14	1.15	1.15	1.17	1.18	1.19	1.20	1.20	1.20	1.20				

TABLE A.6.

Distribution of χ^2 (Chi-Square)^a.

Degrees of Freedom	Probability of Obtaining a Value as Large or Larger							
	.99	.95	.90	.50	.10	.05	.01	.001
1	.0002	.00393	.0158	.455	2.706	3.841	6.635	10.827
2	.0201	.103	.211	1.386	4.605	5.991	9.210	13.815
3	.115	.352	.584	2.366	6.251	7.815	11.345	16.268
4	.297	.711	1.064	3.357	7.779	9.488	13.277	18.465
5	.554	1.145	1.610	4.351	9.236	11.070	15.086	20.517
6	.872	1.635	2.204	5.348	10.645	12.592	16.812	22.457
7	1.239	2.167	2.833	6.346	12.017	14.067	18.475	24.322
8	1.646	2.733	3.490	7.344	13.362	15.507	20.090	26.125
9	2.088	3.325	4.168	8.343	14.684	16.919	21.666	27.877
10	2.558	3.940	4.865	9.342	15.987	18.307	23.209	29.588
11	3.053	4.575	5.578	10.341	17.275	19.675	24.725	31.264
12	3.571	5.226	6.304	11.340	18.549	21.026	26.217	32.909
13	4.107	5.892	7.042	12.340	19.812	22.362	27.688	34.528
14	4.660	6.571	7.790	13.339	21.064	23.685	29.141	36.123
15	5.229	7.261	8.547	14.339	22.307	24.996	30.578	37.697
16	5.812	7.962	9.312	15.338	23.542	26.296	32.000	39.252
17	6.408	8.672	10.085	16.338	24.769	27.587	33.409	40.790
18	7.015	9.390	10.865	17.338	25.989	28.869	34.805	42.312
19	7.633	10.117	11.651	18.338	27.204	30.144	36.191	43.820
20	8.260	10.851	12.443	19.337	28.412	31.410	37.566	45.315
21	8.897	11.591	13.240	20.337	29.615	32.671	38.932	46.797
22	9.542	12.338	14.041	21.337	30.813	33.924	40.289	48.268
23	10.196	13.091	14.848	22.337	32.007	35.172	41.638	49.728
24	10.856	13.848	15.659	23.337	33.196	36.415	42.980	51.179
25	11.524	14.611	16.473	24.337	34.382	37.652	44.314	52.620
26	12.198	15.379	17.292	25.336	35.563	38.885	45.642	54.052
27	12.879	16.151	18.114	26.336	36.741	40.113	46.963	55.476
28	13.565	16.928	18.939	27.336	37.916	41.337	48.278	56.893
29	14.256	17.708	19.768	28.336	39.087	42.557	49.588	58.302
30	14.953	18.493	20.599	29.336	40.256	43.773	50.892	59.703

Table A.6 is abridged from Table IV of Fisher and Yates: *Statistical Tables for Biological, Agricultural and Medical Research*, published by Longman Group Ltd., London (previously published by Oliver and Boyd, Edinburgh), by permission of the authors and publishers.

TABLE A.7.

Values of the correlation coefficient, r , for certain levels of significance.^a

Degrees of Freedom	Probability of Obtaining a Value as Large or Larger			
	.1	.05	.01	.001
1	.9879	.9969	.9999	1.0000
2	.9000	.9500	.9900	.9990
3	.8054	.8783	.9587	.9912
4	.7293	.8114	.9172	.9741
5	.6694	.7545	.8745	.9507
6	.6215	.7067	.8343	.9249
7	.5822	.6664	.7977	.8982
8	.5494	.6319	.7646	.8721
9	.5214	.6021	.7348	.8471
10	.4973	.5760	.7079	.8233
11	.4762	.5529	.6835	.8010
12	.4575	.5324	.6614	.7800
13	.4409	.5139	.6411	.7603
14	.4259	.4973	.6226	.7420
15	.4124	.4821	.6055	.7246
16	.4000	.4683	.5897	.7084
17	.3887	.4555	.5751	.6932
18	.3783	.4438	.5614	.6787
19	.3687	.4329	.5487	.6652
20	.3598	.4227	.5368	.6524
25	.3233	.3809	.4869	.5974
30	.2960	.3494	.4487	.5541
35	.2746	.3246	.4182	.5189
40	.2573	.3044	.3932	.4896
45	.2428	.2875	.3721	.4648
50	.2306	.2732	.3541	.4433
60	.2108	.2500	.3248	.4078
70	.1954	.2319	.3017	.3799
80	.1829	.2172	.2830	.3568
90	.1726	.2050	.2673	.3375
100	.1638	.1946	.2540	.3211

^aTable A.7 is abridged from Table VI of Fisher and Yates: *Statistical Tables for Biological, Agricultural, and Medical Research*, published by Longman Group Ltd., London (previously published by Oliver and Boyd, Edinburgh), by permission of the authors and publishers.



THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
CROP SCIENCE DEPARTMENT
AGG 6211

UNIVERSITY EXAMINATIONS JUNE 2006

Answer five questions only, however question 4 is compulsory. All questions carry equal marks
Time: 3 Hours.

Marks
20

- 1.0 Write short notes on the following:
- The model of an experiment
 - The difference between the Z and the T Distributions in statistical inference
 - What does a researcher mean when he/she states that "factors are crossed"
 - What is meant by the term "Balanced and Unbalanced" experiments
 - Multi-factor experiments are said to be superior to single factor experiments. Explain why this is so.

2.0 The Analysis of Variance from a factorial experiment is shown as in the table below.

Source	df	SS	MS	EMS
R_i	2	337.15	---	$\sigma^2_e + 18\sigma^2_r$
S_i	1	16.66	---	$\sigma^2_e + 9\sigma^2_{rs} + 27\sigma^2_s$
RS_{ij}	2	---	63.39	$\sigma^2_e + 9\sigma^2_{rs}$
H_k	2	15.59	---	$\sigma^2_e + 6\sigma^2_{RH} + 18\sigma^2_H$
HS_k	2	80.12	---	$\sigma^2_e + 3\sigma^2_{SRH} + 9\sigma^2_{HS}$
RH_{ik}	4	---	15.71	$\sigma^2_e + 6\sigma^2_{RH}$
SRH_{ijk}	4	229.44	---	$\sigma^2_e + 3\sigma^2_{SRH}$
Error	36	200.00	---	σ^2_e
Total	53	1068.59	---	

- i) Complete the ANOVA and do a test of significance

- ii) Which of the factors are fixed and which are random?

