THE UNIVERSITY OF ZAMBIA

SCHOOL OF AGRICULTURE

2011 SECOND SEMESTER FINAL EXAMINATIONS

1. AGA 322 RUMINANT PRODUCTION (BEEF, DAIRY, SHEEP, GOATS AND RABBITS)
2. AGA 332 APPLIED ANIMAL NUTRITION
3. AGA 412 APPLIED ANIMAL PRODUCTIONS.
4. AGA 422 GAME RANCHING
5. AGA 2011 ANATOMY OF DEMESTIC ANIMALS
6. AGA 2022 PHYSIOLOGY OF DOMESTIC ANIMALS
7. AGA 442 INTERGRATED AQUACULTURE AND FISH NUTRITION.
8. AGA 511 TECHNIQUES IN ANIMAL SCIENCE.
9. AGA 542 ANIMAL HEALTH
10. AGA 552 ANIMAL PRODUCTS AND BY-PRODUCTS
11. AGC 312 CROP PROTECTION
12. AGC 322 FORAGE CROP PRODUCTION
13. AGC 332 INTRODUCTORY PLANT PATHOLOGY
14. AGC 342 FUNDAMENTALS OF CROP PATHOLOGY
15. AGC 521 ADVANCED PLANT BREEDING
16. AGC 542 INTERGRATED PEST MANAGEMENT
17. AGC 552 HORTICULTURAL SCIENCE
18. AGC 572 POST HARVEST TECHNOLOGY
19. AGC 2022 PLANT PHYSIOLOGY
20. AGE 421 PRODUCTION ECONOMICS
21. AGE 452 INTERMEDIATE AGRIBUSINESS MANAGEMENT

22. AGE 421 PRINCIPLES OF FARM MANAGEMENT
23. AGE 462 AGRICULTURE MARKETING AND PRICING
24. AGE 552 AGRICULTURE EXTENSION EDUCATION
25. AGE 562 INTERMEDIATE FARM MANAGEMENT
26. AGE 572 AGRICULTURE POLICY ANALYSIS
27. AGE 582 PROJECT MONITORING AND EVALUATION
28. AGE 2011 FUNDAMENTALS OF ORGANIC CHEMISTRY (PRACTICAL)
29. AGE 2022 FUNDAMENTALS OF MACRO-ECONOMICS
30. AGE 311 CHEMICAL TECHNIQUES IN FOOD ANALYSIS
31. AGF 321 FOOD CHEMISTRY (PRACTICAL)
32. AGF 332 METHODS IN FOOD ANALYSIS
33. AGF 342 FOOD TOXICOLOGY
34. AGF 352 FOOD MICROBIOLOGY
35. AGF 362 FOOD EVALUATION
36. AGF 411 UNIT OPERATIONS IN FOOD ENGIREERING
37. AGF 422 NUTRITION
38. AGF 432 PROCESS CONTROL AND INSTRUMENTATION
39. AGF 441 WATER AND FOOD WASTE MANAGEMENT
40. AGF 442 FOOD PACKAGING
41. AGF 452 METHODS IN FOOD ANALYSIS II
42. AGF 512 TECHNOLOGY OF MEAT AND FISH PRODUCTS
43. AGF 521 PRINCIPLES OF FOOD TECHNOLOGY II
44. AGF 522 TECHNOLOGY OF FERMENTED PRODUCTS
45. AGF 531 TECHNOLOGY OF PLANT PRODUCTS I
46. AGF 532 TECHNOLOGY OF PLANT PRODUCTS II
47. AGS 311 SOIL SURVEY TECHNIQUES
48. AGS 421 PRODUCTION ECONOMICS
49. AGS 422 SOIL MICROBIOLOGY

50. AGS 452 PRINCIPLES OF LAND HUSBANDRY
51. AGS 542 SOIL GENESIS AND CLASSIFICATION
52. AN 212 HUMAN ANATOMY II
53. BC 211 GENERAL BIOCHEMISTRY
54. GEO 971 AERIAL PHOTOGRAPHY AND AERIAL PHOTO
55. ITSS 319 INFORMATION TECHNOLOGY AND STUDY SKILS
56. PGY 211 MEDICAL PHYSIOLOGY.

THE UNIVERSITY OF ZAMBIA

THE SCHOOL OF AGRICULTURAL SCIENCES

2010 Academic Year – Second Semester Final Examinations

Course AGA 322 – Ruminant Production (Beef, Dairy, Sheep, Goats and Rabbits)

Time Allowed: Three (3) Hours Only

Instructions to Candidates:

a. All Questions carry equal marks (20).
b. Answer any five (5) questions, **at least one from each section.**
c. Use different answer books for Sections 1 and 2.

SECTION A – BEEF PRODUCTION:

Q. 1 In December 2009, Achimwene Banda from Malawi, Selma Nangula from Namibia and Nasilele Kapijimpanga Musonda from Zambia were asked by Southern African Development Community (SADC) to establish a regional beef demonstration centre in chief Haamusonde area in Southern Province, Zambia. The centre is to be used to train farmers in various practical aspects of beef farming. They decided to buy 2 Tonga bulls and 60 boran cows. The following year in 2010, 55 calves (25 male and 30 female) were born between 1st September and 28th November presenting a calving percentage of 92%. Comment of the performance of this demonstration centre in terms of;

a) Breeding Ratio (5 marks).
b) Type of breeding or breeding system they used. Is it correct or wrong? Give an explanation to support your answer (5 marks).
c) Breeding season used. Is it correct or wrong? Give reasons to support your answer (10 marks).

Q. 2 More than 80% of beef cattle are owned by traditional farmers in Zambia. The animals suffer from various form of poor management which if corrected could improve the performance of these animals.

a) What are the recommended routine operations that should be carried out to improve the performance of these animals? Please indicate why and when each routine should be carried out (15 marks).
b) What is the recommended slaughtering procedure of these beef animals in order to produce good quality beef (5 marks)?

SECTION B – DAIRY PRODUCTION:

Q. 3 Explain how you would feed and manage a newly born calf up to the time of weaning. What are the key management considerations that you would undertake?

Q. 4 Assuming that you would like to establish a dairy business through the cross breeding of the local cattle with the exotic dairy breeds. Explain the steps that you would take in order to improve the herd of cattle over the years. What assisted animal production techniques would you wish to make use of and why?

SECTION C – SHEEP AND GOAT PRODUCTION:

Q. 5 In Zambia, sheep and goats are used as sources of income by many households and also provide as sources milk and meat, i.e. mutton and chevon. Sheep and goats are also very well known for their high fertility, short gestation period and their resistance to number of diseases. Being ruminants, sheep and goats, should depend fully and mostly on natural grazing.

a. Discuss the factors that may affect the dry matter intake of sheep and goats on farm of your choice.

b. Discuss the factors that should be taken into consideration in the process of selecting of the ram and the buck as breeding stock?

Q. 6 Having been recently appointed as the Farm Manager of an intensive sheep and goat enterprise in Lusaka West, discuss any ten (10) lamb and kid routine management practices that you would put in place to ensure that the farm operates profitably.

SECTION D – RABBIT PRODUCTION:

Q. 7 Rabbit production is especially adapted to villages, small farms and in urban areas where other types of livestock cannot be raised. A farmer from Mumbwa West would like to establish a rabbit unit at his farm.

a) Write notes on any five (5) the factors that may affect feed intake in rabbits.

b) As an expert advise the farmer where to obtain breeding stock and what to look for in good breeding rabbits.

Q. 8 Rabbit meat has been described as tasty, of good quality and highly nutritious just like chicken meat. As a result rabbit meat is now eaten in most countries of the world and is highly recommended for the aged, the sick and children. In addition, rabbits are small and very cheap to purchase and to house; therefore, the initial capital outlay is minimal because with some scrap wood or bamboo a rabbit hutch can easily be constructed. Prepare notes on any other ten (10) reasons of raising rabbits in preference to other types of livestock in any district of Zambia of your choice.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

THE SCHOOL OF AGRICULTURAL SCIENCES

2010 ACADEMIC YEAR – SECOND SEMESTER DEFERRED EXAMINATIONS

COURSE AGA 342 – ANIMAL BREEDING AND GENETICS

TIME ALLOWED: THREE (3) HOURS ONLY

INSTRUCTIONS TO CANDIDATES:

a) All Questions carry equal marks (20).
b) Answer any five (5) questions and clearly show all the calculations.

Q. 1 a) Explain the sequence of events that take place during Prophase I of Meiosis and indicate their genetic consequences.

b) Assume that in the fruit fly, ***Drosophila melanogaster***, there are three (3) pairs of alleles +/a, +/b and +/c. As shown by the symbols each mutant allele is recessive to its wild type allele. Across between females that are heterozygous at all three loci and wild type males gives the following results:

+ b +	441
a + c	430
a b c	39
+ + c	32
+ + +	30
a b +	27
+ b c	5
a + +	3

i. Are these genes linked? Justify your answer.
ii. What is the correct order of the genes?
iii. What are the genotypes of the flies involved in the parental cross and the test cross?
iv. What is the map distance between the genes?
v. Calculate the coefficient of coincidence.

Q.2 Write notes on mutagenic agents.

Q. 3 a) Given that the genes R, S and T are linkage group with 15% recombination between R and S, and 25% recombination between S and T; and that the Coefficient of Coincidence is 0.6, what are the expected frequency of phenotypes from a test cross whose progeny are 1000?

b) An animal scientist studying the heritability of growth rate in Angoni Cattle at UNZA's Liempe Farm in ten (10) beef cattle collected the following data in the year 2009. Below is the growth rate of the ten (10) beef cattle obtained from

Katete District (x) and the corresponding is the growth rate of their progeny (y). Work out the heritability of growth rate in the Angoni cattle.

Growth rate of Angoni Cattle (x)	Growth rate of Progeny (y)
1.05	1.00
1.00	1.00
0.85	1.00
0.90	0.95
1.00	1.05
1.10	1.00
0.90	0.95
0.95	1.00
1.00	1.20
0.90	0.95

Q.4 Briefly explain what is meant by each of the following:

i. Phenotype;
ii. Autosexing;
iii. Sex linkage;
iv. Transcription;
v. Linkage group;
vi. Duplicate gene action;
vii. Dicentric chromosome;
viii. Xenophobia pimentosum;
ix. The law of segregation; and
x. Co-dominance and multiple allesism;

Q. 5 a) Given that the genes R, S and T are linkage group with 15% recombination between R and S, and 25% recombination between S and T; and that the Coefficient of Coincidence is 0.6, what are the expected frequency of phenotypes from a test cross whose progeny are 1000?

b) Work out the following:

i. Given that a group of 6 month-old-weaner calves has an average weight of 170 kg from which selected breeding stock with an average weight of 185 kg is selected. If the heritability of live-weight is 40%, what is the average weight of the first generation progeny of the selected breeding stock?

ii. If in a population of pigs, the heritability in the narrow sense for the mature weight is 0.5, the phenotypic variance is 100 kg, the total genetic variance is 50 kg and the epistatic variance is 0 kg, calculate the dominance variance and the environmental variance.

Q. 6 Outline the structure of Deoxyribonucleic Acid (DNA) in relation to its function as a carrier of genetic information. How is this information translated to the sequence of amino acids in proteins?

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

END OF SECOND SEMESTER EXAMINATIONS
JULY – AUGUST 2001

COURSE AGA 412 – APPLIED ANIMAL PRODUCTION

TIME ALLOWED: THREE (3) HOURS

INSTRUCTIONS TO CANDIDATES:

i. **Answer all five (5) questions.**
ii. **All questions carry equal marks.**

Q1 Chemical disinfection is one method of ensuring a disease free environment for housed animals. Which four (4) chemical disinfectants available on the Zambian market would you recommend for use in disinfecting pig and poultry houses? Give reasons for your recommendations.

Q2. Write briefly on the following:

i. Moulting in chickens.
ii. Facilities required in a commercial hatchery
iii. Two types of village chicken
iv. Feeding quails

Q3 Imagine you have been employed by a 20,000 broiler rearing company which has just fired all its workers due to total negligence of duty. One of your duties is to direct and supervise the activities of new broiler production attendants. Upon visiting the ten poultry houses, each having 2,000 birds, you see on the outside pools of stagnant water everywhere left by the rain. At the door of several poultry houses you are met with an irritating pungent smell coming from inside. Inside the buildings you often notice the chicks are huddled up in the corners. The chicks have white feathers covering most of the body but with yellow down feathers still covering the head. The birds look weak and stunted and their droppings generally show stains in different variations of the colour red. Most of the feeders and drinkers are empty and the feed storage is empty. You are

informed that there have been high mortalities from all the houses but there are no records.

i. Give details of your assessment of the previous management and care of the birds and their environment.
ii. What is the biochemical basis for your observations?
iii. What instructions would you give the animal attendants in order to save the remaining flock?

Q4 Explain the variation in protein, energy and calcium content for the different Zambia Bureau of Standards recommended feeds for commercial pigs.

Q5 Compare and contrast the management of pigs reared under the 'scavenging management system' and those reared under the 'intensive management system'. What consequences do the management practices utilized under the two systems have on the performance of the pigs?

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES

2010-2011 ACADEMIC YEAR: SECOND SEMESTER
FINAL EXAMINATIONS

AGA 442: INTEGRATED AQUACULTURE AND FISH NUTRITION
PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS. ANSWER QUESTIONS **1 AND 5.** ANSWER **TWO** QUESTIONS FROM **EACH** SECTION AND THE FIFTH QUESTION FROM EITHER SECTION. USE DIAGRAMS AND OTHER ILLUSTRATION AS APPROPRIATE. USE **SEPERATE ANSWER BOOKS** FOR EACH SECTION.

SECTION A: INTEGRATED AQUACULTURE

1. Suggest **causes** and **solutions** to the following problems experienced in small scale integrated fish farming:
   (a) Excessive water loss from earthen ponds.
   (b) Failure of the fish pond water to respond to fertilisation or addition of manures.
   (c) Fish not able to grow to market size as expected during a production cycle.
   (d) Excessive escape of farmed fish from earthen ponds.
   (e) The reluctance of financial institutions to provide credit to both small and medium scale farming projects.

2. A former Civil Servant based in Kaoma, Western Province, has decided to start fish farming using semi-intensive fish cum duck farming methods after failing to become a member of parliament in the 2006 elections. A preliminary survey of his farm indicated that he could use 3,000 m^2 for the production ponds. The topography of the area where the production ponds are to be located is such that it is possible to have fish production ponds of the same size.
   (a) Indicate the **number** and **sizes** of production ponds that you would recommend for the intending fish farmer. Give reasons for your suggestions.
   (b) Estimate the number of **fingerlings** and **ducks** needed for the production ponds annually.
   (c) Estimate the area that would be required for **breeding** and **nursery** ponds.
   (d) Approximate the annual water requirement for the **entire** fish farm.

3. Compare and contrast aquaculture systems used for Cichlids and Cyprinids in either medium or small scale fish farming systems indicating advantages and problems for each one.

4. (a) Summarise the methods that are used in farming fish of species of the Family Claridae, the barbel fishes.
   (b) Highlight some of the advantages and difficulties associated with farming fishes of this family.

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SECTION B: FISH NUTRITION

5. Explain in detail the following in the context of fish nutrition or aquaculture
   (a) Cyanophyta and Chlorophyta.
   (b) Energy requirements for fish are lower than that terrestrial animals
   (c) Live foods.
   (d) Types of fish feeds.
   (e) Nutritional requirements of the *Tilapia*.

6. (a) Indicate the sources of plant proteins that a fish nutrition research expert would select in order to formulate a fish diet that would substitute animal proteins.
   (b) Outline the pros and cons of each of the plant protein sources selected and discuss the factors that justify their selection if used to substitute animal protein in the formulation process.

7. Give details on the **role** and **sources** of major fish feed nutrients in aquaculture nutrition.

8. (a) Discuss the precautions that could be considered in order to provide good storage conditions for fish feeds.
   (b) Highlight examples and estimates of the maximum permissible storage time for selected feedstuffs in tropical areas.

END OF THE EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCOOL OF AGRICULTURE

2010-2011 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

AGA 422: GAME RANCHING

TIME: THREE HOURS

INSTRUCTIONS: QUESTION **ONE** IS COMPULSORY. ANSWER QUESTIONS **ONE** AND **FOUR** OTHERS. USE ILLUSTRATIONS WHERE NECESSARY.

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1. (a) A rodent survey in the ranch area used a capture-recapture method to determine the distribution and habitat preference of the Cane Rat (*Thryonomys swinderianus).* The technique however requires that before a large number of traps can be set, it was important to test the behavioural pattern of the rat. Therefore, seven (7) traps were set at different points in the area for 15 days, and each captured rat was marked and released. The following data were obtained.

TRAPS	**A**	**B**	**C**	**D**	**E**	**E**	**G**
RATS CAUGHT	6	9	23	14	18	0	3

From the data provided, determine whether or not the capture of each rat was independent of the location of the trap.

1. (b) In the same area, a census of the same species involved setting up of a number of traps at different points along each transect in the area for two occasions, and each captured rat was marked and released. The data in the Table below were obtained.

	TRAPS		
TRANSECTS	A	B	C
Initial capture	06	09	10
Second capture	12	13	11
Recaptures	03	08	03

(i) Using the Lincoln – Petersen index method, calculate the populations of the rats in the area.
(ii) Discuss the limitations of this method in estimating wildlife populations.

2. Describe the main characteristics of a wildlife habitat and relate these to the ecology of the following species:
(a) Tsessebe (*Damaliscus lunatus*)

(b) Sitatunga *(Tragelaphus spekei)*

3. Discuss the management application of the following concepts as used in wildlife population management:
(a) Maximum Sustainable Yield.
(b) Point-centered method

4. Discuss features that would indicate that a wildlife species population was being over exploited in the ranch and prescribe measures most significant in reversing the trend.

5. Discuss difficulties associated with the translocation and restocking operations in wildlife management.

6. Munyamadzi Farms Ltd is considering establishing a game sanctuary in Kalomo District along the Nazhila stream. Initial investigations show that the range is suitable for Impala, Zebra, Wildebeest, Kudu and Buffalo. The range is relatively flat, well watered and nearly all the range is within 3.5km from water. Based on the information from the Ministry of Agriculture and Cooperatives in Choma, the soils are generally Fersiallitic and excellent for a game sanctuary. The average rain fall is 800mm and the vegetation is dominated by Acacia-Combretum woodland and dry Miombo. And also results from your preliminary investigations indicate that the production of key forage species averages about 100kg/ha of dry matter per year. The proposed Sanctuary is 10,000 ha in size. Assuming that allowable use is 25% and daily dry matter intake is 2% of the animal body weight,

(a) Determine the number of 204 kg Hartebeest you would stock as your base herd in the area
(b) Discuss the limitations of this method in estimation the stocking rate of wildlife species.

7. Discuss in detail the management application of the following terms as used in Game Rancing:

   (a) Kidney / Fat Ratio Index
   (b) King Census method and its modification

8. Study carefully Figures **1** provided and answer the following questions:

Fig. 1.

(a) Name the Order to which the species belongs
(b) Give its scientific name
(c) Discuss the habitat of the species
(d) Discuss the feeding habits of the species

END OF EXAMINATION

UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
DEPARTMENT OF ANIMAL SCIENCE

2011 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATION

AGA 542: ANIMAL HEALTH

TIME: THREE HOURS

INSTRUCTIONS:

1. Please read the instructions and each question carefully.
2. Answer ALL questions.
3. Write the answers to each question in a separate examination answer book.
4. All questions carry equal marks.

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1. Animal diseases constitute a major obstacle to livestock production in Zambia. However, animals counteract diseases through several protective mechanisms and barriers.
   a) Outline the physical barriers by which animals counteract infection. **(5 marks)**
   b) With the aid of a table, show the differences between primary and secondary immune responses in cattle following administration of two doses of a vaccine 4 weeks apart. **(5 marks)**
   c) Outline the major cells of the immune system and their functions. **(5 marks)**
   d) List the primary and secondary immunological organs. **(5 marks)**

2. Write short notes on any **four (4)** of the following
   a) Effects of livestock disease on livestock productivity and human welfare. **(5 marks)**
   b) Depopulation as a method of disease control. **(5 marks)**
   c) The tick, *Rhipicephalus appendiculatus.* **(5 marks)**
   d) Direct losses associated with infestation of cattle with ticks. **(5 marks)**
   e) Diagnosis and treatment of trypanosomosis in cattle. **(5 marks)**

3. Compare and contrast Anthrax from Haemorrhagic Septicaemia on the basis of their identification, transmission, dynamics, geographic distribution/occurrence and control. **(20 marks)**

4. Write concise notes on the following:
   a) Clinical signs and treatment of Bovine Babesiosis. **(5 marks)**
   b) Diagnosis and control of Theileriosis. **(5 marks)**
   c) Transmission and postmortem signs of Anaplasmosis. **(5 marks)**
   d) Postmortem signs and diagnosis of Cowdriosis. **(5 marks)**

5. Infectious diseases result from invasion of susceptible animals by microorganisms through various routes, and their subsequent proliferation and spread in the animal body to exert their effects on the host.
   a) Outline the various routes of infection. **(5 marks)**
   b) Lists any **five (5)** factors that affect the outcomes of infection. **(5 marks)**
   c) List the types of infectious agents and state how they cause disease. **(5 marks)**
   d) Briefly describe the similarities and differences between passive and active immunity. **(5 marks)**

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END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF AGRICULTURAL SCIENCES
2010/2011 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

AGA 552

ANIMAL PRODUCTS AND BY-PRODUCTS

TIME ALLOWED: THREE HOURS

INSTRUCTIONS:

1) **ANSWER ALL QUESTIONS**
2) **WRITE EACH SECTION IN A SEPARATE ANSWER BOOK**

SECTION A (Meat)

QUESTION 1 [35 POINTS]

Write short notes on the following:

a) Steric effect in relation to water holding capacity **[7]**
b) Accumulation of lactic acid in muscle post-mortem **[7]**
c) Effects of accelerated temperature drop in muscle post-mortem **[7]**
d) Influence of aging of beef on tenderness **[7]**
e) Meat juiciness **[7]**

SECTION B (Milk)

QUESTION 2 [15 POINTS]

Milk quality is of paramount importance in the production of quality dairy products.

a) Discuss the types of tests carried out on raw milk at the reception point of the milk processing plant. **[8]**

b) An enterprising farmer sales raw milk in 2 litre containers. He approaches you with a problem of a cream layer at the top of his containers which, his clients do not like and is difficult to clean after the milk has been removed. Explain the phenomenon causing the problem and give the possible solution. **[4]**

c) Explain the difference between spoilage and pathogenic bacteria and give an example for each. **[3]**

QUESTION 3 [15 POINTS]

a) Explain in detail with illustrations, the UHT milk manufacturing process. **[10]**

b) Give two tests used to distinguish a UHT milk sample from a pasteurized milk sample in the laboratory. **[2]**

c) Discuss the symbiotic relationship of the yoghurt cultures. **[3]**

SECTION C (Eggs)

QUESTION 4 [20 POINTS]

The bird egg is a marvel of nature. It is one of the most complete foods known to humans, as evidenced by the excellent balance of proteins, fats, carbohydrates, minerals, and vitamins which it provides during the 20-day in-the-shell period when it serves as the developing chick's only source of food.

a) Mention and explain the components that make up the egg. **[6]**

b) What are the normal physical characteristics of eggs **[4]**

c) Periodically, a deviation in the mechanics of egg laying will create abnormal eggs. Some of these abnormalities occur due to management problems or they can also be physiological. What are these common abnormalities and suggest ways of correcting them. **[5]**

d) How should eggs be processed so that there is maximum benefit for the industry and local consumers **[5]**

SECTION D (Hides and Skins)

QUESTION 5 [20 POINTS]

About 40% and 60% of total hides and skins respectively produced in the traditional livestock sector in Zambia are wasted, incorrectly processed or simply thrown away. Those which find their way to the tanner are of poor quality.

a) Explain why there is such excessive wastage of hides and skins from these traditional farmers. **[6]**

b) Mention and explain the causes of the damage to the skins and hides which makes it difficult for the tanners to buy these hides and skins **[8]**

c) Hides and skins can be converted into a non putrefiable, flexible and workable product through tanning. Describe the process of tanning. Mention some products of tanning. **[6]**

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END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
UNIVERSITY SECOND SEMESTER EXAMINATIONS – MAY, 2011
AGA 562 – APPLIED ANIMAL BREEDING

TIME: 3 HOURS

INSTRUCTIONS: ANSWER ANY FIVE (5) QUESTIONS.

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1. a. Explain what is meant by genetic and environmental interactions?

   b. Briefly define genetic progress and how is it calculated?

   c. Explain how heterosis is calculated and what are the possible genetic causes for it?

2. Discuss the test procedures used to eliminate genetic defects that are dependent on a single recessive gene in a livestock population.

3. a. Define or explain ''coefficient of inbreeding.''

   b. How does inbreeding affect gene action known as over-dominance?

   c. Explain the effect you believe that the practice of inbreeding has on the frequency of recessive lethal genes, the incidence of genetic abnormalities, and the likeness between herds within a purebred breed.

4. a. Define gene frequency.

   b. Briefly outline the Hardy-Weinburg rule.

   c. Explain the circumstances under which chance or "genetic drift" may be an important factor concerned with change of gene frequency.

5. Discuss the methods based on relationships most widely used to determine heritability in farm animals.

6. a. Selection is an important tool used in the improvement of livestock. What are the factors selection depends on for effectiveness?

   You have been appointed the Officer responsible for developing a new breed of village chicken to be distributed in most areas of Zambia. The breed is to have high egg production and have good meat characteristics. How would you go about developing the breed, clearly state the method you will employ and give reasons for choosing the particular selection method to accomplish your assignment.

END OF EXAMINATION

The University of Zambia

School of Agricultural Sciences

Department of Crop Science

Second Year Examinations for the Degree of Bachelor of Agricultural Sciences

AGC 322: Forage Crop Production

Second Semester, 2011

Date: 6 May, 2011 **Time: 09.00 – 12.00hrs**

Instruction to Candidates

Answer any five questions. All questions carry equal marks

1. Achimwene Gondwe from Malawi, Boneficuous Singu from Namibia and Bwalya Bulaya from Zambia have been asked by Southern African Development Community (SADC) to establish a regional fodder bank in Chief Sinazongwe in the rangelands of Southern Province, Zambia.

a). Name two pasture legumes that could be included in the fodder bank and indicate their agricultural importance. (8 marks).

b). Fodder trees or browse trees are the third component of natural grazing resources that could be included in the fodder bank.

i). What is the importance of including fodder trees in fodder bank?(4 marks).

ii). What are the problems associated with use of these fodder trees as feed for the grazing animals (4 marks).

iii) How should they be managed to improve their productivity (4 marks).

2. During one of the forage crop production lessons a student was asked to define rotational grazing and he said that rotational grazing is a kind of grazing where the animal rotates while it is grazing. The other students upon hearing this laughed a lot.

a). From your understanding of rotational grazing would you agree or disagree with this definition? Give an explanation for your answer (5 marks)

b). What are the benefits of rotational grazing (4 marks)

c). Explain why herbage ingested or eaten by grazing animals may differ markedly in botanical and chemical composition from that of the pasture from which the animal is grazing (5 marks)

d). What are the factors that affect grazing time (6 marks)

3. You have been giving a series of talks to cattle farmers in Mchinji area in Malawi concerning feeding their animals. Last time you discussed how to conserve forage through making of Hay and silage. For the next lesson indicate what you would tell the farmers as regards the following questions they asked last time.

   a) What are the characteristics of good quality hay (9 marks)
   b) how should hay be enhanced to improve its feeding value before giving it to animals (4 marks).
   c) What are the characteristics of good quality silage (7 marks).

4. "The Lord is my shepherd I shall not want (I shall not lack anything). He maketh (makes) me to lie down in green pastures". So says the Psalmist
   a). Draw a graph to show that grazing animals sometimes lack green pastures at certain times of the year in arid and semi-arid lands of Southern Africa. Please explain the meaning of the graph (10 marks).
   b). If you were a good shepherd like our Lord what would you do to ensure continuous supply of adequate feed to grazing animals throughout the year (10 marks).

5. In a Village in Chief Mpezeni, the chief had called for a meeting to settle a dispute between two of his subjects. The accused Mr Mbuzi, was blamed for setting his bush surrounding his house ablaze. Now the fire had gone on to Mr Mafuta's farm where it burnt all the surrounding bushes. The problem is that Mr Mafuta is a dairy farmer who depends on the surrounding bush for grazing his animals. Mr Mafuta has sued Mr Mbuzi for burning his grazing area and would like him to pay for the damage and suffering caused by the fire. Mr Mbuzi has however refused to pay because he thinks the bush is communally owned and was not planted or cultivated by anyone. Infact he thinks he has done his neighbours a favour by burning and clearing the bush thereby driving snakes and other dangerous animals away.
   a) How do you think this dispute should be resolved. Do you think Mr Mafuta should be compensated for the loss of his valuable feed resource (5marks).
   b) From this story list the problems a farmer faces in using natural pastures as a source of feed for his animals (7 marks).
   c) Mention any two other grazing methods you know and what are their advantages and disadvantages (8 marks).

6. A farmer on Kaprivi Strip in Namibia sold off 150 Nguni cattle he had. He then imported the following herd of cattle for his farm; 2 Boran bulls from South Africa , 2 Brahman cows from Botswana, 1 Angoni bull, 20 Angoni Cows and 10 Angoni heifers from Zambia. 15 of the 20 Angoni cows came with a calf each,. He has 10 hectares of field crops, 30 hectares of citrus fruits, 177 hectares of natural grazing land. **Take 1 livestock unit to 5 hectares**
   a) Define stocking rate (5 marks).
   b) Is this farmer overstocking or understocking his grazing land? Show all calculations to support your answer (10 marks).
   c) What would be your advice to this farmer (5 marks).

Livestock Units of Different Breeds of Cattle

Breed	Cow	Bull	2-3 Years	1-2 Years	5-11 Months	0-5 Months
Brahman, Simmental	1.5	1.8	1.5	0.8	0.4	0.2
Hereford, Sussex, South Devon	1.3	1.6	1.3	0.7	0.3	0.2
Africander, Boran, Friesian	1.2	1.4	1.2	0.6	0.3	0.2
Barotse, Gurnsey	1.0	1.2	1.0	0.5	0.3	0.1
Tonga, Angoni, Jersey	0.9	1.1	0.9	0.5	0.2	0.1

6 goats = 1 Livestock unit

6 sheep = 1 Livestock unit

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

PROGRAMME: BACHELOR OF AGRICULTURAL SCIENCES- THIRD YEAR
AGC 332: INTRODUCTORY PLANT PATHOLOGY
2010/2011ACADEMIC YEAR, SEMESTER II.

DATE: 17th May, 2011 TIME: 09:00 – 12:00HRS

INSTRUCTIONS:

1) Answer **question 1** and **any other 4** questions,
2) All question carry equal marks.
3) Duration 3 (three) hours.

Question 1

a) Indicate whether the following statements are true or false

(i) All plant viruses are biotrophs.

(ii) Spore is a symptom

(iii) *Phytophthora infestans* is a bacterium.

(iv) Leaf diseases of sorghum can infect sweet potatoes.

(v) An avirulent pathogen is not pathogenic.

(vi) Ascospores are always 6 in number.

(vii) Root knot nematode has a wide host range.

(viii) Plant viruses are predominantly DNA based.

(ix) Disease incidence is the measure of damage done by a plant.

(x) Bacterial ooze is a symptom of a bacterial infection.

b. Explain the following:

i. Horizontal resistance.

ii. Alternate host.

iii. Blight.

iv. Gall.

v. Scab. **[20 marks]**

Question 2

a) List the genera of bacteria and give one disease example of each.

b) Describe five major symptoms of bacterial diseases.

c) How are bacterial diseases managed? **[20 marks]**

Question 3

(a) Explain the following as used in classification of viruses

(i) Biological properties.

(ii) Serological properties.

(iii) Genome properties.

(iv) Particle morphology.

(b) How are viral diseases managed? **[20 marks]**

Question 4

(a)

pathogen ↑

	Resistance or susceptibility genes in the plant	
Virulence or avirulence genes in the ~~host~~	R (resistant) dominant	r (susceptible) recessive
A (avirulent) dominant		
a (virulent) recessive		

Fill in the above and explain the disease reactions which follow.

(b) Define plant disease cycle. Describe the 5 (five) stages of the disease cycle. **[20 marks]**

Question 5.

What is integrated plant disease management? List and explain the 6 (six) basic components of integrated disease management. **[20 marks]**

Question 6

a) How do plant parasitic nematodes cause disease and what are the symptoms associated with Nematode attack?

b) How are nematodes managed? **[20 marks]**

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

School of Agricultural Sciences
Department of Crop Science
Third Year Examinations for the Bachelor of Agricultural Sciences
AGC 342: Principles of Crop Production
Second Semester 2010/2011 Academic Year

Date: 11th May, 2010 **Time: 14:00 –17:00 hrs**

Instructions:

1. **Answer all questions**
2. **Marks as indicated**

QUESTION 1 (15 Marks)

a) Why are soil measurements with a Neutron probe not determined at a depth lower than 20 cm? **(3 Marks)**
b) What is Nutrient depletion? **(3 Marks)**
c) What is yield response factor? **(3 Marks)**
d) How is irrigation interval calculated from Actual and Maximum Evapotranspiration? **(3 Marks)**
e) What are the common constitutes of growth media? **(3 Marks)**

QUESTION 2 (25 Marks)

A

i) What is soil water potential? **(2 Marks)**
ii) Express soil water potential as energy per unit mass and energy per unit weight. **(2 Marks)**
iii) What is the advantage of using the concept of soil water potential? **(3 Marks)**
iv) How is soil water storage derived? **(3 Marks)**

B

The rainfall over 10-day period was 13 mm. A farmer has irrigated her crop with 9 mm water. Assuming drainage of 2 mm, negligible runoff and the soil water storage of 10 mm was measured. What was the evapotranspiration? What could the time of the year the measurements were taken. **(15 Marks)**

QUESTION 3 (20 Marks)

i) Several factors influence photosynthesis, explain how each of these factors affect photosynthesis. **(10 Marks)**

ii) Explain how Crassulacean Acid Metabolism (CAM) is a strategy to cope with very hot and dry desert conditions. **(10 Marks)**

QUESTION 4

i) Which are three phytohormones involved in each of the following processes; germination and senescence in plants? **(5 Marks)**

ii) Explain how these phytohormones in conjunction with external factors regulate these growth processes. **(15 Marks)**

QUESTION 5 (20 Marks)

The families Fabaceae, Euphobiaceae, Poaceae and Malvaceae are important in the economy of the country.

a) Give 2 members of each family, (4 **Marks)**
b) What are their scientific names and places of origin, (4 **Marks)**
c) Briefly describe their morphological features, (**5 Marks)**
d) What are 3 optimum conditions of growth, (**3 Marks)**
e) How are these crops important to the national economy. (4 **Marks)**

END OF EXAMINATION

UNIVERSITY OF ZAMBIA

School of Agricultural Sciences
DEPARTMENT OF CROP SCIENCES
B. Agric. Sci. Programme- Second Semester Final Examinations
AGC 542: INTEGRATED PEST MANAGEMENT

Date. 6th May 2011

Time 09:00 to 12:00 hrs

INSTRUCTIONS

1. Answer ANY 5 (FIVE) questions.
2. Duration- 3 (THREE) hours.

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1. Insects have a lot of enemies. Discuss the various defense mechanisms used by insects. **[20 marks]**

2. What is cultural control? Describe the various components of cultural control used in Integrated Pest Management (IPM) programs. **[20 marks]**

3. Transgenic crops are used as a tool in IPM programs. Describe the major steps involved in the development of transgenic crops. **[20 marks]**

4. Pesticides are a major component of IPM programs. Describe the various classification systems used for pesticides. **[20 marks]**

5. The bollworm [*Helicoverpa armigera* (Huber)] is a major pest of cotton (*Gossypium hirsutum*). Construct a conceptual model showing the development stages of the bollworm and describe the State, Rate and Driving variables that affect their development? **[20 marks]**

6. A new pest has just been introduced into Zambia. You have been requested to identify a suitable Biological Control Agent. What steps are you going to follow in identification and introduction of the biological control agent? **[20 marks]**

END OF EXAMINATION

UNIVERSITY OF ZAMBIA

School of Agricultural Sciences
DEPARTMENT OF CROP SCIENCES
B. Agric. Sci. Programme- Second Semester Final Examinations
AGC 552: ADVANCED HORTICULTURE

Date. 10th May 2011

Time 14:00 to 16:30 hrs

INSTRUCTIONS

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

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1. Indigenous trees have historically played an important role in our dietary needs. Their utilization has declined, can you give concise description of the priority activities for their increased utilization locally. Additionally what are the limitations for their entry into the international market? **[25 marks]**

2. Write short notes on
   a. Role of storage carbohydrates in plant development;
   b. Photorespiration.
   c. Rejuvenation pruning. **[25 marks]**

3. Describe the different photosynthetic systems and how each of them affects productivity efficiencies of each category of plants. **[25 marks]**

4. Describe fully the pruning and training systems of mango (*Mangifera indica*) and oranges (*Citrus sinensis*). **[25 marks]**

5. As a Horticultural Officer can you develop an Extension Bulletin on how to successfully improve small scale Banana (*Musa* spp) production in Zambia? In your answer include the different cultivars, climatic condition and cultural practices. **[25 marks]**

END OF EXAMINATION

UNIVERSITY OF ZAMBIA

SCHOOL OF AGRICULTURAL SCIENCES

DEPARTMENT OF CROP SCIENCES

SEED SCIENCE AND TECHNOLOGY

AGC562

FINAL EXAMINATION

Date: Wednesday 18th May 2011

Time: 09:00 – 12:00 hours (3 hour)

Venue: Omnia.

Level: For fifth years

INSTRUCTIONS

Question 1 is compulsory, answer it. Questions 2, 3 and 4 are optional. Answer only 2 of them. Points for each question are indicated.

COMPULSORY

Q1 (30 points)

a) Define a seed program
b) Describe a seed program by outlining all its components and how they are interlinked
c) What is a variety and how do you differentiate among the following:
   - A single cross hybrid, a double cross hybrid, a synthetic, a top cross and a composite variety. Give examples of actual varieties falling in these categories
d) Discuss the experimental set ups, statistical analysis and reporting for performance and DUS trials.

OPTIONAL

Answer two questions only

Q2 (15 points)

a) Define a seed, seed germination and seed vigor
b) What are cicardian rhythms and what is their importance to a seed technologists?
c) What is the difference between
    a. agamospermy and vivipary
    b. Cleistogamous and chasmogamous
    c. Protandry and protogyny
    d. Anemophily and entomophily

Q3 (15 points)

a) Outline the different types of seed dormancy and describe how to break each of them
b) Describe the concept of the product life cycle and place the following varieties on that graph: MM752, SC709, PAN6363, PHB30G19 and DK8083
c) Define seed certification and briefly describe the measures involved in the certification process.

Q4 (15 points)

a) Enumerate the usual operations involved in seed processing and discuss what is involved in basic cleaning.
b) Describe recalcitrant seeds and give five examples of seed falling in this category
c) Describe the marketing strategy that SEEDCO uses.

--End of Examination--

UNIVERSITY OF ZAMBIA
School of Agricultural Sciences
Department of Crop Sciences

Fifth Year Final Examinations for Bachelor of Agricultural Sciences
AGC 572: POST HARVEST TECHNOLOGY
Second Semester 2010/2011

Date: 23rd May 2011 **Time 09:00 to 12:00 hrs**

INSTRUCTIONS

Answer ALL questions;
Answer **Each Section in a separate answer** booklet;
Duration- Three (3) hours.

SECTION A- [40 marks]

1. (a) What is the role of informal marketing systems in each of the following, tomato, rape and cabbage production and how does it impact on postharvest losses.

[10 marks]

(b) Describe product quality and its constituent components? What is the relationship between quality and Standards? **[10 marks]**

2. Write short notes on **ANY TWO (2)** of the following

   i. Harvestable maturity;

   ii. The relationship between the Oxidative pentose phosphate cycle and product ripening.

   iii. Farming systems found among small scale horticultural producers in Zambia.

[20 marks]

SECTION B [Total marks -40]

3. (a) How do growth regulators affect horticultural produce/products? What measures should be undertaken to ensure quality is maintained throughout the handling chain?

[22 marks]

(b) List the types of infection that occur in the post harvest life of commodities and also describe conducive conditions for each infection? **[6 marks]**

4. Describe the process of ripening bananas in destination markets clearly indicating the conditions to be observed during the process? **[12 marks]**

SECTION C [Total 20 marks]

5. Answer all questions in this section;

   a. Explain with aid of a flow diagram the manufacturing process of canned peas.

   [12 marks]

   b. How can the quality of the canned product be checked before the product is sold? **[2 marks]**

   c. Dried Fruits Ltd engages you as an expert to solve a problem of discoloration of their dried apples and bananas. Give two (2) possible causes and three (3) solutions.

   [6 marks]

END OF EXAMINATION

UNIVERSITY OF ZAMBIA
School of Agricultural Sciences
Department of Crop Sciences

Fifth Year Final Examinations for Bachelor of Agricultural Sciences
AGC 572: POST HARVEST TECHNOLOGY
Second Semester 2010/2011
DEFERRED EXAM

Date: 10th June 2011 **Time 14:00 to 17:00 hrs**

INSTRUCTIONS

Answer ALL questions;
Answer Each Section in a separate answer booklet;
Duration- Three (3) hours.

SECTION A [45 marks]

1. Using data explain the production, marketing and post harvest losses of onion (*Allium cepa*) in Zambia and how this differs from other common fresh vegetables.

[12.5 marks]

2. The following are the National Agricultural policy sectoral strategies. Explain why attention has to be paid to each of them in as far as post harvest is concerned.

   i. Reviewing and realigning institutional and legislative arrangements.
   ii. Facilitating availability of and accessibility to land for agriculture and development of infrastructure in potentially productive agricultural areas.
   iii. Promotion of gender equity in resource allocation and access to agricultural services.

[12.5 marks]

3. Write short notes on any THREE (3) of the following:-

   i. Drivers of standards,
   ii. Chilling injury,
   iii. Fermentation,
   iv. Reasons for adopting quality control.

[20 marks]

SECTION B [45 marks]

4. (a) A grower/packer is growing lemons in the tropical lowlands on the African continent. *Once these lemons have been delivered to the packinghouse, list the* operations the fruit has to undergo before packing. How and why is each operation carried out? **[25 marks]**

(b) List the type of infection that leads to the development of each of the following

Diseases:-

1. *Geotrichum candidum*
2. *Phytophthora hibernalis*
3. *Trichoderma viride*
4. *Diplodia Natalensis*
5. *Penicillium italicum*
6. *Alternaria citri*

[6 marks]

5. Product losses can occur during post harvest handling of commodities. What are the different techniques used to reduce losses in vegetable products? **[14 marks]**

SECTION C [10 marks]

6. Answer all questions in this section;

   a. Explain and illustrate the manufacturing process of pickled cucumbers using a flow diagram. **[6 marks]**

   b. Explain the difference between a dried and dehydrated product. **[1.5 marks]**

   c. Chakwankwa Dried Fruits Ltd engages you as an expert to solve a problem of browning of their dried pears. Give two (2) possible causes and three (3) solutions. **[2.5 marks]**

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF AGRICULTURAL SCIENCES

2010/2011 ACADEMIC YEAR SECOND SEMESTER EXAMINATIONS

AGE 222: FUNDAMENTALS OF MACRO-ECONOMICS

TIME: THREE (3) HOURS

INSTRUCTIONS: ANSWER ALL QUESTIONS IN SECTIONS A, B AND C.

SECTION A

ANSWER ALL QUESTIONS

Multiple Choice Questions: Tick or circle the correct answer on the question paper and hand it in together with the answer booklet – (one mark each)

1. Macroeconomics is concerned with
   (a) The level of output of goods and services
   (b) The general level of prices
   (c) The growth of real output
   (d) All of the above
2. Real *GDP* increases
   (a) When there is an increase in the price level
   (b) When there is an increase in the output of goods and services
   (c) When there is an increase in the population
   (d) At a constant rate over time
3. In a disequilibrium model where the price level remains above the price level at which aggregate supply and aggregate demand intersect,
   (a) Output is determined by the aggregate supply curve
   (b) Output is determined by the aggregate demand curve
   (c) There is an output shortage
   (d) There is an output surplus
4. In a private sector model,
   (a) Household saving is a leakage from the circular flow
   (b) Investment is a spending injection
   (c) Saving leakages equal investment injection
   (d) All of the above
5. In an open economy model, *GDP* is the sum of
   (a) Consumption, gross investment, government spending, and net exports
   (b) Consumption, net investment, government spending, and net exports
   (c) Consumption, gross investment, government spending and gross exports

(d) Wages, rent interest, profit, and depreciation

6. In a closed economy, three sector model,
   (a) Household saving equals net investment
   (b) Household saving equals gross investment
   (c) Household saving plus depreciation equals gross investment plus government spending
   (d) Household saving plus taxes plus depreciation equals gross investment plus government spending
7. Frictional unemployment exits
   (a) When there is a decrease in real *GDP*
   (b) Because it takes time to find a job when one is first entering the labour force
   (c) As a result of technological change
   (d) When an individual retirees
8. When saving is greater than investment in a two-sector model
   (a) Output should increase
   (b) Output should decrease
   (c) Output should not change
9. By definition, the marginal propensity to consume
   (a) Equals $\Delta C / \Delta Yd$
   (b) Is the behavioral coefficient c in the equation $C = a + cYd$
   (c) Is the slope of the consumption function
   (d) All of the above
10. When investment is negatively related to the rate of interest, equilibrium output in the goods market
    (a) Is unrelated to the rate of interest
    (b) Is inversely related to the rate of interest
    (c) Is positively related to the rate of interest
    (d) Falls as the rate of interest decreases
11. When the *LM* equation is $Y = K750 + 20i$, there is equilibrium between the supply and the demand for money when
    (a) The rate of interest is 10% and output is $K750$
    (b) The rate of interest is 10% and output is $K800$
    (c) The rate of interest is 10% and output is $K950$
    (d) The rate of interest is 10% and output is $K900$
12. In which of the following situation will an increase in the money supply have no effect upon output?
    (a) *LM* is steeply sloped and *IS* is relatively flat
    (b) *LM* is vertical and *IS* is steeply sloped
    (c) *LM* is steeply sloped and *IS* is vertical
    (d) *LM* is relatively flat as is *IS*

13. Crowding-out is more likely to occur when
    (a) The demand for money is interest, sensitive, and private sector spending is largely interest – insensitive
    (b) The demand for money is interest-sensitive, and private sector spending is interest-sensitive
    (c) The demand for money is interest, and private sector spending is interest-insensitive
    (d) The demand for money is interest-insensitive, and sector spending is interest-sensitive
14. Crowding out occurs when
    (a) A decrease in the money supply raises the rate of interest which crowds-out interest-sensitive private sector spending
    (b) An increase in taxes for the private sector reduces private sector disposable income and spending
    (c) A reduction in income taxes results in a higher interest rate, which crowds out interest-sensitive private sector
    (d) A reduction in government spending induces less consumption spending
15. Which of the following does not result in an increase in Zambia's net export?
    (a) The Zambian Kwacha depreciates
    (b) Output for Zambia's trading partners increase
    (c) Foreign currencies depreciate
    (d) Zambian trading partners lift tariff barriers
16. Which of the following does not increase output when exchange rates are fixed?
    (a) There is an increase in the money supply
    (b) There is an increase in government spending
    (c) There is a decrease in taxes
17. Which of the following increases output when exchange rates are flexible
    (a) There is an increase in the money supply
    (b) There is an increase in government spending
    (c) There is a decrease in taxes
18. The $M1$ definition of money is the sum of
    (a) Currency outside banks and current account deposits
    (b) Currency outside banks, current account deposits, and travelers` cheques
    (c) Currency outstanding and current accounts deposits
    (d) Currency outstanding, current accounts deposits and money market deposit accounts.
19. Which of the following statement is incorrect?
    (a) The precautionary demand for money is unrelated to income
    (b) There is a precautionary demand for money because of uncertainty about the receipt of future income
    (c) The precautionary demand for money is affected by the opportunity cost of holding $M1$ balances
    (d) There is a precautionary demand for money because of unexpected expenditures

20. If the opportunity cost of cars in terms of trucks is higher in country A than in country B, then
    (a) Country A should export trucks
    (b) Country A should export cars
    (c) We cannot tell because we do not know anything about comparative advantage.