- 3.0 A Dairy cow breeding company wishing to increase its market share of semen sales in the SADC of its improved breed set out to study whether or not the cash offer for its bulls varies with the characteristics of the sales agent. It selected one fine looking bull from its prime new breed for which cash offers were solicited from 24 Big dairy Farmers in the SADC. Four sales agents were used in the study (denoted A, B, C, D) and each agent was sent to six dairy farms selected at random from the 24 in the study. The cash offers equivalent to millions of **Zambian kwacha** were as presented in the table below.

DAIRY FARM	SALES AGENT			
	A	B	C	D
1	25	21	26	20
2	24	25	29	23
3	26	23	27	24
4	27	22	28	26
5	23	20	29	21
6	28	22	28	23

- a) Analyze the data and test whether or not cash offers vary for the four different sales agents. Use a level of significance of 0.05
 b) If sales agents A and D are males and B and C are females, examine differences in offers for male and female agents and also differences within each gender group

ANSWER QUESTION 4

- 4.0 There has been a surge of interest in aquaculture in Zambia. This appears to have arisen following the commissioning of a new canning factory in Lusaka which has opened up possibilities for processing fish and presenting it as a canned product to consumers.

The Fisheries department has commissioned a study to test the response of five local Tilapia species to locally manufactured pelleted fish feeds on fish yield after a period of six months. A fish biologist has advised that water temperature does affect fish growth and hence final yield. He then suggested that the study should be done in aquariums in which water will be maintained at 15°C, 20°C, 25°C, 30°C, and 35°C. The suggested range water temperature regimes for the study are for the purpose of simulating the probable temperature regimes the fish will be subjected to during culture. There are five local fish feeds to be tested in this research trial

- a) Design an experiment that will provide information to the Fisheries Department

- b) State the null and alternative hypotheses and give the form of the ANOVA
- c) Comment on why you have chosen this type of design for this research trial.

5.0 Members of a group of two migratory bird species were observed to distribute themselves as follows while feeding:

Species	HABITAT		
	In water	In wet mud	In dry mud
1	39	104	31
2	48	294	162

- a) Does the data show independence of habitat preference by the two bird species
- b) How can a vet surgeon use this information with regards to the danger of bird flu should there be worries that these migratory bird species could be carriers of this flu.

6.0 Recent research findings from the International Plant Genetic Resources Institute (IPGRI) have shown that Livingstone Potatoes (known as Umumbu in Kapiririposhi) are very high in β carotene. This information has led the Government to decree that cultivation of this crop using scientific agronomic methods be started in Zambia right away.

Two factors are said to influence the β carotene content of Livingstone Potatoes and these are Genotype and soil Nitrogen. The genotype or factor A comprised of two local varieties and soil nitrogen or factor B were two rates, that is 50kg/ha N and 100kg/ha N. The response variable is β carotene concentrations in micro grams. Data is presented in the table below.

FACTORS	Treatment combinations	REPLICATIONS			
		1	2	3	4
A	B				
-	-	18.2	18.9	12.9	14.4
+	-	27.2	24.0	22.4	22.5
-	+	15.9	14.5	15.1	14.2
+	+	41.0	43.9	36.1	39.2

- a) Analyze data from this experiment and interpret the results
- b) Draw the AB interaction plot and interpret this plot

7.0 A forage agronomist wishes to establish the relation ship between irrigation water supply and yield of Alfalfa of Lucern for his client. To do this he called on agronomists from the National Irrigation Research Station at Nangwa in Mazabuka to furnish him with past research findings on this subject. The data he was given in tons per hectare is in the table below. Water applications are in millimeters.

Yield (y)	52.7	56.8	62.5	72.1	80.2	87.1	84.2
Water (x)	12.0	18.0	24.0	30.0	36.0	42.0	48.0

- a) develop a prediction equation
- b) Do a test of significance of the regression
- c) Comment on the efficacy of irrigation on forage production in alfalfa in a dairy farm setting.

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

UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
UNIVERSITY EXAMINATIONS

AGG 6211 BIostatistics

DECEMBER 2005

INSTRUCTIONS

Answer **Question 1** and any other **THREE**. Marks for each question are indicated in brackets
TIME: 3 hour

Q.1 When using regression analysis in processing data obtained from experiments certain steps are followed, which include testing for linearity, estimating the magnitude of the regression coefficient and getting the reliability of the coefficient. For the data given below work out these steps. (40 points)

Eggs laid	Ovulated follicles
39	37
29	34
46	52
28	26
31	32
25	25
49	55
57	65
51	44
21	25

Q.2. In a study of inheritance of protein in sweet potato the following data were obtained.

Classes for growth Habit	Protein content classes			Total
	0-14	15-29	Above 30	
Standard	8	24	7	39
Intermediate standard	11	28	17	56
Intermediate alpha	9	31	11	51
Alpha	1	14	11	26
Total	29	97	46	172

Test if there is any independence between protein content and growth habit. (20 points)

Q.3 Give short notes on the following: (4 points each)

- a) Assumptions on which for Analysis of Variance is based
- b) Correlation versus Regression
- c) Simple Effects versus Main Effects in factorial Experiment
- d) Sources of Variation for a Split-split plot design
- e) Uses of Analysis of Covariance

Q.4 The following data were obtained from an experiment on the use of hormones in dairy cows to enhance milk yield in litres per milking session.

Treatments were: Hormone A (0 and 100 mg per day) and Hormone B (0 and 60 mg per day).

	Treatments			
	A1B1	A1B2	A2B1	A2B2
	8.53	17.53	39.14	32.00
	20.53	21.07	26.20	23.80
	12.53	20.80	31.33	28.87
	14.00	17.33	45.80	25.06
	10.00	20.07	40.20	29.33
ΣX	66.38	96.80	182.67	139.06
ΣX^2	963.88	1887.02	6913.63	3912.17

Carry out a comprehensive analysis of these data (20 points).

Q. 5 (a) List the topics that you covered in this course during lectures and during the computer practicals sessions pointing to **one very relevant** and **one least relevant** topic stating why. (10 points)

(b) Outline the advantages and disadvantages of CRD, RCBD and Latin Square Designs. (10 points)

.....**END OF EXAMINATION**.....