SECTION B

True or False questions: Tick or circle the correct answer on the question paper and hand it in together with the answer booklet, (one mark each)

1. Keynesian economists take a noninterventionist approach to macroeconomic problems *T/F*
2. Real *GDP* declines during a recession. *T / F*
3. When the consumption equation is $C = K40 + 0.90Yd$, consumption is $K940$ when disposable income is $K1000$. *T / F*
4. The *Keynesian* model assumes that prices and wages do not adjust immediately to a change in aggregate supply and/or aggregate demand. *T / F*
5. A country which has cyclical unemployment has an unemployment rate greater than its natural rate. *T / F*
6. Gross domestic product is the sum of wages, rent, interest and profit plus indirect taxes and depreciation. *T / F*
7. An increase in the marginal propensity to import has the same effect upon the multipliers as an increase in the *MPC*. *T / F*
8. *IS* is vertical when investment is inversely related to the rate of interest. *T / F* T/F
9. The slope of *IS* decreases when there is an increase in the MPC. *T / F*
10. The *LM* schedule shifts to the right by $K_t \Delta M$ when there is an increase in the money supply. *T / F*
11. There is a liquidity effect every time the Central Bank changes the money supply. *T / F*
12. An increase in the money supply has a small effect upon output when the store of value demand for money is interest-sensitive. *T / F*
13. An increase in government spending always crowds out investment spending. *T / F*
14. An increase in the transactions demand for money ratio decreases the output effect of a change in the money supply. *T / F*
15. An increase in the marginal propensity to import decreases the slope of *IS*. *T / F*

16. The financial assets included in the $M2$ definition of money serve as a medium of exchange. T / F
17. An interest rate monetary policy stabilizes output when the location of IS is uncertain. T / F
18. According to the permanent income hypothesis, consumption is a fixed percentage of current income. T / F
19. A country has a comparative advantage over a second country in the production of the commodity in which it has a higher opportunity cost than the other country. T / F
20. The life cycle hypothesis suggests that high income households have a high APC. T / F

SECTION C: ANSWER ALL QUESTIONS

1. Given the following economic system

$Y=C+I+G+X-M$

Consumption $= 100 + 0.8Yd$

Investment $= 60 - 50i$

Taxation $= 0.2Y$

Government $= 200$

Exports $= 200$

Imports $= 0.05\ Y_d$

(a) Derive the equilibrium equation for Y.(4 marks)

(b) If i = 10%. What is the state of government budget? (4 marks)

(c) If exports increase to 250, what is the new equilibrium level of income.(4 marks)

(d) Is the balance of trade in deficit or surplus at the equilibrium level of income? (4 marks)

(e) What is the value of the multiplier in this economy? (4marks)

2. (a) Find an equation for LM when the money supply is $K200$ and the demand for money is specified as $L = 0.20y - 4i$ (5 marks)

(b) Given a two sector model where
$C = K100 + 0.80Y$ *and* $I = K150 - 6i, M = K150$ *and* $L = 0.20Y - 4i$.

(i) Find an equation for equilibrium in the goods market (IS) and for the money market (LM) .(5 marks)

(ii) Find output and the rate of interest at which there is simultaneous equilibrium in the money and goods markets (5 marks)

(iii) Sketch the IS and (LM) equations and find equilibrium output and the rate of interest. (5 marks)

3. Explain what you understand of the following concepts (4 marks each)

(i) Absolute advantage
(ii) Recession
(iii) Crowding out effect
(iv) Liquidity trap
(v) Phillips curve

END OF EXIMINATION

UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
2011 ACADEMIC YEAR SECOND SEMESTER EXAMINATIONS
AGE 452: INTERMEDIATE AGRIBUSINESS MANAGEMENT
TIME: THREE (3) HOURS

INSTRUCTIONS: ANSWER **BOTH** QUESTIONS IN SECTION A AND ANY **TWO** OF THE THREE QUESTIONS IN SECTION B.

SECTION A

1. Running a successful agribusiness firm requires that you understand the environment you will be operating in and develop right marketing strategies to compete effectively. Choose a specific agribusiness product and detail out how you would strategically plan for its marketing **(25 Marks)**

2. You are an Agribusiness Consultant and have been invited by Citizens Economic Empowerment Fund (CEEC) to give a speech on business planning to potential loan applicants. Prepare your speech notes highlighting the following:

   a) The definition of a business plan **(2 Marks)**
   b) How the business owner benefits from developing a business plan **(8 Marks)**
   c) Suggest a business plan format and its content (**15 Marks**)

SECTION B

3 i) If you were introducing a new electronic dairy feeding system that would reduce costs by 20 to 25 percent

   a. What pricing policy would you suggest? Give reasons for your choice **(5marks)**
   b. Would you stay with the policy indefinitely; explain your answer? **(4 marks)**
   c. What promotional strategy would you use **(6 marks)**

   ii) Outline the principles of Total quality Management and how they can be applied in managing an agribusiness firm **(10 Marks)**

4. a) The decision of where to locate an agribusiness is a strategic issue. Discuss the statement and list the factors you would consider when choosing where to locate a pineapple processing plant **(20Marks)**

   b. Describe two most commonly used methods by agribusinesses to track inventory **(5Marks)**

5. Write short notes on the following :
   a) Sources of innovation as outlined by Peter Drucker **(7 Marks)**
   b) Building blocks of successful entrepreneurship**(12 Marks)**
   c) Linking the sizing of capacity cushion to competitive priorities, capacity intensity and resource flexibility decisions**(6Marks)**

THE END

THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
Department of Agricultural Economics and Extension Education

Second semester final examinations 2010/11 academic year

Course: AGE462 Agricultural Marketing and Pricing

Date: 17th May, 2011

Venue: Other rooms

Duration: 3 hours

Total points: 100

Instructions

Answer all the questions.

1. Briefly discuss the following concepts:
    a. Total elasticity
    b. Homogeneity condition
    c. Price rigidity in oligopoly
    d. Marketing bill
    e. Price transmission **(25 marks)**

2. A growing percentage of agricultural commodities are now being sold by contractual arrangements.
    a. Discuss the main differences between a production and a marketing contract **(6 marks)**
    b. Identify two (2) advantages and two (2) disadvantages of selling produce through production contracts for farmers **(8 marks)**

3. Mr. Mwale is a small-scale dairy farmer producing milk in Chongwe district. Suppose a new firm is established that uses milk to produce a specialized type of cheese, resulting in an increase in the price per liter of milk. However, the firm is forced to shut down due to food safety concerns, resulting in a decline in the price of milk. Use the supply response concept to explain how Mr. Mwale is likely to respond to the increase and subsequent decline in the price of milk. **(12 marks)**

4. Explain, with the aid of graphs, price determination in a pure (perfect) competition market structure for:
    a. Storable agricultural commodities **(5 marks)**
    b. Non-storable agricultural commodities **(5 marks)**

5. Suppose the retail price of pork chops is K18,000 per kilogram, the farm gate price of a pig is K6,500 per kilogram and a 300kg pig yields 150kgs of pork chops,
    a. Calculate and interpret the farm-retail price spread **(8 marks)**

b. Calculate and interpret the farm value as a percentage of the retail price **(6 marks)**

6. Briefly explain the Structure-Conduct-Performance (SCP) model. For each component of the SCP model, describe two issues that an industrial organization economist would evaluate **(15 marks)**

7. A cobweb model is an economic model that explains why prices might be subject to periodic fluctuations in certain types of markets. Use the cobweb model to show the effect of a drought on maize production in Zambia. **(10 marks)**

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

THE UNIVERSITY OF ZAMBIA

SCHOOL OF AGRICULTURAL SCIENCES

2011 ACADEMIC YEAR SECOND SEMESTER

FINAL EXAMINATIONS

AGE 552: AGRICULTURAL EXTENSION EDUCATION

TIME: THREE (3) HOURS

TOTAL MARKS: 100

INSTRUCTIONS: ANSWER ALL QUESTIONS.

ALL QUESTIONS CARRY EQUAL MARKS (i.e. 20)

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1. State the major differences between "agricultural knowledge system" and "agricultural information system" and mention at least four factors that form a basis on which farming systems research focuses on small scale farmers.

2. Identify all "Ideal types" of adopter categories in the diffusion of innovation and for each category explain the type of farmer, advantages and disadvantages associated with working with such a farmer category.

3. Briefly discuss the theoretical importance of objectives, target groups, offering and organization elements in the design of an extension delivery system.

4. Based on at least four principles, show case how Participatory approach is distinguished from the Training and Visit System.

5. "Extension methods are commonly classified into individual, group and mass media".
   a) Define the concept extension methods
   b) With at least two extension methods from each of these classifications examine their suitability to learning situations.
   c) Explain with practical examples three main reasons why group extension methods are considered to be more rewarding compared to individual methods.

THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
2010/2011 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

AGE 572: AGRICULTURAL POLICY ANALYSIS
TIME: THREE HOURS
INSTRUCTIONS: Answer all questions

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1. a) The current National Agricultural Policy for Zambia comes to an end in 2015. You have been tasked to advise on the best approach in formulating a policy for the agriculture sector. Explain and illustrate by use of a diagram your understanding regarding the definition of policy and your advice regarding the basic framework/approach that should underpin the determination of policy position in the agricultural sector. (8 marks)

   b) The allocation of scarce resources among alternative end uses is a basic problem facing all sectors of the economy including agriculture. With the use of the production possibility frontier diagram explain the implications of choices of allocation for an economy producing wheat and rice including the following:
   - Quantity of land, labour and other inputs;
   - Possible changes in consumer tastes for the two goods;
   - Administered prices for the goods by a marketing agency such as Food Reserve Agency (FRA);
   - Possibility of achieving economic growth especially for LDCs like Zambia.

   (12 marks)

2. a) The government may be justified to intervene in the market economy on account of market failure and on the grounds of non-efficiency reasons. What other reasons that have been advanced for intervention in the market economy? (10 marks)

   b) Describe the possible effects of market failure due existence of monopoly power. (10 marks)

3. a) Policy Analysis Matrix (PAM) is a computational framework for measuring input use efficiency in production, comparative advantage and the degree of government interventions. Describe briefly the steps followed in the construction of PAM. (12 marks)

   b) Explain briefly some of the cautionary considerations that should be taken into account in the application of the PAM approach. (8 marks)

4. a) What is pan-territorial pricing policy? Discuss briefly the implications of this policy on regional comparative advantages and the arguments that have been advanced in support of pan-territorial food crop pricing. (10 marks)

b) A strategic reserve can be a particularly heavy fiscal drain if the staple food crop is procured at a pan-seasonal price and is a "switch crop". Explain and illustrate by use of a diagram the possible loss and cost of grain reserve with trade when grain is procured at a pan-seasonal price and is a "switch crop". (10 marks)

5. Write short notes on the following:
a) Pecuniary externalities: the economies of agglomeration (4 marks)
b) Price policies and non-price policies (3 marks)
c) The choice and application of policy instruments (6 marks)
d) Food supply insecurity and food consumption insecurity (4 marks)
e) Private sector contribution to agricultural research (3 marks)

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF AGRICULTURAL SCIENCES

2010 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATION

AGF 332 METHODS IN FOOD ANALYSIS I

TIME: **Three (3) Hours**

INSTRUCTIONS: Answer **any four** questions in this examination paper. Questions carry equal marks.

Question 1

(a) Describe the mechanism of absorption of radiation by a molecule or atom in a food sample.

(b) A peptide was admitted to a high resolution Mass spectrometer and the parent peak mass were measured relative to the parent peak in the spectrum of dibrombenzene (236.8638). The measured ratio of unknown mass/reference mass was 1.001197 ± 0.000002. Compute the exact weight of the peptide.
[$^{12}C = 12.0000$; $^{1}H = 1.0078$; $^{14}N = 14.0031$; $^{16}O = 15.9949$; Br = 78.9184]

(c) Discuss in detail the types of mobility and factors that cause mobility of food solutes in capillary electrophoresis.

(d) You need to determine the concentration of an analyte in a food using UV/visible spectroscopy. At what wavelength would you analyze the sample and what precautions would you take when determining the concentration of the analyte?

(e) Explain the theory and instrumentation of phosphorimetry. Mention few applications of this technique.

Question 2

(a) What is Electroosmotic Flow in Capillary Electrophoresis (CE) and how does it arise?

(b) Briefly outline Job's Method for the determination of the stoichiometry of a coloured food complex.

(c) Predict the relative shape of nuclear magnetic resonance (NMR) spectrum for

(i) 2-butanone (methyl ethyl ketone).

(ii) Methyl butyrate (methylbutylester)

(iii) 4,4-Dimethyl-2-pentanone

(d) A solution containing a mixture of tetracycline and epitetracycline was found to have an absorbance of 0.670 at 254nm and 0.720 at 267nm (b=1.00cm). If the molar Absorptivities of tetracycline are 16000 at 254nm and 19000 at 267nm and the molar Absorptivities of epitetracycline are 16000 at 254nm and 15000 at 267nm, calculate the concentrations of tetracycline and epitetracycline in the mixture.

(e) Mass spectrometry used to be limited to the analysis of small volatile molecules. Today its major use is the analysis of large molecules, very often proteins or nucleic acids. There are several ways to make large molecules 'volatile'. Select one approach and describe how it works.

Question 3

(a) Sketch the instrumentation for a Capillary Electrophoresis (CE) system.

(b) How many possible orientations do spin ½ nuclei have when they are located in applied magnetic field?

(c) In a capillary electrophoresis system, the protein horse heart myoglobin (MW 13,900) has electrophoretic mobility μ_{ep} of 0.65×10^{-4} cm^2/Vs in a pH 8.5 buffer and its diffusion coefficient $D_m = 1 \times 10^{-6}$ cm^2/s at 30, 000 V. Calculate the number of theoretical plates for the protein on this system.

(d) What is the chemical shift of a proton whose NMR signal is observed at 430 Hz down field from TMS in a spectrometer whose basic resonance frequency for hydrogen is 75MHz.

(e) Sulphate in natural waters is often analyzed by using the barium sulphate turbidimetric method. The dissolved sulphate is reacted with a solution containing excess barium chloride to form the barium sulphate suspension. The turbidity measurements are made in a spectrometer at 450nm. The percent transmittance of a series of standards and the unknown are listed in the following table. Calculate the turbidance of each solution and the concentration of the unknown.

Sulphate concentration, mg/litre	**Percent transmittance**
10.2	94
19.8	80
32.2	60
45.1	40
65.6	20
79.6	13
Unknown	34

Question 4

(a) What is the function of the electrostatic sector in a double-focusing mass analyzer? Explain its role in improving the resolution obtained with a magnetic sector mass analyzer.

(b) A substance containing only C, H and O has a spectrum with the parent peak at m/e 184 (10%), another peak at m/e 91 (100%) and two small peaks at m/e 77 and 65. Metastable peaks appear at m/e 45.0 and 46.3.

(i) What are the parent and daughter ions associated with the two metastable peaks?

(ii) What group does the peak at m/e 77 suggest?

(iii) Suggest the possible structure of the compound.

(c) Describe the process of *electro-osmosis* (also called *cathodal drift*) and explain why it is important in capillary electrophoresis.

(d) A proton has resonance 90 Hz down field from tetra methyl silane (TMS) when the field strength is 14100 gauss and the oscillator frequency is 60 MHz. what will its shift in Hz be if the field strength is increased to 28200 gauss and the oscillator frequency to 120 MHz?

(e) When performing UV spectroscopy, what is the effect of increasing the wavelength bandwidth (by increasing monochromator slit width) on sensitivity and specificity?

Question 5

(a) Describe briefly three spectrophotometric methods for the evaluation of the stoichiometry of a coloured food complex.

(b) Outline the apparatus and procedure typically used for separation of analytes by gel electrophoresis.

(c) The absorbances of a series of standard solutions of a compound were measured; they are recorded below. The absorbance of an unknown solution of the same compound was 0.480. Determine the concentration of the unknown.

Concentration, x10^{-4}M	**Absorbance**
1.0	0.080
3.0	0.232
5.0	0.379
7.0	0.524
9.0	0.672
11.0	0.820

(d) You are performing HPLC and your stationary phase is a polar nonionic functional group. What type of chromatography is this and what could you do to increase the retention time of an analyte?

(e) In mass spectrometry, we may use electron impact ionisation or a soft ionisation method (eg chemical ionisation). What are the advantages and disadvantages of electron impact ionisation over a soft ionisation method?

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF AGRICULTURAL SCIENCES

DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

2010/2011 ACADEMIC YEAR. SECOND SEMESTER FINAL EXAMINATIONS

AGF352 FOOD MICROBIOLOGY - PRACTICAL

TIME: THREE (3) HOURS

INSTRUCTIONS:

ANSWER ALL QUESTIONS

ALL THE QUESTIONS CARRY EQUAL MARKS (I.E 50 MARKS)

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1. As Quality Control Manager of a Dairy processing plant, you have just finished designing and implementing a HACCP plan for a "Yoghurt with Peanuts" processing line.

   (i) Give and explain the 7 principles of HACCP you utilized during the implementation.

   (ii) Give a brief process flow diagram for the production of the "Yoghurt with Peanuts" and identifying CCP's.

   (iii) Based on the identified CCP's, please create a HACCP data sheet (as provided below)

Process Step	Hazards (What can go wrong here)	Control (What can I do about it)	Critical Control (Is it critical to food safety)	Monitoring (How can I check)	Limits (What time or temperature must be achieved)	Corrective Actions (What if its not right)	Review (How often should I review the system)

(50 Marks)

2. You are provided with a food sample labeled **X** that is compromised in its microbiological quality.

   I. Describe how you would isolate and quantify the hygiene indicator microorganisms from the provided food sample.

   II. Comment on the intrinsic factors in the food sample that may inhibit the proliferation of the spoilage microorganisms.

   III. Comment on one possible pathogenic microorganism that is likely to inhabit the provided food product and how it brings about food poisoning and the related symptoms from the food poisoning.

   (50 Marks)

GOOD LUCK

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

2009/10 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

AGF 352 / BS 482: FOOD MICROBIOLOGY
TIME: THREE HOURS

INSTRUCTIONS:

The examination has two sections, **A** and **B** and questions in both sections carry equal marks.
There are a total of **SIX** questions; answer **FIVE** questions, all the **THREE (3)** questions in section **A** and **TWO (2)** in section **B**

Section A

1.
   a. Explain **in detail** the effects of **pH** and **Eh** (Oxidation-Reduction Potential) on spoilage of meat and meat products **(16 Marks)**
   b. Describe **two (2)** processing factors in the meat industry that would contribute to meat spoilage **(4 Marks)**

2. Describe **briefly** how each of the following food preservation methods destroy microorganisms
   a. Irradiation **(4 Marks)**
   b. Carbon dioxide (CO_2) and Ozone (O_3) **(4 Marks)**
   c. Phosphates and nitrates **(4 Marks)**
   d. Sodium Chloride and Sugars **(4 Marks)**
   e. Fermentation **(4 Marks)**

3. You have been appointed to manage the catering of a newly opened Boarding High School and are trying to come up with a cleaning and disinfection program for the school cafeteria.
   a. Why should cleaning and disinfection procedures be considered integral to any food establishment? **(4 Marks)**
   b. Outline the basic steps involved in the cleaning and disinfection procedures. **(4 Marks)**
   c. Describe **two (2)** factors that would influence the cleaning procedure to be carried out. **(4 Marks)**
   d. List two chemical sanitizers that you would consider to use for disinfection and for each give **one (1)** advantages and **one (1)** disadvantage. **(4 Marks)**
   e. Explain why it is difficulty to destroy biofilms during cleaning and disinfection in a food establishment **(4 Marks)**

Section B

4. Describe **in detail** contamination and spoilage of the following
   a. Fish **(10 Marks)**
   b. Grain and grain products **(10 Marks)**

5.
   a. In the implementation of a HACCP Plan, describe **in detail** the first five (5) steps and their importance **(15 Marks)**
   b. Name two biological, two chemical and two physical hazards that may be associated with food and food products. **(3 Marks)**
   c. Identify one limitation of HACCP **(2 Marks)**

6. Write short notes on the following
   a. Bovine Spongiform Encephalopathy (BSE) **(5 Marks)**
   b. Listeriosis **(5 Marks)**
   c. Mechanism of intoxication by *Clostridium perfringens* **(5 Marks)**
   d. Control of food intoxication and food infection (give at least five reasoning) **(5 Marks)**

END OF EXAMINATION

UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
DEPARTMENT OF FOOD SCIENCE & TECHNOLOGY

AGF 362: FOOD EVALUATION

EXAMINATION: Second Semester, May 2011 **TIME:** Three (3) Hours

INSTRUCTIONS:

(i) There are five questions in this paper. **Question 1 is compulsory**. Out of questions 2 to 5, answer **any three** questions.

(ii) All questions carry **20 marks** each

(iii) Find also attached **table T4** – Upper α-probability points of student's t-distribution, **table T5** – Upper α-probability points of χ^2-distribution and **table T6**-Upper α-probability points of F-distribution

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QUESTION 1 (Compulsory)

A peanut butter manufacturer plans to improve the spreadability of their peanut butter. You as a hired Product Researcher has proposed two (2) prototypes of peanut butter which you label as sample PB1 and sample PB2. The two prototypes have shown that they are more spreadable than the regular peanut butter (control). Sample PB1 requires more force to initiate spreading while sample PB2 initially spreads easily but reduces spreadability subsequently. The manufacturer wishes to know how different the prototypes are from the regular peanut butter (control) as perceived by his/her consumers. In order to achieve this, you as a product researcher decided to carry out a sensory evaluation test. A pre-weighed amount of peanut butter is placed in a cup. The same amount is weighed out for each sample. The test is performed by evaluating the spreadability of the peanut butter on a piece of biscuit previously proven to have the same surface smoothness for all pieces. The evaluation is limited to two samples at a time. All panelists receive the labeled control first and the test (prototype) sample second. The test uses 10 panelists who evaluate all the three possible pairs, which may be:

- Control vs product PB1
- Control vs product PB2
- Control vs Blind Control

The results obtained are shown in the table below.

Panelist	Blind Control	Prototype PB1	Prototype PB2
1	1	4	5
2	4	6	6
3	1	4	6
4	4	8	7
5	2	4	3
6	1	4	5
7	3	3	6
8	0	2	4
9	6	8	9
10	7	7	9

(a) State with reason(s) what kind of sensory test you carried out to obtain this kind of data **[2 marks]**

(b) Are the prototypes, sample PB1 and sample PB2, significantly different from the regular peanut butter, (blind control sample)? **[5 marks]**

(c) Which sample is significantly more different from the regular peanut butter, sample PB1 or sample PB2? **[5 marks]**

(d) Did the panelists show significant differences in their scores? **[5 marks]**

(e) What decision(s) can you as a product researcher advise the peanut butter manufacturer to make from these results? **[3 marks]**

NOTE: LSD = t*SQRT(2*MS_E/n)
where t= is the t-value for the level of significance of the ANOVA, SQRT= Square root, MS_E= Error Mean Square for the ANOVA and degrees of freedom being equal to the degrees of freedom of the error term (df_E).

QUESTION 2

(a) Define the following terms:

(i) Organoleptic **[1 mark]**
(ii) Discrimination **[1 mark]**
(iii) Nominal data **[1 mark]**
(iv) Augesia **[1 mark]**
(v) Absolute threshold **[1 mark]**

(b) We tend to perceive the attributes of a food item in the following order

(i) Appearance **[1.5 marks]**
(ii) Aroma/fragrance **[1.5 marks]**
(iii) Consistency/texture **[1.5 marks]**
(iv) Flavor **[1.5 marks]**

For each term, define it and give three (3) sub-attributes which can be defined under each given attribute

(c) Give four (4) applications of descriptive analysis in sensory evaluation **[4 marks]**

(d) In the Duo-trio-test, two forms of the test exist. Mention the two and explain the difference between the two forms of the test? **[5 marks]**

QUESTION 3

(a) State three differences between the following pairs;

(i) Kinesthetic and somesthestic perceptions? **[1.5 marks]**

(ii) Gustation and trigeminal perceptions? **[1.5 marks]**

(b) Briefly, describe how you would perform each of the following overall difference tests. Also explain how you would analyze the data from such tests:

(i) Triangle test **[2 marks]**

(ii) Two-out-five test **[2 marks]**

(c) Give and briefly describe three (3) major types of qualitative affective tests **[6 marks]**

(d) (i) Mention and briefly describe three ways in which you can determine color of food for the purpose of research, quality control or commerce **[1.5 marks]**

(ii) Two egg yolks were measured for color using a Minolta color meter at UNZA-Food Science Laboratory. The two egg yolks gave the following CIELAB values,

Egg Yolk A: L=43.3, a=30.0 and b=40.0

Egg Yolk B: L=75.3, a=45.1 and b=58.4

Using the CIELAB-values of the two egg yolks given, show by description the difference in the colour likely to be perceived on the two egg yolks **[4 marks]**

(iii) Mention and explain three pieces of information you can obtain from a texture profile curve **[1.5 marks]**

QUESTION 4

Eight panelists assessed for a single quality attribute on a new maheu product on a given scale. Each panelist retested the new maheu on six successive days (six replications). The panelists involved in the sensory evaluation were Abel, Bob, Cynthia, Derick, Emery, Fordson, Gibbson and Harriate. Each of the panelists scored: 7, 4, 6, 9, 8 and 6; 6, 3, 5, 7, 8 and 7; 5, 7, 8, 8, 7 and 7; 6, 8, 8, 6, 7 and 6; 7, 6, 8,

5, 6 and 5; 8, 5, 7, 7, 9 and 6; 7, 7, 7, 8, 7 and 5; and, 6, 8, 6, 7, 7 and 5. Assume the scores to come from normally distributed data and having come from populations with the same variance.

(a) Was the overall performance of the panelists significantly different? **[5 marks]**

(b) Which panelists scored differently? **[3 marks]**

(c) Was the panel consistent over replications? **[5 marks]**

(d) Identify the sets of replications which are different? **[3 marks]**

(e) Would you recommend for the continuous use of this panel? Explain your answer **[4 marks]**

QUESTION 5

New investors in Zamanita (Zambia) intend to modernize the cooking oil plant by replacing an old solvent extraction equipment with a new model. The Plant Manager would like to know if the cooking oil produced in the new extraction equipment **(Cooking oil B)** is the same as that made in the old solvent extraction plant **(Cooking oil A)**. The original, cooking oil A, has a slight beany flavour which has a carryover effect. In previous market surveys it was, however, proven that the consumers like this slight beany flavour. The Plant Manager hires you as a Sensory Evaluation Consultant. The Plant Manager would like you to determine if the two types of cooking oil produced by the two solvent extraction equipment can be distinguished by flavour. Secondly, the Plant Manager would like you to determine if the new solvent extraction equipment can be used in place of the old solvent extraction equipment. To provide the Plant Manager with the information to his queries, you conducted a sensory test. In this sensory test, you obtained a total of 60 responses, 30 matched pairs and 30 unmatched pairs, collected from 60 panelists. Each panelist evaluated either a matched pair (cooking oil A/cooking A or cooking oil B/cooking oil B) or unmatched pair (cooking oil A/cooking oil B or cooking oil B/cooking oil A) in a single session. The sensory test was conducted in the booth area under red lights. For the matched pairs, 17 panelists said the samples were the same and 13 panelists said the samples were different. On the other hand, in the unmatched pairs, 9 panelists said the samples were the same and 21 panelists said the samples were different.

(i) State with reason(s) what kind of sensory test you carried out to obtain this kind of data **[3 marks]**

(ii) Why was the test performed under red light? **[2 marks]**

(iii) Give advice, outlining your basis, to the Plant Manager regarding his two queries above **[12 marks]**

(iv) In your opinion, what decision is the Plant Manager likely to make? **[3 marks]**

.....End of Examination.....

UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
DEPARTMENT OF FOOD SCIENCE & TECHNOLOGY

AGF 342: FOOD TOXICOLOGY
EXAMINATION: Second Semester, May 2011 **TIME:** Three (3) Hours
INSTRUCTIONS:

(i) There are five questions in this paper. Answer any four questions of your choice.
(ii) All questions carry **20 marks** each

QUESTION 1

(a) Define the following terms and state their importance in food toxicology

(i) Food intoxication **[2 marks]**

(ii) Mutagen **[2 marks]**

(iii) LD_{50} **[2 marks]**

(iv) Systemic exposure **[2 marks]**

(v) Pandemic disease **[2 marks]**

(b) There are number of structural barriers in existence in human beings that restrict entrance of toxicants into certain organs or tissues. State and explain three important examples of structural barriers to toxicants in human beings **[10 marks]**

QUESTION 2

(a) (i) In the growth of the fetus or embryonic cells, which stage is considered the critical or highly susceptible stage with regard to teratogenesis? **[1 mark]**

(ii) What makes the stage you have mentioned critical, explain? **[2 marks]**

(b) In cytotoxic teratogenesis, malformations involve reduction deformities, or missing elements. Why is this plausible for this mechanism? **[2 marks]**

(c) The transformation of normal cells into cancerous cells, also known as carcinogensis, is considered to proceed through at least three phases or stages

(i) State and explain each stage **[4 marks]**

(ii) Which stage could be targeted for chemotherapy, and why? **[1 mark]**

(d) (i) Give and explain three approaches to cancer therapy **[3 marks]**

(ii) State one problem associated with the use of each of the approaches mentioned **[2 marks]**

(e) (i) State and explain three approaches to study or understand teratogenesis **[3 marks]**

(ii) Why is it important for the scientists to study and understand teratogenesis? **[2 marks]**

QUESTION 3

(a) What is the difference between food allergy and food intolerance **[3 marks]**

(b) (i) State and explain four categories of microorganisms in terms of their use in food technology **[6 marks]**

(ii) Which category is important for food toxicology and why? **[2 mark]**

(c) (i) What are mycotoxins? **[2 marks]**

(ii) What do you understand by aflatoxins and discuss their importance in food toxicology **[4 marks]**

(iii) State and explain two of the important factors determining aflatoxin's presence in stored foods **[3 marks]**

QUESTION 4

The compounds stated below may be found in foods. Write short notes on important toxicological aspects about these compounds.

(a) PAHs **[5 marks]**

(b) Acrylamides **[5 marks]**

(c) Cyanogens **[5 marks]**

(d) Scombroid poisoning **[5 marks]**

QUESTION 5

(a) Mention three major routes of exposure due to accidental or intentional exposure of humans to toxicants? **[3 marks]**

(b) Out of these, select one which is considered to be a more important route to food toxicology and give details of how the different parts of this selected route determines the proportion of toxicant that could be absorbed into the blood stream? **[17 marks]**

.....End of Examination.....

THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY
2010/2011 ACADEMIC YEAR. SECOND SEMESTER FINAL EXAMINATIONS

AGF352 FOOD MICROBIOLOGY - PRACTICAL
TIME: THREE (3) HOURS

INSTRUCTIONS:

ANSWER ALL QUESTIONS

ALL THE QUESTIONS CARRY EQUAL MARKS (I.E 50 MARKS)

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1. As Quality Control Manager of a Dairy processing plant, you have just finished designing and implementing a HACCP plan for a "Yoghurt with Peanuts" processing line.

   (i) Give and explain the 7 principles of HACCP you utilized during the implementation.

   (ii) Give a brief process flow diagram for the production of the "Yoghurt with Peanuts" and identifying CCP's.

   (iii) Based on the identified CCP's, please create a HACCP data sheet (as provided below)

Process Step	Hazards (What can go wrong here)	Control (What can I do about it)	Critical Control (Is it critical to food safety)	Monitoring (How can I check)	Limits (What time or temperature must be achieved)	Corrective Actions (What if its not right)	Review (How often should I review the system)

(50 Marks)

2. You are provided with a food sample labeled **X** that is compromised in its microbiological quality.

   I. Describe how you would isolate and quantify the hygiene indicator microorganisms from the provided food sample.

   II. Comment on the intrinsic factors in the food sample that may inhibit the proliferation of the spoilage microorganisms.

   III. Comment on one possible pathogenic microorganism that is likely to inhabit the provided food product and how it brings about food poisoning and the related symptoms from the food poisoning.

   (50 Marks)

GOOD LUCK

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

2010/2011 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

AGF 422 NUTRITION.

TIME: THREE (3) HOURS

INSTRUCTIONS

ANSWER ALL QUESTIONS IN SECTION A AND ANY 2 FROM SECTION B

EACH QUESTION CARRIES 20 MARKS

ANSWER EACH QUESTION IN SECTION B IN A SEPARATE ANSWER BOOKLET

SECTION A

QUESTION 1

Briefly explain the following

i. Rickettes
ii. Hypertension
iii. Type II diabettes
iv. Vitamin K.
v. Thiamin
vi. BMR
vii. Cephalic phase
viii. Activated Transport
ix. Lipoproteins
x. BMI
xi. Hypercholesteroleamia

(20 Marks)

QUESTION 2

State (with examples and brief explanations) the functions of the following;

i. Vitamin A
ii. Minerals
iii. Large intestines
iv. Calcium

(20 Marks)

QUESTION 3

Explain the role of lipids in diet and in the body.

(20 Marks)

SECTION B

QUESTION 4

The outcome of over nutrition in Zambia is being indicated through the prevalence of overweight and obesity in Zambia. As a consultant you have been tasked to explain the probable causes of overweight and obesity in Zambia.

(20 Marks)

QUESTION 5

Iron deficiency is a major public health problem, affecting women and children in Zambia. Describe how iron is absorbed/ balanced in the body and discuss the major factors influencing the bioavailability of iron.

(20 Marks)

QUESTION 6

Whole wheat bread (Fiber, Starch and lactose) is being recommended as a health food for certain individuals in the population.

I. Briefly explain the process of digestion and absorption/transport (after digestion) of whole wheat bread upon consumption.

II. What are the possible health benefits (disease prevention) that can be associated with the consumption of this food?

(20Points)

QUESTION 7

You are a nutritionist at a primary health facility (With a doctor and paediatric ward) in peri-urban area and a mother presents a child with severe PEM.

What clinical signs are you likely to observe?

What treatment regime would you recommend for the full recovery of the infant

(20 Points)

GOOD LUCK!!!!

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

2010/11 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATION

AGF 432: PROCESS CONTROL AND INSTRUMENTATION

TIME: THREE HOURS

INSTRUCTIONS:

1. Carefully read the instructions and each question.
2. Answer **ALL** questions.
3. **ALL** questions carry equal marks.
4. Table of Laplace transformations is provided on the last page.

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1. A mercury thermometer having a first-order dynamics with time constant is placed in a bath at a certain temperature until it reaches steady state.
   a) Derive the first-order dynamic model for a mercury thermometer in the bath. [10 marks]
   b) Draw a sketch showing the variation of the thermometer reading with time. [5 marks]
   c) Outline the differences between the negative feedback and positive feedback systems, and of these two is the most preferred system in food processing. [5 marks]

2. Consider a liquid-level system of a water treatment tank of a cross section area, flow resistance R. assume that q_o, the volumetric flow through R is related to the head h by $q_o = h/R$. constant density Þ.

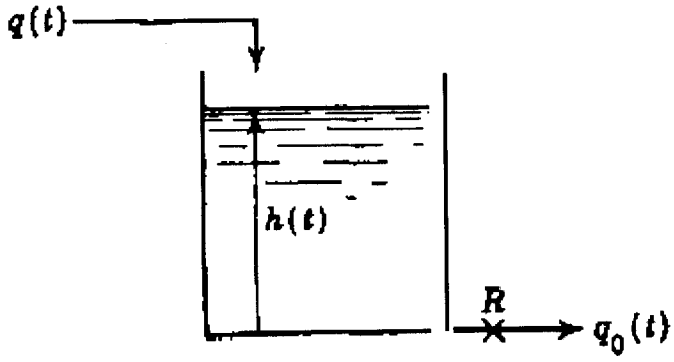


Figure 1

a) State the conservation law of mass. [5 marks]
b) Develop the process model for the system. [10 marks]
c) Determine the transfer control function. [5 marks]

3. The bottling processes of producing *CocaCola* involve mixing of a concentrate, pure sugar, treat water, carbon dioxide in correct proportion. Assume a stream of sugar flows at constant volumetric flow rate q into a tank of constant hold up volume V. concentration of sugar entering the stream, χ (mass.sugar/vol) varies with time.

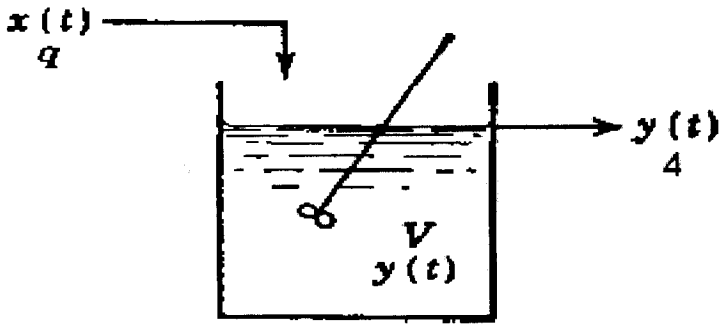


Figure 2.

a) Determine the transfer function relating outlet concentration γ to inlet concentration χ. [5 marks]
b) Determine the process model given that the input is a unit step function. [5 marks]
c) Provide the block diagram for each of the following control functions:

i. $$\frac{Y(s)}{U(s)} = G(s)$$

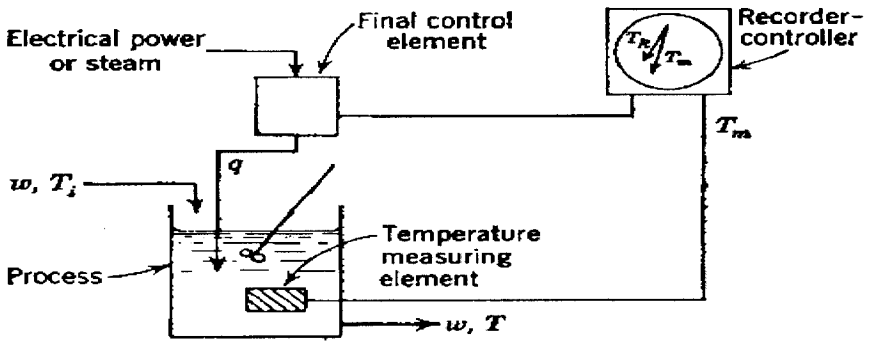
ii. $$\frac{Y(s)}{U(s)} = G_1(s)G_2(s)G_3(s)$$

iii. $$\frac{Y(s)}{U(s)} = G_1(s) + G_2(s)G_3(s)$$

iv. $$\frac{Y(s)}{U(s)} = \frac{G_1(s)G_2(s)}{1 + G_1(s)G_2(s)}$$

[10 marks]

4. The diagram below shows the control system of the higher order.



a) Draw the block diagram representing the control system above. [5marks]
b) Describe how the error is generated and controlled. [3 marks]
c) State the unsteady state balance of the system. [1 marks]
d) State the steady state balance of the system. [1 marks]
e) Determine the transfer function and describe how the system operates. [10 marks]

5. The R&D department of the company you are working for is trying to develop a new concentrated mango juice by blending a pure component A and a mixture of (A and B) using a stirred tank blending system as shown in figure 1.3 below. The following notions are used:
   - w_1, w_2 and w are mass flow rates
   - x_1, x_2 and x are mass fractions of component A.

It is assumed that:
1. w_1 is constant,
2. x_2 = constant = 1 (stream 2 is pure A),
3. Perfect mixing in the tank.

Your control objective is to keep x of the product coming out of the blender at the desired value (or 'set point') x_{sp}, despite variations in x_1. flow rate w_2 can be adjusted for this purpose.

a. What value of w_2 is required to have $x = x_{sp}$? [7 marks]
b. Outline the possible control strategies for the system. [5 marks]
c. Categorize these strategies so that the management can easily understand them during your presentation in the management meeting. [5 marks]
d. Which of the variable in the system would be considered as a disturbance or load variable? [3 marks]

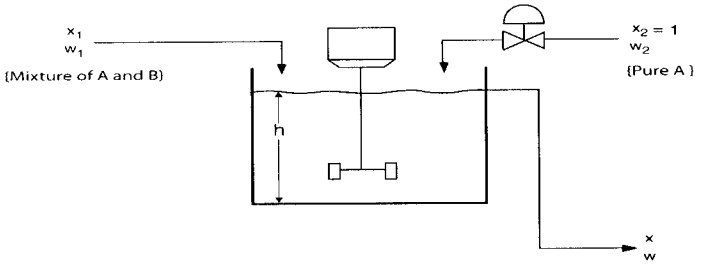


Figure 1.3. Stirred-tank blending system.

Annex: Laplace Transforms

	Functions of time, $f(t)$	Laplace Transforms of $f(t)$, $L\{f(t)\}$
1	$f(t)$	$F(s)$
2	$x(t)+y(t)$	$X(s)+Y(s)$
3	$k\,f(t)$	$k.F(s)$
4	$df(t)/dt$	$sF(s)-f(0)$
5	$d^n f(t)/dt^n$	$s^nF(s)-s^{n-1}f(0)-s^{n-2}f'(0)-\ldots-f^{(n-1)}(0)$
6	$\int_0^t f(\tau)\,d\tau$	$F(s)/s$
7	1	$1/s$
8	t	$1/s^2$
9	e^{-at}	$\frac{1}{(s+a)}$
10	te^{-at}	$\frac{1}{(s+a)^2}$
11	$1-e^{-at}$	$\frac{a}{s(s+a)}$
12	$f(t-a),\quad t>a$	$e^{-as}F(s)$

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

2010/2011 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

FOOD PACKAGING AGF 442

TIME: THREE (3) HOURS

INSTRUCTIONS

ANSWER ALL QUESTIONS.
EACH QUESTION CARRIES 20 MARKS

---

1. Food packaging has many definitions one of which states that: "Food packaging (packaging for food) is a means of achieving safe delivery of products in sound condition to the final user at a minimum cost".

a) In your own opinion, who needs food packaging in the food chain? **(10 marks)**
b) According to head and Stewart (1989), explain the factors that influence the success of a package in advertising? **(4 marks)**
c) Explain the levels of packaging. **(3 marks)**
d) Classify packaging based on migration. **(3 marks)**

2. The food industry uses four basic materials for food packaging namely: metal, glass, plastic and plant matter.

a) Name the basic types of metal cans based on method of construction. **(2 marks)**
b) Give two methods used for manufacturing paper. **(2 marks)**
c) State the special requirement necessary for paper that comes into contact with foods. **(2 marks)**
d) State the major safety concern of using paper as a packaging material. **(2 marks)**
e) Give two problems that are associated with absorption of flavor components by packaging materials. **(4 marks)**
f) Give a complete scenario of product-package interaction resulting from several modes. **(8 marks)**

3. A food company dealing with the manufacture of chocolate is looking for an ideal packaging material to package the chocolates and have come to you for advice.

a) Write a report on what you think should be the best packaging material for the product and give reasons. **(10 marks)**
b) Explain two defects that are usually associated with chocolates. **(3 marks)**
c) List the five modes of deterioration to be considered when selecting suitable packaging materials for breakfast cereals. **(5 marks)**

d) State the two major modes of deterioration to be considered when packaging fried snack foods? **(2 marks)**

4. Governments worldwide regulate foods with two general objectives which are to ensure the safety and wholesomeness of the food supply, hence the health of the public and to prevent economic fraud or deception i.e. food adulteration.

a) Give five situations that make a food to be considered adulterated. **(5 marks)**
b) Give three requirements of food additives. **(3 marks)**
c) What are the three types of information found on a food package label? **(3 marks)**
d) Define is plastic recycling. **(2 marks)**
e) Plastic polymers require greater processing to be recycled when compared to other materials like glass and metal materials. Give reasons for this. **(3 marks)**
f) Explain why plastics are sorted out according to their polymer types before recycling. **(4 marks)**

5. Aseptic technology results in production of ambient-shelf stable foods.

a) Define aseptic technology. **(3 marks)**
b) Discuss the factors that should be considered in order for aseptic packaging to be successful. **(15 marks)**
c) Which gas is not used in MAP despite having good effects and give reasons. **(2 marks)**

THE UNIVERSITY OF ZAMBIA

SCHOOL OF AGRICULTURAL SCIENCES

2010 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATION

AGF 452 METHODS IN FOOD ANALYSIS II

TIME: **Three (3) Hours**

INSTRUCTIONS: Answer **any four** questions in this examination paper. Questions carry equal marks.

Question 1

(a) (i) How can you remove oxygen from the polarographic cell and why?

(ii) Explain how convective and electrostatic attractions are minimized in polarography.

(b) Briefly explain the roles of the working, counter and reference electrodes in potentiostatic electrolytic cell.

(c) Voltammetry was used to determine the zinc content of a breakfast cereal. A 2.314g sample was digested in boiling concentrated nitric acid. After the sample dissolved, it was diluted to 100ml. A 5.00ml portion of this solution was analyzed by differential pulse polarography, giving a current of 2.31μA. when 50.0μL of 100ppm zinc standard was added to this solution, the current was 2.99μA. What is the concentration of zinc in the cereal?

(d) A 0.3619g sample of tetrachloropicolinic acid, $C_6HNO_2Cl_4$, is dissolved in distilled water, transferred to a 1000mL volumetric flask, and diluted to volume. An exhaustive controlled-potential electrolysis of a 10.00ml portion of this solution at a spongy silver cathode requires 5.374C of charge. What is the value of n for this reduction reaction?