**UNIVERSITY OF ZAMBIA
EXAMINATION
AGS 211
FUNDAMENTALS OF SOIL SCIENCE I**

September, 2006

INSTRUCTIONS

Time: 3 Hours.

Answer all questions.

1. Define the following terms: (10 marks)
 - a) Cation Exchange Capacity
 - b) Plutonic rock
 - c) Streak of a mineral
 - d) Regional metamorphism
 - e) Physical weathering
 - f) Mycorrhizae
 - g) Mineralization
 - h) Pedogenic processes
 - i) Hydrolysis
 - j) Rock cycle

2. Indicate whether the following statements are true or false or whether you don't know answer. (10 marks) (1 mark correct answer, -0.5 marks wrong answer, and 0 if u don't know)
 - a) Kaolinite is a trioctahedral 1:1 layer silicate mineral whose chemical formula is $Al_2 Si_2 O_5(OH)_4$.
 - b) Pyroxenes are generally more susceptible to chemical weathering in soils than muscovite.
 - c) Facultative anaerobic soil bacteria can survive both in the presence and in the absence of oxygen in soils.
 - d) A soil with a bulk density of $1.75 g \cdot cm^{-3}$ and a gravimetric moisture content of 0.10 gH_2O/g soil has a total density less than $2.0 g \cdot cm^{-3}$.
 - e) Soil minerals with a zero point of charge of 7.6 will attract Phosphate (PO_4^{3-}) ions at pH 5.5.
 - f) Marble is a carbonate rich igneous rock.
 - g) All minerals that are able to scratch Quartz have a hardness of more than 8 on Mohs hardness scale.
 - h) A pycnometer is an instrument used to measure particle density of soils.
 - i) A sandy loam contains more sand than a loamy sand
 - j) The friction force in Stokes' law is given by the equation $F = 2\pi r T \cos\theta$.

3 Answer the following questions briefly and concisely (25 marks)

- a) A mineral has the formula $\text{Ca}_{0.4} (\text{Al}_{1.6} \text{Mg}_{0.4}) \text{Si}_4\text{O}_{10} (\text{OH})_2$.
- What is the name of this mineral? (2 marks)
 - Draw a schematic diagram of the structure of this mineral indicating the locations of all the elements and ions appearing in its chemical formula. (4 marks)
 - Discuss the properties of this mineral with reference to its cation exchange capacity, main source of charge, specific surface area and ability to swell and contract. (4 marks).
- b) What are the ecological adaptations (requirements) of Bacteria and Fungi soil? Briefly discuss the important roles that these two groups of microorganisms play in soils. (6 marks)
- c) List the five factors of soil formation and describe how any two of these factors affect the formation of soils (5 marks)
- d) Briefly describe the properties of humus and its effect on the physical and chemical properties of soils. (4 marks)

4. Selected properties of a soil from Katete are presented in the Table below:

ρ_b kg.m ⁻³	θ_g g.gsoil ⁻¹	Org C %	Total N %	Sand %	Silt %	Clay %	Exch Acidity meq/100g soil	Exch bases meq/100g soil
1.36	0.104	1.22	0.042	17	6	77	4.2	2.2

Answer the following questions (35 marks):

- Calculate the total density of this soil. (4 marks)
- What is the air filled porosity of the soil if the soil particle density is 2.65g.cm⁻³? (4 marks)
- What is the C: N ration of this soil? (2 marks)
- If it is desired to reduce the exchangeable acidity by 50 % by replacing it with Ca ions, using gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) as the source of calcium. How much gypsum should be added per kilogram of soil? (5 marks).
- How many liters of water will be in the top 15 cm of a Lima (0.25ha) of this soil, after receiving 5 mm of rainfall, assuming all the rain water is stored in top 15 cm of the soil (6 marks)

- f) What is the CEC of this soil in cmol/kg? (4 marks)
- g) What is the base saturation of this soil? (4 marks)
- h) If the CEC of organic matter is 200meq/100g, what is the percent contribution of organic matter to the CEC of this soil? (4 marks)
- i) Draw the USDA Triangle and indicate the position of the textural class of this soil on the triangle (3 marks)
- j) If the specific surface areas of sand silt and clay are 10m²/g 50m²/g and 200m²/g respectively what is the total surface area of 100 grams of this soil? (3 marks)
5. A soil sample obtained from the top 20 cm of a field belonging to a farmer practicing conservation farming was analyzed. It was found to have a pH of 5.6, an organic carbon content of 1.5 %, a C: N ratio of 16: 1 and a bulk density of 1.5g.cm⁻³. The soil also contains 0.12 meq of K per 100grams of soil and 6 milligrams of exchangeable Na per 100g of soil and has an Exchangeable Sodium Percentage (ESP) of 5 %. Answer the following questions (20 marks)
- a) What is the CEC of this soil? (3 marks)
- b) How much nitrogen is present in the top 20cm of a hectare of this soil? (3 marks)
- c) Does the top 20cm of this soil contain enough K to meet the requirements of a crop that requires 90 kilograms of potassium per hectare? Show the calculation to support your answer (4 marks)
- d) If the loss of carbon due to microbial respiration is 78 mgCO₂/kg of soil/week, how much organic matter does the farmer have to apply per Lima (0.25ha) annually to maintain the same level of organic matter in the top 20 cm of the soil? (5 marks)
- e) If one unit of nitrogen is mineralized for every 18 units of organic carbon lost from soil organic matter as CO₂, how kilograms of nitrogen will be mineralized per Lima in 4 months from the top 15 cm of the soil. (5 marks)

SOIL SCIENCE IS FUN

END OF EXAMINATION

UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES

UNIVERSITY FIRST SEMESTER EXAMINATIONS-SEPTEMBER, 2006

AGS 311
AGROCLIMATOLOGY

Time: Three (3) Hours

Marks: 77

Instruction: Answer all Questions

Note that for calculated values the number of decimal places should be rounded off to between one to three decimal places where possible

1. Briefly define each of the following terms as applied in Agro climatology (10 marks)
 - a) Albedo of Earth
 - b) Zero absolute temperature
 - c) Basal Heat Production
 - d) Zone of survival
 - e) Solar Constant

2. With an aid of a diagram indicate all the components in percentages the earth's energy budget (20 marks)

3. The earth's atmosphere is composed of four distinct layers based on its thermal properties. Describe briefly the main features of the lower and the upper most layers (12 marks)