Question 2

(a) Ion selective electrode and reference electrode pair was placed in exactly 100ml of the sample; a reading of 21.6mV was obtained. After the addition of exactly 10ml of a standard solution with a concentration of 100μg/ml, the electrode pair reading gave a reading of 43.7mV. The response slope of the indicator electrode was previously determined to be 57.8mV. What is the sample concentration?

(b) An unknown amount of copper (II) ions in a food sample produces a faradic current of 12.3μA on a normal pulse voltammogram. After 0.100ml of $1.0x10^{-3}$M Cu^{2+} is added to the original volume of 5.00ml, the new current is 28.2μA. Calculate the original amount of copper in the food sample.

(c) The purity of a sample of $Na_2S_2O_3$ was determined by a coulometric redox titration using I^- as a mediator, and I_3^- as the 'titrant'. A sample weighing 0.1342g is transferred to a 100ml volumetric flask and diluted to volume with distilled water. A 10.00ml portion is transferred to an electrochemical cell along with 25ml of 1M KI, 75ml of pH 7.0 phosphate buffer, and several drops of a starch indicator solution. Electrolysis at a constant current of 36.45mA required 221.8s to reach the starch indicator end point. Determine the purity of the sample.

(d) What is the short wavelength limit for a 60kV X-ray tube? What is the atomic number of the element for which just insufficient energy is available for excitation? Given: I = 120.96 units, i = 500mA, $k = 9.6x10^{-7}$.

Question 3

(a) A 0.40g sample of toothpaste Colgate was suspended in 50ml of fluoride ionic strength buffering medium (TISAB), and boiled to extract the fluoride. The mixture was cooled, transferred quantitatively to a 100ml volumetric flask and diluted to volume with deionised water. A 25.0ml aliquot was transferred to a beaker; a fluoride ISE and reference electrode inserted and a potential of -155.3mV was obtained after equilibration. A 0.100ml spike of 0.5mg/ml fluoride stock solution was added after which the potential was -176.2mV. Calculate the percentage of F^- by weight in the original toothpaste sample.

(b) Calculate the potential of half cell of copper which is immersed to the 0.05M $CuSO_4$. Standard potential $E^oCu^{2+}/Cu = 0.337V$ and $t = 25^oC$ ($^aH=1$)

(c) In coulometric titration of Fe^{2+} with Ce^{4+} which were generated at the cathode. The resistance was R = 150Ω, potential was 0.705V and the end point was reached after 352 seconds. Calculate the amount of iron in μg.

(d) Calculate the relative decrease of concentratrion of zinc in %, after electrolysis on the drop mercury electrode which lasted 17 minutes. Suggest that current during electrolysis is constant. Given that: $m = 2.6x10^{-3}$g/s, t = 2.3s, $D = 0.95x10^{-5}cm^2/s$, $C = 2.5x10^{-4}$M volume is 15ml ($3.75x10^{-2}$mmol/l in 15ml or $3.75x10^{-5}$mol/L.

Question 4

(a) You have a sample of mineral fortified spaghetti sauce. You want to determine the amount of Ca, K, Fe, Zn, Cu and selenium in the sample. State with reasons the type of preferred atomic spectroscopy you would use.

(b) Sodium benzoate, a salt of benzoic acid (a weak acid), is widely used as a food preservative. You wish to determine the ionization constant of benzoic acid and you choose to use conductometric method for your determination. You find that the equivalent conductance of a 0.002414M benzoic acid solution is found to be 32.22 at 25°C. Calculate the degree of dissociation of benzoic acid at this concentration, and calculate the ionization constant. Given that the Limiting Equivalent conductance of some ions in water at 25°C are:

Cations	λ°_{+}	**Anions**	λ°_{-}
H^+	349.8	OH^-	198.6
Na^+	50.1	Cl^-	76.4
Ca^{2+}	59.5	Acetate	40.9
Mg^{2+}	53.1	Benzoate	32.4

(c) Ions that react with Ag^+ can be determined electrogravimetrically by deposition on a silver anode:

$$Ag(s) + X^- \longrightarrow AgX(s) + e$$

(i) What will be the final mass of a silver anode used to electrolyze 75.00ml of 0.02380M KSCN if the initial mass of the anode is 12.4638g?

(ii) At what anode potential versus SCE cathode will 0.10M Br^- be deposited as AgBr(s)?

(d) Solute is transported to an electrode by diffusion, convection and electrostatic attraction. In polarography, we want the current to be limited by diffusion. Explain how convective and electrostatic attractions are minimized.

Question 5

(a) The concentration of Ca^{2+} in a sample of sea water is determined using a Ca ion-selective electrode and a one-point standard addition. A 10.00-mL sample is transferred to a 100-mL volumetric flask and diluted to volume. A 50.00-mL aliquot of sample is placed in a beaker with the Ca ion-selective electrode and a reference electrode, and the potential is measured as –0.05290 V. A 1.00-mL aliquot of a 5.00×10^{-2} M standard solution of Ca^{2+} is added, and a potential of –0.04417 V is measured. What is the concentration of Ca^{2+} in the sample of sea water?

(b) Explain how you would determine the molar conductivity at infinite dilution for a strong and weak electrolyte in a food sample.

(c) A Zambia continues to have difficulties with infestations of fruit flies imported from other in travelers' baggage and other personal belongings. Describe the basic organization of a digital image analysis system for on-line inspection detection of fruits (apples, bananas, mangoes, etc) in suitcases as they are transported from aircraft to baggage claim carousels. (5marks)

(d) A milk sample containing trace amounts of zinc is analyzed using an electro thermal atomic absorption spectrophotometer with a photomultiplier tube detector. A calibration sample containing 1.4ppm of zinc gives a signal of 124.5 units. If the background signal is 8.2 units and the concentration equivalent of the background is 1.02ppm, calculate the concentration of zinc in a sample that gives a signal response of 94.5 units. (6marks)

END OF EXAMINATION

PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
				KEY													
				Atomic number													
				X													
				Atomic mass													
				Name of the element X													
1 **H** 1.01 Hydrogen																1 **H** 1.01 Hydrogen	2 **He** 4.00 Helium
3 **Li** 6.94 Lithium	4 **Be** 9.01 Beryllium											5 **B** 10.81 Boron	6 **C** 12.01 Carbon	7 **N** 14.01 Nitrogen	8 **O** 16.00 Oxygen	9 **F** 19.00 Fluorine	10 **Ne** 20.18 Neon
11 **Na** 23.00 Sodium	12 **Mg** 24.31 magnesium											13 **Al** 26.98 Aluminium	14 **Si** 28.09 Silicon	15 **P** 30.99 Phosphorus	16 **S** 32.07 Sulphur	17 **Cl** 35.45 Chlorine	18 **Ar** 39.95 Argon
19 **K** 39.10 Potassium	20 **Ca** 40.08 Calcium	21 **Sc** 44.96 Scandium	22 **Ti** 47.88 Titanium	23 **V** 50.94 Vanadium	24 **Cr** 52.00 Chromium	25 **Mn** 54.94 Manganese	26 **Fe** 55.85 Iron	27 **Co** 58.93 Cobalt	28 **Ni** 58.69 Nickel	29 **Cu** 63.55 Copper	30 **Zn** 65.39 Zinc	31 **Ga** 69.72 Gallium	32 **Ge** 71.61 Germanium	33 **As** 74.92 Arsenic	34 **Se** 78.96 Selenium	35 **Br** 79.90 Bromine	36 **Kr** 83.80 Krypton
37 **Rb** 85.47 Rubidium	38 **Sr** 87.62 Strontium	39 **Y** 88.91 Yttrium	40 **Zr** 91.22 Zirconium	41 **Nb** 92.91 Niobium	42 **Mo** 95.94 Molybdenum	43 **Tc** 97.91 Technetium	44 **Ru** 101.07 Ruthenium	45 **Rh** 102.91 Rhodium	46 **Pd** 106.42 Palladium	47 **Ag** 107.87 Silver	48 **Cd** 112.41 Cadmium	49 **In** 114.82 Indium	50 **Sn** 118.71 Tin	51 **Sb** 121.76 Antimony	52 **Te** 127.60 Tellurium	53 **I** 126.90 Iodine	54 **Xe** 131.29 Xenon
55 **Cs** 132.91 Caesium	56 **Ba** 137.33 Barium	57 – 71	72 **Hf** 178.49 Hafnium	73 **Ta** 180.95 Tantalum	74 **W** 183.84 Tungsten	75 **Re** 186.21 Rhenium	76 **Os** 190.23 Osmium	77 **Ir** 192.22 Iridium	78 **Pt** 195.08 Platinum	79 **Au** 196.97 Gold	80 **Hg** 200.59 Mercury	81 **Tl** 204.38 Thallium	82 **Pb** 207.2 Lead	83 **Bi** 208.98 Bismuth	84 **Po** 208.98 Polonium	85 **At** 209.99 Astatine	86 **Rn** 222.02 Radon
87 **Fr** (223.02) Francium	88 **Ra** 226.03 Radium	89 - 103	104 **Unq** 261.11	105 **Unp** 262.11	106 **Unh** 263.12	107 **Uns** 262.12	108 **Uno** 265.00	109 **Une** 265									

57 **La** 138.91 Lanthanum	58 **Ce** 140.12 Cerium	59 **Pr** 140.91 Praseodymium	60 **Nd** 144.24 Neodymium	61 **Pm** 144.91 Promethium	62 **Sm** 150.36 Samarium	63 **Eu** 151.97 Europium	64 **Gd** 157.25 Gadolinium	65 **Tb** 158.93 Terbium	66 **Dy** 162.50 Dysprosium	67 **Ho** 164.93 Holmium	68 **Er** 167.26 Erbium	69 **Tm** 168.93 Thulium	70 **Yb** 173.04 Ytterbium	71 **Lu** 174.97 Lutetium
89 **Ac** 227.03 Actinium	90 **Th** 232.04 Thorium	91 **Pa** 231.04 Protactinium	92 **U** 238.03 Uranium	93 **Np** 237.05 Neptunium	94 **Pu** 244.0 Plutonium	95 **Am** 243.06 Americium	96 **Cm** 247.07 Curium	97 **Bk** 247.07 Berkelium	98 **Cf** 251.08 Californium	99 **Es** 252.08 Einsteinium	100 **Fm** 257.10 Fermium	101 **Md** 260 Mendelevium	102 **No** 259.10 Nobelium	103 **Lr** 262.11 Lawrencium

UNIVERSITY OF ZAMBIA

SCHOOL OF AGRICULTURAL SCIENCES

SECOND SEMESTER EXAMINATION MAY 2011

TECHNOLOGY OF MEAT AND FISH PRODUCTS

AGF 512

INSTRUCTIONS: 1) Answer all questions in both sections

2) Use separate answer books for either section

3) Time: 3 hours

Section A: Answer both questions

Question 1

a) Discuss microbial invasion in fish and the changes in the microflora during its storage. **[10 marks]**

b) Chilling is a very important step in the handling of fish. Discuss three (3) chilling methods and give their limitations. **[10 marks]**

c) RB Supermarket Ltd sales chilled Mackerel and Tilapia. The manager approaches you with a problem of varying shelf life for the two species of fish with one being shorter than the other. As an expert in fish product technology, explain the reasons for the differences and advise the client accordingly on the actual storage life for each species. **[5 marks]**

Question 2

a) Explain the freezing process of fish and the factors affecting frozen fish storage. **[10 marks]**

b) Chama fisheries is experiencing the following problems on its smoked fish products:

- short storage life
- spoilage of the fish from inside,
- toxic substances on the fish
- moulds on the fish

Explain the causes and offer possible solutions. **[10 marks]**

c) Discuss the types of gases used in the modified atmosphere packaging (MAP) of lean and fatty fish. **[5 marks]**

SECTION B: Answer all questions

Question 1

a) Nitrates are usually used in the production of cured meats. One of their major functions in cured meats is to impart a characteristic colour to the cured meat. Describe and discuss the chemistry of the cured meat colour due to the use of nitrates **[10 marks]**

b) State the causes of stress in animals and explain how stress can contribute to production of poor quality of meat and other animal products **[10 marks]**

Question 2

a) Define the following terms and for each, state how it affects meat quality:

i) Rigor mortis **[2 marks]**

ii) Cold shortening **[2 marks]**

iii) Meat binders **[2 marks]**

iv) Yield grading **[2 marks]**

v) DFD **[2 marks]**

b) What are seasonings and flavors, and what is the importance of these? What materials/substances are used as seasonings and flavorings? Seasonings are usually prone to high microbial loads, how is this treated? **[10 marks]**

Question 3

a) Describe the structure of the myofibril. Further to this, state four of the important proteins in animal muscles and briefly how each of the four contributes to contraction of muscles. **[10 marks]**

b) Describe the structure of comminuted meat as an emulsion? What are the stabilizing and destabilizing factors of comminuted meat? What are the signs of destabilization of comminuted meat? **[10 marks]**

End of Exam

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

2010/11 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATION

TECHNOLOGY OF FERMENTED PRODUCTS AGF 522

TIME: THREE (3) HOURS

INSTRUCTIONS

ANSWER ALL QUESTIONS.
EACH QUESTION CARRY EQUAL MARKS

1.

a. Give the objectives of the fermentation process in acid – based fermented foods. **(5 marks)**

b. Discuss selective and elective conditions for the growth of lactic acid bacteria and explain how these conditions can be achieved. **(5 marks)**

c. With aid of a flow diagram, describe the process of manufacturing pickled cucumbers under controlled conditions **(15 marks)**

2. Koji making is an important process in the manufacturing processes of many types of oriental foods.

   a) Explain the koji making process and compare it with its equivalent processing step in the brewhouse. **(10 marks)**
   b) With aid of a flow diagram, describe the manufacturing process of Sufu. **(10 marks)**
   c) Briefly explain the Chibwantu making process. **(5 marks)**

3.

a. Discuss the role of the Kefir grain microflora during the fermentation process of Kefir.

(10 marks)

b. Explain the classification of starter cultures and for each class, give an example of the type product and its respective starters.

(10 marks)

c. State the importance of acetaldehyde in fermented milk and explain how it is produced.

(5 marks)

4. Micheal, Chama, Gladys and Brina go to a bar to relax after writing their final examination and order hunter's gold (cider), mosi, shake-shake and rose wine, respectively. Differentiate these beverages according on their organolepic properties and production flow processes.

(25 marks)

End of Examination

GOOD LUCK!!!!!

THE UNIVERSITY OF ZAMBIA
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DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY
2010/2011 ACADEMIC YEAR
SECOND SEMESTER FINAL EXAMINATIONS

AGF 532: TECHNOLOGY OF PLANT PRODUCTS II

TIME: THREE (3) HOURS

INSTRUCTIONS:

ALL QUESTIONS CARRY EQUAL MARKS.

ANSWER QUESTION ONE AND ANY OTHER IN SECTION A, AND BOTH QUESTIONS IN SECTION B.

ANSWER EACH SECTION IN A SEPARATE ANSWER BOOKLET.

Section A: Answer question one and any other

Question 1

Crude oleins have found their use as a major ingredient is salad oils and they can be obtained by a fat modification process called fractionation.

Describe in detail how the crude oleins can be obtained from refined sunflower oil by this process. **[25 Marks]**

Question 2

Neutralization, in the refining of vegetable oils, is an important unit operation. Describe in detail the aim of this operation and how it can be achieved. **[25 marks]**

Question 3

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 soy milk processing.

[25 Marks]

Section B: Answer both questions.

Question 1

H. B. Consulting Ltd is contracted to set up a mango canning factory. You are the leading consultant of the company and because of your vast knowledge in fruit and vegetable processing, the company has given you the following tasks.

a. Show the production process using a flow diagram, stating the importance of each step and highlight the types of equipment that will be used to manufacture this product. **[15 marks]**

b. The factory manager informs you that they also like to produce canned peas. Describe the change you would make to the process. **[5 marks]**

c. The factory manager would also like to process dried fruits for his personal business. State the types equipment used for drying and recommend one. Give reason for your recommendation? **[5marks]**

Question 2

a. Explain the chocolate making process using a flow diagram. **[15 marks]**

b. A chocolate approaches you a problem of a white layer on the chocolate in their shop. Diagnosis the problem and offer possible solutions. **[5marks]**

c. Show the difference between black tea and green tea using flow diagrams only. **[5marks]**

END OF EXAMINATION

Good Luck!!!

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

2011 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

AGF 542: PLANT DESIGN

TIME: THREE HOURS

INSTRUCTIONS:

1. Please read the instructions and each question carefully.
2. Answer **ALL** questions.
3. **ALL** questions carry equal marks.

****

1. You see an opportunity to put up a medium scale rice processing project in Kasama district. After doing a market research, you come up with the findings that indeed there is a market for this product both locally and in the immediate neighborhood of Congo DRC. You have identified a supplier in China who is willing to supply you a complete set of rice processing equipment. The equipment can handle 20 tones of feed per day and has the energy requirement of 155 kW. It is complete with: Screening and selecting machine, bucket elevator, specific gravity stone cleaner, rubber roller huller, specific gravity paddy separator, rice mill with blowing wind, rice sorter and rice packaging machine

   The total cost of the equipment (freight inclusive up to Dar es Salaam) is 65, 000 USD. The cost of transporting the equipment from the port to Kasama has been given by TAZARA to be 5,000 USD. Current exchange rate is USD 1 = ZMK 4650.

   The ground rules will be as follows:

   a) The plant will operate 15 hours/day, 7 days /week, 50 weeks/year and 350 days year.
   b) Utilities in the form of electricity, water, and so on are available in the area.
   c) Projected sales forecast: 50 % of the product sold per annum and the price of rice will be set at ZMK 7500 per Kg.
   d) Take a rough recovery of product to be 48% of the feed

Other important information for the project

1. Assume ZESCO tariff to be K924/kWh
2. Operating labor, 5 people at K8,000,000 each gross per month
3. Raw material cost: K1,000,000 per tone
4. Miscellaneous materials: estimated at 10% of the maintenance cost
5. Maintenance cost: estimate at 5% of the fixed capital
6. Laboratory costs: Take as 30% of the operating labor
7. Capital charges (CEEC rate at about 7.5%) of the fixed capital
8. Insurance (estimate at 1% of the fixed capital)
9. Miscellaneous (Taxes, sale and promotion, Research and development): estimate at 5% of the fixed capital

Table 1: Typical factors for estimation of project fixed capital cost

Item	Process type		
	Fluid	Fluid-Solids	Solids
1. Major equipment, total purchase cost	PCE	PCE	PCE
f_1 Equipment erection	0.4	0.45	0.5
f_2 Piping	0.70	0.45	0.20
f_3 Instrumentation	0.20	0.15	0.10
f_4 Electrical	0.10	0.10	0.10
f_5 Building, process	0.15	0.10	0.05
f_6 Utilities	0.50	0.45	0.25
f_7 Storage	0.15	0.20	0.25
f_8 Site development	0.05	0.05	0.05
f_9 Ancillary buildings	0.15	0.20	0.30
2. Total physical Plant Cost (PPC) PPC=PCE(1 + f_1 + ... + f_9)			
f_{10} Design and engineering	0.30	0.25	0.20
f_{11} Contractor fee	0.05	0.05	0.05
f_{12} Contingency	0.10	0.10	0.10
Fixed capital = PPC (1 + f_{10} + f_{11} + f_{12})			

a) Estimate the total investment cost for the project using factored estimate approach based on the cost of the major equipment. **(10 points)**

b) Is this investment worth making? Show by performing detailed calculations and your judgment should be based on the economic evaluation criteria of projects such Rate of Return (ROR) and the Pay-back period. **(15 points)**

2. In a storage place, two compartments are connected in series. The two compartments are labelled as compartment 1 and compartment 2 as shown in figure 2 below. Inside them two different agricultural products, i.e., product 1 and product 2 are stored in the respective compartments. In compartment 2 there is a humidifying equipment (W_2 in figure) that injects water at a rate of 0.002 *kg/s*. The outside temperature and absolute humidity is 5 *°C* and 4 *g/kgDA* respectively. Part of the outside air is heated to 8°C and supplied to compartment 1 (V_2, in the figure) at the rate of 0.243 m^3/s. The k-value for all the walls roofs and floors is reported to be 1.5 $W/m^2.°C$. Table 1 shows product, environmental and material property data.

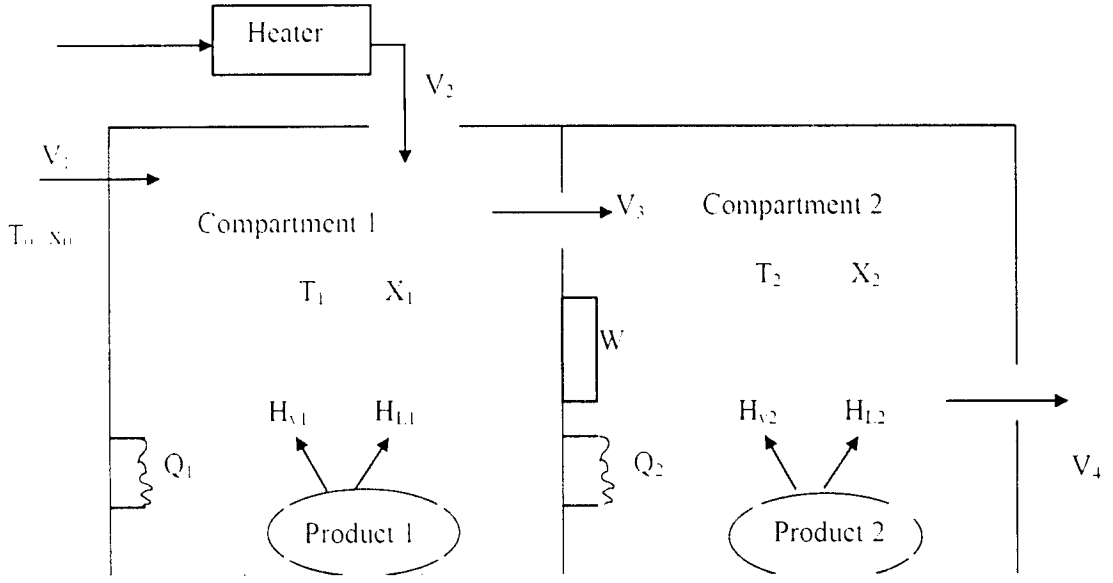

Table 1. Product, environmental and material properties

Compartment 1	Compartment 2
L = W=H = 5m	L = W=H = 5m
H_{S1} = 500W	H_{S2} = 388W
H_{L1} = 550 W	H_{L2} = 420W
T_{opt} = 10 °C	T_{opt} = 15 °C
X_{opt} = 6g kgDA	X_{opt} = 8 g/kg DA
γ = Dry air density	1.2 *kg DA/m³*
C_p = Specific heat of dry air	1.005 *kJ/kgDA.°C*
ε = Heat of Vaporisation of water	2501 KJ. (Kg H_2O)$^{-1}$

Assuming optimum conditions are fulfilled for the two products.

a) Is there a need to install humidifier or dehumidifier inside compartment 1? Justify your answer. **(11 points)**

b) Calculate Q_1 and Q_2. **(10 points)**

c) Outline four ways by which the process of air conditioning can be achieved to bring about the desired temperature and humidity levels **(4 points)**

3. An investor would like to purchase an evaporator for his newly built plant to be used for concentrating pure orange juice. You have been approached as a plant design engineer to give him technical advice.

a) Outline to him **six** important factors to be considered when selecting the above mentioned equipment. **(10 points)**

b) What would be your advice on aluminum, cast iron and stainless steel as materials of construction **(9 points)**

c) Mention at least any **four** specification that he may look for from the vendors of this equipment **(4 points)**

d) List at least **two** techniques/procedures for making cost estimates of individual items **(2 points)**

4. You have formed a joint venture and intend to put up a mango processing project in Mongu district of Zambia that will be processing a variety of mango based products to cater for both the local and regional markets.

a) Right now you are in Mongu, please discuss with me five factors that may influence your site selection decision. **(7.5 points)**

b) With regard to plant layout, describe briefly five principal factors that will ensure economic construction and efficient operation of the process units **(7.5 points)**

c) Discuss the social forces that you may consider important during your planning stage before venturing into this business **(7.5 points)**

d) Do a brief competitor analysis for this business of mango processing you have decided to venture into. **(5 points)**

UNIVERSITY OF ZAMBIA
2010 SECOND SEMESTER EXAMINATIONS

AGS222
FUNDAMENTALS OF SOIL SCIENCE

DURATION: 3 hours
INSTRUCTIONS: Answer all Questions **MARKS**: 100

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1. Indicate whether the following statements are true or false **(12 marks)**

   a) More energy is required to extract water from soil particles in a soil with a matric potential of -7 bars than to extract pure water from a solution made by dissolving 150 grams of $MgSO_4.7H_2O$ in 2 litres of pure water at 25° C.

   b) Twenty (20) kilograms of Urea (46% N) contains more nitrogen than 50 kg of $(NH_4)_2HPO_4$.

   c) The decomposition of a sea weed with a composition $C_{106}H_{263}O_{110}N_{16}P$ in the soil will result in the mineralization of phosphorus and nitrogen.

   d) Saline sodic soils have more stable aggregates than non saline sodic soils.

   e) Aluminium toxicity is more likely to occur in acid mineral soils than in acid organic soils.

   f) Water in soil always moves from a region of high water content to a region of low water content.

   g) A mixture of 80 % pure calcite ($CaCO_3$) and 20 % quartz has a higher acid neutralizing value than pure siderite ($FeCO_3$)

   h) The Isomorphous substitution can take place between Ca^{2+} and Zr^{4+}.

   Useful Atomic masses: Ca= 40g Na =23g, Mg =24g, C=12g, O=16g, S=32 g P=31g, H=1g, Fe=56 g N=14g

2. Define the following terms **(15 marks)**

   a) Compound Fertilizer

   b) Photoautotrophic microorganism

   c) Isomorphous substitution

   d) Immobilization of nutrients

   e) Permanent Wilting Point

   f) Active Acidity

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

a) The macronutrients, nitrogen, phosphorus and potassium undergo fixation in soils. Define nitrogen, phosphorus and potassium fixation and describe how they occur in soil. *(7.5 marks)*

b) $CO(NH_2)_2$, $(NH_4)_2HPO_4$ and KCl are three chemical compounds commonly used as fertilizers. Answer the following: (i) Indicate the Trade names of these materials as fertilizers, and whether they are straight or compound fertilizers. Give reasons to support your answers. (ii) Give the guarantees of these chemical compounds in terms of % N: % P_2O_5: % K_20. Show calculations to support your answers. *(7.5 marks)*

c) Describe how fungi and bacteria contribute to making nitrogen and phosphorus available to plants in soil. *(5 marks)*

d) List the components of the total water potential in an unsaturated soil and describe how each of them affects the total water potential. *(5 marks)*

Useful Atomic masses: C = 12g, N=14 g, P=31 g; Cl=35.5 g; O= 16 g; H=1 g; K= 39 g

4 Tensiometers are instruments used to measure the matric potential of soils. Below are Tensiometer readings expressed as suctions in cm that were obtained at three different depths of a soil used to cultivate tomato.

Horizon	soil depth (cm)	*Suction* (cm)
A	15	660
B1	30	540
B2	60	500

Based on the data provided above answer the following questions: ***(18 marks)***

a) Is the soil in the tomato field saturated with water or not? Give reasons to support your answer?*(2.5 marks)*

b) If the osmotic potential of the water in this soil is equivalent to that of a 0.01 molal solution of $Na_2MgSO_4.4H_2O$ at 20 °C, calculate the total soil water potential in bars at each of the three soil depths. Use the soil surface as the reference level for your calculations. *(8 marks)*

c) With the help of a diagram showing the three points in the A, B1 and B2 horizons, indicate the direction of water flow among the points? Give reasons to support your answer. *(5 marks)*

d) If the A horizon has a field capacity of 18 $cm^3H_2O/100\ cm^3$ soil, is the volumetric moisture content of the A horizon greater or less than 18 %? Give reasons to support your answer. *(2.5 marks)*

Useful data: R = $8.3415 Jmole^{-1}.K^{-1}$. 0 °C =273.15 K

5 A soil from Kawambwa has the following selected physical and chemical properties.

Depth (cm)	pH ($CaCl_2$)	ρb $g.cm^{-3}$	Available P mg/ kg soil	K	Al^{3+}	H^+	ECEC	$CEC_{8.2}$	Org C	Total N	Clay
				---------cmol/kg soil -------					--------%----------		
0 -20	4.8	1.44	3.4	0.1	0.8	0.3	3.4	6.6	1.5.	0.081	17

Answer the following questions based on the soil with the above properties. ***(30 marks)***

i) Calculate the base saturation of this soil based on the ECEC. *(2.0 marks)*

ii) What is the agronomic classification and interpretation of the pH of this soil? *(2.0 marks)*

iii) How long will it take for the organic matter content of this soil to drop to 2.5 % if the soil has a constant respiration rate of 4.5 mg C/kg soil per day? *(4 marks)*

iv) Given that the negative charge on soil organic matter is variable charge, calculate the percentage of the CEC of this soil measured at pH 8.2 that is due to variable charge? *(3.0 marks)*

v) If the soil has a constant respiration rate of 10 mg C/kg soil in the rainy season and the microbes assimilate 75 % of nitrogen released during the decomposition of organic matter, how much nitrogen will be mineralized per hectare of this soil in 3 months during the rainy season? *(4 marks)*

vi) Based on the amount of N mineralized in 3 months, and the available levels of K and P in the soil, determine if this soil would meet the requirements of a crop that needs130 kg Nitrogen /ha, 30 kg P/ha and 110 kg K/ha over a 3 months growing period. Give reasons to support your answer *(6 marks)*

vii) How many 50 kilograms bags of Compound D (10:20:10) Urea (46:0:0) and Muriate of potash (0:0:60) would be required to meet shortfalls in available N,P and K on a 4 hectare plot for the crop described above? *(5 marks)*

viii) How much Agricultural lime is required per hectare to neutralize 50 % of the total acidity of the soil based on the CEC measured at pH 8.2, if the Agricultural lime available has a Neutralizing Value of 78 %? (4 *marks)*

SOIL SCIENCE IS FUN

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

2010 SECOND SEMESTER EXAMINATIONS

AGS 331

SOIL SURVEY TECHNIQUES

INSTRUCTIONS: ANSWER ALL QUESTIONS

TIME: THREE (3) HOURS **MARKS: 65**

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1. a) How useful would soil survey information be in fisheries? (4 marks)

   b) Explain the different approaches in soil surveying. (6 marks)

2. A soil is classified as an Ustox at suborder level. Answer the following questions:

   a) Describe the general characteristics of the soil. (5marks)

   b) Explain its main agricultural limitations. (5 marks)

3. a) What is a soil catena? (5 marks)

   b) What is soil variability? (5 marks)

4. a) Explain the main characteristics of the Zambian Land Capability Classification System. (5 marks)

   b) Explain the meaning of each of the following land capability classes: (10 marks)

   i. C3w
   ii. S1d
   iii. Gw
   iv. C4d
   v. S2s

5. a) How are air-photos used in soil survey? (5 marks)

   b) Explain what is involved in the field stage of a soil survey. (5 marks)

6. Explain the different levels of soil survey as used in Zambia (10 marks)

END OF EXAMINATION

UNIVERSITY OF ZAMBIA

UNIVERSITY SECOND SEMESTER EXAMINATIONS-MAY, 2011

AGS 322
SOIL PHYSICS

Time: Three (3) Hours **Marks**: 85
Instruction: Answer all Questions

Non-programmable calculators are allowed

1. Briefly define each of the following terms ***(15 marks)***
   a) Void ratio
   b) Hydraulic conductivity
   c) Soil water capacity
   d) Available water capacity
   e) Laplace equation

2. With the aid of a diagram briefly describe factors that lead to hysteresis of the retention and loss of water by the soil ***(15 marks)***

3. The application of the general flow equation depends on a number of factors: ***(15 marks)***
   a) Describe briefly the main factors that affect its application,
   b) Develop equations for vertical flow

4. A layered vertical soil column consists of a loamy textured soil (*L=75cm*) with a sandy textured soil (*L=25cm*) layer over it. The top of the column has water ponded at a constant height of 20 cm above it, and the bottom is open to the atmosphere. The hydraulic conductivity of the sandy layer is five times greater than the loamy layer. If the discharge is -13.75 cm^3/hr over a cross-sectional area of 100cm^2: ***(20 marks)***

a) Calculate the flux in (*i*) mm/day and (*ii*) m^3/day/ha
b) Calculate the water potential (h) at the interface between the two layers (in cm)
c) Calculate (***i***) the hydraulic conductivities of each layer and (***ii***) the effective hydraulic conductivity of the entire system (in mm/day)
d) If another layer (*L=10cm*) was added in between the two layers and the flux remained the same, calculate its hydraulic conductivity (in mm/day)

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

	June 10		June 17	
Depth (cm)	h (cm)	θv (%)	h (cm)	θv (%)
10	-278.2	16.8	-448.2	7.5
30	-172.5	18.6	-245.5	15.9
50	-136.1	17.3	-155.0	16.2
70	-117.4	16.8	-132.5	16.7
90	-101.2	24.1	-116.2	24.2
110	-131.6	15.2	-132.8	15.5

From the above data:
a) Determine the average depth for the plane of zero flux
b) Determine the change in soil water storage from the surface to the plane of zero flux (in m^3/ha)
c) Determine the amount of water loss (mm) in the profile through (***i***) the soil surface and (***ii***) depth below 110 cm
d) Determine the hydraulic conductivity at the depth of 90 cm

End of Exam

THE UNIVERSITY OF ZAMBIA

UNIVERSITY SECOND SEMESTER EXAMINATIONS

MAY 2011

AGS 422: SOIL MICROBIOLOGY

TIME: 3 HOURS **MARKS: 100**

INSTRUCTIONS: ANSWER ALL QUESTIONS

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1. Environmental bioremediation and waste management is an area that can potentially benefit from the application of microbiology. Explain:
    a. Three possible reactions involving microbes that might be useful in this process [9 marks]
    b. The reasons why composting as a waste management option, on a large scale, might fail [6 marks]
    c. The two different ways in which fungi can be used in bioremediation and waste management [5 marks]

2. The establishment of the relationship between rhizobia and legumes is accomplished through a series of stages, all of which are mediated by a chronological cascade of physiological signals from both participants.
    a. Outline the stages of symbiotic N fixation establishment [15 marks]
    b. Explain why nodules actively metabolizing nitrogen are pink/red in colour [5 marks]
    c. Giving examples of agronomic crops in which these would be found, discuss the differences between determinate and indeterminate nodules [10 marks]

3. *Rhizobia* spp are gram negative, non-spore forming and mostly motile bacteria that can grow readily in culture. Explain how you would:

    a. Go about isolating the *Rhizobia* spp. from the soil [5marks]
    b. Ensure the successful culture of the bacteria after isolation. [5 marks]

4. Nitrogen in soil undergoes many different transformations most of which are mediated by microbes. List the terminal forms of N and their oxidative states resulting from the following N transformation processes:
    a. Mineralization [2.5 marks]
    b. Immobilization [2.5 marks]
    c. Nitrification [2.5 marks]
    d. Denitrification [2.5 marks]

5. 'It is difficult to determine the exact population of microorganisms in the soil or know if they are living and active.' Describe two methods in microbiology, based on properties of living organisms, that could be used to respond to the above statement positively. [10 marks]

6. (i) In Zambia, conservation farming involves five principal practices two of which are:
    a. Retention of crop residues in fields, with no burning
    b. Rotations with nitrogen-fixing legumes with a minimum of 30% legumes in the system.

    Discuss how soil microorganisms play a role in the accomplishment of the objectives of conservation farming in view of the two principles listed above [15 marks]

    (ii) A laboratory analysis of *Tithonia diversifolia* has shown that it contains 0.15-0.2% P on a dry weight basis. This level of P is higher than that found in legumes commonly used in agroforestry. Explain why this is the case. [5 marks]

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THE UNIVERSITY OF ZAMBIA

UNIVERSITY SECOND SEMESTER EXAMINATIONS
MAY 2011

AGS 452
PRINCIPLES OF LAND HUSBANDRY

TIME: 3 HOURS MARKS: 85
INSTRUCTIONS: **ANSWER ALL QUESTIONS AND WRITE LEGIBLY**

1. Define the following:
   a. Soil fertility [2 Marks]
   b. Soil productivity [2 Marks]
   c. Land degradation [2 Marks]
   d. Soil erosion [2 Marks]
   e. Waterlogging [2 Marks]

2. There are different factors which contribute to low adoption of new land management technologies in a particular area. Briefly discuss five (5) of these factors stating:
   a. How they affect adoption of technologies, and [7.5 Marks]
   b. How the difficulties related to these factors can be overcome. [7.5 Marks]

3. For different forms of constraints you need to use different alleviation strategies. Explain and give two (2) examples of:
   a. Alleviation of constraints by changing characteristics of use [6 Marks]
   b. Alleviation of constraints by changing severity. [6 Marks]

4. Recommendation domain is an important concept for extension workers.
   a. Give the meaning of recommendation domain citing examples [6 Marks]
   b. Discuss the type if information you would consider and why it would be necessary to consider such information in the process of coming up with a recommendation domain. [10 Marks]

5. There are two concepts which are important when defining characteristics of land user groups. Discuss the implications of each of the two concepts below:
   a. The concept of "optimal ignorance" [5 Marks]
   b. The concept of "appropriate imprecision". [5 Marks]

6. Farmers are the ultimate decision-makers on what happens on their land. Briefly discuss the different factors that affect the decisions they make. [10 Marks]

7. What are the main characteristics which distinguish the different types of farming (resource-poor, small scale, commercial, etc.) and why do you think these characteristics are important? [10 Marks]

8. What role does placement of watering points have on level of land degradation? [2 Marks]

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

UNIVERSITY SECOND SEMESTER EXAMINATIONS – MAY 2011

AGS 522
SOIL AND PLANT ANALYSIS

TIME: 3 HOURS Marks: 90
INSTRUCTIONS: **ANSWER ALL QUESTIONS AND WRITE LEGIBLY**

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1. Describe briefly the nature of injury caused to crops by the following:

   a. Herbicide [2 Marks]
   b. Air pollution [2 Marks]
   c. Insect pests [2 Marks]
   d. Nematode attack [2 Marks]
   e. Soil compaction [2 Marks]

2. The quality of Soil and Plant analysis laboratory results depend to a large extent on the sampling quality.

   a. Briefly state two (2) important points to be considered when taking soil samples. [4 Marks]

   b. Briefly describe how you would take a good diagnostic plant sample stating the most important issues to bear in mind. [6 Marks]

   c. Why is it advisable to avoid sampling vegetative organs after flowering in non-woody determinate species? [2 Marks]

   d. In some cases soil samples may be taken from as much of crop rooting profile as possible. Give three (3) reasons for deeper soil sampling. [6 Marks]

3. Measurements and calculations are important aspects of laboratory procedures.

   a. What is the mass of NaCl required to make 750 mls of a 0.01 M solution given that the atomic mass for Na is 23 and that of Cl is 35.5 [4 Marks]

   b. What volume (ml) of concentrated H_2SO_4 is required to prepare 500 ml of 2 M Sulphuric acid? Sulphuric acid is 96% concentrated, molecular weight is 98 and specific gravity is 1.84. [4 Marks]

   c. Convert 500 μg Mg g^{-1} soil to meq Mg 100 g^{-1} soil. [4 Marks]

4. In Soil Analysis different methods are used to determine different parameters.

   a. Describe the different steps involved in the determination of Total N in the soil using the Kjeldhal method. [8 Marks]

   b. List six (6) physical factors which affect the extraction of available phosphorus. [12 Marks]

   c. Explain how to extract and determine the concentrations in the soil of the four elements generally referred to as bases. [8 Marks]

   d. Describe four (4) methods used to determine lime requirement. [8 Marks]

5. Sulphur is an important essential element.

   a. Give two (2) main reasons why S is generally not determined on routine basis. [4 Marks]

   b. Describe and explain the principle behind any two (2) methods used to determine concentrations of S in soil extracts. [10 Marks]

END OF EXAMINATION

UNIVERSITY OF ZAMBIA, SECOND SEMESTER EXAMINATIONS

AGS 542

SOIL GENESIS AND CLASSIFICATION

MAY, 2011

Marks: 100

Instructions: Answer all questions: **Time:** 3 hours

1. Define the following terms: **(12 marks)**
   a. Bhs horizon
   b. Aquic moisture regime
   c. Argillans
   d. Siliceous mineralogy
   e. Rubification
   f. Natrustalf

2. Indicate whether the following statements are true or false or whether you don't know the correct answer **(1 8 marks).** *(2 for correct answer, 0 for I don't know,* and *-1 for wrong answer)*

   a. A surface horizon with a C: N ratio of 16.03: 1 that contains 0.053 % nitrogen, meets the organic carbon requirement for a Mollic epipedon.

   b. Gleization is more likely to occur in a soil with an Aquic moisture regime than in a soil with a Udic moisture regime.

   c. A soil derived from quartzite is likely to contain less clay than a soil derived from granite.
   d. A field with a Cryalf will be more suitable for growing sugarcane under irrigation than a field with an Ustalf.
   e. A horizon containing 37 % clay, with a sum of exchangeable bases of 9.9 meq/100 g, and a base saturation of 66 % based on the CEC with NH_4OAc at pH 7 has high activity clay.

   f. A montmorillonitic mineralogy is likely to be associated with a Chromustert than with a Haplustox
   g. A natric horizon can have a base saturation of 10 % based on the CEC with NH_4OAc.

   h. A surface horizon containing 10 % organic carbon and 32 % clay in the mineral fraction meets the organic carbon requirement for a Histic epipedon.

   i. A predominance of Acacia vegetation in Zambia is often soils derived from limestone.

3. Soil Taxonomy is one of the most widely used International Soil Classification Systems. Answer the following questions related to this classification system: **(15 marks)**

   a) List the different categories of classifying soils in Soil Taxonomy. (4 marks)

   b) List the 12 Orders of Soil Taxonomy and indicate which of these occur in Zambia. (4 marks)

   c) What criteria are used to classify soils at family level in Soil Taxonomy? (3 marks)

   d) Which Orders of Soil Taxonomy are classified on the basis of possession of certain diagnostic surface or subsurface horizons? Indicate the diagnostic horizon or horizons associated with each of the soil orders you have listed. (5 marks)

4. Chemical weathering is one of the main processes responsible for the formation and development of soils. Please answer the following: **(25 marks).**

   a. Write a balanced reaction of the weathering of biotite [$K(Fe_2Mg)(Si_3Al)O_{10}(OH)_2$] in the presence of oxygen and carbonic acid to form Gibbsite $Al(OH)_3$ and Hematite (Fe_2O_3). (6 marks)

   b. What subsurface diagnostic horizon is likely to form as a result of the weathering reaction described in 4a under conditions of high rainfall and good drainage in a tropical region? Give reasons to support your answer. (4 marks)

   c. Would the horizon that develops under conditions described above have high or low activity clay? Give reasons to support your answer. (3 marks)

   d. To which order in Soil Taxonomy would the soil that forms under conditions described above belong? Give reasons to support the answer. (4 marks)

   e. What is likely to be the soil reaction, general fertility status and availability of P in the soil horizon that would form under conditions described in 4c? Give reasons to support your answer. (4 marks)

   f. If the subsurface horizon is 35 cm thick and is 55 cm below the soil surface calculate the thickness of the horizon that will be part of the control section of the moisture regime of the soil given that the overlying horizon has a water holding capacity of 8 $cm^3/100\ cm^3$, while the subsurface horizon has a water holding capacity of $7gH_20/100$ g soil and a bulk density of 1370 kg/m^3. (4 marks)

5. A Bt horizon from a soil profile in Zambia was sampled and analyzed to determine the composition of the soil solution. The results of the analyses are presented below:

Depth	pH	CO_3^{2-}	Ca^{2+}	Mg^{2+}	K+	Na+	SO_4^{2-}	Cl^-
(cm)	H_2O	mg/L						
60-90	9.45	363	46	44	12	2784	8765	496

Answer the following questions: **(30 marks)**

a) Calculate the Sodium Adsorption Ratio of this horizon? (4 marks)
b) What is the name of this Bt horizon in Soil Taxonomy? Give reasons to support your answer? (3 marks)
c) Given that the sum of cations in solution (meq/L) ≈ EC (mS/cm) x10, and that the Osmotic potential (bars) ≈ EC (mS/cm)x(-0.36), estimate the EC (in mS/cm) and Osmotic potential (in bars) of the soil solution and classify this horizon in terms of its salinity and sodicity. (7 marks)
d) Determine if gypsum and calcite are likely to form in this horizon at 25°C and 1 bar pressure assuming the values given in the table represent the activities of ions? Use the thermodynamic data for gypsum and calcite given below in the calculations to support your answer. (8 marks)
e) In which Agro-Ecological Zone of Zambia would one expect to find this soil? Give reasons to support your answer (4 marks).
f) If the above soil has an ochric epipedon, to which order of Soil Taxonomy will it belong? Give reasons to support your answer? (4 marks)

Thermodynamic data of species that may be relevant for answering 5 are given below:

Species	**ΔGf° (KJ/mol)**
$CaCO_3$	-1129.07
$CaSO_4.2H_2O$	-1797.36
Ca^{2+}	-552.8
SO_4^{2-}	-744.0
CO_3^{2-}	-527.9
H_2O	-237.14

Useful Atomic Masses: Ca= 40; S=32; C=12; O= 16; Na= 23; Mg= 24; H=1; K= 39

END OF EXAMINATION

UNIVERSITY OF ZAMBIA

SECOND SEMESTER EXAMINATIONS – MAY 2011

AGS 562: Management of Irrigation and Drainage systems

Time: 3hrs **Marks: 100**

INSTRUCTIONS: ANSWER ALL QUESTIONS. WRITE CONCISELY AND LEGIBLY. WRITE ALL NON-NUMERICAL QUESTIONS IN ESSAY FORMAT (NOT BULLET POINTS)

Q1. Describe the following terms giving the advantages and disadvantages of each:

i. Solid set system
ii. Periodic move systems
iii. Centre pivot
iv. Travelers (20 marks)

Q2. Mr. Chimusoro is a practicing commercial farmer; mention the benefits he would get from having a good drainage system incorporated in his farming system (10 marks)

Q3. Write briefly on each of the following:

i. Decision criteria in irrigation projects
ii. Irrigation uniformity
iii. Irrigation efficiency
iv. Pumping head requirement
v. Irrigation Set time (10 marks)

Q4. In sprinkler irrigation systems, what factors affect uniformity of water distribution and how can these factors be remediated? (15 marks)

Q5. Determine the system capacity for a sprinkler irrigation system to irrigate 16 hectares of Maize crop. Design moisture use rate is 5 mm per day. Moisture replaced in soil at each irrigation event is 6 cm. Irrigation efficiency is 70 percent. Irrigation period is 10 days in a 12 day interval. The system is to be operated for 20 hours per day.

(15 marks)

Q6. Mr. Jere, a retiree has a 16 ha piece of land which he would like to put under irrigation. He consults you as an expert to help him with the layout of a sprinkler irrigation system layout. After some measurements you determine that, the land has loamy soils with a terminal infiltration rate equal to 1.1 mm hr-1, and depth equal to 0.5 m. Mr. Jere prefers a groundnut crop with maximum root growth equal to 30 cm with an average kc of 0.87. The prevailing ETo in the area is 6 mm /day. The dimensions of the field are 800 m x 200 m. Due to water scarcity problems Mr Jere does not want to comprise on the system application efficiency maintaining that it has to be at least 75 %. He has enough resources to purchase 4 laterals to be operated during each shift. The layout imposed by the market availability of components is 12 m x 18 m. Mr. Jere being a family man, can only afford to dedicate 12 hours each day to the operation of the irrigation system and needs a day for other farm operations. Design a suitable sprinkler irrigation system for Mr. Jere with the main line positioned on one edge of the field. For the designed so developed, specify the:

i. Net water application depth
ii. Gross water application depth
iii. Sprinkler precipitation rate
iv. Irrigation frequency and Irrigation cycle
v. Required system Capacity
vi. Sprinkler discharge rate

(30 marks)

THE UNIVERSITY OF ZAMBIA

SCHOOL OF MINES

FIRST SEMESTER EXAMINATIONS –MAY 2011

1. GG201 Introduction to geology II (practical)
2. GG311 Crystallography and optical mineralogy II (practical)
3. GG311 Crystallography and optical mineralogy I (theory)
4. GG335 structural geology and mapping techniques I (theory)
5. GG411 Igneous petrology I (theory)
6. GG421 Sedimentology II (practical)
7. GG421 Sedimentology I (theory)
8. GG435 Structural geology and plate tectonics II (practical)
9. GG471 Geochemistry I (theory)
10. GG471 Geochemistry II (practical)
11. GG551 Exploration, mining geology and management
12. GG561 Engineering geology and rock mechanics
13. MI209 Introduction to mine development
14. MI455 operations research
15. MI465 Mineral economics
16. MI469 Investment analysis
17. MI475 Mine Ventilation
18. MI535 Coal mining
19. MI561 Geotechnical engineering
20. MI575 Safety health and environment
21. MI585 Mine transportation
22. MM331 Chemical thermodynamics I
23. MM411 Comminution and classification
24. MM421 Phase transformation
25. MM441 Hydrometallurgy
26. MM515 Special topics in mineral processing
27. MM525 Mechanical metallurgy

THE UNIVERSITY OF ZAMBIA
SCHOOL OF MINES

FIRST SEMESTER EXAMINATIONS – OCTOBER 2010

GG201 – INTRODUCTION TO GEOLOGY

PAPER II - PRACTICAL

INSTRUCTIONS:	Answer all questions. Illustrate your answers wherever possible.
TIME:	Three (3) Hours

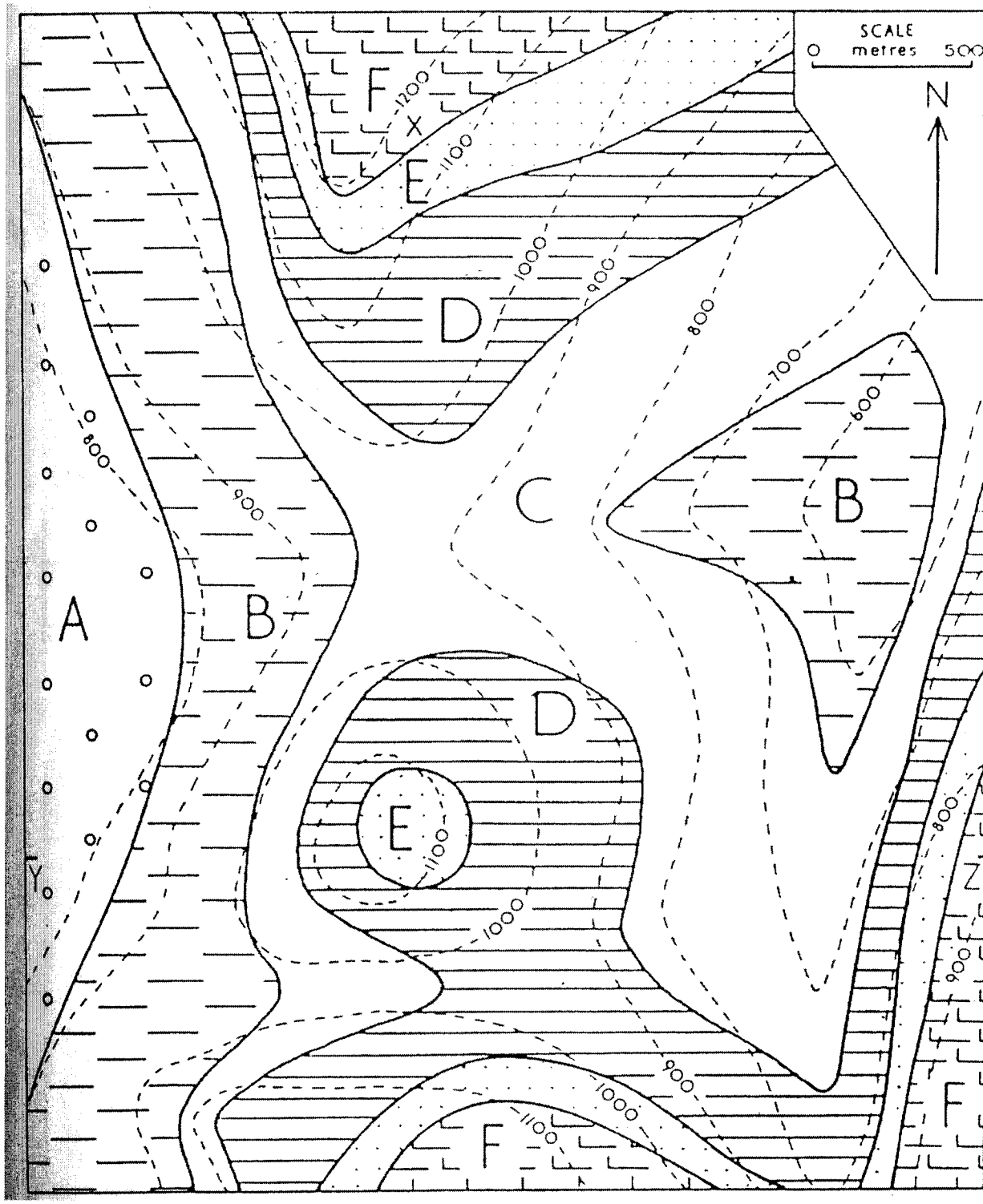
Q1. You are provided with mineral specimens A, B, and C. Using the following physical properties identify the minerals: colour, hardness, streak, cleavage/fracture, magnetism, feel & reaction with acid. You are expected to describe the properties. (15 marks)

Q2. Rock specimens D, E, and F have to be identified. Use the following physical properties to identify these rocks: colour, texture (grain size), structure (foliation – schistosity, gneissosity; bedding) or massive (without structure), mineralogy, reaction with acid, crystalline or not, sorting, roundness, & versicular or amygdaloidal. State with reasons whether the rock is igneous, sedimentary of metamorphic. (15 marks)

Q3. Using Map X on which layers A, B, C, D, E and F are shown to be exposed, do the following (scale 2.5cm to 500 m):

(a) Determine with reason(s) whether the strata in the given map are horizontal, inclined or vertical; (3 marks)
(b) Draw strike lines and label them appropriately. (10 marks)
(c) Determine the strike, dip and dip direction assuming that the layers are of uniform dip. (6 marks)
(d) Draw the geological cross section along line Y-Z. (8 marks)
(e) Determine the true thicknesses for all the layers. (8 marks)
(f) Write a brief geological history of the area. (5 marks)

----------End of Exam & Good Luck----------



MAP X (Scale: 2.5cm to 500 m)

THE UNIVERSITY OF ZAMBIA

FIRST SEMESTER UNIVERSITY EXAMINATIONS – NOVEMBER 2009

GG311 CRYSTALLOGRAPHY AND OPTICAL MINERALOGY

PAPER II – PRACTICAL

INSTRUCTIONS: ANSWER ALL QUESTIONS.
TIME: ONE AND HALF HOURS

Q.1 You are given Model 8. Do the following (20 marks):

(i) Determine the elements of symmetry (i.e. diads, triads, tetrads, hexads, planes of symmetry and centre).

(ii) Using the characteristic elements of symmetry classify the crystal into a given crystal system and state why.

(iii) Sketch the crystal and indicate on it the characteristic elements of symmetry.

Q.2 Plot a stereogram of Model 8 indicating on it the elements of symmetry and crystallographic axes. (15 marks)

Q.3 Using the optical properties identify the mineral in the given thin section A. (15 marks)

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

THE UNIVERSITY OF ZAMBIA
SCHOOL OF MINES

FIRST SEMESTER UNIVERSITY EXAMINATIONS – OCTOBER 2010

GG311 – CRYSTALLOGRAPHY AND OPTICAL MINERALOGY

PAPER II - PRACTICAL

INSTRUCTIONS:	Answer all questions illustrating your answers wherever possible.
TIME:	One and Half Hours

1. Study the mineral Y under the microscope and using optical properties identify the mineral. (15 marks)

2. Using the provided crystal model 10 and assuming that z-axis goes through centres of 2 opposite six-sided faces, x-axis through centres of 2 opposite vertical edges and y-axis through centres of 2 opposite horizontal edges and interfacial angle (or co-latitude angle) of 60° between (001) & (011) and angle between y-axis and (110) of 45°, do the following: (25 marks)

   (a) Sketch the model and label all faces and crystallographic axes
   (b) Identify and name the type of forms present on the crystal and faces that belong to each type
   (c) Plot a stereogram for the crystal model ensuring that all the crystallographic axes, all the faces, and elements of symmetry (i.e. rotational axes of symmetry and planes of symmetry) are clearly labeled.
   (d) Determine the interfacial angle between (001) and (110).

----------End of Exam----------

THE UNIVERSITY OF ZAMBIA
SCHOOL OF MINES

FIRST SEMESTER UNIVERSITY EXAMINATIONS – OCTOBER 2010

GG311 – CRYSTALLOGRAPHY AND OPTICAL MINERALOGY

PAPER I - THEORY

INSTRUCTIONS: Answer any four questions illustrating your answers wherever possible.

TIME: Three (3) Hours

Q1. (a) Define the following: (12 marks)
- (i) Unit cell
- (ii) Crystal Lattice
- (iii) Plane of symmetry
- (iv) Rotational axis
- (v) Inversion axis
- (vi) Centre of symmetry

(b) State the Law of Constancy of Interfacial Angles. (3 marks)

(c) State the addition rule in crystallography. (3 marks)

(d) A crystal in a monoclinic system has 8 faces with the z-axis going through centers of 2 opposite edges, while x-axis and y-axis through centers of two opposite faces. Sketch the crystal and label all faces and axes, name the four forms on the crystal and their faces. (7 marks)

Q2. (i) What is interfacial angle? (2 marks)

(ii) If interfacial angles between faces A and B and B and C are 50° and 38°, respectively. Sketch and determine the interfacial angle between faces A and C. (4 marks)

(iii) If the angle between two adjacent faces (001) and (101) on a crystal of the tetragonal system is 40°, make a sketch and determine the angle between faces (100) and (101) and axial ratios c/a, c/b and a/b (9 marks).

(iv) Intercepts that faces make with crystallographic axes are given below. Determine the Miller Indices and thus symbols of such faces. (6 marks)
Face A: 1/2,3,1/7; Face B: Infinity,2/9,1; and Face C: 5/3, 2/3, 4

(v) Prove if the following sets of faces lie in one zone: (4 marks)
(a) (100), (201), (101), (102) and (011); and
(b) (01bar11), (11bar21), (21bar31).

Q3. (a) Write short notes on the following terms and concepts. (12 marks)
- (i) Isomorphism
- (ii) Polymorphism
- (iii) Solid solution
- (iv) Pleochroism
- (v) Birefringence
- (vi) Relief

(b) Distinguish contact twin from penetration twin. (6 marks)
(c) Explain how refractive index affects the passage of rays of light in the mineral. (7 marks)

Q4. (i) What is coupled substitution? Why does this occur? (4 marks)
(ii) Write two equations illustrating coupled substitution, one in alkali feldspars and another in plagioclase feldspar. (4 marks)
(iii) What is coordination number? (3 marks)
(iv) Name and describe briefly two of the three Goldsmidt rules that govern atomic substitution within a mineral. (8 marks)
(v) Under what conditions in terms of the rules described above does each of the following occur? (a) element capture, (b) element admission and (c) element camouflage. (6 marks)

Q5. (a) Distinguish between ionic and covalent bonds. Give one mineral example of each type of bonds. (8 marks)
(b) Describe briefly the following silicate structures giving at least one mineral example of each: (i) Single Chain Silicates; (ii) Island Silicates; (iii) Layer Silicates; and (iv) Framework Silicates. (12 marks)

Q6. (a) State situations when a mineral would appear isotropic under a microscope and explain why. (6 marks)
(b) What is visible light? (4 marks)
(c) State the BREWSTER'S Law. (4 marks)
(d) What is the effect of density on refractive index of a mineral? (4 marks)
(e) Sketch interference figures for a uniaxial positive mineral and a biaxial negative mineral. (4 marks)
(f) What is lustre responsible for in gemstones? (3 marks)

----------End of Exam----------

THE UNIVERSITY OF ZAMBIA
SCHOOL OF MINES

FIRST SEMESTER UNIVERSITY EXAMINATIONS – OCTOBER 2010

GG311 – CRYSTALLOGRAPHY AND OPTICAL MINERALOGY

PAPER I - THEORY

INSTRUCTIONS: Answer any four questions illustrating your answers wherever possible.

TIME: Three (3) Hours

Q1. (a) Define the following: (12 marks)
- (i) Unit cell
- (ii) Crystal Lattice
- (iii) Plane of symmetry
- (iv) Rotational axis
- (v) Inversion axis
- (vi) Centre of symmetry

(b) State the Law of Constancy of Interfacial Angles. (3 marks)

(c) State the addition rule in crystallography. (3 marks)

(d) A crystal in a monoclinic system has 8 faces with the z-axis going through centers of 2 opposite edges, while x-axis and y-axis through centers of two opposite faces. Sketch the crystal and label all faces and axes, name the four forms on the crystal and their faces. (7 marks)

Q2. (i) What is interfacial angle? (2 marks)

(ii) If interfacial angles between faces A and B and B and C are 50° and 38°, respectively. Sketch and determine the interfacial angle between faces A and C. (4 marks)

(iii) If the angle between two adjacent faces (001) and (101) on a crystal of the tetragonal system is 40°, make a sketch and determine the angle between faces (100) and (101) and axial ratios c/a, c/b and a/b (9 marks).

(iv) Intercepts that faces make with crystallographic axes are given below. Determine the Miller Indices and thus symbols of such faces. (6 marks)
Face A: 1/2,3,1/7; Face B: Infinity,2/9,1; and Face C: 5/3, 2/3, 4

(v) Prove if the following sets of faces lie in one zone: (4 marks)
(a) (100), (201), (101), (102) and (011); and
(b) (01bar11), (11bar21), (21bar31).

Q3. (a) Write short notes on the following terms and concepts. (12 marks)
- (i) Isomorphism
- (ii) Polymorphism
- (iii) Solid solution
- (iv) Pleochroism
- (v) Birefringence
- (vi) Relief

(b) Distinguish contact twin from penetration twin. (6 marks)
(c) Explain how refractive index affects the passage of rays of light in the mineral. (7 marks)

Q4. (i) What is coupled substitution? Why does this occur? (4 marks)
(ii) Write two equations illustrating coupled substitution, one in alkali feldspars and another in plagioclase feldspar. (4 marks)
(iii) What is coordination number? (3 marks)
(iv) Name and describe briefly two of the three Goldsmidt rules that govern atomic substitution within a mineral. (8 marks)
(v) Under what conditions in terms of the rules described above does each of the following occur? (a) element capture, (b) element admission and (c) element camouflage. (6 marks)

Q5. (a) Distinguish between ionic and covalent bonds. Give one mineral example of each type of bonds. (8 marks)
(b) Describe briefly the following silicate structures giving at least one mineral example of each: (i) Single Chain Silicates; (ii) Island Silicates; (iii) Layer Silicates; and (iv) Framework Silicates. (12 marks)

Q6. (a) State situations when a mineral would appear isotropic under a microscope and explain why. (6 marks)
(b) What is visible light? (4 marks)
(c) State the BREWSTER'S Law. (4 marks)
(d) What is the effect of density on refractive index of a mineral? (4 marks)
(e) Sketch interference figures for a uniaxial positive mineral and a biaxial negative mineral. (4 marks)
(f) What is lustre responsible for in gemstones? (3 marks)

----------End of Exam----------

THE UNIVERSITY OF ZAMBIA
SCHOOL OF MINES

FIRST SEMESTER EXAMINATIONS – OCTOBER 2010

GG335 – STRUCTURAL GEOLOGY AND MAPPING TECHNIQUES

PAPER I - THEORY

INSTRUCTIONS: Answer any four questions. Illustrate your answers wherever possible. Questions Carry Equal marks.

TIME: Three (3) Hours

Q1. Define any four of the following terms:
- (a) Transposition
- (b) Microlithons
- (c) Piercing points
- (d) Cataclasite
- (e) Fault line scarp
- (f) Crenulation cleavage

Q2. (a) Define "S-C" fabrics and state in which rock types you would expect to find them.
- (b) Make a careful sketch of S and C planes in a left-lateral shear zone. Be sure to label the planes and show where you would expect the highest strains to be found.

Q3. (a) Describe how folds with class 2 dip isogers are produced.
- (b) Compare and contrast buckling and flextural slip.
- (c) Compare and contrast between ductile deformation and brittle deformation (discuss processes and products for each)

Q4. (a) What are the similarities and differences among mylonites, brecciia and gouge? In your answer, be sure to explain the processes by which each forms and where in the crust you would expect to find each one.
- (b) Discuss the net stratigraphic effect commonly produced by a thrust fault (use a diagram)

Q5. (a) Discuss the difference between force, stress, and strain.
- (b) Explain the mojor difference between co-axial and non-co-axial strain and give examples.
- (c) Using stress-strain diagrams, show the difference in deformation response between elastic and linear viscous (Newtonian) materials.

Q6. (a) What is compressive rock strength?
- (b) Define homogenous strain and provide an example.
- (c) What are the rheological characteristics of plastic deformation?
- (d) Define linear strain and provide examples

----------End of Exam and Good Luck!----------

THE UNIVERSITY OF ZAMBIA
SCHOOL OF MINES
UNIVERSITY EXAMINATIONS – OCTOBER 2010

GG 411 – IGNEOUS PETROLOGY

PAPER I – THEORY

INSTRUCTIONS:	ANSWER ANY FIVE QUESTIONS USING SKETCHES WHERVER POSSIBLE; ALL QUESTIONS CARRY EQUAL MARKS.
TIME:	THREE (3) HOURS

Q1. (a) Rocks are correlated to plate tectonics. Show how plate tectonic settings and magmatism are correlated.

(b) Basaltic rocks can be divided into tholeiitic and alkali groups, what are the main criteria for distinguishing the two groups?

Q2. Differentiate between the following:

(a) Eutectic point and coetectic point in geological phase diagrams.
(b) Shallow granitic intrusions and deep-seated granitic intrusions.
(c) Tholeitic basalt and alkaline basalt.

Q3. Summarize the main characteristic features of the Skaergaard Igneous Complex.

Q4. Show how magmatic rocks can be divided into alkaline and subalkaline.

Q5. Define the following terms:
(a) Ophiolite
(b) Degree of freedom
(c) Liquid immiscibility
(d) Magmatic differentiation

Q6. (a) What is the importance of Kimberlites?
(b) Show how Kimberlites are classified.
(c) Discuss the tectonic setting of Kimberlites.
(d) Name three countries in Africa where Kimberlites are found

Q7. What are the main characteristics features of GRANITE ROCKS?

----------Good Luck and End of Exam----------

THE UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS – OCTOBER 2010

GG 421 – SEDIMENTOLOGY

PAPER II – PRACTICAL

INSTRUCTIONS: Answer both questions.

TIME: Three (3) Hours

Q1. A property development company has acquired a piece of land from the City Authorities to construct a housing estate. It is a known fact that the area is underlain by a sequence of sedimentary rocks. The continuity of the various lithologies is not established since no detailed subsurface geological work has been done over the area so far. The property development company is concerned about this lack of detailed geological information as it needs to plan well on where to locate what type of structures. In essence, the company wants to know the distribution of the competent and less competent rock formations.

Your company has been engaged for geological consultancy services to undertake site investigations. You are the geologist that has been assigned the task. Your Company has in its possession logs of two bore holes, SM/1 and SM/2, which were drilled in the area many years ago. It intends to extract as much information from them as possible before moving to the next step. Bore hole SM/2 is 557m to the east of SM/1. The logs are not very good but that is all there is available.

As the initial phase of the consultancy, your Boss has instructed you to carry out the following (70 marks):

(a) Make sedimentary logs of both cores, using the standard format available;
(b) Interpret these cores in terms of processes of deposition and depositional (sub) environment basins, indicating how some facies are related to each other;
(c) Correlate the two bore holes with a view of establishing possible continuities and comment, with good reasons, on whether their rocks were deposited in the same sub-basin or channel;

Log: SM/1 (Bore hole collar = 665m above sea level)

0-2m	Very fine-grained mudstone, in places with shaly partings, desication cracks and root traces;
2-5m	Very fine- to medium-grained sandstone, horizontal bedding and locally massive;
5-10m	Coarse-grained to pebbly sandstone, trough cross-bedding alternating with planar x-beds;
10-16m	Matrix supported conglomerates, massive with crude bedding locally horizontal bedding;
16-19m	Clast-supported conglomerates, complex bed forms with tabular sheets;
19-21m	Pebbly sandstones, trough cross-bedding;
21- 24m	Very coarse grained sandstone, trough cross-bedded to parallel laminated;
24-25m	Medium-grained sandstone, ripple cross-laminated;
25-27m	Alternating mudstone and very fine-grained sandstone;
27-28.5m	Pebbly mudstone at base that is followed by mudstone, massive, followed by thinly laminated and then massive beds

Log: SM/2 (Bore hole collar = 753m above sea level)

0-2m	Mudstone, in places with intraclasts, massive beds, desication cracks;
5-7m	Clast-supported conglomerates – mainly cobbles, complex bed forms with tabular sheets;
7-15m	Matrix supported conglomerates – mainly pebbles, massive with crude bedding locally horizontal bedding;
15-20m	Very fine-to medium-grained sandstone, horizontal bedding and locally massive;
20-23m	Mudstone, in places with shaly partings, thinly laminated overlain by massive beds; bioturbated with root traces;
23-24.5m	Undifferentiated metasediments

Q2. You are provided with four hand specimens marked A, B, C and D. You are required to do the following (30 marks):

(a) Describe the texture, composition, colour and any observable structures of each specimen, and then name the rock;

(b) Outline briefly, the depositional environment of each rock, suggesting the possible transportation mechanisms and distance from the source.

----------End of Exam and Good Luck----------

THE UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS – OCTOBER 2010

GG 421 – SEDIMENTOLOGY

PAPER I – THEORY

INSTRUCTIONS: Answer any five questions using sketches wherever possible. All questions carry equal marks.

TIME: Three (3) Hours

Q1. (a) Briefly discuss what is meant by the terms: (i) Sedimentary Basin analysis, and (ii) Back striping.

(b) Write brief but clear and well illustrated notes on (i) Forearc, and (ii) Backarc.

(c) Discuss the difference between active and passive continental margins.

(d) Explain the typical morphology of a passive continental margin and how each of the four perspectives used to classify them affect the resulting depositional environment.

Q2. (a) Write short notes on Loess.

(b) Define the following: (i) Rudite, (ii) Arenite, (iii) Arkose, and (iv) Greywacke.

(c) Briefly discuss three main ways of representing grain size distribution in a sediment.

(d) Discuss (i) Siliciclastic sediments, and (ii) Non-siliciclastic sediments in terms of their origin, compositions, texture, particle size range and matrix. Give two examples of rocks formed in each of two types of sediments.

Q3. (a) Discuss the following: (i) Authigenic minerals, (ii) Concretion, and (iii) Differential compaction.

(b) Discuss sediment maturity and how it provides evidence on the history of the sediment, paying particular attention to composition and texture, among others.

(c) Explain the process of diagenesis paying particular attention to the chemical and physical changes it may bring about.

(d) Write short notes with illustrations on the following: (i) Point bars, (ii) Alluvial fans, and (iii) Crevasse-splay deposits.

Q4. (a) (i) What determines a delta's morphology? (ii) Write brief notes, with well labeled illustrations, on the three main morphological types of deltas.

(b) In sediment transport, define the following terms: (i) traction, (ii) suspension, and (iii) saltation.

(c) Discuss briefly how each of the following transports sediments: (i) channel flow, (ii) waves, (iii) ocean currents and, (iv) tides.

(d) Costal environments may be classified as **constructive** or **destructive.** Discuss these two types of environments.

Q5. (a) Write short notes on the term facies and facies analysis.
(b) Discuss the sedimentary processes and environments that would lead to the following in a stratigraphy: (i) fining upwards and, (ii) coarsening upwards.
(c) Discuss any two types of gravity flow deposits.
(d) Define and discuss Walther's Law.

Q6. (a) Discuss lateral and horizontal facies changes in rock record and the environmental processes that lead to the changes.
(b) Write brief notes on the following: (i) facies associations, and (ii) facies succession.
(c) Write short notes on glacial depositional environments and give an example of a glacially deposited rock.
(d) Define glaciofluvial deposits?

Q7. (a) Discuss aeolian depositional environments and give examples of two typical sedimentary structures related to these environments.
(b) Briefly discuss the Bernouilli effect.
(c) Discuss the kind of deposits and structures related to (i) meandering streams and, (ii) braided streams.
(d) Write short notes on shallow marine depositional environments.

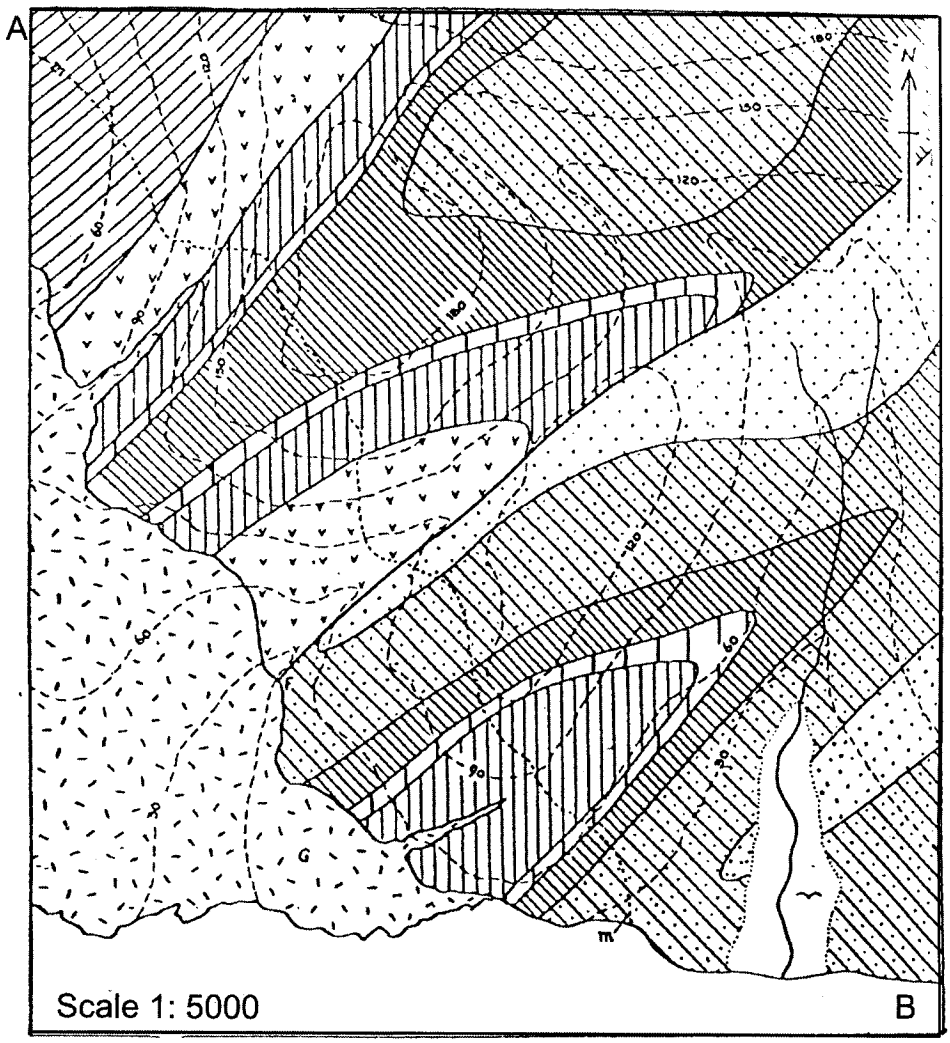
----------End of Exam and Good Luck----------

UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – OCTOBER 2010

GG435-STRUCTURAL GEOLOGY AND PLATE TECTONICS
PAPER II - PRACTICAL

Instructions:	Answer All Questions
Time:	Three (3) Hours

Q1. Below is a map that shows the geology of Spring Valley area. Answer the questions that follow:



(a) Draw structure contours (strike lines) on the map and then a cross-section A-B. Use the cross-sections to write the geological history of the area. (60 marks).

Q2. A sandstone bed of possible Cambrian age in the Gwembe Valley is oriented 360°40°W and possesses ripple marks oriented 33° towards 233°. What is the current direction that deposited the bed in Cambrian times? (10 Marks)

Q3. The "Mabvuto Anasila" area has been mapped by an exploration geologist. However his field note book and map were burnt in a tent in his camp site while in the field. One excel file which he had sent to the main office in Lusaka has been retrieved for a partial report and recorded the following information:

S_o (bedding) was measured at 020°30E; schistosity (S_1) was measured as 060°60NW°; flute marks were measured as 12° towards 318°. Some areas with the same geology are not folded, but are sub-cropping. The ripples possesses heavy mineral sands and their orientation in the unfolded zone is required for drilling.

(a) Find the other limb of the fold in the area. (5 marks)
(b) What is the orientation of the fold axis in the area? (5 marks)
(c) What was the orientation of the flute marks before the beds were folded? (5 marks)
(d) Write the geological history of the area based on his structural data and show how the ripple marks can be obtained from the flute marks data (15 Marks)

----------End of Exam and Good Luck----------

THE UNIVERSITY OF ZAMBIA
FIRST SEMESTER UNIVERSITY EXAMINATIONS – OCTOBER 2010
GG 471 - GEOCHEMISTRY

PAPER I – THEORY

INSTRUCTIONS: Answer any five questions. Use diagrams and equations wherever necessary. All the questions carry equal marks.

TIME: Three (3) Hours

Q1. Describe the relative abundances of the major elements in the continental crust and the major methods that have been employed to determine these abundances.

Q2. Use the thermodynamic data given below and appropriate equations to construct an Eh-pH diagram for the system U-O-H at 1 bar pressure and 25 ^{0}C. Discuss how the addition of carbonate ions to this system may affect the mobility of uranium.

Species	ΔG^0_f (Kcal/gfw)
UO_2 (c)	-246.62
U_3O_8 (c)	-805.35
UO_2^{2+} (aq)	-227.66
H_2O (liq)	-56.69

Q3. Discuss briefly the major factors that control the aqueous mobility of Al, Fe, S and Cu in the surficial environment.

Q4. The chemical composition of sediments in three sedimentary environments is given in table 1. Use the given data to answer the following questions:

Table1. Composition of sediments

Component	Sediment A	Sediment B	Sediment C
SiO_2	48.90	1.15	51.03
Al_2O_3	12.8	0.45	13.47
Fe_2O_3	5.54	-	8.06
FeO	-	0.26	-
MgO	2.48	0.56	1.15
CaO	9.79	53.80	0.78
Na_2O	1.57	0.02	0.41
K_2O	2.52	0.05	3.16
TiO_2	0.58	-	-
P_2O_5	0.17	-	0.31
S	1.63	-	7.29
CO_2	7.30	42.69	-
C	1.32	-	13.11
H_2O	6.26	0.92	3.2

(a) Describe the mineralogical composition of the sediments and establish the prevailing Eh and pH conditions in the sediments.

(b) Discuss briefly the processes through which the minerals in the sediments have been formed.

Q5. The chemical composition of ocean water is given below. Use the supplied data and equations to determine the state of saturation of this water with respect to anhydrite.

Component	Ocean water (g/kg)
Na^+	10.7
K^+	0.39
Ca^{2+}	0.41
Mg^{2+}	1.29
Cl^-	19.35
SO_4^{2-}	2.71
HCO_3^-	0.72

-log activity coefficient $=Az^2[(I^{0.5}/1+I^{0.5})-0.2I]$
$A= 0.5085$
K_{sp} for anhydrite $=10^{-4.5}$

Q6. The composition of the parent rock and the soil developed on it is given below. Use the supplied data to answer the following questions.

Component	Parent rock	Soil
SiO_2	50.4	0.7
Al_2O_3	22.2	50.5
Fe_2O_3	9.9	23.4
FeO	3.6	-
MgO	1.5	-
CaO	8.4	-
Na_2O	0.9	-
K_2O	1.8	-
TiO_2	0.9	0.4
H_2O	0.9	25.0

(a) Determine the drainage and climatic conditions under which the soil has developed.
(b) Arrange the major elements in increasing order of mobility in this environment.
(c) Describe the dominant processes through which the soil has formed.

Q7. (a) Write short notes on the classification of surficial dispersion patterns of ore components.

(b) Describe the processes that would lead to the development of dispersion patterns of Sn and Ta in the drainage system of an area where mineralized pegmatites whose average composition is given below are exposed.

Component	Pegmatite
(%)	
SiO_2	73.75
Al_2O_3	15.47
Fe_2O_3	0.64
FeO	-
MgO	0.006
CaO	0.01
Na_2O	0.34
K_2O	4.48
TiO_2	0.001
P_2O_5	0.04
(ppm)	
Rb	2816
Sn	1350
Ta	356

----------End of Exam and Good Luck!----------

THE UNIVERSITY OF ZAMBIA
FIRST SEMESTER UNIVERSITY EXAMINATIONS – OCTOBER 2010

GG 471 - GEOCHEMISTRY

PAPER II – PRACTICAL

INSTRUCTIONS:	Answer all the questions. Use diagrams and equations wherever necessary.
TIME:	Three (3) Hours

Q1. Describe the analytical procedures which you would employ to determine the concentrations of heavy metals in soils contaminated by emissions from the smelter stacks. (15 marks)

Q2. The composition of 3 samples collected from 3 different natural waters are given in table 1. Use the data in table 1 to answer the following questions. (25 marks)

(a) Classify the waters on the basis of TDS and give suggestions on the most likely sources of these samples.
(b) Discuss the quality of the water samples and the major factors that appear to be controlling the concentrations of the dissolved constituents.

Table 1

Constituent	Groundwater	Surface water A	Surface water B
Ca	260	3.2	411
Mg	49	0.1	1290
Na	13	1.2	10700
K	3.2	0.14	390
Silica	23	0.1	2.9
Al	12	-	.001
Fe	143	-	.034
Zn	345	0.0003	.01
Sulphate	1650	5.1	2710
Cl	3.7	1.0	19350
TDS	2500	11	35500
pH	2.5	3.5	8.2

Q3. The data obtained in an orientation survey for nickel anomalies in stream sediments of the Munali Hills area is given in figure 1 and table 2. The host rock for the nickel mineralization is the Munali gabbro. In the search for gabbro hosted nickel deposits a reconnaissance stream sediment survey conducted in solwezi area generated the data in table 3. Use the given data to answer the following questions.

(a) Identify the elements that are associated with nickel in figure 1 and discuss the possibility of using Fe, Mg, Co, Pt and S as path finder elements in hydrogeochemical surveys.
(b) Discuss the processes that have led to the development of the nickel and

copper dispersion patterns in figure 1.

(c) Use an appropriate statistical method to establish the range of background and anomalous values in table 3.

(d) Discuss the potential for nickel sulfide mineralization in Solwezi area.

Table 2

S.NO.	Sample type	Fe (%)	Ni (ppm)	Cu (ppm)	Co (ppm)
1a	Rock	12.03	2068	164	147
1b	Gossan	66.36	8020	423	5
1c	Rock	11.49	1972	201	149
1	Stream sediment	52.28	506	266	296
2	"	38.17	274	152	129
4	"	32.78	192	170	119
6	"	23.13	119	140	8
7	"	12.33	43	40	30
8	"	16.86	108	42	9
9	"	10.14	38	37	41
10	"	15.54	87	102	6
11	"	9.05	33	34	45
12	"	13.89	61	74	33
14	"	28.34	85	85	63

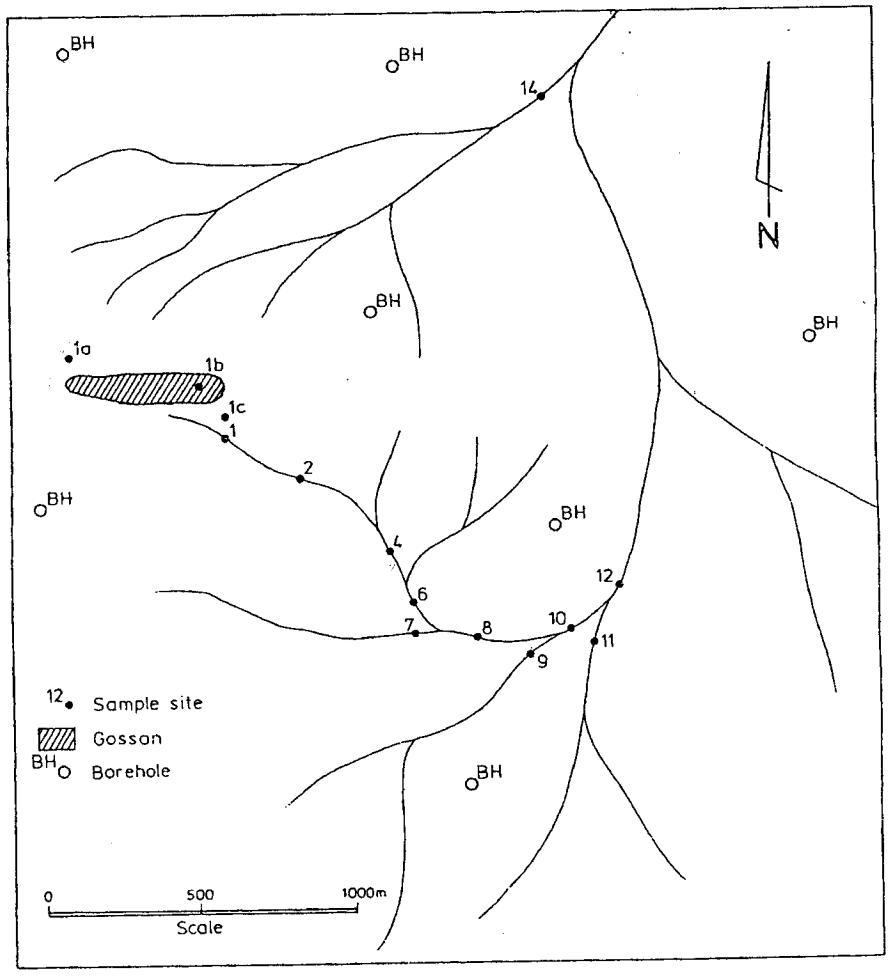

BH
14
N
1a
1b
1c
1
2
4
6
7
8
9
10
11
12
12 Sample site
Gossan
BH Borehole
0
500
1000m
Scale

Figure 1

Table 3

Ni content (ppm)	Frequency
0	5
5	10
10	82
15	31
20	162
25	35
30	187
35	39
40	189
45	31
50	141
55	34
60	129
65	23
70	73
75	16
80	42
85	10
90	38
95	4
100	25
105	2
110	9
115	1
120	5
125	1
130	2
140	1
145	1
160	1
170	2
190	1
220	2
270	1
330	1
455	1
660	1
909	1

----------End of Exam and Good Luck----------

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – OCTOBER 2010

GG 551 - EXPLORATION, MINING GEOLOGY AND MANAGEMENT

Instructions:	Answer Any Four (4) with at least one question from each section. Answer four (4) questions. You have 5 minutes to read through the questions.
Time:	Three (3) Hours

SECTION A

Q1. (a) It is said that the life a mine does not start the day that production begins, but many years before, when a company sets out to explore for a mineral deposit. State and briefly describe the stages of an exploration project from the study phase to Bankable Feasibility Study (BFS) (*5 marks*).

(b) Your Canada-based exploration manager wants you to explore the possibility of carrying out copper exploration in Central Africa. Prepare him/her some relevant notes for at least two countries in the region, stating the factors that have influenced your choice of country and area (*5 marks*).

(c) Exploration strategy may be classified as either empirical or conceptual. Discuss the two approaches with regard to the following aspects:

(i) Number of prospects that may be initially generated (*2 marks*)

(ii) The quality of the prospects (*2 marks*)

(iii) the levels of expertise required (*2 marks*)

(iv) Define the following terms:

a. Greenfields exploration (*2 marks*)

b. Brownfields exploration (*2 marks*)

(v) You are exploring for magmatic nickel sulphide style mineralization and you have got several ground geophysical techniques at your disposal. Your hanging wall lithologies at one of your preferred targets comprise graphitic schist, dolomites and quartzites in this order away from the suspected host gabbro.

a. State any one technique likely to produce appreciable contrast (*2 marks*)

b. State the technique that is likely to produce ambiguity and the likely cause/s (3 marks).

Q2. (a) You have been approached by a businessman who wants to drill his newly acquired oxide copper prospect. He would like some professional advice on the most suitable drilling technique. With him is a list of techniques he has got from a student geologist including:

(i) Hand Auger

(ii) Rotary Air Blast (RAB)

(iii) Reverse Circulation

(iv) Diamond

Prepare a summary report for him, preferably in tabular format, detailing the suitable applications, advantages and disadvantages of each technique (*10 marks*).

(b) Drillholes rarely take straight paths from collar positions. List at least 5 causes of drillhole deviation (*5 marks*).

(c) You have received some assay results for your geochemical anomaly and you are suspicious that they (the results) could be a hydromorphic artifact. What step/s could you take to prove or dismiss this suspicion? (*2 marks*).

(d) When carrying out soil surveys, it is critical to differentiate residual from transported overburden. For each type of overburden, give at least two (2) characteristics (*5 marks*).

(e) How would you physically and chemically differentiate a true gossan from a false gossan (*3 marks*).

SECTION B

Q3. (a) Define the following terms as they relate to a mining environment:

(i) Internal dilution (*1 mark*)
(ii) External dilution (*1 mark*)
(iii) A regionalized variable (*1 mark*)
(iv) Geological continuity (*1 mark*)
(v) Value/grade continuity (*1 mark*)

(b) You have been approached by a group of businessmen which has won a tender to supply nickel ore to a nearby operating mine in Zambia. They would like you to determine the tonnage and average grade of their nickel deposit (Chilengwaleza Ni project) for them to present to their client. You find historical data at the Geological Survey Department which summarizes the deposit as follows:

- 10 holes completed on the deposit in 1978. Results for a section comprising two adjacent holes (DDH001 and DDH002) available on the public domain, the rest of the results missing. The holes were 25m apart. Section lines on which the holes are located are at a distance of 50m apart. Average RL of 800m.
- Mineralization outcrops ~25m due east of DDH001.
- The ore body has two different types of ore: lateritic ore and semi-massive ore. The lateritic ore is allocated a specific gravity (SG) of 1.25 whereas the semi-massive ore is allocated specific gravity of 2.0
- The ore body strikes North-South and dips at around 60° towards the west. All drilleholes inclined at -65° at collar.
- Holes deviated at an average rate of 1° every 18m or 0.5° every 9m in the hangingwall. Negligible deviation in intervals less than 9m. More deviation observed in the hangingwall lithologies. Limited deviation within the orebody. All holes deviated upwards.

The rest of the data regarding the deposit is presented in Table 1:

Table 1: Chilengwaleza Ni project assay data

Hole_ID	From	to	Drilled length (m)	Mineralized intersection (m)	Ni assay (%)	Geology notes
DDH001	0	27	27	-	Not assayed	Overburden
DDH001	27	31	4	4m from 27m	1.2%	Lateritic zone, base of lateritic ore zone at 31m
DDH001	31	35	4	4m from 31m	2.9%	Semi-massive ore
DDH001	35	40	5	-	not assayed	End of hole at 40m, Barren Gabbro.
DDH002	0	54	54	-	Not assayed	Overburden, hole collared down-dip of DDH001
DDH002	54	58	4	4m from 54m	1.1%	Lateritic zone, base of lateritic zone at 58m
DDH002	58	61	3	3m from 58m	3.5%	Semi-massive ore
DDH002	61	70	9	-	Not assayed	End of hole at 70m. Barren Gabbro.

Using the provided data:

(i) Sketch a profile (not to scale) of the nickel deposit (*2 marks*)

(ii) Calculate the respective average grades (% Ni) of the intersections at DDH001 and DDH002 (*8 marks*)

(iii) Calculate the respective tonnages around DDH001 and DDH002 (*8 marks*)

(iv) Present to your client the total tonnage and average grade of the section across DDH001 and DDH002 (*2 marks*).

Q4. (a) You are a consulting geologist at Chuumbabenzu Coal prospect in Zambia's Southern Province and have been presented with the following proximate analysis results for the main seam (Table 2).

Table 2. Proximate analysis results for Chuumbabenzu Coal Prospect.

Parameter	**%**
Moisture	1.0
Volatiles	27.2
Fixed Carbon	50.7
Ash	21.1
Calorific Value (Air dried) B.T.U./lb	10600

(i) Classify the coal according to the American Society for Testing and Materials (ASTM) and advise on the possible uses of this coal based on the preliminary results (*5 marks*)

(ii) State at least three elements you would consider submitting for ultimate analysis with brief notes on the relevance of each analyte (*3 marks*)

(b) A number of theories have been proposed to explain the origin of the Central African Copperbelt mineralization.

(i) Describe the merits of the syndiagenetic model vs the syngenetic model (*5 marks*)

(ii) The major weakness of an epigenetic model for the Lower Roan-hosted Copperbelt mineralization (*2 marks*).

(iii) Describe the geology of the Zambian Copperbelt with regard to the metal sources, transport mechanism, precipitation mechanism and state the desired attributes of this deposit type that might be used to explore for deposits of similar style (*10 marks*).