4. There has been significant level of consensus amongst scientists that there has been a global temperature change on Earth. What are these agreed changes according to IPCC (2001)? (10 marks)

5. Given the following meteorological data measured this year (2005) Brussels, Belgium (04°23' E, 50°48' N and altitude 100 m): (25 marks)

Maximum air temperature	21.5°C
Minimum air temperature	12.3°C
Maximum relative humidity	84 %
Minimum relative humidity	63 %
Wind speed measured at 10 m height	10 km hr ⁻¹
Estimated extraterrestrial radiation	476.644 W m ⁻²
Measured solar radiation	256.012 W m ⁻²
Inverse relative distance Earth-Sun	0.967 radians

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

Determine:

- Wind speed at standard reference height for agricultural uses (**m/s**)
- Latitude in **radians**
- Solar radiation on a clear-sky day in **MJ m⁻² d⁻¹**
- Net shortwave radiation in **MJ m⁻² d⁻¹**
- Sunset hour angle **in degrees**

End of Exam

THE UNIVERSITY OF ZAMBIA
UNIVERSITY FIRST SEMISTER EXAMINATIONS – SEPTEMBER 2006

AGS 411
SOIL FERTILITY

TIME: 3 Hours

Marks: 80

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

1. a) How is TSP manufactured? [2 Marks]
 - b) What is PAPR? [2 Marks]
 - c) What are the advantages of using PAPR? [4 Marks]
 - d) After adding soluble P to soils you may expect precipitation, adsorption and occlusion of P to take place. Explain how and under what conditions these reactions may take place. [6 Marks]
2. The soils of Northern Zambia are highly weathered as compared to those of Southern Zambia. Briefly discuss the implications of this fact in terms of:
- a) soil acidity
 - b) P availability
 - c) Types of clay minerals [6 Marks]
3. a) What is agroforestry? [2 Marks]
- b) Discuss the beneficial effects of agroforestry systems in terms of soil fertility improvement. [10 Marks]
4. a) What is meant by ions being i) adsorbed and ii) exchangeable? [4 Marks]
- b) What is lyotropic series? Give an example. [2 Marks]
- c) What is complementary ion effect? [2 Marks]
- d) Why are nutrient ratios important in interpretation of soil test results? [2 Marks]
- e) What is reversibility of cation exchange? Give two conditions (reactions) when reversibility is not possible. [4 Marks]
5. Discuss the differences between NH_4^+ and NO_3^- ions in terms of application to the soil, plant uptake and utilization by the plant. [10 Marks]

6. Given the following information, calculate the nitrogen mineralized per hectare in one year: Total soil N is 0.15%, mineralization rate is 3% per year and bulk density of the top 20 cm soil is 1.4 gcm^{-3} . [4 Marks]
7. What are the differences between the characteristics of a saline soil and that of a sodic soil? [10 Marks]
8. a) Molybdenosis and bronzing are soil fertility related conditions. On what species would one observe the associated visual symptoms, and under what soil conditions might one find these problems? [6 Marks]
- b) How would you control these problems? [4 Marks]

END OF EXAMINATION

UNIVERSITY OF ZAMBIA EXAMINATIONS
AGS 431
SOIL MINERALOGY AND MICROMORPHOLOGY
September 25, 2006

INSTRUCTIONS

Time: 3 Hours.

Answer all questions.

1. Define the following terms: (20 marks)
 - a. Amorphous clays
 - b. Phyllosilicates
 - c. Dioctahedral clay mineral
 - d. Integral thermal analysis
 - e. Siallisation
 - f. Refractive Index
 - g. Triclinic crystal system
 - h. Rotary Inversion axis
 - i. Pleochroism
 - j. Crystal form
2.
 - a. What is isomorphous substitution? (2 marks)
 - b. Explain how isomorphous substitution affects chemical properties of phyllosilicates and consequently the soil. (4 marks)
 - c. Briefly discuss the role of (a) leaching and (b) chelation in chemical weathering of rocks. (4 marks)
3. A soil sample from Kabwe was analyzed by X-ray diffraction analysis using $\text{Co } k_{\alpha}$ radiation with a wavelength of 1.79 \AA (Angstroms). Attached is an X-ray diffractogram of the clay fraction of the soil treated with sodium dithionite to remove iron oxides.
 - a) Calculate the d-spacings corresponding to the 5 labelled peaks on the diffractogram in Angstroms and rounded off the answer to one decimal point. (10 marks)
 - b) Indicate the layer silicate minerals to which the calculated d-spacings belong and give reasons to support your answer. (5 marks)
4. A soil from Mpika has a clay fraction composed of muscovite $\text{KAl}_2(\text{Si}_3\text{Al})\text{O}_{10}(\text{OH})_2$, kaolinite $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$ and goethite (FeOOH). A chemical analysis of the soil shows that the clay fraction contains 2.4 % potassium; while a Thermo gravimetric analysis of 120mg of the clay fraction records a weight loss of 9.6 mg at 550°C .

Assuming that all the potassium in the clay fraction is associated with muscovite and that the weight loss at 550 ° C is due to dehydroxylation of kaolinite, answer the following:

- a. Calculate the percentages of muscovite, kaolinite and goethite present in the clay fraction of this soil. Show calculations to support your answers. (20 marks)
- b. If you were to carry out a chemical analysis of the iron (Fe) content of the clay fraction, how much iron (in percent) would you expect to find in this sample? Show calculations to support your answers (5 marks)

Note: Atomic masses: Al = 27g; Si = 28 g; O = 16 g; H = 1g; K = 39 g and Fe = 56 g

- 5 Clearly indicate the differences in structure between Vermiculite and Chlorite and explain the difference in their negative charge. (10 Marks)
- 6 A sample of Apatite ($\text{Ca}_5(\text{PO}_4)_3(\text{OH}, \text{F}, \text{Cl})$) from Chilembwe, in Petauke District of the Eastern Province of Zambia was analyzed at the International Fertilizer Development Centre in the USA. Below are results of the chemical and mineralogical analysis of the apatite from Chilembwe.