SECTION C

Q5. (a) Communication can be in different forms including written, verbal or visual, among others.Give the advantages and disadvantages of the mentioned forms of communication (*15 marks*)

(b) Describe what you understand by the following managers' roles:

(i) Planning (*2 marks*)

(ii) Organising (*2 marks*)

(iii) Co-ordinating (*2 marks*)

(iv) Commanding (*2 marks*)

(v) Controlling (*2 marks*)

Q6. (a) Define a decentralized management structure and give at least three of its advantages (*5 marks*)

(b) Many large organizations today prefer outsourcing labour. Define the concept of outsourcing, giving at least three advantages and two disadvantages of this approach (*5 marks*).

(c) Leadership may be classified into three styles: autocratic, Laissez-faire and democratic. Briefly describe the three types (*5 marks*).

(d) Define a trade union and state the employee benefits of belonging to one in a large organization (*5 marks*)

(e) Define the following forms of Industrial Action

(i) Strike (*1 mark*)

(ii) Picketing (*1 mark*)

(iii) Work to rule (*1 mark*)

(iv) Go slow (*1 mark*)

(v) Non-cooperation (*1 mark*)

----------**End of Exam and Good Luck!**----------

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – OCTOBER 2010

GG 561 – ENGINEERING GEOLOGYAND ROCK MECHANICS

Instructions:	Answer Any Four (4) Questions. All Questions Carry Equal Marks
TIME:	Three (3) Hours

Q1. (a) Lusaka City Council is planning to establish a new cemetery on the Lusaka Granite. In the siting of this site, a detailed site investigation will be required.

(i) What would be the aim of such an investigation?
(ii) Describe the various stages of such an investigation.

(b) Give the empirical formula of Coulumb's Law and describe all quantities involved.

(c) Illustrate, with the aid of diagrams, the three main categories of geologic materials based on their shear strength parameters.

Q2. (a) Discuss, giving examples, the differences between properties of materials and properties of mass with regard to both soils and rocks. Why is there any difference? Why is this difference of importance in engineering geology?

(b) A slope, 45°, was cut in one of the hills for the construction of an embankment on the Great East Road. A plane, P, dipping at 30°, was seen daylighting into this slope.

Triaxial cell tests performed on three soil specimens filling this discontinuity gave the following results:

σ_2 (kN m^{-2})	1	5	9.5	15
σ_1 (k Nm^{-2})	9.2	28	48.7	74

If a block, with a mass of 800kN, and a contact area of 500 m^2, is resting on this discontinuity, determine:

(i) The total force resisting sliding.
(ii) The factor of safety of the block against sliding.
(iii) The magnitude of the force of a rock bolt installed perpendicular to the plane that would raise the factor of safety of the block to 2.

Q3. (a) A seismic refraction survey was conducted in the Goma fields as part of a site investigation to determine the average depth to rock head for the construction of UNZA's new sport hall. The investigation gave the following results:

Geophone distance (m)	10	15	20	25	30	35	40	45	50	55
Arrival times (ms)	3	4.5	6	7	7.8	8.5	9	10	10.6	11.5

Assuming that the layers are horizontal or shallowly dipping, calculate:

(i) The wave velocities in each layer
(ii) The Possion's ratio of the first geologic layer at the site
(iii) The depth to the first refractor surface, which may be assumed to represent rock-head.

(b) A soil sample of length 12 cm and 4 cm in diameter was cored from the site. When subjected to an unconfined compressive strength test, it shortened by 1 mm and increased by 0.5 mm in diameter. Determine for this soil sample:

(i) Its longitudinal and diametral strains.
(ii) The sample's modulus of elasticity.
(iii) Poisson's ratio.
(iv) Comment on the reason for the difference, if any, with the Poisson's ratio determined in (ii) of (a) above.

Q4. (a) Write brief notes on the following:

(i) Differential settlement

(ii) Ultimate bearing capacity

(iii) The Maximum Safe Bearing Capacity

(b) The Resident Engineer's Department is planning to build a new sports hall at one of UNZA's Goma Fields. It is designed to be supported by rectangular (1m x 2m) footings founded at 0.5m below ground surface. If the unit weight of the foundation soil was determined to be 15 kN m^{-3}, and shear box tests performed on three specimens of this soil gave the following results:

Normal pressure (kN m^{-2})	35	70	105
Shear pressure (kN m^{-2})	29	58	87

determine the ultimate bearing capacity of the soil under each footing.

$N_{c(rectangle)} = N_{c\{strip\}}*(1 + 0.3.B/L)$; $N_{q\ (rectangle)} = N_{q\ \{strip\}}$; $N_{\gamma\ (recanglet)} = N_{\gamma\ \{strip\}}*(1-0.2.B/L)$; bearing capacity factors are given at the end of the paper.

Bearing capacity factors

ϕ	N_c	N_q	N_γ
0	5.14	1	0
5	6.5	1.6	0.5
10	8.3	2.5	1.2
15	11	3.9	2.6
20	14.8	6.4	5.4
25	20.7	10.7	10.8
30	30.1	18.4	22.4
32	35.5	23.2	30.2
34	42.2	29.4	41.1
36	50.6	37.7	56.3
38	61.4	48.9	78
40	75.3	64.2	109.4
42	93.7	85.4	155.6
44	118.4	115.3	224.6
46	152.1	158.5	330.4
48	199.3	222.3	496
50	266.9	319.1	762.9

Q5. (a) A 10m deep borehole was drilled in marbles for site investigations at the new Levy Junction construction site, along Church Road, to determine the integrity of the underlying rock. The recovered rock cores (in cm) are shown in the Table below.

20.0	12.3	2.8	5.8	13.8	3.0	87.9	10.8	16.0	7.3	10.5	7.9	12.3
2.3	10.3	3.3	5.0	19.4	7.8	3.3	10.5	8.0	110	36.0	10.8	7.3
11.8	1.3	3.0	5.3	17.0	3.8	2.5	9.0	95.3	5.0	5.0	2.8	5.3
6.5	11.0	7.0	59.0	6.5	7.5	4.3	3.0	5.5	7.0	8.0	53.1	8.2

Determine for this drill hole:

(i) The core loss

(ii) The Rock Quality Designation (RQD)

(iii) Total Core Recovery (TCR)

(iv) The quality of the rockmass intersected by the drill hole and give a comment on the integrity of the rockmass

(b) After the construction of pad footings for one structure at the Levy Junction site, it was discovered that the structure would impose principal stresses of 700 kNm^{-2} and 450 kNm^{-2} at a point underlying the foundation with an angle of shearing resistance of 22.5°. **Determine,** for this point, the **Normal** and **Shear** stresses induced by these principal stresses.

Q6. (a) A soil sample collected from the Goma fields for the construction of the UNZA's new sport hall gave the following results:

Grain size (mm)	50	35.5	20	14	10	6.3	3.35	1.18	0.6	0.15	0.063
Mass retained (g)	0	15.5	17	10	11	33	114.5	63.6	18.2	17	10.5

If the total mass of the sample collected was 315 grams,

(i) Plot the particle size distribution curve
(ii) Determine its effective size (D_{10})
(iii) Calculate its uniformity coefficient
(iv) Describe and name the soil.

(b) A portion of this sample was used for the determination of Atterberg Limits. The following results were obtained from the test:

(i) Liquid Limit (Casagrande Apparatus)

Test Number	Mass of Tin	Tin + Wet Soil (g)	Tin + Dry Soil (g)	Number of Blows
1	23.68	40.86	34.68	13
2	22.93	42.62	35.78	20
3	26.27	38.02	34.27	47

(i) Plastic Limit

1	25.34	32.17	31.01
2	24.83	30.48	29.51

Determine the plasticity index of the soil.

(c) Another piece of core from the site was subjected to testing in a triaxial cell. It gave the following results:

σ_1 (kNm^{-2})	35	51.8	70	99.4	124	128.8
σ_2 (kNm^{-2})	35	35	35	35	35	35
Strain (ε)	0	0.0025	0.005	0.01	0.02	0.03

Determine the modulus of deformation for this soil

----------End of Exam and Good Luck!----------

THE UNIVERSITY OF ZAMBIA

FIRST SEMESTER UNIVERSITY EXAMINATIONS

OCTOBER 2010

MI ~~455~~ 209 INTRODUCTION TO MINE DEVELOPMENT

TIME : THREE [3] HOURS FULL MARKS : 100
INSTRUCTIONS : ANSWER FIVE QUESTIONS; ONE FROM SECTION A AND FOUR FROM SECTION B

SECTION A [ANSWER ONLY ONE QUESTION]

QUESTION ONE

Give brief accounts of all the steps involved an exploration programme using the geochemical approach. **[20 Marks]**

QUESTION TWO

Answer the following questions:

a) What is remote sensing and give two examples of the simplest remote sensing equipment. **[4 Marks]**

b) State four properties that are inherent in Earth materials that make them possible for geophysical investigations. **[2 Marks]**

c) Why are some of the geophysical methods called active and others passive. Give two examples for each. **[6 Marks]**

d) Name four minerals that are highly magnetic. **[2 Marks]**

e) What is an anomaly and what is the background? **[4 Marks]**

f) How would you interpret a magnetic low? **[2 Marks]**

SECTION B

QUESTION ONE

a) Discuss the concepts of resources and reserves.
b) Discuss the main reserve classification systems.
c) Why are mineral projects perculiar from other projects?
d) What are the main determinants of exploration activities?
e) What determines a countries level of well being? **[20 Marks]**

QUESTION TWO

a) Discuss the main stages of implementing mining projects (5 Marks)
b) Discuss the meaning of ore, gangue and cut off grade. (5 Marks)
c) Determine the cut-off grade for the following

When net value is = $2.5 grade is 0.55%

When net value is = -0.30 grade is 0.35% (10 Marks)

QUESTION THREE

a) What are the three main components of drilling equipment (6 Marks)

b) Discuss two main theories of mechanical breakage and why most machines are indentors (8 Marks)

c) Discuss the main types of bits, their advantages and disadvantages (6 Marks)

QUESTION FOUR

a) Differentiate between low and high explosives (4 Marks)

b) Using detonation theory explain why explosives are so efficient in breaking (6 Marks)

c) Discuss the main classes of mining explosives (5 Marks)

d) From safety fuse to current remotely controller detonation explain the major improvements in detonators (5 Marks)

QUESTION FIVE

a) Ground control is dependent or understanding how rock/soil material behaves insitu and when excavated. Explain (5 Marks)

b) What rock factors should be considered in designing a support system (5 Marks)

c) (i) Discuss roof bolts as a supporting method (4 Marks)

(ii) Tuber as a supporting method (3 Marks)

(iii) Steel as a supporting method (3 Marks)

QUESTION SIX

a) Discuss the major consideration in classifying mining methods (8 Marks)

b) Discuss when caving methods are best used (6 Marks)

c) Discuss the main characteristics of materials used as fill in room and pillar mining methods (6 Marks)

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

FIRST SEMESTER UNIVERSITY EXAMINATIONS

OCTOBER 2010

MI 455: OPERATIONS RESEARCH

TIME : THREE [3] HOURS **FULL MARKS** : 100
INSTRUCTIONS : ANSWER QUESTION 1 AND ANY OTHER 3

QUESTION 1

a) Clearly define the following terms as they are applied in linear programming

i) Entering nonbasic variable **[1 Mark]**

ii) Surplus variable **[1 Mark]**

iii) Artificial variable **[1 Mark]**

iv) Optimal ''Relaxed'' solution as used in Total Integer Programming **[1 Mark]**

v) Branch and bound diagram **[1 Mark]**

b) Solve the following linear programming model using the simplex method

$Z = 20X_1 + 10X_2$

$X_1 + X_2 = 150$

$-X_1 \geq -40$

$X_2 \geq 20$

$X_1, X_2 \geq 0$ **[25 Marks]**

[Total: 25 Marks]

QUESTION 2

a) A mine developer must decide which recreation facilities to construct in its community. Four new recreation facilities have been proposed: a swimming pool, a tennis centre, an athletic field and a gymnasium. The mine wants to create facilities that will maximise the expected daily usage by residents of the community subject to land and cost limitations. Expected daily usage, cost and land requirements for each facility are shown in **Table 2**.

Table 2: Daily usage, cost and land requirements for each facility

Recreation facility	Expected usage (people/day)	Cost ($)	Land requirements (acres)
Swimming pool, X_1	300	35,000	4
Tennis Centre, X_2	90	10,000	2
Athletic field, X_3	400	25,000	7
Gymnasium, X_4	150	90,000	3

The mine developer has a $120,000 construction budget and 12 acres of land. Because the land for the swimming pool and tennis centre are in the same area of the country,

however, only one of these two facilities can be constructed. The mine wants to know which of the recreation facilities to construct in order to maximise the expected daily usage and you have been requested as a newly employed engineer to assist management.

i) Construct the linear programming model for solving this problem using 0 - 1 integer programming **[5 Marks]**

ii) Using implicit enumeration, provide a complete enumeration (list of all possible solution sets) for this model **[10 Marks]**

iii) Select the optimal solution from the solution set and determine the maximum expected usage (Z value) of the facilities. **[5 Marks]**

b) Clearly describe the following integer solution terminologies

i) A total integer model **[1 Marks]**

ii) A 0 – 1 integer model **[1 Marks]**

iii) A Mixed integer model **[1 Marks]**

iv) Implicit enumeration **[1 Marks]**

v) Partitioning feasible solution **[1 Marks]**

[Total: 25 Marks]

QUESTION 3

Copper is produced from four mines every year as shown in **Table 1.**

Table 3.1: Mines producing copper

	Mines	Capacity (000'000 tonnes)
1	Luanshya	90
2	Chibuluma	50
3	Lumwana	80
4	Chambishi	60

These mines supply the following quantities of copper to manufacturing companies in three industrial cities as shown in **Table 2.**

Table 3.2: Manufacturing companies receiving copper shipment

	Cities	Capacity (000'000 tonnes)
A	New Delhi	120
B	Berlin	100
C	New York	110

The rail and sea shipment costs per tonne of copper are shown in **Table 3.** Because of railroad construction, shipments are presently prohibited from Luanshya to New Delhi.

Table 3.3: Rail and sea transportation costs (US$'000)

FROM	TO		
	1	2	3
A	7	10	5
B	12	9	4
C	7	3	11
D	9	5	7

a) Formulate this problem as a linear programming model. **[5 Marks]**

b) Set up the transportation tableau for this problem and determine the initial solution using minimum cost method and compute the total cost. **[5 Marks]**

c) Solve the model using Stepping Stone Method **[10 Marks]**

d) Are there multiple optimal solutions? If so, identify them. **[5 Marks]**

[Total: 25 Marks]

QUESTION 4

a) Lumwana Mine has embarked on a project to expand the current open pit mine and preliminary studies show that there will be nine (9) major activities as shown in Table 4.

i) Construct the CPM network described by the following set of activities

ii) Compute the length of each path in the network

iii) Indicate the critical path

Table 4(a): Activity time estimates for Lumwana Mine expansion project

Activity	Time (Years)
1→ 2	4
1→ 3	7
2→ 4	8
2→ 5	3
3→5	9
4→5	5
4→ 6	2
5→ 6	6
3→ 6	5

[10 Marks]

b) Given the following **PERT activity** time estimates, determine the expected time and variance for each activity, and indicate the critical path.

Table 4(b): PERT activity time estimates

Activity	Time Estimates (weeks)		
	a	m	b
1→ 2	6	10	15
1→ 3	2	7	16
1→ 4	4	8	11
2→ 3	3	10	15
2→5	7	9	20
2→6	4	12	15
3→ 6	3	6	9
4→ 6	5	9	16
5→ 7	3	20	35
4→ 7	4	12	16
6→ 7	2	9	14

i) Construct the PERT network described by the following set of activities

ii) Compute the expected time and variance for each activity

iii) Indicate the critical path

iv) Determine the probability that the project will be completed in less than **30 days**

[15 Marks]

[Total: 20 Marks]

QUESTION 5

An inventory system has the following annual ordering cost of US$200 per order, an annual unit carrying cost of US$0.75, and an annual demand of 5000 units (assuming a 365-day year). Compute the following:

i) Economic order quantity (Analytically and graphically) **[5 Marks]**

ii) Minimum total annual inventory cost (Analytically and graphically) **[5 Marks]**

iii) Optimum number of order per year **[5 Marks]**

iv) Optimum time between orders **[5 Marks]**

v) Why is it important to hold inventory for mining companies **[5 Marks]**

[Total: 25 Marks]

UNIVERSITY EXAMINATIONS

2010 SEMESTER 1 FINAL EXAMINATIONS

MI 465 MINERAL ECONOMICS

TIME: 3 HOURS **FULL MARKS: 100**

INSTRUCTIONS: ANSWER ONLY FIVE QUESTIONS

1. What factors affect the supply of mineral resources in:

   (i) The short term **[10 marks]**
   (ii) The the long term? **[20 points]**

2. Market structures can be identified as perfect competition, monopolistic competition, oligopoly and monopoly types respectively. Give a brief description of factors that characterize each of these market structures. **[20 points]**

3. If the marginal revenue function of the firm is given by MR = 100,000-20n, where n is the total amount of all types of dynamite produced in units. Estimates of next year's cost has yielded the following total cost relationship:

   $$TC = 0.2n^2 + 10{,}000{,}000$$

   What volumes of production would have the following characteristics:

   a) Break- even point **[8 points]**
   b) Maximum profit **[8 points]**
   c) Minimum average cost **[4 points]**

4. Suppose that the demand function for commodity X is given by the equation:

   $$Q_x = 60 - 1.5P_x^2 + 3P_y + 0.04I$$

   (i) Determine the price elasticity of demand for X when $P_x = \$10$, $P_y = \$20$, and $I = \$5{,}000$. **[10 marks]**
   (ii) What do you understand by the term "cross elasticity of demand"? Explain what happens when its magnitude assume certain values. **[10 points]**

5. Discuss the major goals of macroeconomics policy and what instruments can be used to achieve these goals. **[20 points]**

6. What do you understand by the term "the principle of diminishing returns'? Discuss reasons why in the long-run as the scale of operations increase, diseconomies of scale may set in.

[20 points]

End of Examination

UNIVERSITY EXAMINATIONS

2010 SEMESTER 1 FINAL EXAMINATIONS

MI 469 INVESTMENT ANALYSIS

TIME: 3 HOURS **FULL MARKS: 100**

INSTRUCTIONS: ANSWER ONLY FIVE QUESTIONS

1. Diatech limited has identified three key parameters as sales quantity, selling price and total operating costs whose probability distributions were established as follows:

Sales Quantity (Q)	Probability p(Q)	Sales price per unit (P)	Probability p(P)	Total operating costs (OC)	Probability p(OC)
5,000	0.1	$20	0.1	$100,000	0.2
7,500	0.3	22	0.2	125,000	0.5
10.000	0.4	24	0.4	150,000	0.3
12,000	0.2	26	0.2		
		28	0.1		

i) Determine the expected value of each of the above three parameters **[3 marks]**

ii) Determine the expected value of the net profit. **[3 marks]**

iii) Using Monte Carlo simulation technique with the following table of random numbers below, determine the expected profit and its associated variance from 10 simulations. Why does this figure from 10 simulations differ from the one obtained in (ii) above? **[10 marks]**

Table of Random Numbers

Sales Quantity Random numbers	Sales price Random numbers	Total cost Random numbers
0.798	0.690	0.504
0.496	0.053	0.211
0.176	0.569	0.304
0.383	0.067	0.601
0.591	0.942	0.118
0.776	0.583	0.013
0.529	0.597	0.223
0.477	0.545	0.334
0.180	0.009	0.743
0.910	0.132	0.261

iv) From the simulation (assuming each of the ten outcomes has an equal probability of occurrence), determine the probability of obtaining a greater than $90,000 profit. **[4 marks]**

2. Discuss briefly factors that may affect mineral investment decisions in a country. **[20 marks]**

3. Discuss reasons why feasibility studies are undertaken before an investment is made. Give the various stages involved in a mine feasibility study. **[20 marks]**

4. Consider the following three mining project proposals:

End of Year	Cash Flows		
	Proposal A	Proposal B	Proposal C
0	-$75,000	-$75,000	-$75,000
1	25,000	20,000	0
2	25,000	25,000	0
3	25,000	30,000	0
4	25,000	35,000	130,000
Salvage value at end of year 4	5,000	2,000	3,000

The minimum acceptable rate of return is 10%

Determine the most attractive alternative based on:

i) The Payback period **[10 marks]**
ii) Net present value **[10 marks]**

5. Some equipment costs $840,000 and has a six-year depreciable life and an estimated salvage value of $120,000 at the end of six years.

Taking into account the salvage value, find the depreciation rate for:

i) Straight-line method **[4 marks]**
ii) Declining balance method **[4 marks]**
iii) Sum-of-digits method **[4 marks]**

What is the book value of the equipment after 3 years using the straight-line method? **[4 marks]**

What is the book value of the equipment after 5 years using the sum-of-digits method? **[4 marks]**

6. (i) What is optimum economic life of equipment? **[5 marks]**
(ii) The initial cost of a truck is $30,000. Operating costs and salvage values for the following 10 years are:

Year	Operating costs	Salvage values
1	10,000	21,000
2	11,000	14,500
3	12,000	10,200
4	13,200	7,000
5	15,000	5,000
6	17,500	3,000
7	21,000	2,500
8	25,000	2,000
9	30,000	1,500
10	35,000	1,000

Assume a Declining balance scheme of 30% and tax rate of 50%

Determine the optimum economic life of this equipment. **[15 marks]**

End of Examination

THE UNIVERSITY OF ZAMBIA

FIRST SEMESTER UNIVERSITY EXAMINATIONS

OCTOBER 2010

MI 475: MINE VENTILATION

TIME : THREE [3] HOURS **FULL MARKS : 100**

INSTRUCTIONS: ANSWER ANY FIVE QUESTIONS. QUESTION ONE IS COMPULSORY. GRAPH IS PROVIDED

Question 1

CB and later adit ED. Adit AB connects to the shaft AB, as shown in figure 1. It is decided to drive a lower level DE and deepen the shaft BD. Adits are 1.5 x 2.0 m and the shaft 1.8 x 1.8m. The friction factor for all airways is 0.01 kg/m^3. If the fan is installed to exhaust 30 m^3 at the collar of shaft A, determine the quantity that will flow on each level and the mine heads. Solve algebraically or graphically.

[20 Marks]

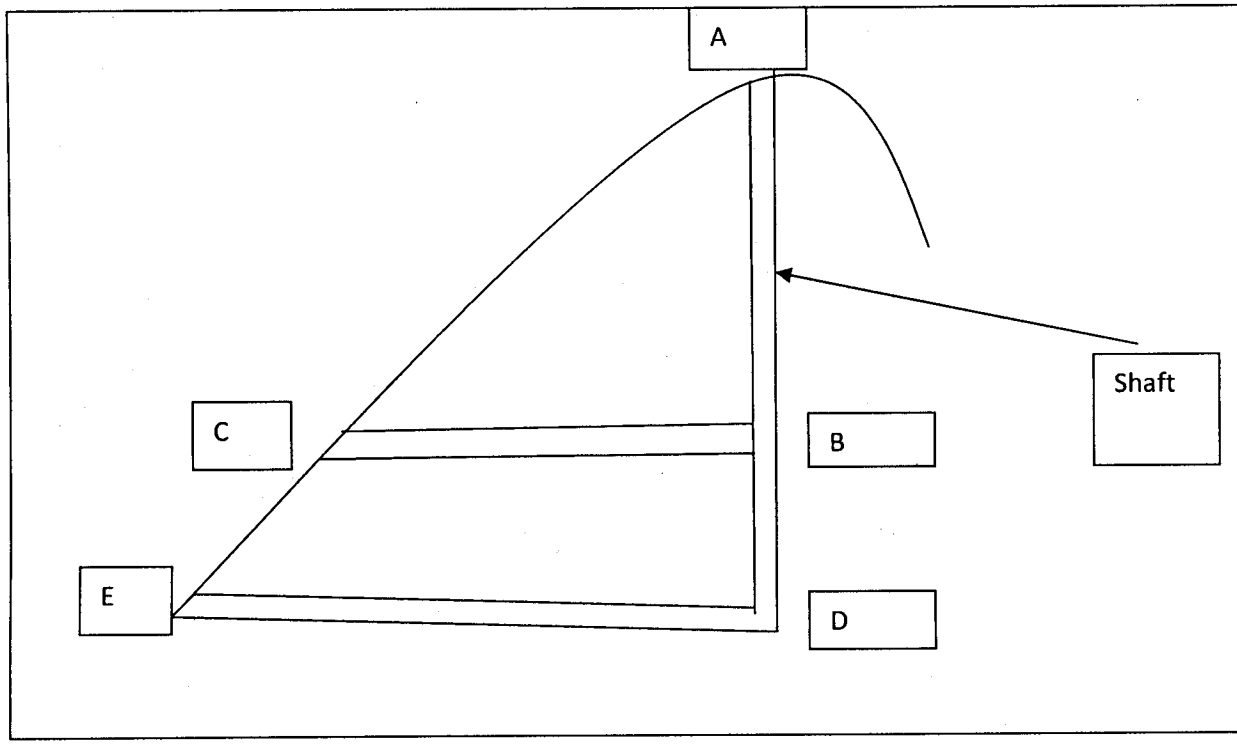


Fig. 1. Ore-body opened up by adits and shaft

Question 2

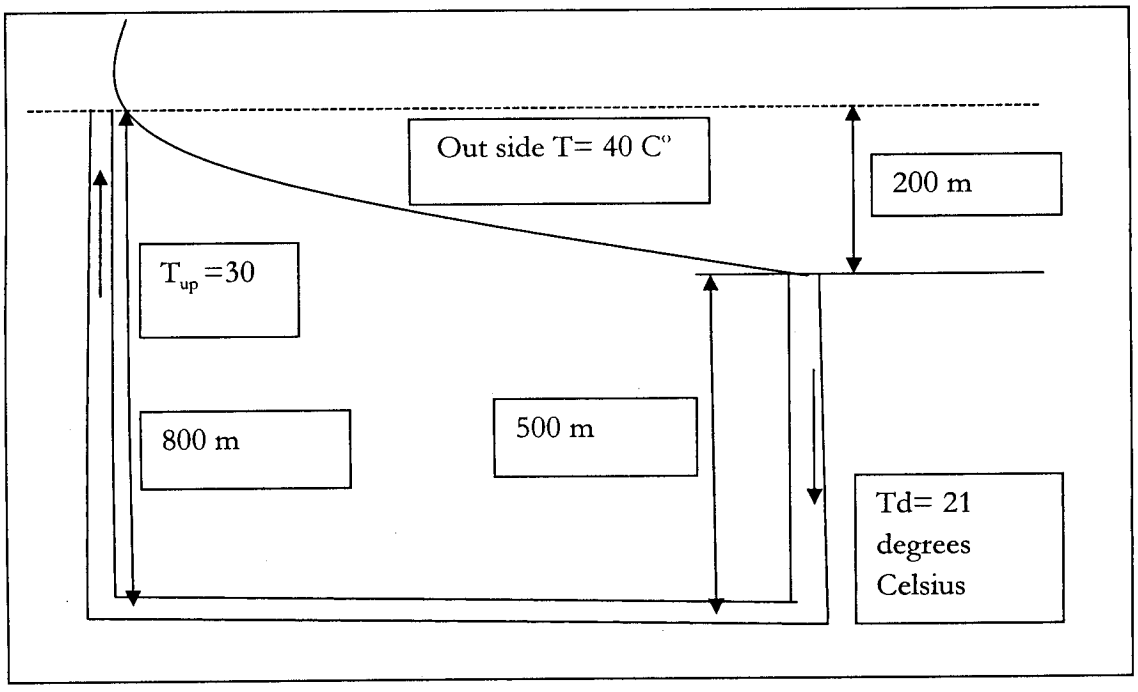
b) Determine the speed at which a 1.8m diameter fan should operate to deliver 42 m^3/s at 498 Pa and density 1.36 kg/m^3 . The fan performance for characteristic curve for a similar fan of 1.20 diameter operating at 1500 rpm and 1.20 kg/m^3 is given in table 1.

Fan Head, H (Pa)	Fan Quantity, Q (m^3)
1000	.0
800	10
600	20
250	30

Using fan laws, plot fan characteristics curve for 1.8 m operating at 1000 rpm b.) Find speed necessary for the 1.8 fan to deliver 42 m^3/s at 500 pa **[20 Marks]**

Question 3

a) Given mine schematic diagram in figure 2, calculate the natural ventilation pressure **(NVP)** of the system. **[10 Marks]**



b) With the help of clear diagrams briefly explain basic mine refrigeration cycle and what can be done to the cycle to improve it. **[10 Marks]**

Question 4

a) What is the estimated time required for the build up in an underground repair workshop of an average acetone concentration to 750 ppm, given the following standard conditions?

C_1=0 ppm , Initial concentration. Start of shift
C_2= 750 ppm - final concentration)
Vr=130 m^3 , volume of underground repair work shop
Q= 2.5 m^3/s dilution volume flow rate **[10 Marks]**

b) With the help of clear diagrams, explain briefly various methods of cleaning contaminated air in the mine. **[10 Marks]**

Question 5.

Derive equations for estimating

a) Pressure drop for a fluid under laminar flow, flowing in a smooth cylindrical pipe of uniform cross section area **[15 Marks]**

b) Heat pick up in mine road ways **[5 Marks]**

Question 6

A two mesh network is shown diagrammatically in figure 2. A differential pressure of **2500 Pa** is across the circuit and a natural ventilating pressure (NVP) of **500 Pa** is applied acts in the direction of air flow with mesh 1. A regulator $\mathbf{R_6}$, is constructed in the right most branch in order to limit the airflow in that branch to **20m^3/s**. Given the resistance of all airways, find the distribution of air flow and the resistance of the regulator. **[20 Marks]**

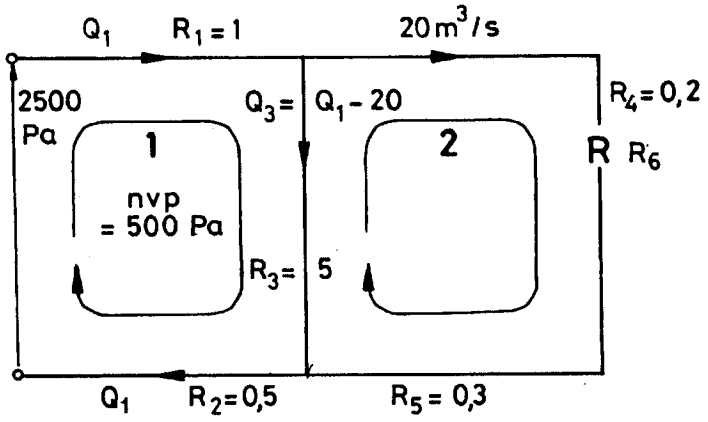


Fig. 3. Two -mesh ventilation circuit

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

THE UNIVERSITY OF ZAMBIA

FIRST SEMESTER FINAL EXAMINATIONS

OCTOBER 2010

MI 535: COAL MINING

TIME : THREE [3] HOURS **FULL MARKS : 100**

INSTRUCTIONS:

a) **ANSWER QUESTION 1 AND ANY OTHER 5**
b) **QUESTIONS SHOULD BE ANSWERED IN THE ORDER THEY APPEAR**
c) **NEATLY DRAWN FIGURES IS A REQUIREMENT FOR THIS EXAMINATION**

QUESTION 1

a) What is a FAULT and DYKE? How the normal and reverse faults were originated? **[5Marks]**

b) Explain how the THROW and SHIFT in the case of a reverse fault can be estimated? **[5Marks]**

c) The Run- of –coal (ROM) generally contains a number of impurities due to which coal cannot be used unless these are removed. Explain with the help of diagram the method used for this purpose. **[10Marks]**

QUESTION 2

a) A coal deposit 5.0 m thick, lying at a depth of 300 m has been planned to mine using board and pillar mining. Explain, step by step, the process of development, depillaring, decision on the size of a panel, equipment for cutting the coal and transporting it on the surface keeping in mind the statutory requirements where ever necessary. **[10Marks]**

b) In a coal panel , 300 by 300 m, having 12 pillars , at a depth of 300 m to be mined . If the safety factor of the pillar to be maintained equal to 1.2, find the size of the pillar. Given the strength of the pillar equal to 10 M Pa and the unit weight of the over lying rock is 25 kN/m^3. **[10Marks]**

QUESTION 3

a) A coal deposite has been decided to work extract using a long wall retreat method. DESIGN a retreat face to produce two million tones of coal per year. Given, no of production shift available per day is two of 8 hours duration (but the actual production hours is only 70 % in a shift. The coal deposit is at 700 m below the earth surface and the specific gravity of coal is 1.7.
Name the equipment you will need, with their location on the face , and also the system to transport the coal from face to the surface. **[10Marks]**

b) Calculate the expected % convergence in a long wall road way if the depth of coal deposits is at the depth of 600 m , the thickness of seam to be extracted is 3.0 m . Take the value of Pack Index= 2 and Floor Index =06. **[6Marks]**

QUESTION 4

a) A coal seam having a thickness of 12 m , at a depth of 600 m to be mined. Describe a suitable method to mine this deposit **[10Marks]**

b) What are the different methods suggested to calculate the size of a SHAFT PILLAR? Use a method suggested by Mining Engineers for a shaft 500 m deep, having diameter equal to 6.0 m and the thickness of the coal seam extracted is 6.0 m. **[6Marks]**

QUESTION 5

a) A coal seam having a dip of 23°, 5.0 m in thickness, at a depth of 250 m, has to be extracted . Describe an appropriate method keeping in mind that at least 70 % coal be extracted. **[10Marks]**

b) What is a DOUBLE UNIT FACE? show by means of a diagram and write its advantages over the Single Unit Face **[6Marks]**

Q6, (a) What are main parameters used in the design of a coal pillar in case of room and pillar mining ? How can you achieve a particular safety factor for this method? **[10Marks]**

(b) Given: Pillar width = 1.5, room width = 4.2, pillar height = 3.0 m, Depth of deposit below the surface = 300m, Unit weight of overlying rock= 25 kN/m^3, Uniaxial compressive strength = 150 Mpa. Calculate the safety factor of the pillar and comment on the stability of the same **[6 Marks]**

QUESTION 7.

a) According to the Coal Mining Regulations certain statutory requirements to be followed against the dangers from WATER INUNDATION, COAL and SILICA DUST, METHANE GAS, and FIRE. Write the requirements of these statutes. **[10Marks]**

b) What is meant by ADEQUATE ventilation? What dangers this likely to cause if this is not maintained. **[10Marks]**

QUESTION 8

a) What are the general considerations for the adoption for room and pillar and longwall method of mining? **[10Marks]**

b) Why there is a variation in the thickness of the coal strata and its rank ? Explain. **[6 Marks]**

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

FIRST SEMESTER UNIVERSITY EXAMINATIONS

OCTOBER 2010

MI 561: GEOTECHNICL ENGINEERING

TIME : THREE [3] HOURS **FULL MARKS : 100**

INSTRUCTIONS: ANSWER ALL QUESTIONS

QUESTION ONE

Large caverns mined underground are used for a variety of purposes in civil engineering. These include caverns housing turbines, electrical generators and transformers in hydroelectric projects, caverns for storing liquid or gaseous fuels, underground warehouse and underground sports facilities. Because of the high capital costs and the risks associated with public access to these facilities, care has to be taken in the design of the caverns to ensure that potential risks are kept to an absolute minimum while, at the same time providing cost effective and practical engineering solutions.

Discuss the characteristics of large caverns in jointed rock under the following headings

a) Typical Problems

b) Critical Parameters

c) Stability Analysis methods

d) Design acceptability criteria **[20 marks]**

QUESTION TWO

Foundations on rock slopes act as footings and transmit various service loads depending on service structures that they serve be it residential accommodation, bridge footings or wall footings. Discuss the following as related to foundations on rock slopes:

a) Typical problems

b) Critical parameters

c) Analysis methods

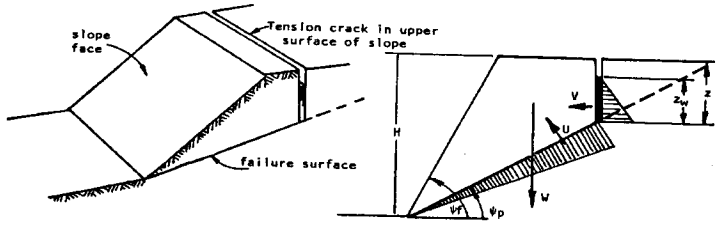
d) Acceptability criteria **[20 marks]**

QUESTION THREE

A.typical open pit mine may only suffer two or three major slope failures during its operating life. This aside, identify the 2 distinct stages followed in the approach to the planning of a slope stability programme, identifying critical situations as they occur and remedial measures that may be undertaken. **[10 marks]**

QUESTION FOUR

A 40m high slope with a face angle of 60^0 is found to have a bedding plane running through it at a dip of 30^0 (See Figure below). A tension crack occurs 10m behind the crest of the slope and from an accurately drawn cross section of the slope, the tension crack is found to have a depth of 16m. The unit weight of the rock is $\gamma = 25.23KN/m^3$, that of the water is $\gamma_w = 9.81KN/m^3$



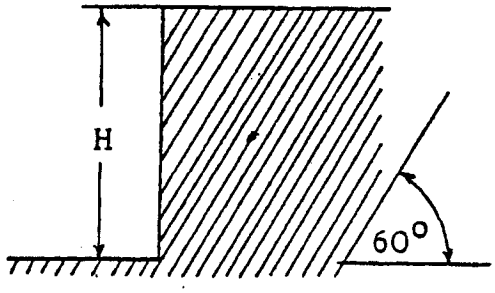
Assuming that the cohesive strength of the bedding plane is $C=47.88KN/m^2$ and the friction angle $\Phi = 30^0$, find the influence of water depth Z_w upon the factor of safety of the slope.

Make general comments on your findings.

Note: Use the Charts attached to end of Examination paper for Question Four **[40 marks]**

QUESTION FIVE

A vertical cut is expected to be made in a closely jointed and completely dry rock mass as shown in figure below.



The joints strike parallel to that of the vertical cut.

Sliding would occur on the joint surfaces when:

$\tau = 30 + 0.38\sigma$

Where τ = Shear Stress along the dip and σ is the stress normal to the dip plane.

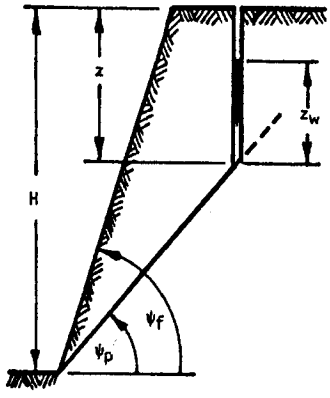
The mass density of rock is 2700 Kg/m^3.

Considering a unit length of the cut:

a) Determine the factor of safety of the rock structure when the height was 6m.

b) Calculate the height at which failure would take place. **[10 marks]**

END OF EXAMINATION



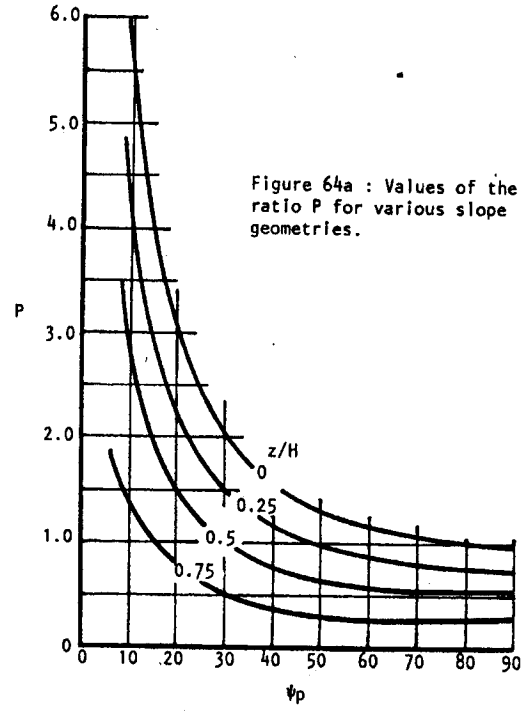
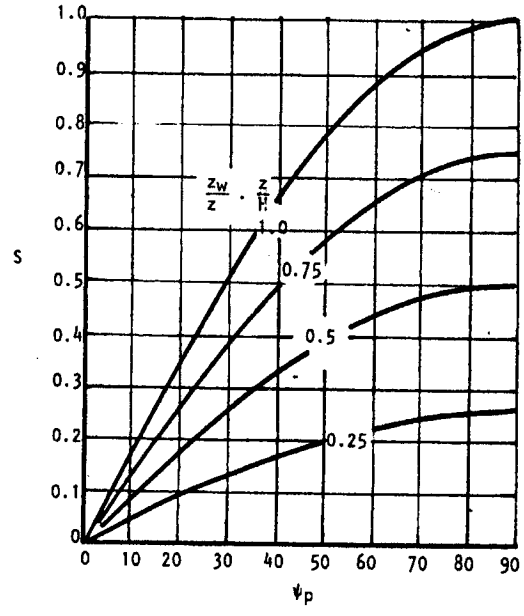
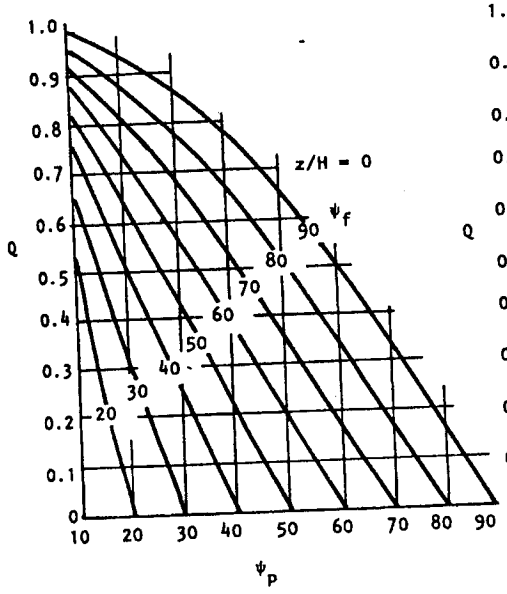
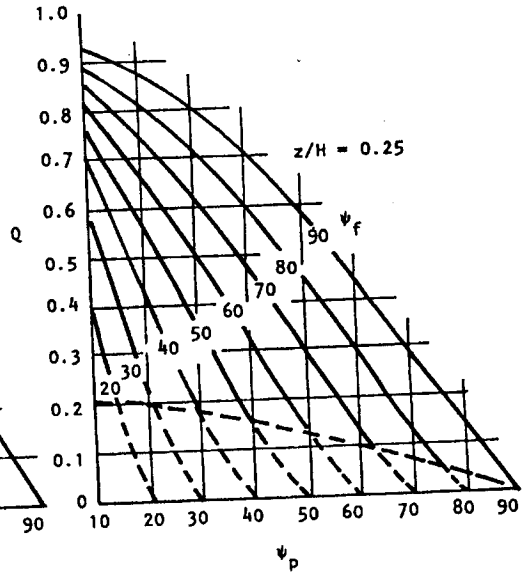


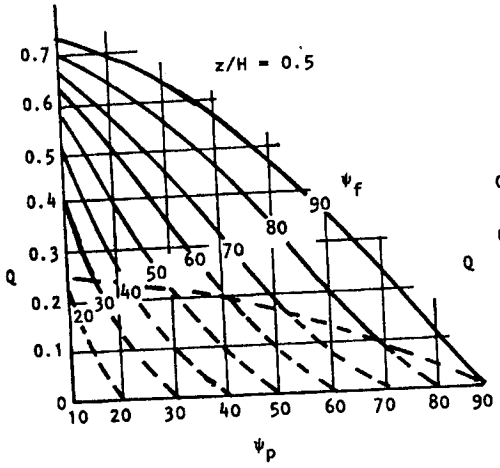
Figure 64a : Values of the ratio P for various slope geometries.

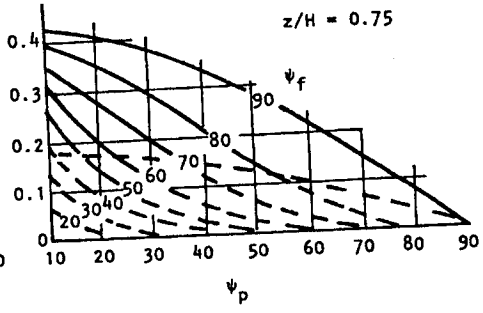


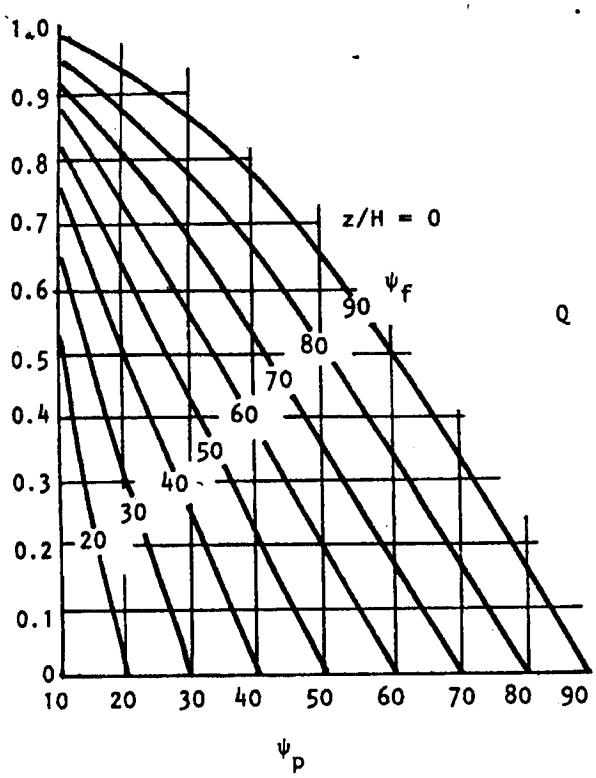


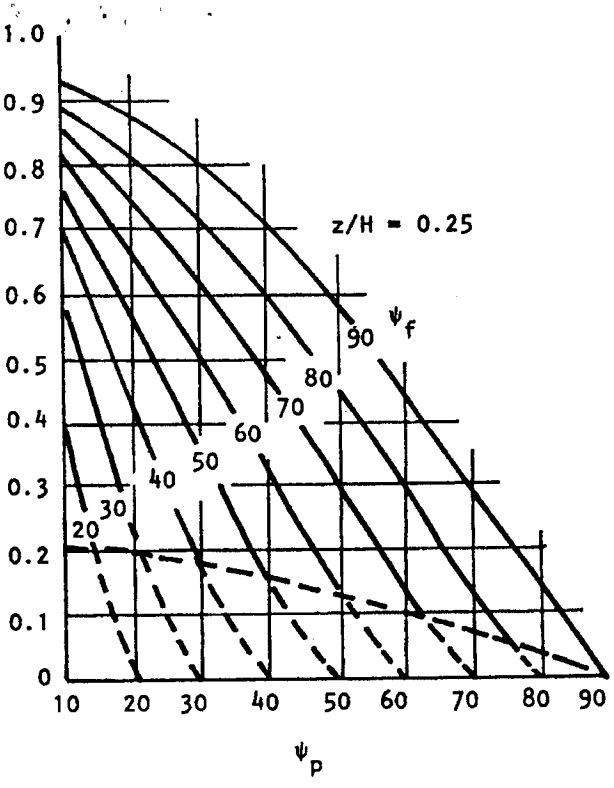


Note:
Dashed lines refer to tension crack in slope face.









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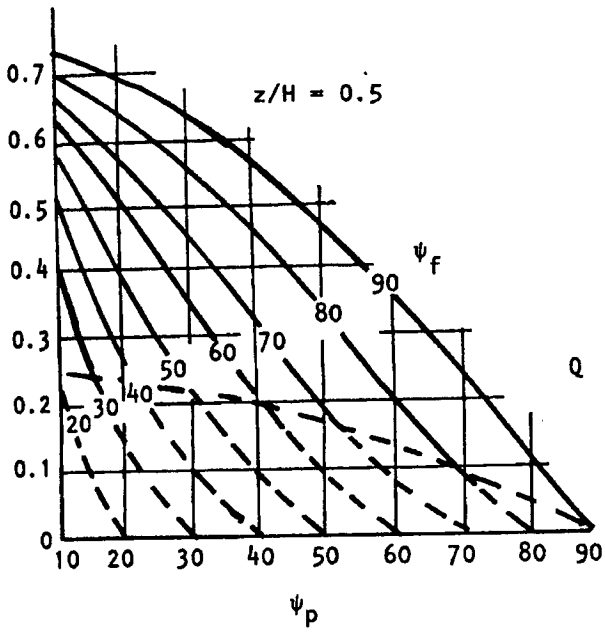

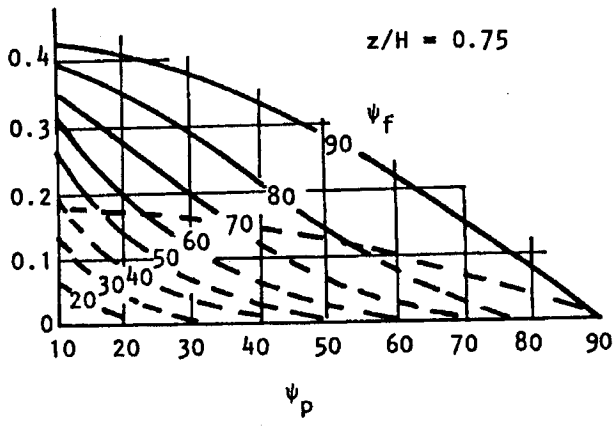

THE UNIVERSITY OF ZAMBIA

FIRST SEMESTER UNIVERSITY EXAMINATIONS

OCTOBER 2010

MI 575: SAFETY HEALTH AND ENVIRONMENT

TIME : THREE [3] HOURS FULL MARKS : 100
INSTRUCTIONS : ANSWER ANY FIVE QUESTIONS. QUESTION 1 IS COMPULSORY

QUESTION 1

A chemical spill of unknown substance has occurred along Great East Road resulting in widespread contamination near Marshland area and part of Goma Lakes. In some places,fire is burning and requires to be put off.As an experton hazardous materials,what advice would you give to people tasked to put off fire and clean up the spill? Draw up a plan of action to deal with the emergency.

[20 Marks]

QUESTION 2

a) Briefly explain the purpose and objectives of conductingenvironmental audits and environmental monitoringprogrammes at particular at a particular mine. **[10 Marks]**

b) Suggest possible ways of financing environmental issues in Zambia **[10 Marks]**

QUESTION 3

a) An LHD operator works for an 8 hour shift which is divided into:

- 6 hours loading and hauling in environment containing average concentration of CO is 30 mg/m^3
- 15 minutes break refueling in a bay in which average concentration of CO is 350 mg/m^3 and
- 20 minutes of daily inspection of LHD in a garage containing an average of CO concentration of 390 mg/m^3 . Assuming he spends the rest of the minutes moving in places where CO concentration is negligible, find the TWA exposure of a driver in a full shift.

[10 marks]

b) What are the physiological effects on workers exposed to high dry bulb and wet bulb temperatures in the working environment? Suggest possible measures of dealing with such effects.

[10 marks]

QUESTION 4

a) Suggest environmental issues that should be incorporated in mining planning at an early stage of mine development. What is the purpose of incorporating such environmental issues?

[10 marks]

b) Briefly explain the contents of an environmental project brief and state circumstances under which it may be required.

[10 Marks]

QUESTION 5

Briefly explain factors hampering effective waste management in Zambia with regard to waste generation, storage, transportation and disposal. Are the current regulations concerning waste management in Zambia adequate?

[20 marks]

QUESTION 6

a) Briefly outline the major contents of an environmental impact assessment report (EIA). What types of projects are exempted from submitting an EIA in Zambia? **[10 marks]**

b) Explain different criteria used in conducting noise surveys. Suggest control measures fordealing with industrial noise that cannot be reduced at the source. **[10 marks]**

==========END OF EXAMINATION==========

THE UNIVERSITY OF ZAMBIA

FIRST SEMESTER UNIVERSITY EXAMINATION

OCTOBER 2010

MI 585: MINE TRANSPORTATION

TIME : THREE [3] HOURS FULL MARKS : 100

INSTRUCTIONS: ANSWER QUESTIONS 7 AND ANY OTHER FIVE

(a) Questions to be answered in the way it appears

(b) Neat diagrams and complete calculations are the requirements of this examinations

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QUESTION 1

(a) The correct selection of mine transportation equipment is a sensitive issue in terms of satch, economy and efficient mining. Write the major factors that governs the choice of the equipment. **[10 Marks]**

(b) Write the recommended wire ropes required for the following properties.

(i) Winding of cage or skip

(ii) as 'Guide' ropes

(iii) In shaft sinking

(iv) as haulage ropes

(v) In cable conveyor belts and

(vi) Draglines

How often the holsting rope should be tested as per the requirements of statute and for what parameters? **[6 Marks]**

QUESTION 2

(a) What are the different types of mine transport system used underground for transportation of minerals, materials and men? Between the locomotives and conveyor belts, compare their merit and demerits. **[10 Marks]**

(b) What are the most common reasons for the derailments of mine car (or tubs). How the derailment can be controlled. **[6 Marks]**

QUESTION 3

(a) For underground mineral transport system, conveyor belts are getting more popular particularly the nylon type. Give the reasons for this and recommend the width (in mm) and expected mineral carrying capacity tonnes/hour for use (i) at face or gate roadway (ii) trunk roadway. **[10 Marks]**

(b) Calculate the mineral carrying capacity (in t/h) if the width of the belt in 1.0m. The bulk density of the materials to be transported is 1.35 t/m^3 and the speed of the belt is 80m/mm. **[6 Marks]**

QUESTION 4

(a) What are the factors you would consider in the DESIGN of all underground hoisting system? Write the reasons for the parameters you have chosen. **[10 Marks]**

(b) Calculate the fleet angle (in degrees) from the data given below:

- Ratio of $(T_1 / T_2) = 2.02$.

where T_1 and T_2 are the weight on the loaded cage and empty cage side respectively and,

- Coefficient of friction between the sheave and the winding rope = 0.45

If the fleet angle calculated is not within the recommended range, how can it be corrected? **[6 Marks]**

QUESTION 5

5 (a) What carves deterioration of winding ropes and how these can be avoided? **[10 Marks]**

(b) Name the popular equipment for use for removal of overburden and mineral extraction in a surface mining.

Recommend and describe all equipment which can be used for both removal and soft overburden and mineral. **[6 Marks]**

QUESTION 6

(a) What are the essential considerations in the DESIGN of a pit – top layout for a cage window? Describe with the help of diagrams a suitable pit – top layout wing "trun tables". **[10 Marks]**

(b) Whether the above layout can also be used in 'skip' winding system? Of not, suggest a different layout for skip winding with the help of a diagram. **[10 Marks]**

QUESTION 7

(a) DESIGN a hoisting system for a drum winder required to life a cage from a 450 m deep shaft. The other details are given below:-

- Total weight to be operated = 13 tonnes
- Factors of safety for role should be = 10
- Diameter of the dram = 3.0m
- Values of [K] and [S] for round strand rope) are 0.36 and 52 respectively.

In the design you are expected to specify (i) the diameter (mm) of the rope (ii) weight of the rope (in kg/m) and (iii) total length of the rope (in mm) keeping in mind the statutory requirement in recommending total length of ropes. **[10 Marks]**

(b) Write the safety and emergency devices provided in the friction winder system. Write the purpose of the devices provided. **[10 Marks]**

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF MINES

UNIVERSITY EXAMINATIONS – OCTOBER/NOVEMBER 2010

MM 331 CHEMICAL THERMODYNAMICS I

TIME: THREE HOURS

ANSWER ANY FIVE QUESTIONS AND ALL CARRY EQUAL MARKS. WHERE APPLICABLE, ALL CALCULATIONS ARE TO BE PERFORMED CORRECT TO THREE DECIMAL PLACES.

The gas constant R	= 0.08206 litre-atm/(mol)(K)
	= 8.314 J/(mol)(K)
1 litre-atm	= 101.3 joules
1 atm pressure	= 1.013×10^5 N/m^2
c_V for an ideal gas	= 1.5R
c_P for an ideal gas	= 2.5R

---

1. (a) Define the following:

   (i) A system and its surroundings
   (ii) A closed system
   (iii) An open system
   (iv) Equilibrium
   (v) A process and its path

   (7 marks)

   (b) An ideal gas occupies 0.3 litre at a pressure of 1.8×10^5 Pa. What is the new volume of the gas maintained at the same temperature if the pressure is reduced to 1.15×10^5 Pa?

   (2 marks)

   (c) If the gas in part (b) were initially at 330 K, what will be the final volume if the temperature is raised to 550 K at constant pressure?

   (2 marks)

   (d) One mole of an ideal gas at 25 ^{0}C is held in a cylinder by a piston at a pressure of 100 atm. The piston pressure is released in two stages: first to 50 atm; and then to 10 atm. Calculate the work done by the gas during these irreversible isothermal expansions and compare with the work done in an isothermal reversible expansion from 100 atm to 10 atm at 25 ^{0}C.

   (9 marks)

2. (a) Derive the expression

$$\left(\frac{\partial U}{\partial T}\right)_p = c_P - P\left(\frac{\partial V}{\partial T}\right)_p.$$

Show that for an ideal gas $(\partial H/\partial V)_T = 0$ and $(\partial c_V/\partial V)_T = 0$.

(6 marks)

(b) A system comprises one mole of an ideal gas at 0^0C, 1 atm pressure and volume of 22.4 litres. The system is subjected to the following processes, each of which is conducted reversibly:

(i) A 10-fold increase in volume at constant temperature,
(ii) then a 100-fold adiabatic increase in pressure,
(iii) then a return to the initial state along a straight-line path in the P-v diagram. *Along this path,* **P = - 1.116v + 26** *where* v *is in litres per mole.*

Calculate the work done by the system in each step and the total heat added to or withdrawn from the system as a result of the cyclic process. For an adiabatic process involving an ideal gas we have Pv^γ = constant where $\gamma = 5/3$.

(14marks)

3. (a) When tungsten carbide WC was burned with excess oxygen in a bomb calorimeter, it was found for the reaction

$$WC(s) + \frac{5}{2}O_2 \rightarrow WO_3(s) + CO_2(g)$$

that $\Delta U^0_{300} = -1192$ kJ.

What is ΔH^0_r at 300 K? What is the ΔH^0_f of WC from its elements if the ΔH^0_C for combustion of pure C and pure W at 300 K are -393.5kJ and -837.5 kJ respectively?

(6 marks)

(b) Calculate the enthalpy change for the industrially important shift-conversion reaction as

$$CO(g) + H_2O(g) \rightarrow CO_2(g) + H_2(g)$$

at 1200K and at 1500 K.
Use the following additional information:

ΔH^0_{f298} for CO (g) = - 110.520 kJ mol^{-1}
ΔH^0_{f298} for H_2O(g) = - 241.820 kJ mol^{-1}
ΔH^0_{f298} for CO_2(g) = - 393.510 kJ mol^{-1}

Heat capacity data at constant pressure for $c_P = a+bT+cT^2$ *in J mol^{-1}K^{-1}*

Component	a	b × 10^3	c × 10^{-5}
CO(g)	28.41	4.1	-0.46
H_2O(g)	30.54	10.29	0
CO_2(g)	44.22	8.79	- 8.62
H_2(g)	27.28	3.26	0.5

(14marks)

4. (a) In terms of entropy, state the Second Law of Thermodynamics.

(4 marks)

(b) One mole of an ideal gas is heated from 100^0C to 200^0C. Calculate the entropy change if the heating takes place at a constant pressure of one atmosphere.

(4 marks)

(c) A 1500-gm piece of lead at 100^0C is placed in 100 gm of adiabatically contained water at 25^0C in a Dewar flask. The specific heat capacity of water can be taken as 75.44 J/mol.K and independent of temperature; and the specific heat capacity of the lead is 26.7 J/mol.K. The molecular weights of H_2O and Pb are 18 and 207 respectively.

(i) What is the final temperature of the water?

(6 marks)

(ii) What is the entropy change of the universe of the system for this irreversible process?

(6 marks)

5. (a) A steam engine operating between 150^0C and 30^0C performs 2000 joules of work. What is the minimum quantity of heat which must be drawn from the heat source in order to obtain this amount of work? Which of the following would give a greater increase in the efficiency of the engine: an increase of 10^0C in the temperature of the heat source (T_h) or a decrease of 10^0C in the temperature of the heat sink (T_l)?

(5 marks)

(b) From 298 K up to its melting temperature of 1048 K, the constant-pressure molar heat capacity of RbF is given as

$$c_P = 33.3 + 38.5 \times 10^{-3} T + 5.06 \times 10^5 T^{-2} \text{ joules.mol}^{-1}\text{K}^{-1}$$

From the melting temperature to 1200 K, the constant-pressure molar heat capacity of liquid RbF is given as

$$c_P = -47.3 + 3.49 \times 10^{-3} T + 1467 \times 10^5 T^{-2} \text{ joules.mol}^{-1}\text{K}^{-1}$$

At its melting temperature the molar heat of fusion of RbF is 26,400 joules. Calculate the increase in the entropy of 1 mole of RbF when it is heated from 300 K to 1200 K. Start from first principles.

(15marks)

6. (a) Define the fugacity, activity and activity coefficient. How are they related to one another?

(4 marks)

(b) Derive the van't Hoff equation in the form

$$\frac{d \ln K_P}{dT} = -\frac{\Delta H^0}{RT^2}$$

(4 marks)

(c) You are given the following reaction:

$$N_2(g) + 3\,H_2(g) \leftrightarrows 2\,NH_3$$

At 400^0C, $K_P = 1.60 \times 10^{-4}$

(i) What is the value of ΔG^0 for the reaction?

(2 marks)

(ii) Calculate the total pressure that must be used to obtain a 10% conversion of nitrogen to ammonia, assuming an initially equal molar mixture of nitrogen and hydrogen. Also calculate the corresponding gaseous partial pressures. Assume ideal gas behaviour.

(10marks)

END OF EXAMINATION IN MM331

THE UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS – OCTOBER 2010

MM 411
COMMINUTION AND CLASSIFICATION

TIME: THREE HOURS

INSTRUCTIONS: 1. ANSWER QUESTION ONE AND ANY OTHER FOUR
2. ALL QUESTIONS CARRY EQUAL MARKS

Q1

State briefly but clearly what you understand by the following terms, used in minerals engineering:

(i) Comminution
(ii) The angle of nip in a crushing operation
(iii) Classification
(iv) The angle of repose of a mass of loose material
(v) Equivalent diameter of a particle
(vi) Separating size in a classifier in operation
(vii) Particle size distribution (PSD)
(viii) A modular particle
(ix) Semi-Autogenous (SAG) Mill
(x) Critical speed of a tumbling mill

[20]

Q2

(a) What do you understand by the term 'reduction ratio'? Outline the various ways in which reduction ratio can be defined. Include in your answer the applications and limitations of the proposed definitions. **[4]**

(b) What do you understand by the grindability of an ore? Why does the grindability of an ore frequently vary with size to which the ore is being ground? **[3]**

(c) Give the definition of Bond's work index. **[2]**

The equation for Bond's work index can be written as:

$$W_i = W_{F\to P}\left[\frac{F^{0.5}}{F^{0.5}-P^{0.5}}\right]\left[\frac{P}{100}\right]^{0.5}$$

What do the symbols used in the above equation represent and in which units should they be expressed? **[2]**

(d) (i) A material has a ball mill work index of 15.6 kWh/ton, and a particle size of 80% passing 1 mm. How much energy would be needed to reduce this material to 80% passing 100 μm in a mill 8 feet in diameter? **[3]**

(ii) If you want to know the energy required per tonne of this material in the size range 1mm to 36 μm (80% passing size), could you simply use the same equation that you used under 2d(i)? Explain your answer. **[3]**

(iii) If it is required to mill 11000 tonnes/day of the material from 1mm to 100 μm in 3 shift operations, with an expected mill availability of 92%, what minimum horsepower should be installed in the grinding section, based upon the above data (1hp = 0.75 kW). **[3]**

Q3

(a) Draw a functional sketch of a hydrocyclone in operation, name its parts and describe its separating action (or classification mechanism). Describe how the cyclone efficiency can be expressed and draw two rough diagrams, illustrating this for a high efficiency and a low efficiency cyclone respectively. **[6]**

(b) (i) What are the main design variables of a hydrocyclone? **[4]**

(ii) For each of these design parameters, give an indication of its relation with the flowrate of the feed, with the cyclone inlet pressure and with the separating size. **[6]**

(iii) What can you say about the products from a hydrocyclone as compared to the products of a mechanical classifier? Explain briefly. **[4]**

Q4

Consider a grinding circuit shown in Figure 1 below, consisting of a rod mill in open circuit and a ball mill in closed circuit with a hydrocyclone: On the basis of Figure 1, answer the following:

(a) What is understood by the "circulating load" in this circuit? **[2]**

(b) How can you express the circulating load as a percentage of the tonnage of fresh feed into the circuit, using only the size analyses of the particle size fractions? **[2]**

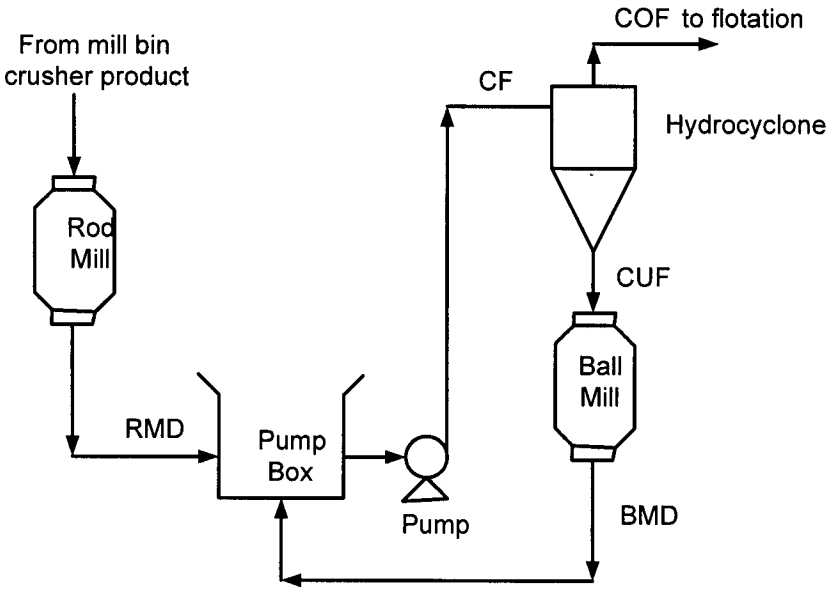

Figure 1: Rod mill-Ball mill-Cyclone Circuit

(c) Imagine that, as part of a survey of the above circuit, samples are taken of the rod mill and ball mill discharges and of the cyclone overflow and underflow, and that screen analyses of the composite samples gave the following results:

Size fraction [μm]	Weight Percentages Retained			
	RMD	BMD	CUF	COF
+ 212	35.1	24.4	34.9	3.6
+ 150	11.7	21.6	25.1	1.2
+ 106	5.8	25.0	22.5	13.3
+ 75	6.4	13.2	9.2	18.4
+ 53	7.4	10.4	3.9	26.9
- 53	33.6	5.4	4.4	36.6

Calculate the circulating load as a percentage of the new feed over the ball mill/cyclone circuit, based upon these screen analyses. **[2]**

(d) If the feed to the rod mill is 95 t h^{-1} (dry weight), what is the actual feed rate to the ball mill, based upon your answer to question (c)? **[2]**

(e) What is the size distribution in the cyclone feed, based upon the above data? **[4]**

(f) From these data, calculate the recoveries to the cyclone underflow for the different size fractions and plot these against particle size on a graph paper. **[4]**

(g) What is the separating size in this cyclone operation, based upon these data? **[2]**

(h) What is the "imperfection" in this cyclone operation, based upon these data? **[2]**

Q5

(a) (i) In industrial screens, the openings are often rectangular ("slotted") rather than square. What can you say about the advantages and disadvantages of rectangular openings as compared to square openings in industrial screens?

(ii) Screens with rectangular openings can be positioned with the largest dimension of the opening in the direction of feeding, or they can be positioned perpendicular to it. What would be the advantage(s) in each case?

(b) (i) Industrial screens are required to give a number of effects to the particles on the screen. These effects are mainly achieved by shaking and vibrating the screen. List the four most important requirements and explain briefly why each of these effects is important.

(ii) Describe briefly how these effects can be achieved on a shaking screen with a Ferraris-type of support. You can make a rough sketch as illustration.

(c) (i) Give four reasons why industrial screening is carried out.

(ii) Give three reasons for using double-deck screens rather than single-deck screens in concentrator crushing plants.

Q6

(a) Give a brief discussion on the flow of ore in bins and illustrate this with rough sketches. Discuss problems of segregation, of arching, of piping, of compaction and of dead ore in the bin. **[6]**

(b) Roughly sketch the main types of bin design and discuss each of these briefly. **[4]**

(c) If, with simultaneous feed and discharge, you see the level of ore in the bin rising, will the discharge of the bin then be coarser, finer or of the same average size as the feed to the bin? And if the level is falling? Explain your answer briefly. **[5]**

(d) State briefly why all longer belt conveyors and all inclined belt conveyors should be equipped with a belt take-up. Give and discuss two different types of belt take-up. **[5]**

Q7

The flowsheet shown (See Figure 2 attached) below is that of a tin concentrator treating 30 dry tonnes per hour of ore.

The ore, containing 10% moisture, is fed into a rod mill, which discharges a pulp containing 65 % solids by weight. The rod mill discharge is diluted to 30% solids before being pumped to cyclones. The cyclone overflows, at 15 % solids, are pumped to the slimes treatment plant.

The cyclone underflow, at 40% solids, and containing 0.9% tin, is fed to a gravity concentration circuit, which produces a tin concentrate containing 45% tin, and a tailing containing 0.2%.

The tailing slurry, containing 30% solids by weight, is dewatered to 65% solids in a thickener, the overflow being routed to the mill header tank, which supplies water to the rod mill feed and rod mill discharge.

Calculate:-

(i) The flowrate of make-up water required for the header tank **[4]**

(ii) The water addition needed to the rod mill feed **[4]**

(iii) The water addition needed to the rod mill discharge **[4]**

(iv) How much water is contained in the cyclone overflow per hour? **[4]**

(v) The recovery of tin to the concentrate **[4]**

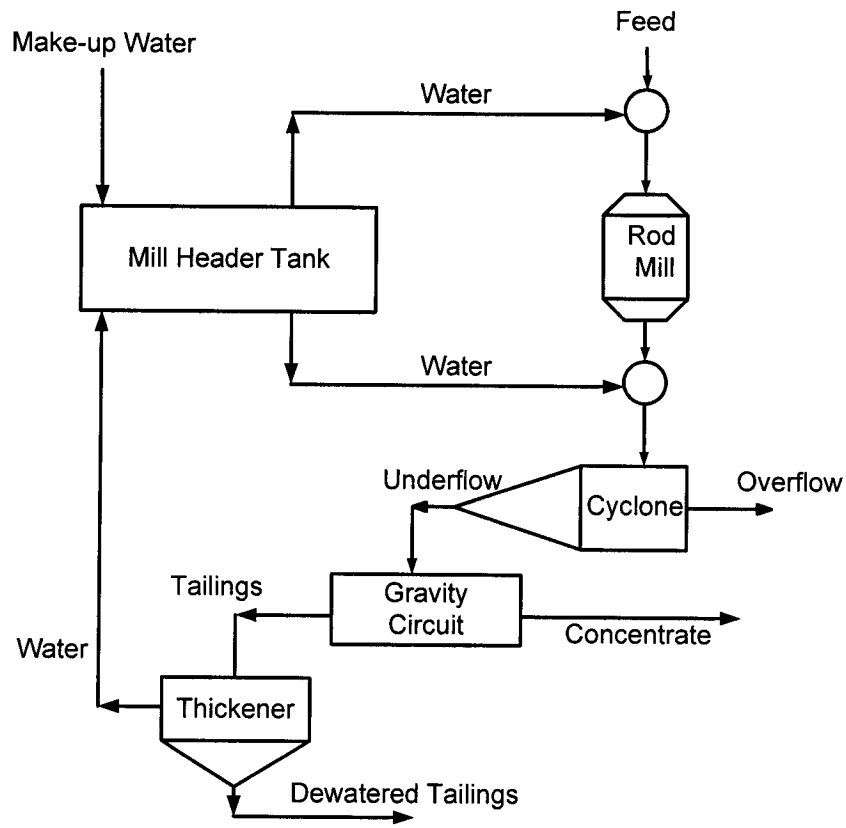

Figure 2: Tin Concentrator Circuit

END OF EXAMINATION IN MM411

THE UNIVERSITY OF ZAMBIA

SCHOOL OF MINES

UNIVERSITY EXAMINATIONS – OCTOBER/NOVEMBER 2010

MM 421 – PHASE TRANSFORMATION

TIME: THREE HOURS

ANSWER ANY FIVE QUESTIONS AND ALL CARRY EQUAL MARKS

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1. (a) If it is given that a dislocation, b, is of mixed type and resolved as b_1 and b_2, and assume that the vectors are at right angles and there is no energy associated with the two vectors. What is the total elastic energy of the two dislocations if edge dislocation strain energy is more than that of the screw type by a factor of $[1/(1 - \upsilon)]$ where υ is Poissons ratio.

$b_1 = b \sin\theta$ and $b_2 = b \cos\theta$

$E_{elastic\ (screw)} = \frac{G.b^2}{4\pi} ln\ (\frac{R}{r_o})$ is the strain energy for a screw dislocation

[12]

(b) Is energy per unit length in the above dependent on character of the dislocation? [4]

(c) Explain why dislocations of opposite sign attract each other when close together to reduce their total elastic energy in terms of their effective Burgers vector.

[4]

2. (a) Why are vacancies important and what happens when they exist in metals and alloys? [6]

(b) It has been shown that the ratio of vacant or equilibrium vacancies to occupied sites (i.e. vacancy concentration) in a material can be expressed as;

$$\frac{n_{eq}}{n_t} = \exp -\frac{H_v}{RT}$$

Using the above expression, determine the vacancy concentration in copper at 1350 K and when it is slowly cooled to 300 K? What could have happened to the vacancies during slow cooling in the said temperature range? (H_v = 83,700 J/mol and R = 8.31 J/mol K). [8]

(c) What would happen to the vacancy concentration in (b) if the copper metal was actually quenched from 1350 K to 300 K? [6]

3. (a) How would the property of hardenability best be measured in a given type of steel taking into account the elimination of the variability of the severity of quench? [6]

(b) What do the eutectic and eutectoid reactions yield in the iron carbon system and suggest one important application for each? [6]

(c) Two steel specimens are austenitised at 760 °C and are allowed to cool to room temperature by the following means below. How would describe the microstructures? [8]

(i) Cooled to room temperature in less than 1 second

(ii) Quenched to 550 °C and held at this temperature for a day and then finally to room temperature.

4. (a) $\Delta G = 4\pi r^2 \gamma + \frac{4}{3}\pi r^3 \Delta G_V$

(i) Define the terms in this equation and sketch the form of ΔG versus r. [6]

(ii) Derive the equations for r* and ΔG^* from the above equation. [4]

(iii) A material has the value $\Delta G_v = -8\ MJm^{-3}$ and $\gamma = 0.4\ Jm^{-2}$ for particles of a second phase to form. Calculate the critical particle size and the critical free energy for homogeneous nucleation and growth of the second phase. [2]

(b) Name the two stages involved in the formation of particles of a new phase. Briefly describe each. [6]

(c) What determines the overall rate of phase transformation? [2]

5. (a) Briefly explain the concept of unsteady-state and steady state as it applies to diffusion. Name and define the atomic mechanisms involved in diffusion. [8]

(b) A plate of iron is exposed to a carburizing atmosphere on one side and a decarburising atmosphere on the other side at 700 °C.If a condition of stead state is achieved. Calculate the diffusion flux of carbon through the plate if the concentrations of carbon at positions of 5mm and 10mm beneath the carburizing surface are 1.2 and 0.8 kg/m^3 respectively. Assume a diffusion coefficient of $3*10^{-11} m^2/s$ at this temperature. [6]

(c) A sheet of steel 2.5 mm thick has nitrogen atmospheres on both sides at 900 °C and is permitted to achieve a steady-state diffusion condition. The diffusion coefficient for nitrogen in steel at this temperature is $1.2 *10^{-10}$ m/s and the diffusion flux is found to be $10*10^{-7}\ kg/m^2/s$. The concentration of nitrogen in the steel at the high pressure surface is 2 kg/m^3.How far into the sheet from this high-pressure side will the concentration be 0.5 kg/m^3? [6]

6. (a) The equilibrium diagram for the Ag-Cu system is given in Figure 1. Describe the phases that are present when alloys of composition (i) Ag-4 wt% Cu and (ii) Ag-40 wt% Cu are cooled from the liquid state to room temperature. Estimate the mass fraction of solid β phase present in both alloys at 780 °C and 778 °C.

[10]

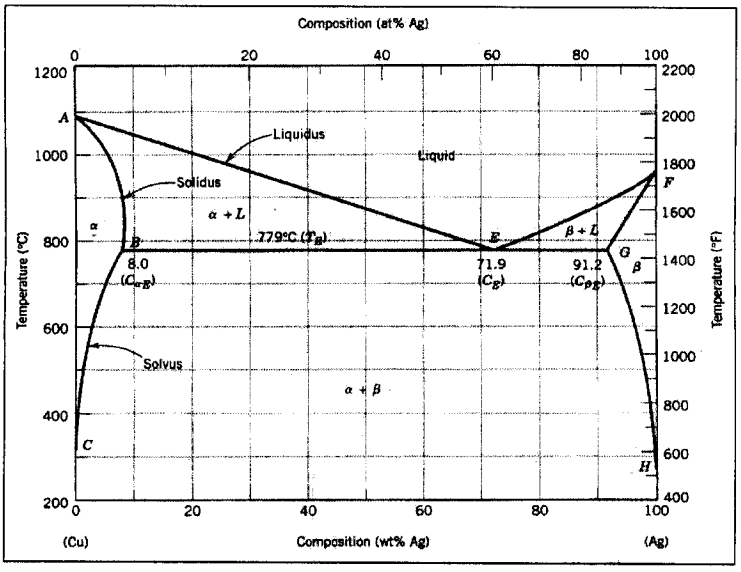

Figure 1

(b) Consider the 40 wt% Ni-60 wt% Cu alloy at 1250 °C in Figure 2. Determine the composition for the phase (s) present, and compute the fractions of each of the phase(s)present. [6]

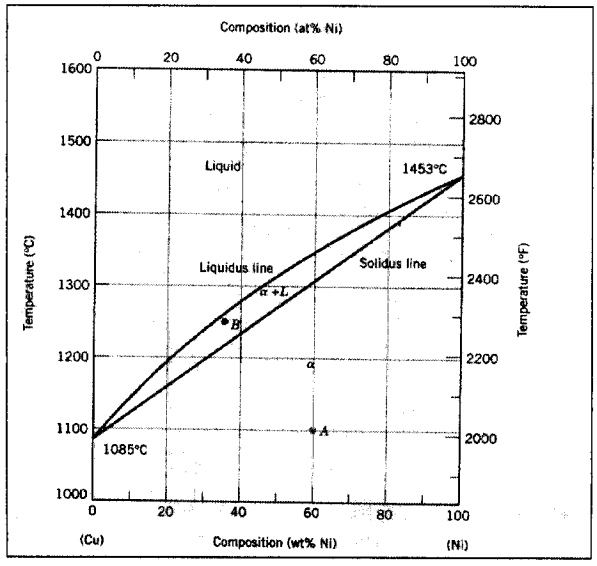

Figure 2

(c) In Figure 3 is shown the pressure-temperature phase diagram for H_2O. Apply the Gibbs phase rule at points A,B, and C, that is, specify the number of degrees of freedom at each of the points. What do the calculated values mean?

[4]

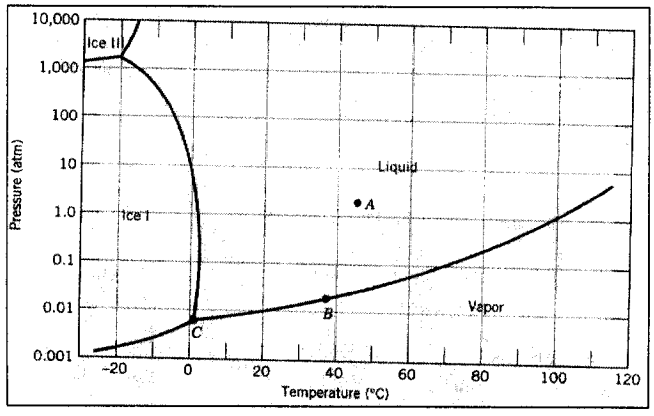

Figure 3

END OF EXAMINATION IN MM 421

THE UNIVERSITY OF ZAMBIA

SCHOOL OF MINES

UNIVERSITY EXAMINATIONS – OCTOBER/NOVEMBER 2010

MM 441 HYDROMETALLURGY

TIME: THREE HOURS

ANSWER ANY FIVE QUESTIONS. THE CREDIT FOR A FULL ANSWER IS SHOWN IN BRACKETS BESIDE EACH QUESTION.

1(a) What steps may be used for material preparation prior to leaching? Account for the importance of each process cited. (6%)

(b) What is agitation leaching and why is it a popular leaching method? (6%)

(c) Use Fick's first law of diffusion to identify parameters that are important for boundary layer diffusion during leaching. Assume Nernst's diffusion model is valid. (8%)

2(a) As used in copper electrometallurgy, what is periodic current reversal and explain if this process can be used for copper electrowinning. (5%)

(b) What is the energy required (in kWh) for copper electrowinning at 2.5V if the current efficiency is 90%? (Atomic weight Cu=63.5; F=96500 C/mol) (5%)

(c) Calculate the time (in hours) needed to deposit 1kg of cobalt onto a cathode placed between two anodes during electrowinning. The current density is 200A/m^2 on a submerged cathode area of 1m^2 while the current efficiency is 80%. (Atomic weight Co=58.9; F=96500 C/mol (10%)

3(a) Explain how co-precipitation occurs in chemical precipitation and how its extent may be minimized. (6%)

(b) Outline, with the aid of an appropriate example in each case, how crystallization is brought about in the metallurgical industry. (6%)

(c) Given the data below, draw two lines that would form part of the nickel-water Eh-pH diagram at 25°C. Assume ionic activities are equal to molar concentrations and that nickel ions are at 10^{-3M}. Label both sides of the lines and state the co-ordinates of the point of intersection. (8%)

Data: F=96500 C/mol; R=8.314 J/K/mol

$Ni^{2+} + H_2O = NiO + 2H^+$ $K = 6.6*10^{-13}$

$NiO + 2H^+ + 2\bar{e} = Ni + H_2O$ $E/ = 0.11V$

4(a) In solvent extraction, what is a pH isotherm and how is it determined? (5%)

(b) How is a McCabe-Thiele diagram for stripping generated and used? (9%)

(c) In a stripping experiment 500 cm^3 of a loaded organic is stripped with 5cm^3 of a strip solution. If 90% of the solute is stripped, what is the value of the stripping coefficient? (6%)

5(a) How does the sorption mechanism of solute onto activated carbon differ from that of solute loading onto an anion ion exchange resin? (8%)

(b) Explain why the cementation of copper on scrap iron requires a higher than stoichiometric amount of iron. (4%)

(c) Hydrogen gas at a partial pressure of 200 atmospheres is used to precipitate cadmium from a solution at 250°C. What pH of the solution will yield an equilibriun activity of Cadmium of 10^{-10}? (8%)

(F=96500 C/mol; R=8.314 J/K/mol)

$Cd^{2+} + 2\bar{e} = Cd$ $\quad E/ = -0.40V$

$2H^{+} + 2\bar{e} = H_2$ $\quad E/ = 0V$

END OF EXAMINATION IN MM 441

THE UNIVERSITY OF ZAMBIA

SCHOOL OF MINES

UNIVERSITY EXAMINATIONS – OCTOBER/NOVEMBER 2010

MM 515 SPECIAL TOPICS IN MINERAL PROCESSING

TIME: THREE HOURS

ANSWER ANY FIVE QUESTIONS AND ALL CARRY EQUAL MARKS

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1. First Quatum Plc in Solwezi have just opened a Cu-Co mines with an ore containing 3% Cu in the form of chalcopyrite ($CuFeS_2$), 0.02% Co as Carrollite ($CoCu_2SO_4$) and the remainder being predominately siliceous gangue (s.g 2.7). The ore is stage crushed from ROM of about 2000 mm to –12mm and sampled before being further treated. The output from the Gyratory crusher is fed to storage bins via a conveyor system at an average rate of 100 tonnes per hour. Assuming that the crushed material is thoroughly mixed, determine the limit of error (at 99% confidence limited) in the Cu assay introduced by taking a 1kg sample from the conveyor at intervals of ¼ an hour. A test of the ore showed that the maximum Cu content of the largest piece in the sample is 10% Cu. The specific gravity of chalcopyrite is 4.2. Take the shape factor and size factor as 0.5 and 0.25 respectively. Discuss the most appropriate sampling method to be used. [20]

2. (a) What are the advantages of using particle size distribution functions over the other methods of presenting sizing data? [5]

   (b) What is the general equation of particle size distribution function. Outline the significance of the parameters with reference to the Guadin-Schulmann and Rosin–Rammler functions. Show the relationship between the two functions. [10]

   (c) A particle size distribution of the ore is known to follow the G.S. function with 90% and 50% of the particle being less than 1mm and 0.5mm respectively. What is the weight percent between $10\,\mu m$ *and* $20\,\mu m$? [5]

3. (a) Explain how an electrical double layer may be formed when minerals are put in a solution. [4]

(b) What do you understand by the following terms?

- Electrophoresis [2]
- Streaming potential [2]
- Electro osmosis [2]
- Sedimentation Potential [2]

How can you measure the first two and give detailed explanation of how Electrophoresis will lead to establishing the zeta potentials and explain how this may be use in the separation of different minerals. [8]

4. What is the purpose of particle size reduction in mineral processing? [4]

(i) Give the various definitions of "Reduction Ratio" and identify the most important definitions. [8]

(ii) In Energy-Size reduction relationships as used in the design of comminution equipment, empirical "laws" are normally used. Name these laws and explain on which basis each one is used. Using a generalised equation derive each on of them. [6]

(iii) What do you understand by the term "Bond index? [2]

5. (a) "Only regular geometrical shapes can have their sizes conveniently qualified". Discuss the implications of this statement with regards to:

(i) The various definition of "size"
(ii) Applications of these definitions size. [10]

(b) Discuss the principle involved in incremental methods and show how the data obtained may be useful. [6]

(c) Describe the Andreassen pipette and the interpretation/calculation of results. What are the main disadvantages of this apparatus? [4]

6. The following data refer to the adsorption of n-butane at 273 K by a sample of tungsten powder which has a specific surface area (as determined from nitrogen adsorption measurements at 77 K) of 6.5 m^2g^{-1}:

Relative pressure (p/p_0)	0.04	010	0.16	0.25	0.30	0.37
Volume of gas adsorbed/ cm^3 (s.t.p.) g^{-1}	0.33	0.46	0.54	0.64	0.70	0.77

BET equation may be written as:

$$\frac{p}{n(p_o - p)} = \frac{1}{n_m C} + \frac{(C-1)}{n_m C}\left(\frac{p}{p_o}\right)$$

Use the BET equation to calculate a molecular area for the adsorbed butane at monolayer coverage and compare it with the value of 32.1 x $10^{-20}m^2$ estimated from the density of liquid butane. Explain the reasons for having two different values. [20]

END OF EXAMINATION IN MM 515

THE UNIVERSITY OF ZAMBIA
SCHOOL OF MINES

2010/11 ACADEMIC YEAR FIRST SEMESTER
FINAL EXAMINATIONS

MM525 MECHANICAL METALLURGY

TIME: THREE HOURS

ANSWER: Question 1 and FOUR other Questions

---

1. (a) In class, it was stated that the force (or pressure) P required for metal fabrication has three components and can be expressed as

$$P = f(\sigma_0) + f(\mu) + f(C)$$

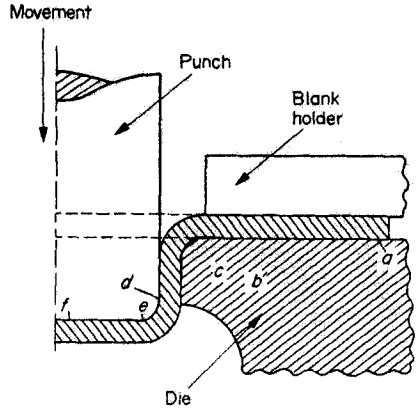
where σ_0 = yield strength, μ = coefficient of friction and C = geometric factor that is characteristic of the particular mode of working. Explain how each one of these components affects the overall force (or pressure) requirements during metalworking.

(b) Show that the work for plastic deformation during metalworking is

$$W_{pl} = \frac{VK\varepsilon^{m+1}}{m+1}$$

(c) Justify why during most metalworking processes it is essential to subject the stock material to stress levels that will cause it to yield.

2. (a) Using the sketch below, describe the processes that are taking place during deep drawing as the stock material moves from "a" to "f".



(b) How will the total load change with punch movement?

(c) Describe the problem of springback during bending.

(d) In class, it was stated that the force for bending P can be expressed as

$$P = \frac{\sigma_o L h^2}{2\left(R + {}^{h}/_{2}\right)} \tan\frac{\alpha}{2}$$

Discuss how each one of the variables in this expression can be optimized in order to minimize the bending force.

3. (a) Why is a cluster mill a much better design as compared to other mills?
   (b) What is the effect of applying front and back tension on the rolling load? Your discussion should include the effect of front and back tension on the size of the "friction hill."
   (c) Determine the deformed radius of curvature of steel rolls 500 mm diameter, rolling copper strip 800 mm wide and 75 mm thick, given 20% reduction, if the yield stress of copper is 675 N/mm^2. For this steel $\gamma = 0.35$ and E = 2.01 MN/mm^2.
   (d) For the steel rolls in question (c), calculate the minimum gauge of steel with a flow stress of 530 N/mm^2, which can be rolled in this mill ($\mu = 0.135$).

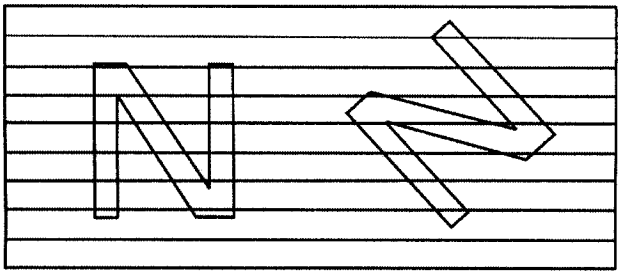
$$P = \sigma_o b \sqrt{R\,\Delta h}$$

$$C = 16\,\frac{(1-\gamma^2)}{\pi E}$$

$$\frac{R'}{R} = 1 + \frac{CP'}{b\,\Delta h}$$

$$h_{min} = C\mu R\sigma_o$$

4. (a) Suppose you wanted to punch-out an N-shaped object from the stock material shown below containing a series of horizontal flow lines. Explain why both of the two N-shaped objects depicted here would not be good designs?



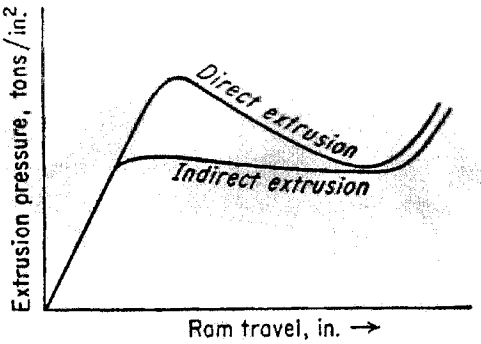
   (b) Discuss how you can come up with a properly designed N-shaped object from the stock material in part (a). Your discussion should include an appropriate sketch of the properly designed N-shaped object.
   (c) For a piece of metal of thickness h, width 2a and length l, show that the forging pressure p exerted on it at various points by the press is

$$p = \sigma_o'\left[1 + \frac{2\mu}{h}(a - x)\right]$$

where $\sigma_o' = 1.15\sigma_o$. A von Mises yield criterion for plane strain conditions is

$$\sigma_1 - \sigma_3 = \frac{2}{\sqrt{3}}\sigma_o = \sigma_o'$$

5. (a) What is meant by redundant work in extrusion? With the aid of appropriate sketches, show how you can determine the existence of redundant work during extrusion.
   (b) The curves for the variation of extrusion pressure with ram travel for different types of extrusion are shown below. Justify the differences in the extrusion pressures for these two types of extrusion.



   (c) Where would the curve for hydrostatic extrusion lie with respect to the two curves shown above? Explain your reasoning.
   (d) A 40 mm long, 30 mm diameter billet is used in a direct extrusion press. When its length has been reduced to 20 mm, the extrusion pressure was found to have decreased by 30%. Use this information to estimate the coefficient of friction for the process.

$$p = p_o \exp\frac{4\mu L}{D}$$

6. (a) Tubes made by extrusion and rolling are usually finished by drawing. List the advantages of such tube drawing processes.
   (b) The figure below shows the drawing processes with and without back tension. P = drawing force, T = tension in the stock material, Q = back tension, Y_1 = yield stress of material before drawing and Y_2 = yield stress of material after drawing. Discuss why the presence of back tension does not actually result in savings in amount of work required for drawing.