Specific gravity = $3.2\text{g}\cdot\text{cm}^{-3}$ Crystal system: Hexagonal

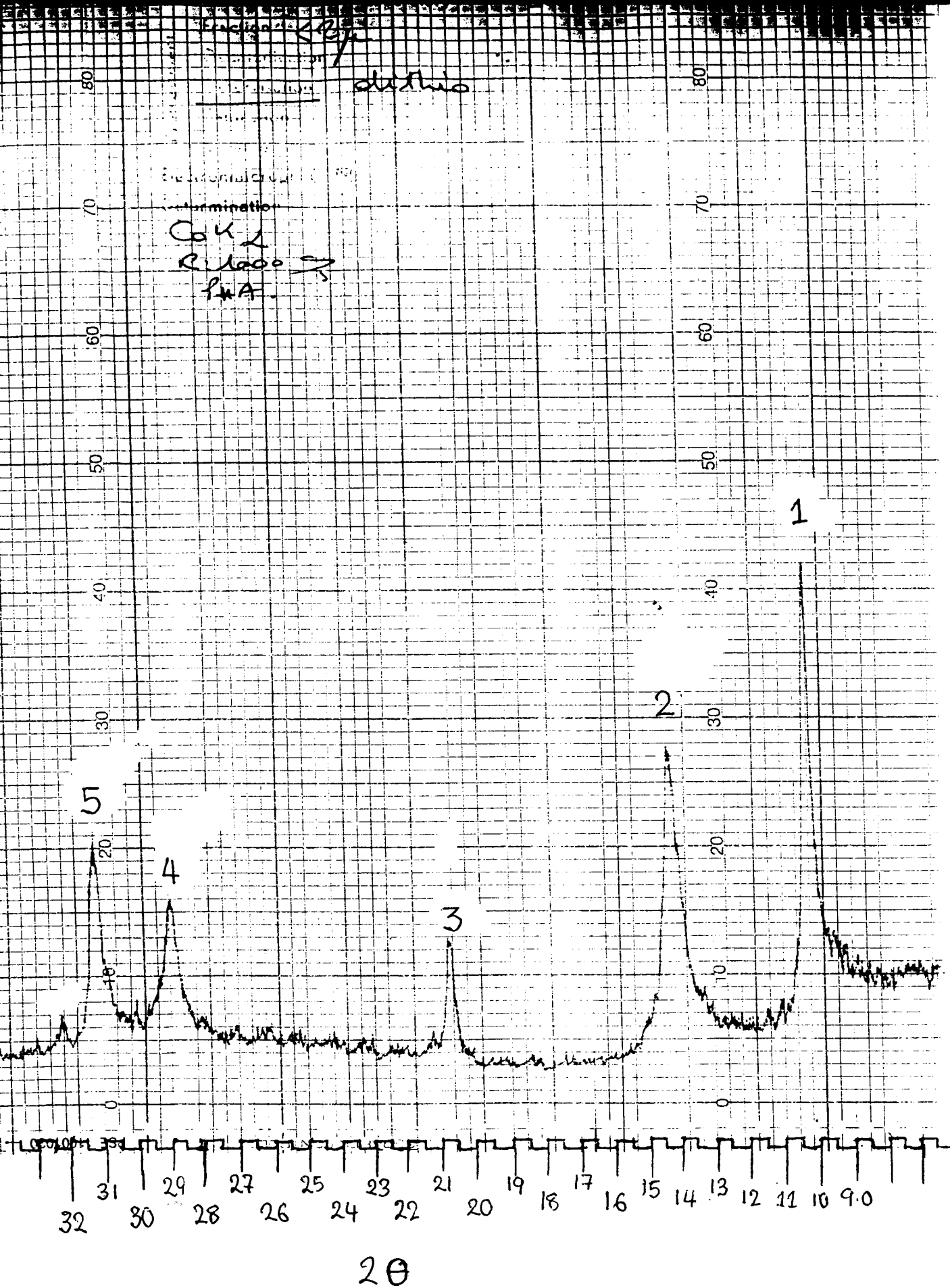
Crystallographic axes: $a = 9.37\text{ nm}$, $c = 6.33\text{ nm}$

~~Lowest~~ ^{Highest} refractive index = 1.632; ~~Highest~~ ^{Lowest} refractive index = 1.628

Answer the following questions:

- a. What are the values of angles α , β , and γ for the Chilembwe apatite? (3 marks)
- b. Draw a schematic diagram of the unit cell of this crystal, showing the various angles and crystal axes. (2.5 marks)
- c. What is the axial ratio of the Chilembwe apatite? (1.5 marks)
- d. Does this mineral polarize light? Give reasons to back your answer. (2.5 marks)
- e. What is the birefringence of this mineral? (1.5 marks)
- f. At what 2θ value would you expect to find the (001) spacing of this mineral if you use X-rays with a wavelength of 0.154nm to analyze the mineral? (5 marks)
- g. If the average phosphate content of Chilembwe phosphate rock is 20% (expressed as P_2O_5) how much Apatite is present in a metric tonne of the phosphate rock if all the P in the rock is in the apatite, and the apatite is $\text{Ca}_5(\text{PO}_4)_3\text{F}$? Note: atomic masses are Ca = 40g, F=19g, P = 31g and O = 16 g (4 marks)

END OF EXAM



2θ

Diffraction pattern of clay fraction for question 3

UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
UNIVERSITY FIRST SEMESTER EXAMINATIONS-SEPTEMBER, 2006

AGS 441: AGRICULTURAL HYDRAULICS AND HYDROLOGY

Time: Three (3) Hours

Marks: 75

Instruction: Answer all Questions

1. Briefly define each of the following terms: (10 marks)

- a) Weight and mass
- b) Vector quantity
- c) Power
- d) Gauge pressure
- e) Sluice gate

2. A storage tank 2.3m long by 1.2m wide and 0.8m deep is full of water (20 marks)

Calculate

- a) The mass of water in the tank (kg)
- b) The pressure on the bottom of the tank (N/m^2)
- c) The force at the end of the tank (N)
- d) The position of this force below the water surface (m)

3. With the aid of a diagram define the different components of specific energy in a channel used to supply water to a farm and give some important points about the specific energy in channel design (15 marks)

4. Kaley Small-holder irrigation scheme in Mazabuka have constructed a 1km pipeline with a diameter of 100cm to deliver water from the Kafue River to their main reservoir for redistribution into farm blocks. For redistribution, irrigation water is supplied through open rectangular channels which are 2.3m wide. The first hydraulic Jump is constructed 500m away from the farm block at a channel discharge of $2.5\text{m}^3\text{s}^{-1}$ with an upstream depth of 0.25m (20 marks)

Calculate:

- a) Velocity (ms^{-1}) in the pipe given the elevation difference of 15m and pipe friction factor of 0.04
- b) Froude number for the channel flow
- c) Depth of flow downstream for the Jump (m)
- d) Energy loss in the Jump (m)

5. A fountain is designed for the Goma lakes. A nozzle diameter of 50mm is chosen and the water velocity at the nozzle will be 8.5ms^{-1} . (10 marks)

- a) Calculate the height to which the water will rise
- b) If the jet of water passes through a circular opening 2m above the nozzle, calculate the diameter of the opening

End of Exam

THE UNIVERSITY OF ZAMBIA

UNIVERSITY FIRST SEMESTER EXAMINATIONS – SEPTEMBER 2006

AGS 511

SOIL CHEMISTRY

TIME: THREE HOURS

INSTRUCTION: ANSWER ALL QUESTIONS (MARKS SHOWN)

1. Oxidation and reduction reactions are considered to be very important in soils.
 - a. Define redox. (3 points)
 - b. Given a wet-land soil and a well drained soil, how would you explain their redox states and probable soil weathering processes/stages? (5 points)
 - c. Discuss the use of pe concept in evaluating the redox status of soils. (3 points)
 - d. Draining submerged soils can make them useful for crop production by raising oxidation status. However, in the case of acid sulphate soils this is not so. Explain. (3 points).

2. Use the free-energy data of Appendixes I and II to explore the possible spontaneity of formation of glucose from carbon dioxide and water. (6 points)

3. The base titration curves for an old H-clay suspension and a new H-clay suspension are likely to be displaced from each other on the graph.
 - a. Discuss the concept of new and old clay in terms of silicate structure and soil surface. (5 points)
 - b. With illustration, explain the comparative positions of the pH and Ec curves between new and old clay, give reasons for the displacement, and finally relate this concept to field situation. (10 points)

4. A farmer has brought in a soil sample for analysis. Upon reading the pH, you suspect that it is an alkaline soil. When you suspend the soil in solution, it remains dispersed and cannot be filtered.
 - a. How would you confirm that this is an alkaline soil? (2 points)
 - b. Fully explain what is causing this alkaline soil to be dispersed? (4 points)
 - c. Using your understanding of ionic strength, dielectric constant, temperature and valence, among others, explain the principles behind how would you go about flocculating this soil suspension?

$$\text{DDL} = \frac{\sqrt{DKt}}{\epsilon\sqrt{8\pi}\sqrt{\mu}} \quad \text{where, } D = \text{dielectric constant,} \quad (4 \text{ points})$$

$t = \text{temperature}$

5. Define or briefly explain the following terms: (10 points)
- Gibbs free energy
 - Ion selectivity
 - ZPC
 - CEC
 - Complex ion
6. A solution contains 0.01 M CaSO_4 , 0.02 M NaCl and 0.04 M CaCl_2 .
- What is the ionic strength of this solution? (2 points)
 - What is the activity of Ca in the solution? (3 points)
($A = -0.509$, $B = 0.328 \times 10^8$, $d = 6 \times 10^{-8}$)
- 7a. Cation exchange process and ion adsorption process are moderated by either ion concentration or ion ratio. Match one with the other and discuss. (5 points).
- 7b. Explain the reactions that govern concentrations of micro elements in the soil solution? (5 points)
8. It is frequently said that Zambia has vast land resource for agriculture. Yet many practitioners of agriculture suggest that low soil productivity is a real challenge to crop production. From a soil chemistry view point, discuss in a generic manner the properties of soils found in the northern, middle and southern parts of Zambia. If there are limitations to their use, what are the chemistry limitations and why are they limitations. What are the possible remedies to make these soils useable for crop production? (15 points)
9. When urea is burned at constant pressure it yields gaseous carbon dioxide, liquid water and nitrogen gas. Show that the heat evolved is consistent with the heat of formation values given in Appendixes I and II. (10 points)
10. Why are soils at an advanced stage of weathering called low activity clay, variable charge soils, and what are the sources of soil charge in this type of clay? (5 points)

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
UNIVERSITY FIRST SEMESTER EXAMINATIONS
SEPTEMBER, 2006

AGS 531: LAND EVALUATION AND IMPROVEMENT

TIME: 3 HOURS

INSTRUCTIONS: ANSWER ALL QUESTIONS.

MARKS: 100

1. Give two (2) of the most widespread land uses in Zambia and explain their major impacts on the environment, suggesting what measures must be taken to mitigate the effects. **(10 marks)**

2. You have been hired as a project manager for a project that intends to promote low to medium input rainfed maize in Mbala.
 - (a) Mention four (4) land qualities that you would estimate in the field. **(4 marks)**
 - (b) Explain why your selected land qualities are critical for the success of this project. **(12 marks)**
 - (c) For each of the selected land qualities, list five (5) associated land characteristics. **(12 marks)**

3. With suitable examples, explain the concepts of:
 - (a) Land characteristics. **(3 marks)**
 - (b) Adaptation. **(3marks)**
 - (c) Farming system. **(3marks)**
 - (d) Major kind of land use. **(3 marks)**

4. Distinguish between currently not suitable and permanently not suitable. **(6 marks)**

5. Provided below is a soil profile description representing a land unit in Solwezi in Northwestern Province in Zambia.
 - (e) Use the Zambian land classification system to determine and explain the capability of this land unit for rainfed arable crop production. **(12 marks)**
 - (f) By evaluating the capability of this land unit, as you have just done in question 4a above, explain the main rules of the Zambian land classification system you have violated. **(5 marks)**

- 6 (a) For the same land unit you have used in question 4, use the Storie Index to determine and explain the productivity of this land unit. **(12 marks)**
- (b) Would it be economically viable to grow 10Ha of cotton on this land unit if we knew that the maximum yield of cotton was 6tons/Ha, it would cost K3.5million/Ha, and that the market price of cotton was K3,000/Kg? **(5 marks)**
7. Using suitable illustrations write short notes on Parametric Land Evaluation Methods. **(4 marks)**
8. Mumbwa District Council has asked you to develop a land use plan for an 80km² area within the district. Discuss in detail the steps you would follow to execute this assignment. **(6 marks)**

END OF EXAMINATION. GOOD LUCK!!!