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2011 SECOND SEMESTER FINAL EXAMINATIONS

1. BIO 1022 MOLECULAR BIOLOGY AND GENETICS
2. BIO 2032 BASIC MICROBIOLOGY
3. BIO 2062 DIVERSITY OF ANIMALS
4. BIO 2085 INTRODUCTION TO BIOSTATISTICS
5. BIO 3301 VIROLOGY
6. BIO3202 INSECT TOXONOMY, CLASSIFICATION AND NOMENALATURE (THEORY PAPER)
7. BIO 4332 ECOLOGY AND MANAGEMENT OF FISHERIES
8. C 102 INRODUCTORY CHEMISTRY II
9. C 212 INRODUCTORY BIOCHESTRY
10. C 252 ORGANIC CHEMISTRY II
11. C 342 INORGANIC CHEMISTRY III
12. C 252 ORGANIC CHEMISTRY III
13. C 422 APPLIED ANALYTICAL CHEMISTRY (OGANIC COMPOUNDS)
14. C 482 INORGANIC INDUSTRIAL CHEMISTRY II
15. CS 3251 ELECTRONICS FOR COMPUTING I

16. CST2032 EXAM

17. CST2041 EXAM

18. CST3022 EXAM

19. CST3062 EXAM

20. CST3142 SOFTWARE ENGINEERING II

21. CST4012 ADVANCED OPERATING SYSTEMS AND DISTRIBUTED SYSTEMS

22. CST4122 COMPILERS

23. CST4132 COMPUTER GRAPHICS

24. EM 312 ENGINEERING MATHEMATICS

25. GEO 111 INTRODUCTION TO HUMAN GEOGRAPHY I

26. GEO 112 INTRODUCTION TO HUMAN GEOGRAPHY II

27. GEO 175 INTRODUCTION TO MAPPING TECHNIQUES IN GEOGRAPHY THEORY II

28. GEO 211 THE GOEGRAPHY OF AFRICA

29. GEO 272 QUANTITATIVE TECHNIQUES IN GEOGRAPHY II

30. GEO 482 ENVIRONMENT AND DEVELOPMENT II

31. GEO 492 NATURAL RESOURCES ECONOMICS

32. GEO 911 POPULATION GEOGRAPHY

33. GEO 912 GEOGRAPHY FOR REFUGEES AND MIGRATION

34. GEO 951 CLIMATOROGY

35. GEO 955 GEOMORPHOLOGY

36. GEO 962 BIOGEOGRAPHY

37. GEO 975 CARTOGRAPHY

38. GEO 995 ENVIRONMENTAL AND NATURAL RESOURCES MANAGEMENT I

39. M 111 MATHEMATICAL METHODS 1

40. M 112 MATHEMATICAL METHODS II-A

41. M 114 MATHEMATICAK METHODS II-B

42. M 161 INTRODUCTION TO MATHEMATICS, PROBABILITY AND STATISTICS I

43. M 162 INTRODUCTION TO MATHEMATICS, PROBABILITY AND STATISTICS II

44. M 211 MATHEMATICAL METHODS III

45. M 212 MATHEMATICAL METHODS IV

46. M 221 LINEAR ALGEBRA I

47. M 261 INTRODUCTION TO STATICS

48. M 292 INTRODUCYION TO PROBABILITY

49. M 325 GROUP AND RING THEORY

50. M 412 FUNCTIONS OF A COMPLEX VARIABLE II

51. M 422 MODULE AND FIELD THEORY

52. M 431 REAL ANALYSIS V

53. M 912 MATHEMATICAL METHODS VI

54. M 962 TIME SERIES ANALYSIS

55. P 192 INTRODUCTORY PHYSISCS II (OPTION A)

56. P 198 INTRODUCTORY PHYSICS II (OPTION B)

57. P 212 MAGNETISM IN MATTER AND ATOMIC PHYSICS

58. P 252 CLASSICAL MECHANICS II

59. P 302 COMPUTATIONAL PHYSICS I

60. P 332 STATISTICAL AND THERMAL PHYSICS

61. P 411 NUCLEAR EXPERIMENTAL TECHNIQUES

62. P 412 NUCLEAR PHYSICS

63. P 441 ANALOGUE ELECTRONICS II

64. P 442 DIGITAL ELECTRONICS II

65. P 485 THE PYSICS OF RENEWABLE ENERGY AND ENVIRONMENT.

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2010-2011 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 412: APPLIED ENTOMOLOGY
THEORY PAPER I

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS. ILLUSTRATE YOUR ANSWERS WHERE NECESSARY.

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1. Discuss the prospects and constraints of establishing Integrated Pest Management (IPM) for crop insect pests in Zambia, drawing on experiences from other countries in Africa.

2. Describe **two** types of insecticide sprayers and explain pest situations where they are used.

3. Summarise **four** of the following:
   (a) Field based monitoring of insect pests.
   (b) Pesticide granular formulations.
   (c) Host plant resistance.
   (d) Botanical pesticides.
   (e) Crop compensation for insect injury.

4. (a) Discuss the economic factors which affect crop protection decisions taken by a farmer.
   (b) Explain how information on pest intensity can affect pest control measures taken by a farmer.

5. Discuss the advantages and disadvantages of Biological Control of insect pests with particular reference to a case study you are familiar with.

6. Describe the main characteristics of **three** families of the order Homoptera having important named crop pests.

7. Describe the formulae and symbols used in the calculations of:
   (a) Economic Injury Level (EIL).
   (b) Economic Threshold (ET) and give reasons why ET is more appropriate in the control of insect pests.

8. A new pesticide has been discovered in Zambia, describe the method you would use to determine its efficacy in controlling insect crop pests.

END OF EXAMINATION

THE UNIVERSTITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2010-2011 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 432: ADVANCED PARASITOLOGY II
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS. USE ILLUSTRATIONS WHERE NECESSARY

---

1. (a) Discuss nutrient transport in *Plasmodium* and explain how this parasite modulates the host cell membrane.
   (b) Based on the principle stated on (a) above, describe the mode of action of chloroquine as anti-malarial drug.

2. With the aid of a labled diagram, describe the ultrastructure of parasite plasma membrane and explain any three roles proteins played by membrane proteins in the parasite.

3. Discuss how differences in Folate metabolism in man and Protozoa could be exploited to develop anti-protozoal drugs.

4. Describe the tegumentary structure and functions of Cestodes.

5. Discuss carbohydrates and energy metabolism in African Trypanosomes.

6. Discuss the mechanism of action of Neuro-muscular Blocking Agents against helminthes. Give an example of a specific drug in your answer.

7. Discuss tricarboxylic Acid cycle in free-living and larval stages of helminthes.

8. (a) Draw a diagram of *Trichomonas vaginalis* and label its parts. Describe the organelle in which pyruvate oxidation takes place.

   (b) Name the enzymes that are involved in pyruvate oxidation in the parasite mentioned in (a) above

---

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2010-2011 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 455: WILDLIFE ECOLOGY
PRACTICAL PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **ALL** QUESTIONS. USE ILLUSTRATIONS WHERE NECESSARY.

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1. Study the specimens provided and answer the questions.

   Specimen A:
   Describe the habitat in which this plant is co-dominant

   Specimen B:

   B1 Give the scientific Name of the specimen

   B2 Give the scientific Name of the specimen

   Specimen C:
   C1 Describe the habitat of this species

   C2 Describe the feeding habits of this specimen

   Specimen D:
   Describe characteristics that distinguish the two specimens
   D1
   D2

TURN OVER

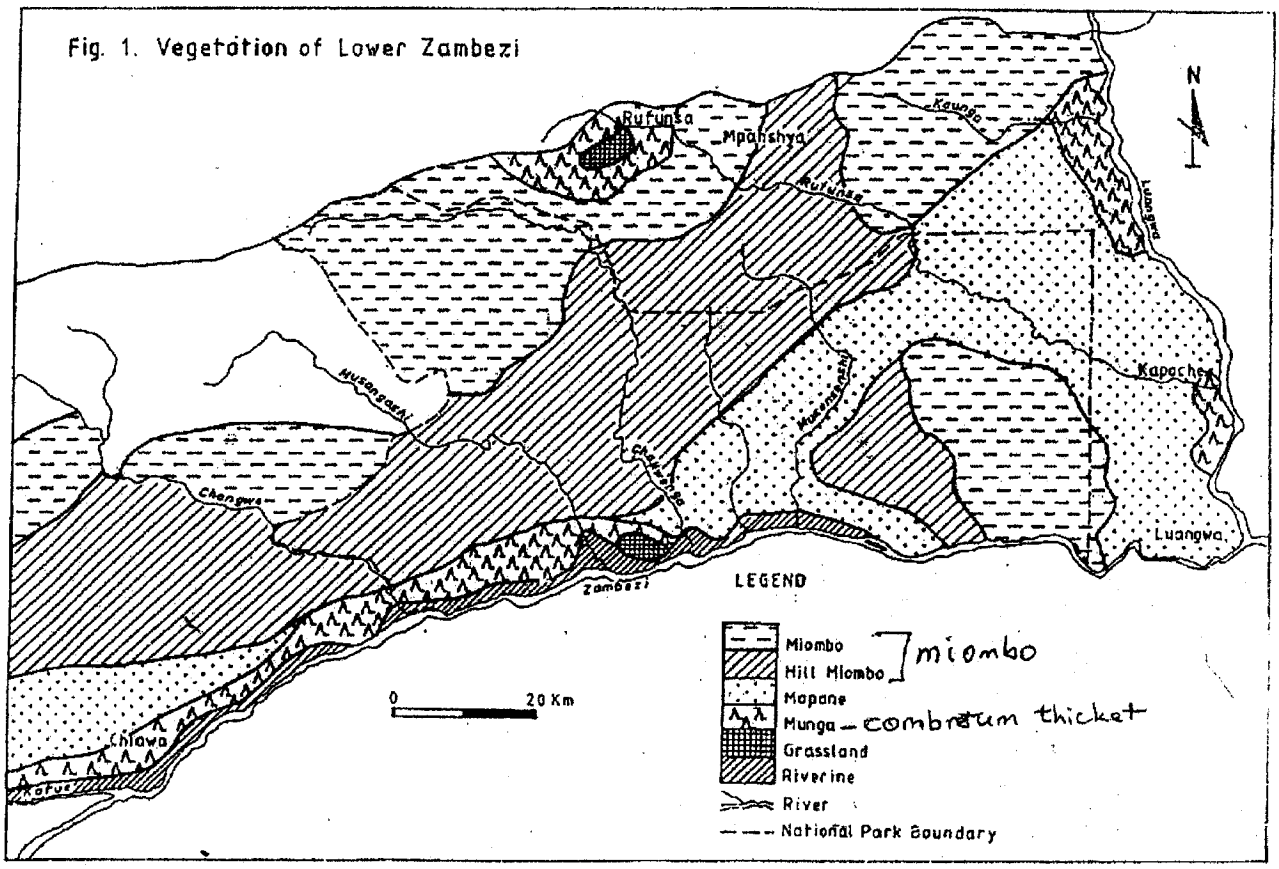

Figure 1: Lower Zambezi National Park

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2010-2011 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 482: FOOD MICROBIOLOGY
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS, **TWO** EACH FROM BOTH SECTION A AND B AND **ONE** FROM EITHER SECTION. USE A SEPARATE ANSWER BOOKLET FOR EACH SECTION.

SECTION A

1. Discuss two parameters that affect the growth of microorganisms in food products listing five factors for each parameter.

2. Explain each of the following:
   (a) Why poultry meat is an ideal medium for microbial growth.
   (b) The significance of microorganisms in milk.
   (c) Two factors that cause spoilage of canned foods.
   (d) The principle of food fermentation.

3. Discuss organisms of concern in food microbiology with reference to:
   (a) Intoxication, infection and enterotoxins.
   (b) Population at risk.
   (c) Incubation period.

4. (a) List the groupings of the enterovirulent *Escherichia coli.*
   (b) Describe the possible sources of *Salmonella* food poisoning.
   (c) List three pathogens of importance that are a threat to humans processing tropical fish and explain the spoilage of marine fish despite storage on ice after harvesting from the sea.

SECTION B

5. Distinguish between pathogens and spoilage organisms and list four types of microorganisms responsible for most food contamination.

6. Describe dehydration food preservation techniques and their benefits.

TURN OVER

7. Describe high-temperature food preservation techniques and their benefits.

8. Bacteriocins are regarded as antibiotics. However, they clearly differ from antibiotics in a number of ways.
   (a) Define the term bacteriocin and explain how these differ from antibiotics as well as their classification.
   (b) Explain how bacteriocins are used in food preservation industry and the factors that limit their efficacy.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2010-2011 ACADEMIC YEAR: SECOND SEMESTER
FINAL EXAMINATIONS

BS 492: FISHERIES BIOLOGY
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS. ANSWER QUESTIONS **1 AND 2** AND ANY **THREE** OTHER QUESTIONS. USE ILLUSTRATIONS WHERE NECESSARY

---

1. Discuss the following in relation to fish growth and development:

   (a) Asymptotic length.
   (b) Growth coefficient.
   (c) Condition factor.
   (d) Recruitment.
   (e) Fecundity.

2. Discuss the following terms and concepts as applied in management and conservation of fish stocks:

   (a) Growth overfishing.
   (b) Maximum Sustainable Yield.
   (c) Output controls.
   (d) Total Allowable Catch.
   (e) Preservation zones.

3. When determining fish stock sizes using the tagging method, explain how the estimates are affected if:

   (a) a constant of 10 percent of tagged fish are unreported by fishers.
   (b) fishers gradually lose interest in returning tagged fish owing to poor incentives given by the research team for reporting tagged fish.

4. Summarise applications of the swept area method in estimating fish stock sizes and highlight both its advantages and limitations.

TURN OVER

5. Discuss the rationale and limitations of the mean length method of Beverton and Holt (1956) in estimating total fish mortality (Z).

6. Explain in detail how fish length frequency data can be processed and used in constructing growth length and age curves.

7. Assess the advantages and disadvantages of a fishery management objective that aims at exploiting fish stocks at the Economic Break Even Point.

8. Discuss the different components of a fisheries management plan highlighting the significance of each one.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2010 -2011 ACADEMIC YEAR FIRST SEMESTER
FINAL EXAMINATIONS

BS 915: BIOLOGY OF SEED PLANTS
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS. USE ILLUSTRATIONS WHEREVER NECESSARY

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1. Compare and contrast cycads and flowering plants in terms of:
   (a) Microsporogenesis.
   (b) The mature male gametophytes.

2. Describe pseudo-cereals with reference to species composition, food value and their potential in improving food security in Zambia.

3. Describe the sporophyte morphology of conifers and the reproductive strategy adopted by them. Explain the biological and economic importance of conifers.

4. Compare Green Revolution for its merits and demerits in relation to the use of traditional varieties of crop plants.

5. Describe the causes of dormancy in seeds and explain how to overcome them.

6. Describe the primary and secondary stem structure in flowering plants with particular reference to the vascular tissue organization.

7. Compare and contrast *Ephedra* and *Gnetum* with reference to distribution, sporophyte morphology and the economic importance.

8. Summarize any Two of the following.

   (a). Crop improvement.
   (b). Grafting.
   (c). Zambezian Phytoregion.
   (d). Apomictic Seed

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2010 – 2011 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 925: BIOLOGY OF TERRESTRIAL VERTEBRATES
PRACTICAL PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **ALL** QUESTIONS. ILLUSTRATE YOUR ANSWERS WHERE NECESSARY.

EXAMINATION ANSWER BOOK

Candidate's Computer Number.....

Full - Time or Part - Time Student.....

Qualification for which registered .....

Course No.....No of Paper.....

Date of Examination.....

Examination Venue.....

COMPUTER No ----------

QUESTIONS 1 – 10

Examine specimens **1-10** provided. Identify the taxa and answer the questions associated with each specimen in the spaces provided.

SPECIMEN 1

(a) Order----------

(b) Species----------

(c) Draw and label both the dorsal and ventral shields of specimen 1.

SPECIMEN 2

(a) Species ----------

(b) Conservation status in Zambia----------

TURN OVER

COMPUTER No----------

(c) Habitat----------

(d) Feeding habits----------

SPECIMEN 3

(a) Order ----------

(b) Species----------

(c) Breeding biology----------

PROCEED TO THE NEXT PAGE

COMPUTER No----------

SPECIMEN 4

(a) Order----------

(b) Family----------

(c) Species----------

(d) Defensive and feeding habits----------

SPECIMEN 5

(a) Class ----------

(b) Draw, label and describe the different types of feathers found on specimen 5 and their functions

TURN OVER

COMPUTER No----------

PROCEED TO THE NEXT PAGE

Computer No----------

SPECIMENS 6 & 7

Construct a key for identifying specimens 6 and 7.

TURN OVER

COMPUTER No----------

SPECIMENS 8 & 9

(a) Draw and label the dorsal head shields of specimens 8 and 9.

(b) Compare and contrast the feeding habits of specimens 8 and 9.

PROCEED TO THE NEXT PAGE

COMPUTER No----------

SPECIMEN 10

(a) Sub-order----------

(b) Family----------

(c) Species----------

(d) Conservation status in Zambia----------

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2010 - 2011 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 925: BIOLOGY OF TERRESTRIAL VERTEBRATES
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS. USE ILLUSTRATIONS WHERE NECESSARY.

---

1. Describe the morphological, anatomical and physiological adaptations which enabled crossopterygian fishes to successfully invade terrestrial habitats.

2. Discuss why crocodilians are considered to be closely related to birds than to other reptiles.

3. Compare and contrast *Bufo regularis* and *Xenopus laevis* in terms of:
   (a) Habitat.
   (b) Nervous system.
   (c) Breeding.
   (d) Feeding.
   (e) Osmoregulation.

4. Discuss the arboreal adaptive features of *Chamaeleo dilepis*.

5. Describe the different types of feathers found in Class Aves and their functions.

6. Summarise the following:
   (a) Amplexus.
   (b) Neoteny.
   (c) Uropygeal gland.
   (d) Jacobson's organ.

7. Discuss why snakes are believed to have evolved from burrowing lizards.

8. Compare and contrast the reproductive advantages of metatherians and eutherians.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2010 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

C102: INTRODUCTORY CHEMISTRY II

TIME: THREE HOURS

INSTRUCTIONS TO CANDIDATES

1. Indicate your student **ID number (ONLY)** and **TG** number on ALL your answer booklets.

2. This examination paper consists of two (**2**) sections **A** and **B.**

3. Section **A** has ten (**10**) short answer questions [Total marks = **40**]

4. Section **B** has five (**5**) long answer questions [Total marks = **60**]
   Questions carry equal marks

5. **ANSWER ALL QUESTIONS IN SECTION A; AND ANSWER B1 AND ANY OTHER THREE QUESTIONS IN SECTION B.**

6. **ANSWER ALL QUESTIONS IN SECTION A IN THE MAIN BOOKLET**

7. **ANSWER SECTION B QUESTIONS EACH IN A SEPARATE BOOKLET**

YOU ARE REMINDED OF THE NEED TO ORGANIZE AND PRESENT YOUR WORK CLEARLY AND LOGICALY

USEFUL DATA

The Periodic Table of Elements

The Periodic Table of Elements is attached at the end of the Examination paper

Gas constant R

8.3145 J mol^{-1} K^{-1}
0.083145 L bar mol^{-1} K^{-1}
0.08206 L atm mol^{-1} K^{-1}
62.364 L torr mol^{-1} K^{-1}
62.364 L mmHg mol^{-1} K^{-1}

Pressure

1 atm = 1.01325×10^5 Pa
= 1.01325×10^5 N m^{-2}
= 760 torr
= 760 mmHg
= 1.01325 bar

1 bar = 1.00000×10^5 Pa

SECTION A **ANSWER ALL QUESTIONS**

Question A1.

Calculate K_c at 298 K for the reaction:

$$A\ (aq) + B\ (aq) \rightleftharpoons C(aq) \qquad \Delta G_r^0 = -439.6\ kJ\ mol^{-1}$$

Question A2.

The solubility of bismuth sulfide (Bi_2S_3) is 1.8×10^{-5}g/100 mL of water at 18 °C. Calculate the K_{sp} for Bi_2S_3 at 18 °C.

Question A3.

The composition of an equilibrium mixture produced at 2.0 atmospheres and 997 K is shown below.

	$CH_4(g) + H_2O(g)$		$\rightleftharpoons$	$CO(g) + 3H_2(g)$	
Amount in equilibrium mixture (in mol)	0.80	0.80		1.20	3.60

(a) Write the expression for the equilibrium constant, K_p,

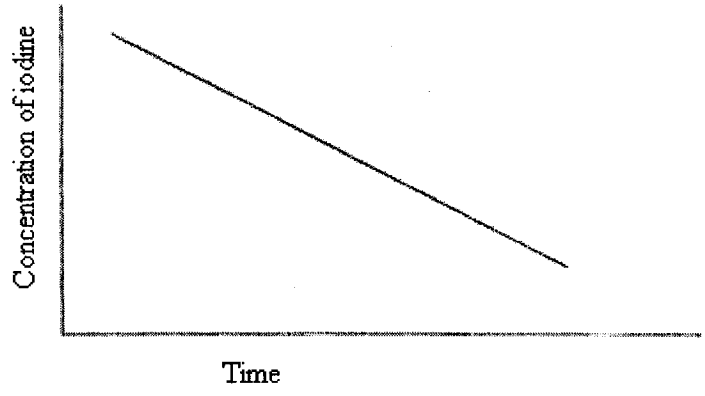
(b) Calculate the value of K_p

Question A4.

A student investigated the reaction between iodine and propanone in acidic conditions.

$$CH_3COCH_3(aq) + I_2(aq) \rightarrow CH_3COCH_2I(aq) + HI(aq)$$

(a) The shape of the graph obtained from the results of the experiment is shown below.



Use the graph to deduce the order of reaction with respect to iodine, explaining your reasoning.

(b) In a further experiment a student collected following data:

Experiment	Volume of H_2SO_4	Volume of propanone	water	Volume of iodine	rate
	20.0	8.0	0.0	4.0	8×10^{-5}
	20.0	4.0	4.0	4.0	4×10^{-5}

$[H_2SO_4] = 2.0$ M

[propanone] = 2.0 M

(i) Deduce the order with respect to propanone.

(ii) If the order with respect to acid is one, write the rate equation.

Question A5.

Name all the intermolecular forces present in each of the following substances?

(a) H_2O (b) H_2S (c) SO_3 (d) CH_3NH_2

Question A6.

(a) Which aqueous solution is likely to have the higher freezing point, 0.5 m NaI or 0.5 m Na_2CO_3? Explain.

(b) Calculate the freezing point of 0.5 m aqueous solution of Na_2SO_4?

$K_f(H_2O) = 1.86$ K kg mol^{-1}.

Question A7.

The van't Hoff equation is given by

$$\ln K_{sp} = -\frac{\Delta H_{sol}}{R}\frac{1}{T} + \frac{\Delta S_{sol}}{R}$$

$$y = bx + a$$

For an exothermic reaction shown below at diffent temperatures, the van't Hoff plot has a **positive slope, b**.

$$Ca(OH)_2(s) + H_2O(l) \rightleftharpoons Ca^{2+}(aq) + 2OH^-(aq)$$

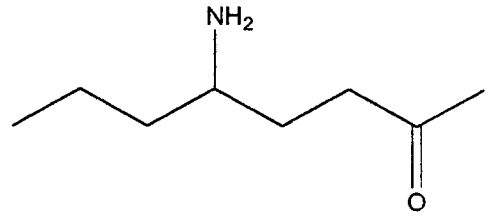
(a) Make a sketch of the van't Hoff plot of the above reaction.

(b) What is the effect of increasing temperature on solubility product, K_{sp}, of $Ca(OH)_2$ in water.

Question A8.

Provide the IUPAC names for following compounds:

(a)



(b)

Question A9.

Give the line (bond-line) formulae corresponding to the following IUPAC names.

(a) 4-Hydroxyheptanal

(b) 1,3-Dimethylbenzene

Question A10

The following names are incorrect. Draw the line (bond-line) structures and provide their correct IUPAC names.

(a) 1-Hydroxy-4, 4-dimethylcyclohexane

(b) 2-Isopropyl-4-methylpentane

SECTION B **ANSWER B1, AND ANY THREE QUESTIONS EACH IN A SEPARATE BOOKLET**

Question B1

In the C102 Experiment 2 "The quantitative study of reaction rate II: The Effect of Temperature", the following reaction is involved in the experiment:

$$2H^+(aq) + S_2O_3^{2-}(aq) \rightarrow S(s) + SO_2(aq) + H_2O(g)$$

A student collected the following data:

Temperature (K)	Reaction time (s)
295	53.46
305	26.10

(a) Write the Arrhenius equation. **[2 marks]**

(b) Calculate the activation energy of the reaction, given that the rate constant, k, is proportional to $\frac{1}{[\text{reation time}]}$. **[9 marks]**

(c) Give two major sources of error in the experiment. **[4 marks]**

Question B2

For an acid HA the value of the dissociation constant, K_a, is 1.45×10^{-4} at 298 K.

(a) Write an expression for K_a for HA. **[2 marks]**

(b) Calculate the pH of a 0.250 mol dm^{-3} solution of HA at 298 K. **[5 marks]**

(c) A mixture of the acid HA and the sodium salt of this acid, NaA, can be used to prepare a buffer solution.

(i) State and explain the effect on the pH of this buffer solution when a small amount of hydrochloric acid is added. **[3 marks]**

(ii) The concentration of HA in a buffer solution is 0.250 mol dm^{-3}. Calculate the concentration of A^- in this buffer solution when the pH is 3.59. **[5 marks]**

Question B3.

(a) What is normal boiling point of a substance? **[2 marks]**

(b) Below are the vapour pressures of some common chemicals measured at 20 °C. Arrange these substances in order of increasing intermolecular forces. **[3 marks]**

Substance	P(torr)
Benzene ,C_6H_6	80.0
Acetone,C_3H_6O	184.8
Water, H_2O	17.5

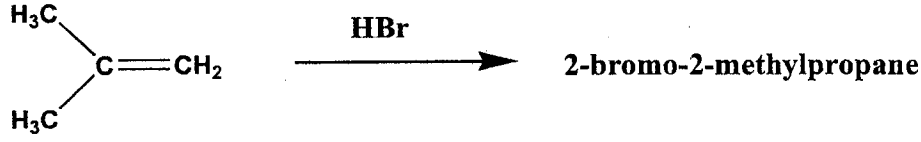
(c) The vapour pressure of acetone is 184.8 torr at 20 °C .The enthalpy of vapour of acetone is 30.3 kJ mol^{-1}. Using the Clausius-Clapeyron equation calculate the normal boiling point of acetone. **[10 marks]**

Question B4.

(a) Write the line (bond-line) formulae for all six possible isomers (acylic and cyclic) with molecular formula C_4H_8. **[3 marks]**

(b) Two isomeric compounds, **A** and **B**, have molecular formula C_4H_8 as the compounds you have drawn in part (a) above. Compound **A** decolorizes a solution of bromine in carbon tetrachloride but compound **B** does not react with bromine. On this basis choose one possible structure for **A** and one for **B**. **[2 marks]**

(c) When 2-methylpropene is reacted with hydrogen bromide, 2-bromo-2-methylpropane is obtained as the major product and a minor product, 1-bromo-2- methylpropane.



(i) Give the bond-line formula for the product shown above. **[1mark]**

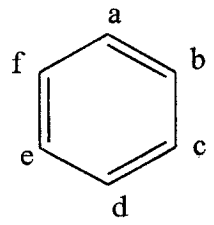
(ii) Given that this reaction proceeds via a carbocation intermediate, show all steps and mechanisms for this reaction. **[6 marks]**

(iii) Using the reaction mechanism, explain why 1-bromo-2-methylpropane is minor product. **[3 marks]**

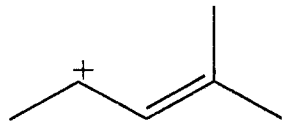
Question B5

(a) Draw the resonance structures for each of the following species. Clearly show the movement of electrons. **[4 marks]**

(i)



(ii)



(b) Give the structures and names for all the five monochlorinated products arising from the reaction of 1-methylcyclohexane and chlorine in light. **[5 marks]**

(c) Complete the following reaction equations by providing reagent and conditions **A** and reactant or substrate **B**: **[2 marks each]**

(i) $H_3CH_2CHC{=}CHCH_2CH_3$ $\xrightarrow[\text{reagent and conditions}]{\text{A?}}$ Hexane

(ii) **B?** (**Reactant or substrate required**) $\xrightarrow{Cl_2}$ 2, 3-Dichlorobutane

(iii) C_6H_{12} + excess O_2 $\longrightarrow$ **Products and balance the equation**

END OF EXAMINATION

PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 **H** 1.01 Hydrogen																1 **H** 1.01 Hydrogen	2 **He** 4.00 Helium
3 **Li** 6.94 Lithium	4 **Be** 9.01 Beryllium											5 **B** 10.81 Boron	6 **C** 12.01 Carbon	7 **N** 14.01 Nitrogen	8 **O** 16.00 Oxygen	9 **F** 19.00 Fluorine	10 **Ne** 20.18 Neon
11 **Na** 23.00 Sodium	12 **Mg** 24.31 magnesium											13 **Al** 26.98 Aluminium	14 **Si** 28.09 Silicon	15 **P** 30.99 Phosphorus	16 **S** 32.07 Sulphur	17 **Cl** 35.45 Chlorine	18 **Ar** 39.95 Argon
19 **K** 39.10 Potassium	20 **Ca** 40.08 Calcium	21 **Sc** 44.96 Scandium	22 **Ti** 47.88 Titanium	23 **V** 50.94 Vanadium	24 **Cr** 52.00 Chromium	25 **Mn** 54.94 Manganese	26 **Fe** 55.85 Iron	27 **Co** 58.93 Cobalt	28 **Ni** 58.69 Nickel	29 **Cu** 63.55 Copper	30 **Zn** 65.39 Zinc	31 **Ga** 69.72 Gallium	32 **Ge** 71.61 Germanium	33 **As** 74.92 Arsenic	34 **Se** 78.96 Seleniu m	35 **Br** 79.90 Bromine	36 **Kr** 83.80 Krypton
37 **Rb** 85.47 Rubidium	38 **Sr** 87.62 Strontium	39 **Y** 88.91 Yttrium	40 **Zr** 91.22 Zirconium	41 **Nb** 92.91 Niobium	42 **Mo** 95.94 Molybdenum	43 **Tc** 97.91 Technetium	44 **Ru** 101.07 Ruthenium	45 **Rh** 102.91 Rhodium	46 **Pd** 106.42 Palladium	47 **Ag** 107.87 Silver	48 **Cd** 112.41 Cadmium	49 **In** 114.82 Inidum	50 **Sn** 118.71 Tin	51 **Sb** 121.76 Antimony	52 **Te** 127.60 Telluriu m	53 **I** 126.90 Iodine	54 **Xe** 131.29 Xenon
55 **Cs** 132.91 Caesium	56 **Ba** 137.33 Barium	57 – 71	72 **Hf** 178.49 Hafnium	73 **Ta** 180.95 Tantalum	74 **W** 183.84 Tungsten	75 **Re** 186.21 Rhenium	76 **Os** 190.23 Osmium	77 **Ir** 192.22 Iridium	78 **Pt** 195.08 Platinum	79 **Au** 196.97 Gold	80 **Hg** 200.59 Mercury	81 **Tl** 204.38 Thallium	82 **Pb** 207.2 Lead	83 **Bi** 208.98 Bismuth	84 **Po** 208.98 Polonium	85 **At** 209.99 Astatine	86 **Rn** 222.02 Radon
87 **Fr** (223.02) Francium	88 **Ra** 226.03 Radium	89 - 103	104 **Unq** 261.11	105 **Unp** 262.11	106 **Unh** 263.12	107 **Uns** 262.12	108 **Uno** 265.00	109 **Une** 265									

KEY

Atomic number
X
Atomic mass

Name of the element X

57 **La** 138.91 Lanthanum	58 **Ce** 140.12 Cerium	59 **Pr** 140.91 Praseodymium	60 **Nd** 144.24 Neodymium	61 **Pm** 144.91 Promethium	62 **Sm** 150.36 Samarium	63 **Eu** 151.97 Europium	64 **Gd** 157.25 Gadoliniu m	65 **Tb** 158.93 Terbium	66 **Dy** 162.50 Dysprosium	67 **Ho** 164.93 Holmium	68 **Er** 167.26 Erbium	69 **Tm** 168.93 Thulium	70 **Yb** 173.04 Ytterbium	71 **Lu** 174.97 Lutetium
89 **Ac** 227.03 Actinium	90 **Th** 232.04 Thorium	91 **Pa** 231.04 Protactinium	92 **U** 238.03 Uranium	93 **Np** 237.05 Neptunium	94 **Pu** 244.0 Plutoniun	95 **Am** 243.06 Americium	96 **Cm** 247.07 Curium	97 **Bk** 247.07 Berkelium	98 **Cf** 251.08 Califofnium	99 **Es** 252.08 Einstienium	100 **Fm** 257.10 Fermium	101 **Md** 260 Mendelevium	102 **No** 259.10 Nobelium	103 **Lr** 262.11 Lawrenciu m

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2010 ACADEMIC YEAR SECOND SEMESTER

FINAL EXAMINATION

C 212: INTRODUCTORY BIOCHEMISTRY

TIME: THREE HOURS

1. All questions carry **EQUAL** marks
2. Answer **QUESTION 1** and any other **FOUR (4)** questions
3. Your answers must **NEAT AND TIDY**
4. There are **FOUR (4)** printed pages in this examination paper

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Question 1 (COMPULSORY)

a) A buffer solution has a pH = 4.00. It was made using the conjugate pair benzoic acid and sodium benzoate. The benzoic acid concentration is 0.20 M. If the K_a of benzoic acid is 6.5×10^{-5}, **what** is the concentration of the sodium benzoate in the solution?

[5 marks]

b) **What** is the pH of a 1 L solution containing 0.240 mol $HC_2H_3O_2$ and 0.180 mol $NaC_2H_3O_2$? $K_a(HC_2H_3O_2) = 1.8 \times 10^{-5}$.

[3 marks]

c) **Calculate** the pH of an aqueous solution prepared by combining 60 mL of 0.1 M KOH and 180 mL 0.1 M acetic acid (pKa = 4.76). **What** would be the pH if a further 20 ml of the KOH solution is added to this solution?

[12 marks]

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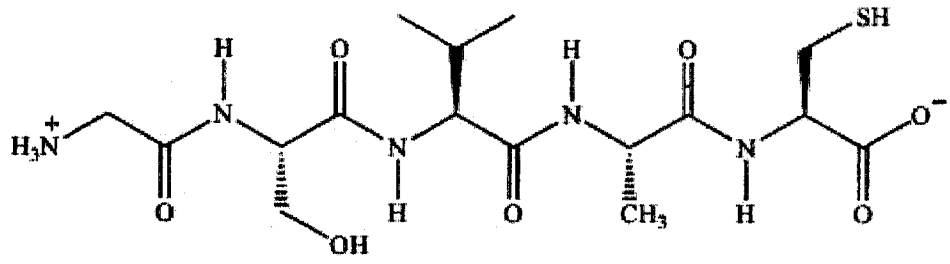
Question 2

a) **Write** down the names and three letter abbreviations of all the amino acids in the peptapeptide below starting from the N-terminal:



[15 marks]

b) **Which** of the amino acids in questions 2 a) above is an α-helix breaker? **Why**?

[5 marks]

Question 3

a) **Draw** structures of:
   i) UMP
   ii) dGDP

[5 marks]

b) **Complete** the pairing in the following piece of DNA indicating clearly the polarity of the molecule:

GATAACCTC

[5 marks]

c) If an *E. coli* cell is a flat ended cylinder of diameter 1.00 μm and length 2.00 μm:
   i) **What** is the volume of such a cell in cm^3?
   ii) If such a cell contains one chromosome of molecular weight 2.5×10^9, **what** is the intracellular molarity in mol/L of DNA, and
   iii) its concentration in $\mu g/cm^3$
   iv) **Calculate** the approximate length of the bacterial chromosome in mm.

[10 marks]

NOTE:

Avogadro's number = 6.022×10^{23} particles/mole, the average molecular weight of nucleotide in DNA is 310, the diameter of DNA is 2.00 nm and each nucleotide occupies 0.34 nm along the DNA molecule. 1 kb = 1000 base pairs. 1 μm = 10^{-6} m, 1 nm = 10^{-9} m.

PLEASE TURN TO THE NEXT PAGE

Question 4

a) If a mixture consisting of a triglyceride and phosphatidic acid were analyzed by thin layer chromatography on a silica gel in a chloroform-methanol-water developing solvent, you would observe complete separation, with R_f of the triacylglyeride being approximately 1 and that of phosphatidic acid approximately 0.4. Using general structures of these lipids, briefly **explain** why their R_f values differ so widely.

[10 marks]

b) On hydrolysis a compound X gave the following products: glycerol, palmitic acid, palmitoleic acid and inorganic phosphate. The compound X extractable into a hexane/methanol mixture was observed to be optically active. **Draw** the possible structure(s) of compound X.

[10 marks]

Question 5

a) Given the following information:

D-glyceraldehyde 3-phosphate + NAD^+ + H_3PO_4 =➔ 1,3 – Bisphosphoglyceric acid + NADH + H^+

$\Delta G^{0'} = +1500$ cal/mol

In vivo (pH 7.0, temp. 37 ^{0}C) the flowing concentrations are observed:
[D-glyceraldehyde 3-phosphate] = 10^{-4} M
[1,3-bisphosphoglyceric acid]= 10^{-5} M
[inorganic phosphate] = 0.01 M

What must the ratio of NAD^+/NADH be in order for the reaction to proceed spontaneously from left to right? **Show** your calculation.
R = 1.987 cal/K.mol

[10 marks]

PLEASE TURNOVER THE PAGE

b) The H^+ concentration in gastric juice is 0.1M. The protons arise from blood, which has a pH of 7.4. **Calculate** the free energy change required for transport of enough protons to produce 1 liter of gastric juice at 37 ^{0}C.
HINT: You are asked to calculate the free energy change (ΔGt) for transport of a compound from a compartment where its concentration is C_1 across a membrane into another compartment where its concentration is C_2.
The "reaction" is:
$solute_{origin}$ -----> $solute_{destination}$.

$\Delta G^{0'}$ for this transport process = 0 because the "reactants" and "products" are chemically identical.

R = 8.315 J/K.mol

[10 marks]

Question 6

i) Match the enzyme on the left with the appropriate reaction on the right in the table below:

Enzyme	**Reaction**
Oxidoreductases	Isomerizations
Transferases	Hydrolysis reactions
Hydrolyases	Group elimination to form double bonds
Lyases	bond formation coupled with ATP Hydrolysis
Isomerases	Oxidation-reduction reactions
Ligases	Transfer of functional groups

[12 marks]

ii) Methanol is oxidized by alcohol dehydrogenase (ADH, found in the liver and other tissues) to the highly toxic compound formaldehyde. Drinking methanol is fatal because of the production of formaldehyde; methanol itself is harmless and is excreted by the kidneys.
ADH will also oxidize other alcohols, such as ethanol.

Based on this information **propose** a way to treat an individual who has ingested methanol. **What** additional information would you need before such a treatment could be tried?

[8 marks]

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2010 ACADEMIC YEAR SECOND SEMESTER

FINAL EXAMINATION

C322 ANALYTICAL CHEMISTRY III

TIME: **Three (3) Hours**

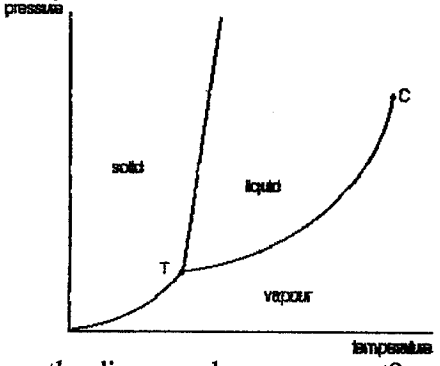
INSTRUCTIONS: Answer **any four** questions in this examination paper. Questions carry equal marks.

Question 1

(a) (i) How can you remove oxygen from the polarographic cell and why?

(ii) Explain how convective and electrostatic attractions are minimized in polarography.

(b) (I) Use the diagram below to answer the following questions:



(i). What does the diagram above represent?
(ii). What do points T and C represent?
(iii). What happens along the curve TC?

(II). Compare the efficiency of two separations with retention factors of 0.90 and 0.25 respectively, with clear reference to the mobile and stationary phases of the systems involved.

(c) Voltammetry was used to determine the zinc content of a breakfast cereal. A 2.314g sample was digested in boiling concentrated nitric acid. After the sample dissolved, it was diluted to 100ml. A 5.00ml portion of this solution was analyzed by differential pulse polarography, giving a current of 2.31μA. when 50.0μL of 100ppm zinc standard was added to this solution, the current was 2.99μA. What is the concentration of zinc in the cereal?

(d) A 0.3619g sample of tetrachloropicolinic acid, $C_6HNO_2Cl_4$, is dissolved in distilled water, transferred to a 1000 ml volumetric flask, and diluted to volume. An exhaustive controlled-potential electrolysis of a 10.00ml portion of this solution at a spongy silver cathode requires 5.374C of charge. What is the value of n for this reduction reaction?

Question 2

(a) Ion selective electrode and reference electrode pair was placed in exactly 100ml of the sample; a reading of 21.6mV was obtained. After the addition of exactly 10ml of a standard solution with a concentration of 100μg/ml, the electrode pair reading gave a reading of 43.7mV. The response slope of the indicator electrode was previously determined to be 57.8mV. What is the sample concentration?

(b) An unknown amount of copper (II) ions in a food sample produces a faradic current of 12.3μA on a normal pulse voltammogram. After 0.100ml of $1.0x10^{-3}M$ Cu^{2+} is added to the original volume of 5.00ml, the new current is 28.2μA. Calculate the original amount of copper in the food sample.

(c) The purity of a sample of $Na_2S_2O_3$ was determined by a coulometric redox titration using I^- ions as a mediator, and I_3^- ions as the 'titrant'. A sample weighing 0.1342g is transferred to a 100ml volumetric flask and diluted to volume with distilled water. A 10.00ml portion is transferred to an electrochemical cell along with 25ml of 1M KI, 75ml of pH 7.0 phosphate buffer, and several drops of a starch indicator solution. Electrolysis at a constant current of 36.45mA required 221.8s to reach the starch indicator end point. Determine the purity of the sample.

(d) (I) Ethanol and methanol were separated on a capillary GC column. Retention times recorded were 370 and 385seconds respectively and peak base widths of 16.0 s and 17.0 s while an unretained air peak occurred at 10.0 s. Calculate the resolution, R_s for the two compounds.

(II). The height equivalent to a theoretical plate (HETP) is defined according to the equation: HETP = $A + B/u + Cu$; where u is the average velocity of the mobile phase. A, B, and C are factors which contribute to band broadening.

(i). What is the name of the equation used to ensure optimal operational conditions in GLC?

(ii). Explain the role of any one of the constants A, B and C in the equation?

Question 3

(a) A 0.40g sample of toothpaste Colgate was suspended in 50ml of fluoride ionic strength buffering medium (TISAB), and boiled to extract the fluoride. The mixture was cooled, transferred quantitatively to a 100ml volumetric flask and diluted to volume with deionised water. A 25.0ml aliquot was transferred to a beaker; a fluoride ISE and reference electrode inserted and a potential of -155.3mV was obtained after equilibration. A 0.100ml spike of 0.5mg/ml fluoride stock solution was added after which the potential was -176.2mV. Calculate the percentage of F^- ions by weight in the original toothpaste sample.

(b) In coulometric titration of Fe^{2+} with Ce^{4+} which were generated at the cathode. The resistance was R = 150Ω, potential was 0.705V and the end point was reached after 352 seconds. Calculate the amount of iron in µg.

(c) (i) Define the term retention factor, and state which type of chromatography it is used in.

(ii). Calculate the retention factor, R_f, for a chromatography experiment during which the analyte travels 2.1cm, while the solvent front travel 2.8cm. What are the units of R_f?

(d) Calculate the relative decrease of concentratrion of zinc in %, after electrolysis on the drop mercury electrode which lasted 17 minutes. Suggest that current during electrolysis is constant. Given that: $m = 2.6x10^{-3}$g/s, t = 2.3s, $D = 0.95x10^{-5}cm^2/s$, $C = 2.5x10^{-4}$M volume is 15ml ($3.75x10^{-2}$mmol/l in 15ml or $3.75x10^{-5}$mol/L.

Question 4

(a) (i). A certain chromatographic separation resulted in a retention factor equal to 1. Explain why.

(ii). Give two characteristics which differentiate partition and ion-exchange chromatography equilibration processes.

(iii). A column has a retention time of 52.3 mm, and width at peak base = 9.0 mm. Calculate the number of theoretical plates for the column.

(b) Sodium benzoate, a salt of benzoic acid (a weak acid), is widely used as a food preservative. You wish to determine the ionization constant of benzoic acid and you choose to use conductometric method for your determination. You find that the equivalent conductance of a 0.002414M benzoic acid solution is found to be 32.22 at 25°C. Calculate the degree of dissociation of benzoic acid at this concentration, and calculate the ionization constant. Given that the Limiting Equivalent conductance of some ions in water at 25°C are:

Cations	**λo+**	**Anions**	**λo-**
H^+	349.8	OH^-	198.6
Na^+	50.1	Cl^-	76.4
Ca^{2+}	59.5	Acetate	40.9
Mg^{2+}	53.1	Benzoate	32.4

(c) Ions that react with Ag^+ can be determined electrogravimetrically by deposition on a silver anode:

$$Ag(s) + X^- \longrightarrow AgX(s) + e$$

(i) What will be the final mass of a silver anode used to electrolyze 75.00ml of 0.02380M KSCN if the initial mass of the anode is 12.4638g?

(ii) At what anode potential versus SCE cathode will 0.10M Br^- be deposited as AgBr(s)?

(d) What potential would a cell have which contain hydrogen electrode and calomel electrode. Potential of calomel electrode is 0.244V, $t = 25^oC$ and pressure of H_2 is $P_{H2} = 101.325kPa$

Question 5

(a) Briefly explain the roles of the working, counter and reference electrodes in potentiostatic electrolytic cell.

(b) Explain how you would determine the molar conductivity at infinite dilution for a strong and weak electrolyte in a food sample.

(c) The concentration of Ca^{2+} in a sample of sea water is determined using a Ca ion-selective electrode and a one-point standard addition. A 10.00-mL sample is transferred to a 100-mL volumetric flask and diluted to volume. A 50.00-mL aliquot of sample is placed in a beaker with the Ca ion-selective electrode and a reference electrode, and the potential is measured as –0.05290 V. A 1.00-mL aliquot of a 5.00×10^{-2} M standard solution of Ca^{2+} is added, and a potential of –0.04417 V is measured. What is the concentration of Ca^{2+} in the sample of sea water?

(d) (i). Name any three (03) key components of a gas chromatograph, then give details of what occurs in the sample injection port.

(ii). The efficiency of a chromatographic (GLC) column is expressed as (N) the number of theoretical plates. Calculate the retention time of a column with width at peak base = 20.0 s, and number of theoretical plates equal to 500 plates.