UNIVERSITY OF ZAMBIA

SCHOOL OF AGRICULTURAL SCIENCES

DEPARTMENT OF SOIL SCIENCE

FIRST SEMESTER: 2006 FINAL EXAMINATIONS

**COURSE: PLANNING AND DEVELOPMENT OF IRRIGATION AND
DRAINAGE SYSTEMS: AGS 551**

DATE: 25 September 2006

TIME: Three hours

INSTRUCTIONS: Marks are indicated for each question

ANSWER: All questions

Q.1

Define, describe or discuss the following words, expressions, phrases or statements with respect to irrigation or irrigation systems:-

- (i) Safe moisture depletion level in irrigation,
- (ii) Plant and soil characteristics which influence plant growth,
- (iii) The role of cytokinin and abscissic acid in plant growth,
- (iv) The four environmental factors which affect plant growth.

(20 Marks)

Q.2

- (i) Considering irrigation in its broadest sense, list and briefly discuss each of the reasons for carrying out irrigation.

(10 Marks)

- (ii) Discuss the humid, arid and semi-arid regions of the world with respect to irrigation and for each describe the role that irrigation may or plays in crop production.

(10 Marks)

Q.3

- (i) Explain the four steps involved in determining furrow length when designing furrow irrigation systems.

(10 Marks)

- (ii) What do the two equations below stand for and what are they used for?

$$IR = (Q_0 - Q_{100}) \frac{1000}{W_{100}} \text{ and}$$

$$Q_{cb} = (Q_0 - Q_{100}) \frac{L}{100}$$

(10 Marks)

Q.4

- (i) There are four parameters taken into consideration when designing border strip irrigation systems. Name each of the four and describe what is taken into consideration in each of the steps.

(10 Marks)

- (ii) In basin irrigation systems, two methods exist to supply water to the basin. Name these two. In the second method two options exist. Describe the two methods and the two options of the second method.

(10 Marks)

Q.5

There are eleven steps in designing sprinkler irrigation systems. Name each step and briefly describe what is involved in each step.

(10 Marks)

Q.6

The control head of a drip irrigation system has ten (10) essential components. Name these and describe their function.

(10 Marks)

THE END OF THE EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
DEPARTMENT OF SOIL SCIENCE
FINAL EXAMINATIONS-DECEMBER, 2005

AGS 6141 PLANT NUTRITION

TIME: 3 hours

Marks: 80

ANSWER ALL QUESTIONS LEGIBLY

1. Define the following:
 - a) Micronutrient
 - b) Metabolism
 - c) Michaelis constant
 - d) Water potential
 - e) Rhizosheath [15 Marks]

2.
 - a) What is permanent wilting point? [2 Marks]
 - b) Would the permanent wilting point be reached when there is the same amount of water remaining in a clay soil and a sandy soil? Explain and giving reasons. [4 Marks]

3.
 - a) Explain clearly how radial transport of nutrients across the roots is achieved, giving pathways involved and examples of nutrients transported. Give the relative importance of the portions of pathways to nutrient uptake. [15 Marks]
 - b) Discuss the radial transport of water. [5 Marks]

4.
 - a) What are the main barriers to passive solute movement into the roots? [2 Marks]
 - b) What is the volume of root tissue available for passive solute movement called? [2 Marks]
 - c) Explain clearly why cations may accumulate in the free space whereas anions are repelled. [2 Marks]
 - d) Do plants differ in the effect of cations and anions in the apoplasm; if so why and do those differences affect passive uptake of cations? [4 Marks]
 - e) Give an example of one essential element which is greatly aided by the apoplasm in its transport. [1 Mark]

5. a) Discuss the main environmental factors that affect (control) root growth.
[4 Marks]
- b) How do the following affect root growth?
- i) soil compaction
 - ii) cattle grazing
 - iii) placement of fertilizers [6 Marks]
6. Describe the functions of the following plant nutrients and give one type of plants or crop for which they are important.
- a) sulphur
 - b) phosphorus
 - c) chlorine
 - d) molybdenum
 - e) calcium [15 Marks]
7. Explain what is meant by C_3 and C_4 pathways of CO_2 fixation. [3 Marks]

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

FIRST SEMESTER EXAMINATIONS, SEPTEMBER 2006

EA 311 (FARM POWER AND MACHINERY)

TIME ALLOWED: THREE HOURS

INSTRUCTIONS: THIS EXAMINATION PAPER HAS TWO SECTIONS. ATTEMPT FIVE QUESTIONS ONLY, AT LEAST TWO FROM EACH SECTION. ALL QUESTIONS CARRY EQUAL MARKS. ANSWER EACH SECTION IN A SEPARATE ANSWER BOOKLET

SECTION A: ANSWER AT LEAST TWO QUESTIONS FROM THIS SECTION.

Question 1

(a) Define the following terms:

- i) Mechanisation
- ii) Basal Metabolic Energy
- iii) Glycolysis
- iv) Aerobic limit

[6 points]

(b) i) Human beings take in food (that can be considered as chemical energy) and oxygen and gives out carbon dioxide, water and energy just like heat engines take in fuel (that is equally considered as chemical energy) and oxygen and gives out carbon dioxide, water and energy. Briefly outline how human power is different from mechanical power?

[5 Marks]

ii) Edward Banda, a casual worker at a farm in Ngwerere reports for work at 07:00 hours, and the following are the tasks he is assigned to do by his supervisor for the day.

- ⇒ 07:00 to 09:00 Clearing bushes and shrubs
- ⇒ 09:00 to 13:00 Felling trees
- ⇒ 13:00 to 14:00 Lunch break
- ⇒ 14:00 to 17:00 Driving a single axle tractor

Calculate the total rest time Mr. Banda needs for this working day.

[6 Marks]

Additional information:

Activity	Gross power consumption
Clearing bush and shrub	500 W
Tree felling	600 W
Driving single axle tractor	200 W

c) Briefly explain why power used in crop production is limited to human, animal and mechanical power.

[3 Marks]

Question 2

Define the following terms:

- i) Appetite Limit
- ii) Maintenance Energy

[4 points]

State **four** characteristics of a good harness.

[4 points]

A farmer has a pair of oxen, each weighing about 450kg that he uses for ploughing. Each ox provides a sustainable pull of 15% of its own weight when working individually. However, when working as a pair, the pull exerted by each animal reduces by 10% in line with the law of diminishing return. The oxen are fed on maize grain during ploughing season and they work for 5 hours per day. Given the following additional information:

Acceleration due to gravity:	= 10 m/s ²
Maize grain gross energy content:	= 19.0 MJ/kg
Maize grain DE : GE Ratio (DE/GE):	= 0.8
Maintenance Energy:	= 8.3 + (0.091W) MJ/day
Appetite Limit:	= 0.025W kg of dry matter where W is the mass of the draft animal

Energy conversion efficiency of draft animals: = 20%

- (i) Calculate the power each ox develops in order to pull the plough, assuming that they pull the plough to the limit of their sustainable pull. The walking speed when ploughing may be taken to be 3.6 km/hr.
- (ii) Calculate the quantity of maize grain needed to meet the total daily energy requirement of each ox.
- d) State **three** functions that the feed animals eat performs.

[3 points]

[6 points]

[3 points]

Question 3

A farmer has one tractor that he uses for primary tillage, secondary tillage and planting crops on his 59-hectare holding. Below are the typical field operating characteristics for the implements.

Operation	Equipment	Implement Width (m)	Field efficiency (%)	Field Speed (km/h)
Primary Tillage	Chisel Plough	2.5	80	7.5
Secondary Tillage	Disk Harrow	5.0	85	10
Planting	Precision Planter	4.0	75	8.0

Calculate the effective field capacity of each implement.

[6 Marks]

If each implement covers the whole farm once per year, calculate the annual use (in hours) for:

- i) Chisel plough
- ii) Disk harrow
- iii) Precision Planter
- iv) Tractor

[4 Marks]

Question 3 Continues ...

c) Given the following additional information:

	Tractor	Planter	Chisel Plough
Purchase price (P)	K120,000,000	K12,000,000	K12,000,000
Economic Life (n)	12 years	5 years	5 Years
Salvage Value (s)	10% of P	0	0
Annual Shelter/Insurance/Tax	2.0% of P	1.0% of P	1.0% of P
Fuel Consumption	20 l/hr	-	-
Price of diesel fuel	K5,000/l	-	-
Cost of Lubricants and filters	15 % of fuel cost	-	-
Repair and Maintenance/200 hr	0.8% of P	2.5% of P	2.5% of P

Labour Cost is estimated at K5,000/hr and the bank interest rate is 10%.

i) Calculate the cost of planting the crop both per hour and per hectare.

[10 marks]

Question 4

a) Define the following terms:

- i) Engine
- ii) Cylinder displacement
- iii) Compression ratio
- iv) Firing interval

[8 marks]

b) A five-cylinder four-stroke cycle diesel engine operates at 2500 rpm and has a fuel consumption of 20 litres per hour.

i) Determine the firing order and draw the corresponding firing order diagram, clearly indicating the points where the power stroke start and end in each cylinder.

[4 marks]

ii) Calculate the power stroke overlap?

[2 marks]

iii) Calculate the total number of power strokes per minute.

[3 marks]

iv) Calculate the average volume of each fuel injection (*in cubic millimetres*)

[3 marks]

SECTION B: ANSWER ATLEAST TWO QUESTIONS FROM THIS SECTION.

Question 5

- a) With reference to **Figure Q5** list the parts **A** to **G**. [7 marks]
- b) What type of engine is this? Give reasons for your answer [3 marks]
- c) Describe how ignition is achieved in this engine. [5 marks]
- d) What are the functions of parts **A**, **B**, **C** and **D**. [5 marks]

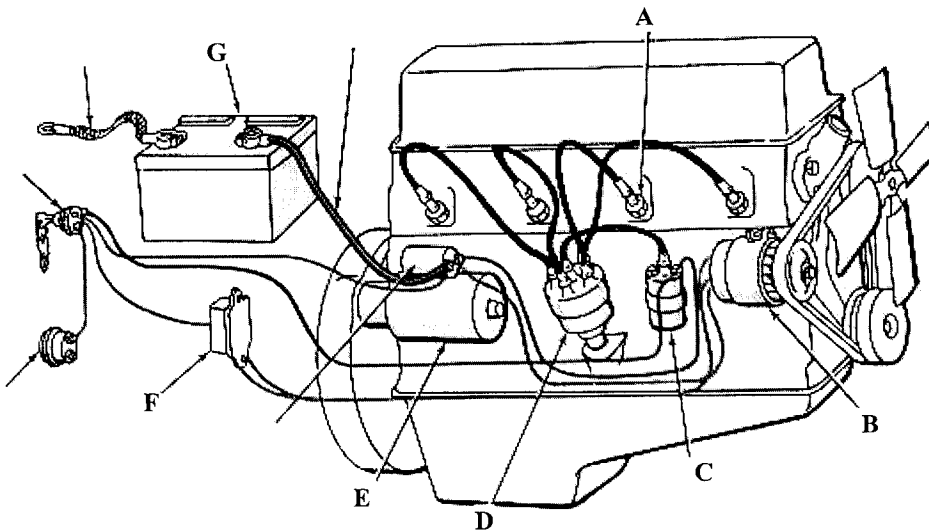


Figure Q5

Question 6

The magneto system has permanent magnets that rotate with the magneto shaft. When the magnets rotate there is reversal in the direction of magnetic field which induces current in the primary winding. Every half revolution of the magneto induces change in flow of current. When the circuit is interrupted by the opening of a contact breaker point, the magnetic field collapses and a high voltage is induced in the secondary circuit. This is seen as a spark at the spark plug.

- a) Make a table showing the similarities and differences between magneto system described above and the normal ignition system found on petrol engine powered tractors. [8 marks]
- b) Name **four** main parts of the combined cooling system. Briefly outline how it functions. [8 marks]
- c) Describe the oil mist lubrication system. [4 marks]

Question 7

Outline essential field operations required in the production of a crop of wheat in their correct sequence of execution. The crop is to be grown in a field where Soya beans has just been harvested. The field has well drained clay loam soil. It is recommended that conservation farming practices are applied on the soil. For each field operation;

- i) state the objective for carrying out the operation.
- ii) recommend the most appropriate machinery to be used.

[20 marks]

Question 8

- a) List three factors that would encourage mechanization.
[2 marks]
- b) Outline **four** objectives for carrying out tillage operation during crop production process and name one implement that best achieves each objective stated.
[6 marks]
- c) Describe the general qualities of a suitable seedbed
[4 marks]
- d) State **two** situations that would encourage the use of a chisel plough for primary tillage and explain why.
[4 marks]
- e) List **four** parts of a seed drill and explain the function of any two parts.
[4 marks]

THE END OF EXAMINATION