END OF EXAMINATION

PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

KEY

Atomic number
X
Atomic mass

Name of the element X

1 **H** 1.01 Hydrogen																1 **H** 1.01 Hydrogen	2 **He** 4.00 Helium
3 **Li** 6.94 Lithium	4 **Be** 9.01 Beryllium											5 **B** 10.81 Boron	6 **C** 12.01 Carbon	7 **N** 14.01 Nitrogen	8 **O** 16.00 Oxygen	9 **F** 19.00 Fluorine	10 **Ne** 20.18 Neon
11 **Na** 23.00 Sodium	12 **Mg** 24.31 magnesium											13 **Al** 26.98 Aluminium	14 **Si** 28.09 Silicon	15 **P** 30.99 Phosphorus	16 **S** 32.07 Sulphur	17 **Cl** 35.45 Chlorine	18 **Ar** 39.95 Argon
19 **K** 39.10 Potassium	20 **Ca** 40.08 Calcium	21 **Sc** 44.96 Scandium	22 **Ti** 47.88 Titanium	23 **V** 50.94 Vanadium	24 **Cr** 52.00 Chromium	25 **Mn** 54.94 Manganese	26 **Fe** 55.85 Iron	27 **Co** 58.93 Cobalt	28 **Ni** 58.69 Nickel	29 **Cu** 63.55 Copper	30 **Zn** 65.39 Zinc	31 **Ga** 69.72 Gallium	32 **Ge** 71.61 Germanium	33 **As** 74.92 Arsenic	34 **Se** 78.96 Seleniu m	35 **Br** 79.90 Bromine	36 **Kr** 83.80 Krypton
37 **Rb** 85.47 Rubidium	38 **Sr** 87.62 Strontium	39 **Y** 88.91 Yttrium	40 **Zr** 91.22 Zirconium	41 **Nb** 92.91 Niobium	42 **Mo** 95.94 Molybdenum	43 **Tc** 97.91 Technetium	44 **Ru** 101.07 Ruthenium	45 **Rh** 102.91 Rhodium	46 **Pd** 106.42 Palladium	47 **Ag** 107.87 Silver	48 **Cd** 112.41 Cadmium	49 **In** 114.82 Inidum	50 **Sn** 118.71 Tin	51 **Sb** 121.76 Antimony	52 **Te** 127.60 Telluriu m	53 **I** 126.90 Iodine	54 **Xe** 131.29 Xenon
55 **Cs** 132.91 Caesium	56 **Ba** 137.33 Barium	57 – 71	72 **Hf** 178.49 Hafnium	73 **Ta** 180.95 Tantalum	74 **W** 183.84 Tungsten	75 **Re** 186.21 Rhenium	76 **Os** 190.23 Osmium	77 **Ir** 192.22 Iridium	78 **Pt** 195.08 Platinum	79 **Au** 196.97 Gold	80 **Hg** 200.59 Mercury	81 **Tl** 204.38 Thallium	82 **Pb** 207.2 Lead	83 **Bi** 208.98 Bismuth	84 **Po** 208.98 Polonium	85 **At** 209.99 Astatine	86 **Rn** 222.02 Radon
87 **Fr** (223.02) Francium	88 **Ra** 226.03 Radium	89 - 103	104 **Unq** 261.11	105 **Unp** 262.11	106 **Unh** 263.12	107 **Uns** 262.12	108 **Uno** 265.00	109 **Une** 265									

57 **La** 138.91 Lanthanum	58 **Ce** 140.12 Cerium	59 **Pr** 140.91 Prascodymium	60 **Nd** 144.24 Neodymium	61 **Pm** 144.91 Promethium	62 **Sm** 150.36 Samarium	63 **Eu** 151.97 Europium	64 **Gd** 157.25 Gadoliniu m	65 **Tb** 158.93 Terbium	66 **Dy** 162.50 Dysprosium	67 **Ho** 164.93 Holmium	68 **Er** 167.26 Erbium	69 **Tm** 168.93 Thulium	70 **Yb** 173.04 Ytterbium	71 **Lu** 174.97 Lutetium
89 **Ac** 227.03 Actinium	90 **Th** 232.04 Thorium	91 **Pa** 231.04 Protactinium	92 **U** 238.03 Uranium	93 **Np** 237.05 Neptunium	94 **Pu** 244.0 Plutonium	95 **Am** 243.06 Americium	96 **Cm** 247.07 Curium	97 **Bk** 247.07 Berkelium	98 **Cf** 251.08 Californium	99 **Es** 252.08 Einstienium	100 **Fm** 257.10 Fermium	101 **Md** 260 Mendelevium	102 **No** 259.10 Nobelium	103 **Lr** 262.11 Lawrenciu m

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2010 ACADEMIC YEAR SECOND SEMESTER

FINAL EXAMINATION

C 312: BIOCHEMISTRY II

1. Time: **THREE (3)** hours
2. Answer **ANY FOUR (4)** questions
3. Make sure you have **THREE (3)** printed pages in this examination
4. You are reminded of the need to present your work **NEATLY**

Question 1

a) **Write** down the complete structure of myristic acid (C14:0). **What** steps are involved in the biosynthesis of this fatty acid? **Show** by use of structures of all key compounds.
b) **Write** down four (4) differences between fatty acid oxidation and fatty acid synthesis.
c) **Give** two (2) reasons why biosynthesis of fatty acids does not follow the same path as the breakdown (oxidation) reactions.

Question 2

a) **Calculate** the $\Delta G'_0$ for the transfer of an electron in cyclic photophosphorylation from the primary acceptor of photosystem I (E'_0 = - 0.50 V) to cytochrome b_6 (E'_0 = -0.05 V). Faraday constant = 2.304 x 10^4 cal/volt/eq. Is the amount of energy generated in this process sufficient to result in synthesis of ATP from ADP and Pi. **Explain** (*Hint*: ATP hydrolysis yields 7.3 kcal/mol energy).

b) Reduction of three moles of CO_2 to form one mole of triose phosphate requires nine moles of ATP and six moles of NADPH. **What** is the source of NADPH in the reduction of CO_2? Is additional NADPH required for CO_2 fixation in C4 plants? Briefly **explain**.

PLEASE TURNOVER THE PAGE

Question 3

a) **Outline** the reaction(s) leading to the incorporation of nitrogen as ammonium ion into biological systems (leguminous plants).
b) **Write** down the glutamate dehydrogenase reaction and **explain** why this is considered logical control point in cells.

Question 4

a) Outline the reactions leading to the biosynthesis of deoxythymine 5'-monophosphate from uridine 5'monophosphate.
b) **Compare** and **contrast** the reaction leading to formation of carbamoyl phosphate in the urea cycle and that in the biosynthesis of pyrimidines.

Question 5

"Even when you are on a low-fat diet you can still put on weight if you do not watch your keep a lid on the starch and protein containing foods"

Explain in detail the biochemical basis of the truthfulness of this statement using glucose and the amino acid alanine as examples (show with use of key structures in the reactions).

Question 6

Using a **NEAT** and **WELL-LABELLED** diagram **describe** the replication of DNA. **Highlight** the roles of all enzymes and proteins involved in this process. **Explain** clearly how replication is carried on both strands.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2010 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

C 342: INORGANIC CHEMISTRY III

TIME: THREE HOURS

INSTRUCTIONS: ANSWER ANY FOUR QUESTIONS

Question 1.

(a) Discuss lanthanide contraction giving causes and its consequences.
(b) Explain the following:
(i) Which is more basic: Nd_2O_3 or Dy_2O_3
(ii) Which is thermally more stable: $Sm(NO_3)_3$ or $Tm(NO_3)_3$
(iii) La^{3+}, Lu^{3+}, Yb^{2+}, Ce^{4+} are diamagnetic while Sm^{3+} has low paramagnetism
(c) Discuss the variation in melting point and boiling point, density, magnetic properties and reducing power, reactivity and colour of actinides.

Question 2.

(a) Describe the separation of lanthanides by ion exchange method.
(b) Helium-6 is a radioactive isotope with $t^{1/2}$ = 0.81 s. Calculate the binding energy if mass defect is 0.03141 g/mol. Also calculate binding energy of Helium-4 whose mass defect is 0.03038 g/mol. Is a Helium-6 nucleus more stable or less stable than a Helium-4 nucleus?
(c) Give a detailed description of artificial or induced radioactivity.

Question 3.

(a) What is the importance of binding energy curve?
(b) Chelate effect is essentially entropy effect? Explain
(c) Write the rate law for the formation of $[MnX(OH_2)_5]^+$ from aqua ion and X^-. How would you undertake to determine whether the reaction is dissociative or associative?

Question 4.

(a) Write out the inner and outer sphere pathways for the reduction of azidopentamine cobalt III ion with V^{2+} aq. What experimental data might be used to distinguish between the two pathways?
(b) The reaction of $CrCl_3$ with liquid ammonia ordinarily gives principally $[Cr(NH_3)_5Cl]Cl_2$, but when a trace of KNH_2 is present, the main product is $[Cr(NH_3)_6]Cl_3$. Explain.
(c) In ligand replacement reactions at tetrahedral sites there involves large negative values of Δs (entropy). Comment.

Question 5.

(a) Sketch a η^2 interaction of 1, 3 butadiene with a metal atom M and (b) do the same for an η^4 interaction.
(b) The CO stretching wave numbers in $[Cr(CO)_4(PPh_3)_2]$ are lower than in the corresponding hexacarbonyl compounds. Why?
(c) Do (1) $IrBr_2(CH_3)(CO)(PPh_3)$ and (2) $Cr(C_5H_5)(C_6H_6)$ obey 18 electron rule?

Question 6.

(a) Describe the physical and chemical properties of liquid hydrofluoric and sulphuric acids, ammonia and sulphur dioxide.
(b) Write down the reactions between:
(i) Liquid H_2SO_4 and oxides of nitrogen and SO_3.
(ii) Liquid SO_2 and H_2S at room temperature and at -70° C.
(c) Write down the reactions between AgCl and KNO_3 in liquid ammonia and explain why the result is considerable different if KCl and $AgNO_3$ react in water

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2011 ACADEMIC YEAR SECOND SEMESTER

FINAL EXAMINATIONS

C412: ADVANCED BIOCHEMISTRY II

TIME: THREE HOURS

INSTRUCTIONS:

1. Answer any **FOUR (4)** questions
2. Time: **THREE** (3) hours
3. All questions carry **EQUAL MARKS**

Question 1

a) **What** principles underlie any food preservation method?
b) **What** method may be used in the preservation of fresh milk? meat? beer?
c) **What** is the scientific basis for using each the methods in b) above?

[25 marks]

Question 2

a) Briefly **describe** any four elements of innate immunity.
b) **What** three (3) features distinguish immunoglobulin (Ig) from a T-cell receptor(TCR)?
c) **Explain** in detail the generation of TCR diversity highlighting key differences with generation of Ig diversity.

[25 marks]

Question 3

Discuss in detail real and perceived dangers associated with genetically engineered products.

[25 marks]

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Question 4

Discuss in detail how DNA is packed in the nucleus of eukaryotic cell. **Explain** how this DNA still remains available for replication and gene expression at the same time. **Cite** experimental evidence in your discussion.

[25 marks]

Question 5

i) **Explain** what is meant by:

a) Plasmid
b) Restriction endonuclease
c) PCR
d) Deoxyribonuclease

[10 marks]

ii) Suppose that a circular plasmid contains 1000 bp. It is cut by three different restriction endonucleases, both singly and in pairs, with the results as shown below.

ENZYME(S)	FRAGMENT LENGTH(S)
A	1000
B	100, 300, 600
C	200, 800
A + B	50, 100, 300, 550
A + C	200, 375, 425
B + C	75, 100, 125, 225, 475

Reconstruct the plasmid, indicating where each enzyme cuts and the distances between all cuts.

[15 marks]

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2011 ACADEMIC YEAR, SECOND SEMESTER
FINAL EXAMINATION

C482: INORGANIC INDUSTRIAL CHEMISTRY

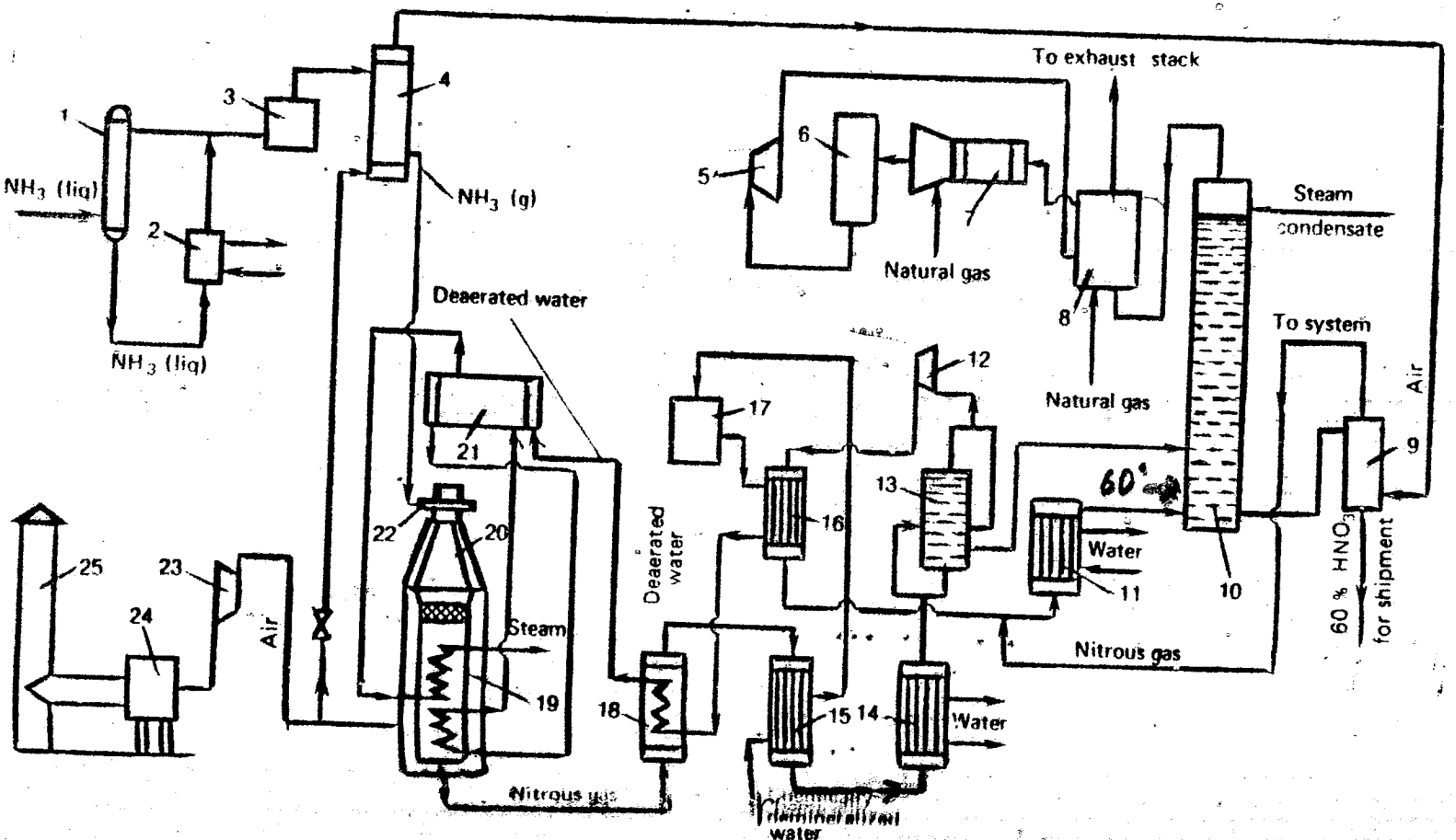
TIME: THREE HOURS

INSTRUCTIONS: ANSWER ANY FOUR QUESTIONS

Question 1.
Describe the properties, manufacture and use of:
(a) Compound fertilizers (give examples of synergism and antagonism of the mixed fertilizers).
(b) Ammonium sulphate.
(c) Single and double superphosphate.

Question 2.
(a) Describe the production processes of calcined soda: write down reactions of the processes, indicate the yield of the products at calcinations and carbonization stages.
(b) In the production of Nitric acid, Ammonia is mostly used. Outline the physicochemical foundation manufacturing dilute Nitric acid.
(c) Outline the production process of dilute nitric acid (write down the temperatures, pressures and concentrations of the main components in the liquid and gaseous phases on the given flow sheet).

Question 3.
(a) Briefly explain how ortho-phosphoric acid is produced by wet-method and how they determine the concentrations of H_3PO_4 and remains of H_2SO_4 in the resulting product.
(b) Describe the production process of concentrated sulphuric acid.
(c) Write down the reactions production of the following Potassium salts: sulphate, carbonate, bromate ,iodate, and permanganate.


NH_3 (liq)
NH_3 (liq)
NH_3 (g)
Deaerated water
To exhaust stack
Natural gas
Natural gas
Steam condensate
To system
Air
60 %
Water
Water
Nitrous gas
Steam
Air
Deaerated water
Nitrous gas
for shipment

Question 4.

In the production of Sulphuric acid Iron pyrite and Sulphur are usually used.
(a) What are the advantages and disadvantages associated with the use of these raw materials?
(b) Describe the SO_2 oxidation to SO_3 process (indicate kindling and other temperatures if Vanadium catalyst is used).
(c) State the properties of 98.3% sulphuric acid and why this acid is used for absorption of SO_3 containing gas?

Question 5.
Write down the reactions and outline the major steps involved in the production of:
(a) Ammonium nitrate.
(b) Urea.
(c) Hydrochloric acid.

END OF EXAMINATION

UNIVERSITY OF ZAMBIA

School of Natural Sciences

Department of Computer Studies

CS3062 Final Exam

Advanced Databases and Information Systems

Time 3 Hours

05/05/11

This exam has seven questions. Answer any five questions. Each question question carries 20 points. Label your questions clearly.

1. Consider the following simplified relational schema for InstantBuy:

OrderDetail(orderNo, itemType)	10,000 records stored in London
Client(clientNo, cCity)	1,000 records stored in Glasgow
ClientOrder(clientNo, orderNo)	100,000 records stored in London

For simplicity, assume that each tuple in each relation is 10 characters long, there are 100 clients who have ordered item 'TV3190', there are 10 clients in Edinburgh and computation time is negligible compared to communication time. The communication system has a data transmission rate of 10,000 characters per second and a 1-second access delay to send a message from one site to another.

   a. Briefly discuss the advantages and disadvantages of a DDBMS. **[2 points]**
   b. Compare and contrast the different ownership models for replication in relation to replication servers. Give examples to illustrate your answer. **[2 points]**
   c. Briefly discuss the advantages and disadvantages of fragmentation. **[2 points]**
   d. Write an SQL query that will list the clients in Edinburgh who have ordered items of type 'TV319'. **[4 points]**
   e. Give five possible strategies for retrieving data for this query. **[5 points]**
   f. Calculate the amount of time it would take to run the query under each of the strategies stating any assumptions you make to support your calculations. **[5 points]**

2. Perilous Printing is a large printing company that does work for book publishers throughout Europe. The company currently has over 50 offices, most of which operate autonomously, apart from salaries, which are paid by the head office in each country. To improve the sharing and communication of data, the company has decided to implement a Distributed DBMS. Perilous Printing jobs consist of printing books or part of books. A printing job requires the use of materials, such as paper and ink, which are assigned to a job via purchase orders. Each printing job may have several purchase orders assigned to it. Likewise, each purchase order may contain several purchase order items.

Office	(officeNo, oAddress, oTelNo, oFaxNo, mgrNIN, countryNo)
Staff	(NIN, fName, lName, sAddress, sTelNo, sex, DOB, position, taxCode, salary, officeNo)
Publisher	(pubNo, pName, pCity, pTelNo, pFaxNo, creditCode, officeNo)
Bookjob	(jobNo, pubNo, jobDate, jobDescription, jobType, supervisorNIN)
PurchaseOrder	(jobNo, poNo, poDate)
POItem	(jobNo, poNo, itemNo, quantity)
Item	(itemNo, itemDescription, amountInStock, price)
Country	(countryNo, countryName)

Office contains details of each office and the office number (officeNo) is the key. Each office has a Manager represented by the manager's national insurance number (mgrNIN).

Staff contains details of staff and the national insurance number (NIN) is the key. The office that the member of staff works from is given by officeNo.

Publisher contains details of publisher and the publisher number (pubNo) is the key. Publishers are registered with the nearest office in their country, given by officeNo.

Bookjob contains details of publishing jobs and the job number (jobNo) is the key. The publisher is given by the publisher number (pubNo) and the supervisor for the job by supervisorNIN.

PurchaseOrder contains details of the purchase orders for each job and the combination of job number and a purchase order number (jobNo, poNo) form the key.

Item contains details of all materials that can be used in printing jobs and the item number (itemNo) is the key.

POItem contains details of the items on the purchase order and (jobNo, poNo, itemNo) forms the key.

Country contains the names of each country that Perilous Printing operates in and the country number (countryNo) is the key.

As well as accessing printing jobs based on the publisher, jobs can also be accessed on the job type (jobType), which can be: 1 – Normal; 2 – Rush.
The offices of Perilous Printing are grouped into countries as follows:

Country 1:	UK	Country 2:	France	Country 3:	Germany
Country 4:	Italy	Country 5:	Spain		

a. A DDBMS may be classified as homogeneous or heterogeneous. Compare and contrast these two types of distributed systems. **[2 points]**
b. Discuss the extended capabilities or services that a DDBMS must provide over a centralized DBMS. **[2 points]**
c. Draw an Entity–Relationship Diagram for the above case study. Indicating clearly the multiplicities. **[6 points]**
d. Using this diagram from (c) above, produce a distributed database design for the system that satisfies the correctness rules for fragmentation and include:
   I. a suitable fragmentation schema for the system; **[4 points]**
   II. in the case of horizontal fragmentation, give a minimal set of predicates; **[4 points]**
   III. The reconstruction of global relations from fragments. **[2 points]**

3. You have a database that has information about a family. Each person stored in the database has a name and may have a father mother and children. Note that in using this data we should be able to interlink the data. For example given a particular person we should be able to retrieve the record of their father if existing.
   a. What is a dtd? **[2 points]**
   b. State and contrast the two different types of dtds. Give examples of their usage. **[4 points]**

c. What are the two data types that are supported in XML? Explain their significance. **[2 points]**
d. Write down the XML dtd that defines the data in the database and some sample XML data that conforms to this dtd. **[5 points]**
e. What is XSLT? **[2 points]**
f. Write the XSLT that displays all the records in the XML document in a table and the other that displays the data of a particular person in a table. **[5 points]**

4. You are a database administrator and you have been assigned the responsibility of designing a simple student record system. The database is to store student names, date of birth and computer numbers. Students take different courses. Those taking science courses do labs. Those taking education related courses have practice sessions. The last category of students is that of social science students and these students should have a reading group. A reading group defines the time and place to meet on a weekly basis.
   a. What is an object oriented database? **[2 points]**
   b. What are the advantages of an object oriented database as compared to a relational database? **[4 points]**
   c. Draw an object model to illustrate the class design. **[2 points]**
   d. Using this model write the java code that would be used to implement the design and create the database using db4o. **[6 points]**
   e. Write the code for inserting a student record into this database, updating the student's record and also for deleting the record. **[6 points]**

5. You have been tasked to implement a simple database for a University. Below is the simple schema of this database

   Student (compNum (PK), fName, lName,contactNum),
   Course (courseID (PK), Description,instructorID)

   a. Write the SQL to create a database Schema called University **[2 points]**
   b. Write the SQL to create the following tables in the University Schema **[4 points]**
   c. The relationship between Course and Student is a many to many relationship. What sorts of problem can this cause? Resolve the problem stating any assumptions made. **[4 points]**
   d. Describe the alternative strategies that can be applied if there is a child record referencing a parent record that we wish to delete. **[2 points]**
   e. Write an SQL trigger that gets activated when updating a student record and inspects the condition (d) above. **[6 points]**
   f. Write a query that returns the number of students enrolled for each course. **[2 points]**

6. There are a lot database related technologies which are arising and are related to networking.
   a. Give two examples of advanced applications that are network based. **[2 points]**
   b. What are the advantages and disadvantages of using Web based applications? **[2 points]**

c. Discuss, in brief, distributed processing and parallel database management systems. **[2 points]**

d. With illustration explain the main architectures for parallel database systems. **[2 points]**

e. How do XML and its related technologies try to support the dynamic aspect of Web pages? **[2 points]**

f. You have just been hired as a database specialist at Fiction Company. Your first task is to automate the capture of sales orders. Given the sales order form below normalize this data to third normal form (3NF) **[10 points]**

Sales Order

Fiction Company
202 N. Main
Mahattan, KS 66502

CustomerNumber:	*1001*	**Sales Order Number:**	405
Customer Name:	*ABC Company*	**Sales Order Date:**	2/1/2000
Customer Address:	*100 Points*	**Clerk Number:**	*210*
	Manhattan, KS 66502	**Clerk Name:**	*Martin Lawrence*

Item Ordered	Description	Quantity	Unit Price	Total
800	*widgit small*	*40*	*60.00*	*2,400.00*
801	*tingimajigger*	*20*	*20.00*	*400.00*
805	*thingibob*	*10*	*100.00*	*1,000.00*
	Order Total			*3,800.00*

7.

a. Explain in details the weaknesses of Relational Database Systems **[5 points]**

b. Compare and contrast synchronous and asynchronous replication **[5 points]**

c. Define and give an example of UNF, 1NF, 2NF, 3NF. **[5 points]**

d. Discuss the general characteristics of advanced database applications. **[5 points]**

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

CS3252: ELECTRONICS FOR COMPUTING IV

SEMESTER 2 EXAM **18th MAY 2011**

TIME: THREE HOURS

ANSWER: ALL QUESTIONS

QUESTION 1

(i) List three (3) VLAN Implementations methods [4 Marks]
(ii) Describe each method in details [12 Marks]
(iii) Give advantages and disadvantages for each [4 Marks]

QUESTION 2

(i) List four (4) layer 1 network design goals and describe each in details [12 Marks]
(ii) List four (4) critical network design components that should be addressed [8 Marks]

QUESTION 3

(i) List four (4) steps in LAN design and implementation [10 Marks]
(ii) Explain the details involved in each step [10 Marks]

QUESTION 4

(i) Design a network encompassing 50 workstations, 1 mail server, 1 web server, 4 switches, and 1 router. The network should have the following characteristics:
1. It should be a three layered hierarchical network in topology
2. It should have at least two departments and VLANs
Describe your design in details (including vertical and horizontal cabling) [40 Marks]

END OF EXAM

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

CS4252: ELECTRONICS FOR COMPUTING IV

SEMESTER 2 EXAM **4th MAY 2010**

TIME: THREE HOURS

ANSWER: ANY FIVE QUESTIONS

QUESTION 1

(i) List three (3) VLAN Implementations methods [3 Marks]
(ii) Describe each method in details [6 Marks]
(iii) Give advantages and disadvantages for each [3 Marks]

QUESTION 2

(i) List four (4) layer 1 network design goals and describe each in details [8 Marks]
(ii) List four (4) critical network design components that should be addressed [4 Marks]

QUESTION 3

(i) List four (4) steps in LAN design and implementation [4 Marks]
(ii) Explain the details involved in each step [8 Marks]

QUESTION 4

(i) Design a network encompassing 100 workstations, 1 mail server, 1 web server, 6 switches, and 2 routers. The network should have the following characteristics:
1. It should be a three layered hierarchical network in topology
2. It should have at least three departments and VLANs
Describe your design in details (including vertical and horizontal cabling) [12 Marks]

QUESTION 5

(i) Explain the Spanning Tree Protocol (STP) [2 Marks]
(ii) Describe its operation in details [5 Marks]
(iii) List the five STP states [5 Marks]

QUESTION 6

(i) List four (4) unique issues about wireless media [4 Marks]
(ii) Describe the configuration of the BSS infrastructure [4 Marks]
(iii)List four (4) MAC functionality [4 Marks]

QUESTION 7

(i) Describe the CSMA/CA protocol in terms of DIFS, PIFS, SIFS and Contention Window [12 Marks]

END OF EXAM

CST 3022 Exam
Friday 6th May 2011

Answer any **five** questions. All questions carry equal marks.
Write clearly and explain steps precisely.
Lecturer: Dr. John Regan

1.

a) Consider a midtest loop, here written in Java, that looks for blank lines in its input:

```
for(;;) {
   line = read_line();
   if (all_blanks(line)) break;
   consume_line(line);
   }
```

Show how you might accomplish the same task using a `while` or a `do-while` loop, if midtest loops were not available. How do these alternatives compare to the midtest version? *Midtest means testing in the middle of a loop.*

b) Consider the following expression in Java: `(a/b > 0 && b/a > 0)`
What will be the result of evaluating this expression when `a` is zero? What will be the result when `b` is zero? Would it make sense to try to design a language in which this expression is guaranteed to evaluate to false when either `a` or `b` (but not both) is zero? Explain your answer in each case clearly.

c) Describe what is meant by an ***r-value*** and an ***l-value***. Give an example of each in a language of your choice.

d) In certain circumstances the following expression may lead to bugs in a developers program. Explain why the expression could be potentially dangerous.

```
a - f(b) - c * d
```

2.

a) Explain the difference between **imperative** and **declarative** languages.

b) Explain the role of the **scanner** and the **parser** in compilation.

c) There is no obvious one-step algorithm to convert a set of regular expressions into an equivalent deterministic finite automaton (DFA). Therefore a typical scanner uses three steps. **Describe and explain** each of these steps.

d) Construct a minimised DFA equivalent to the regular expression

```
digit* ( . digit | digit . ) digit*
```

In answering this question you should break it into the three parts in part c. Marks will be awarded for each of the three parts.

3.

a) Explain the term **binding lifetime** of an object[1].
b) Explain the terms **static allocation, stack based allocation** and **heap based allocation** giving examples of each.
c) Explain the term **garbage collection** and how it relates to programming languages. Give an example of a language that uses garbage collection and one that doesn't.
d) What is meant by the **scope** of an object? Explain the difference between **static scoping** and **dynamic scoping.**
e) Consider the following pseudocode:

```
x : integer;                                --global

procedure set_x(n : integer)
     {
          x := n;
     }
procedure print_x()
     {
          write_integer(x);
     }
procedure first()
     {
          set_x(1);
          print_x();
     }
procedure second()
     {
          x : integer;
          set_x(2);
          print_x();
     }
set_x(0);
first();
print_x();
second();
print_x();
```

What does the program print if the language is **statically scoped**? What does it print with **dynamic scoping**? Explain briefly the reason for the value printed in each case.

1Recall that an object in this sense refers to anything that might have a name: variables, constants, types and so on and is not related to the concept of an object in an object orientated language.

4.

a) Give three examples of **built-in** types in a language of your choice. Clearly name the language and the built-in types.
b) Explain each of the following terms giving examples where appropriate:
   1. Type Equivalence
   2. Type Conversion
   3. Type Compatibility
   4. Type Inference
   5. Universal Reference Types
c) Explain each of the following terms giving an example of a language that uses each:
   1. Row-Major Layout
   2. Column-Major Layout
   3. Row-Pointer Layout

5.

a) Explain the difference between **callee-save** registers and **caller-save** registers.
b) Explain the term **in-line** expansion. Give an example of why and where it would be used.
c) Explain what is meant by ***call-by-value***, ***call-by-reference*** and ***call-by-sharing***. Consider the following pseudocode:

```
a : integer;                          --global
c : integer;                          --global
procedure A(a : integer, c : integer)
{
     c = a/3;
     print a;
     print c;
     a = 19;
}

a = 12;
c = 3*a;
A(a, c);
print a;
print c;
```

What is the output of the above program in each of the following cases:
   1. Call-by-value
   2. Call-by-reference
   3. Call-by-sharing

6.

a) Scheme is a functional language and has both ***first class procedures*** and ***higher order procedures*** – briefly explain both terms.

b) In Scheme ***parameter passing is by value*** – explain briefly what this means with relation to Scheme.

c) Consider the following Scheme code.

```
(define x 6)
(define y 7)

(define (double x) (+ x x))

(define (func1)
     (let ((a 10)
           (b 20))
             (double a)
             (double b)
             (double x)))

(define (func2)
     (let ((a 20)
           (b 40))
             (let ((c 1)
                   (d 2))
               (double a)
               (double c)
               (double d))))
```

a) What is returned by calling `func1`?

b) What is returned by calling `func2`?

c) Using contour scope blocks draw out the bindings for the local variables in `func1` and `func2`.

d) Given the following Scheme code – say what is returned by the call to the procedure `result` at the end and why:

```
(define a 6)
(define (func) a)

(define (result)
     (let ((a 9))
         (func)))
(result)
```

7.

a) Write a scheme procedure which takes the minimum of two numbers.
b) What is meant by the ***car*** of a pair and the ***cdr*** of a pair in scheme?
c) Show in Scheme how to create a variable `foo` which is a pointer to a pair of numbers.
d) Write a procedure in Scheme that calculates the length of a list (ignore the fact that Scheme has a built in procedure called length). Your procedure should take a list as an argument e.g. (my-length my-list) where my-length is the function and my-list is the list passed in as an argument.
e) Give an example of four predicates built into Scheme – explain what each one does.

8.

a) Explain what is meant by the terms ***actual*** parameters and ***formal*** parameters.
b) Explain what the function of the ***stack pointer*** and ***frame pointer*** is.
c) Explain the role of **Dope Vectors** in arrays. Describe what is meant by a **conformant array**.
d) Assume that a subroutine takes as its only argument the size of an array e.g.

```
void foo(int size) {
   double M[size][size];
   ...
   return;
}
```

Using the above subroutine as a template sketch out the stack frame for the above subroutine.

University of Zambia

School of Natural Sciences

Department of Computer Studies

CST3062 Final Exam

Advanced Databases and Information Systems

Time 3 Hours

This exam has two sections. Section A has two compulsory questions and you are expected to answer all the Questions. Section B has Five Questions and you are expected to answer any Three of the Five Questions.

SECTION A

Answer all questions in this Section. Question 1 carries 25 points. Question 2 carries 30 points.

1. Given the form below answer the following questions **[25 points]**

Wellmeadows Hospital
Patient Medication Form

Patient Number: P10034

Full Name: Robert MacDonald

Ward Number: Ward 11

Bed Number: 84

Ward Name: Orthopaedic

Drug Number	Name	Description	Dosage	Method of Admin	Units per Day	Start Date	Finish Date
10223	Morphine	Pain Killer	10mg/ml	Oral	50	24/03/01	24/04/02
10334	Tetracyclene	Antibiotic	0.5mg/ml	IV	10	24/03/01	17/04/01
10223	Morphine	Pain Killer	10mg/ml	Oral	10	25/04/02	02/05/03

(a) Define normalization. **[2 points]**

(b) Identify the functional dependencies represented by the data shown in the form. **[2 points]**

(c) Describe and illustrate the process of normalizing the data shown in the form to first (1NF), second (2NF), third (3NF). **[6 points]**

(d) Identify the primary, alternate, and foreign keys in your 3NF relations. **[3 points]**

(e) An agency called Instant Cover supplies part-time/temporary staff to hotels within Scotland. The table shown below lists the time spent by agency staff working at various hotels. The National Insurance Number (NIN) is unique for every member of staff.

NIN	contractNo	hours	eName	hNo	hLoc
1135	C1024	16	Smith J	H25	East Kilbride
1057	C1024	24	Hocine D	H25	East Kilbride
1068	C1025	28	White T	H4	Glasgow
1135	C1025	15	Smith J	H4	Glasgow

I. The table is susceptible to update anomalies. Provide examples of insertion, deletion, and update anomalies. **[3 points]**

II. Describe and illustrate the process of normalizing the table shown to 3NF. State any assumptions you make about the data shown in this table. **[9 points]**

2. A company called Perfect Pets runs a number of clinics. A clinic has many staff and a member of staff manages at most one clinic (not all staff manage clinics). When a pet owner contacts a clinic, the owner's pet is registered with the clinic. An owner can own one or more pets, but a pet can only register with one clinic. When the pet comes along to the clinic, it undergoes an examination by a member of the consulting staff. The examination may result in the pet being prescribed with one or more treatments.

    a) Identify the main entity types of Perfect Pets Company. **[5 points]**
    b) Identify the main relationship types between the entity types described in (a) and represent each relationship as an ER diagram. **[5 points]**
    c) Determine the multiplicity constraints for each relationship described in (b). Represent the multiplicity for each relationship in the ER diagrams created in (b). **[5 points]**
    d) Identify attributes and associate them with entity or relationship types. Represent each attribute in the ER diagrams created in (c). **[5 points]**
    e) Determine candidate and primary key attributes for each (strong) entity type. **[5 points]**
    f) Using your answers (a) to (e) attempt to represent the data requirements of Perfect Pets as a single ER diagram. State any assumptions necessary to support your design. **[5 points]**

SECTION B

Answer any three Questions in this Section. Each question carries 15 points

3. An Adult Education Department runs various courses during the daytime and evenings, and at different times of the year. For example, 'Spanish level 1' is offered on Monday mornings, Monday evenings or Wednesday evenings, and runs over 25 weeks from October to March. On the other hand, 'Introduction to Digging Up Your Ancestors' only runs for 8 weeks, but is offered on Tuesday or Wednesday evenings from October to December, January to March, and April to June, with an optional field week in August.

    There is always a maximum number of places for each course offering, which is dependent on the individual tutor. For example, 'Spanish level 1' on Monday evenings may be limited to 20 places, but on Wednesday evenings the limit may be 25. Each course offering is only taken by one tutor, however, a tutor may take different courses, for example, 'French level 1' and 'Spanish level 2'. To guarantee enrolment, prospective students must pay the fee before the start of the first class. There is a special reduction for those unemployed. All applicants are kept on a register for subsequent mailshots.

    a) Develop an Entity–Relationship model to illustrate the logical database design. **[5 points]**
    b) Produce a set of tables from your Entity–Relationship model, clearly identifying the primary keys. **[5 points]**
    c) Show that your data model supports the following transactions: **[5 points]**
        I. Add a new course to the database, prior to it being offered on any particular day or from any particular date.

II. Enrol a new student on the 'German level 2' course that runs on Monday evenings commencing October 10 1994.

4.

a) Describe two approaches to checking that a logical data model supports the transactions required by the user. **[3 points]**
b) Describe what a superclass and a subclass represent and the relationship between a superclass and its subclass. **[3 points]**
c) Describe and contrast the process of specialization with the process of generalization. **[3 points]**
d) What two main constraints apply to a specialization/generalization relationship? **[3 points]**
e) Describe the inputs and outputs of physical database design. **[3 points]**

5.

a) Having identified a column as a potential candidate index, under what circumstances would you decide against indexing it? **[3 points]**
b) Discuss the purpose of analyzing the transactions that have to be supported and describe the type of information you would collect and analyze. **[3 points]**
c) Describe the alternative strategies that can be applied if there is a child record referencing a parent record that we wish to delete. **[3 points]**
d) Suppose you are given a relation R = (A, B, C, D, E) with the following functional dependencies: {CE → D,D → B,C → A}. **[6 points]**
    I. Find all candidate keys.
    II. Identify the best normal form that R satisfies (1NF, 2NF, 3NF).

6. Database technology continues to evolve and has many interesting emerging trends.
    a) Give a definition of a data warehouse. Discuss the benefits of implementing a data warehouse. **[3 points]**
    b) Discuss what online analytical processing (OLAP) is and how OLAP differs from data warehousing. **[3 points]**
    c) What is XML and discuss the approaches for managing XML-based data. **[3 points]**
    d) Discuss why the weaknesses of the relational data model and relational DBMSs may make them unsuitable for advanced database applications. **[3 points]**
    e) Explain what is meant by a DDBMS, and discuss the motivation in providing such a system. **[3 points]**
7. Database design is defined as a structured approach that uses procedures, techniques, tools, and documentation aids, to support and facilitate the process of design
    a) Describe the main phases involved in database design **[3 points]**

b) How would you identify entity and relationship types from a user's requirements specification? **[2 points]**

c) A database developer normally uses several fact-finding techniques during a single database project. The five most commonly used techniques are examining documentation, interviewing, observing the business in operation, conducting research, and using questionnaires. Describe each fact-finding technique and identify the advantages and disadvantages of each. **[10 points]**

The University of Zambia
School of Natural Sciences

Semester 2 Final Examinations – May 2011

CST4012 : Advanced Operating Systems and Distributed Systems

Instructions:
Answer FOUR (4) questions
Duration: Three Hours

Question One

There are various functions performed by different operating systems.

a) Explain what you understand by the term distributed operating system. What are the consequences of the given definition on concurrency, time and failure management? (8 Marks)

b) Distinguish between a network operating system and a distributed operating system (10 Marks)

c) Describe the services offered by a network operating system (4 Marks)

d)Give THREE reasons why it has taken a long time to implement a distributed operating system? (3 Marks)

(Total 25 Marks)

Question Two

A distributed system and applications that support internal concurrency require that several activities be performed at the same time.

a) Make a contrast between multiprocessing and multithreading (4 Marks)

b) Give three reasons why multi-threaded process model should be preferred to the multi single-single threaded process in the realization of concurrency. (6 Marks)

c) Describe the complete life cycle of a thread. (5 marks)

d) A client makes remote method invocations (RMIs) to a server. A client makes RMIs to a server. The client takes 5ms to compute the arguments for each request, and the server takes 10 ms to process each request. The local operating system time for each send or receive operation is 0.5 ms, and the network time to transmit each request or reply message is 3 ms. Marshalling or unmarshalling takes 0.5 ms per message.

Estimate the time taken by the client to generate and return from 2 requests if is

i) single-threaded

ii) it has two threads which can make requests concurrently on a single processor

(10 Marks)

(Total 25 Marks)

Question Three

Modern operating systems are designed to handle multiple processors

a) Describe, giving a suitable application, each of the following architectures.

i) Single Instruction Stream Multiple Data stream

ii) Multiple Instruction Stream Single Data stream

iii) Multiple Instruction Stream Multiple Data stream (12 Marks)

b) Critically discuss the relative advantages of the two-tier and three-tier architectures. Give an appropriate example of each architecture. (8 Marks)

c) Discuss five issues that designers of distributed systems have to face (5 Marks)

(Total 25 Marks)

Question Four

a) Many distributed algorithms require the use of a coordinating process. To what extent can such algorithms actually be considered distributed? Discuss (5 Marks)

b) Transactions T and U are run with timestamp ordering concurrency control as illustrated:

T	U
x = Read(i)	
	Write(i,55);
	Write(j,66);
Write(j,44);	
	Commit
Commit	

Required:

i) Describe the information written to the log file on behalf of T and U, allowing for the fact that T has a later timestamp than U and must wait to commit after U.

ii) Why is it essential that the commit entries in the log file be ordered by timestamps?

iii)Describe the effect of recovery if the server crashes between the two Commits

iv) What would be the effect of recovery if the server crashes after both of them?

v) What are the advantages and disadvantages of using timestamp ordering?

(12 Marks)

c) Distinguish between

i) centralized and distributed deadlocks

ii) optimistic and pessimistic concurrency control techniques

(8 Marks)

(Total 25 Marks)

Question Five

a) Provide an overview of the security concerns in a distributed system. (10 Marks)

b) Suppose you were asked to develop a distributed application for setting up and conducting examinations, give at least three statements that would be part of the security policy for such an application. (6 Marks)

c) Critically evaluate the need for data recovery. Discuss three mechanisms that can be used to achieve data recovery. (9 Marks)

(Total 25 Marks)

THE UNIVERSITY OF ZAMBIA
DEPARTMENT OF COMPUTER STUDIES

CST4122 - COMPILERS

UNIVERSITY EXAMINATION

Friday, May 06, 2011; 09:00Hrs

INSTRUCTIONS : There's FIVE(5) questions in this examination and you are required to answer ANY FOUR of them. Good luck!

DURATION : 3 Hours

1.
   a. Describe the phases of the compilation process from the point of view of the analysis and synthesis of a program. Outline the functions of each phase stating the form of its input and output. [you can use a labelled diagram]
   b. Discuss the role that the symbol table plays in the compilation process.
   c. Outline the algorithm used by the compiler to create a symbol table.

2.
   a. Write a regular expression which generates all binary representation of odd numbers. [Note: all odd numbers end in a 1 bit and a zero should not be at the beginning of the binary string e.g. 00101 is simply 101]
   b. Construct an NFA for your grammar above.
   c. Convert NFA into a DFA.
   d. Using a schematic diagram, show how scanner generators process REs into a scanner.

3. For each of the following grammars
   a. State whether it is LL parsable or not, stating reasons if not?
   b. If it is not, convert it into an LL parsable grammar.

      i. $A \rightarrow A\ \alpha$
         $A \rightarrow \beta$
         $A \rightarrow \gamma$

      ii. A -> B C D E F
          A -> B C D G

      iii. A -> B D
           B -> A C | E

   c. Construct a parse table for the LL version of grammar (i)

4. Consider the grammar given the below

```
E -> E + T | E
T -> T * F | F
F -> id | num
```

Where id and num are terminals representing identifiers and numbers respectively

a. Draw the syntax tree for a + b - c
b. Discuss the precedence and associativity of the operators *, +.
c. By using brackets, show how the following expressions are evaluated
   i. a + b * c + d * e
   ii. a + b + c + d + e
d. Suppose you intend to include the unary negative operator(-) to allow sentences of the form -a, -23 etc, how would you change this grammar to accommodate this, given that this operator has the highest precedence of the operators available?

5.

a. Describe the difference between top-bottom (LL) and bottom-up (LR) parsing
b. There are the two modes of implementing an LL parser i.e. using a recursive descent parser and using a stack. Describe these two methods.

c. Given the following grammar

```
E -> id ET
ET -> + E | - E | ε
```

   i. Show how the stack implementation will parse the following expression a + b - c. [you need a parse table]

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

THE UNIVERSITY OF ZAMBIA

Department of Computer Studies

EXAMINATION

CST4132 – Computer Graphics

INSTRUCTIONS: Answer Four(4) out of Five(5) questions in this exam. Question 1 is COMPULSORY.
DURATION: 3 HOURS

1.

a. Describe 5 input devices commonly used in Computer Graphic applications.
b. Explain the difference between Vector display and the Raster display system and cases in which each technology is preferred.
c. Computer Graphics applications are resource intensive (CPU, memory etc). Discuss how the architecture of such applications ensures that they function concurrently with other applications. [Use a labelled diagram]
d. Explain how the Graphics application program, application model and the Graphics system interact and the functions they perform in a Computer Graphics system.

2.

a. Using a labeled diagram, illustrate the operations and functions of the Cathode Ray Tube (CRT) technology.
b. Describe the two mechanisms used to realize colour in the CRT.
c. Differentiate between the operations of Plasma and LCD technologies.

3.

a. Consider the following Raster system with resolution 1024 by 1024 with 24 bits per pixel with a frame refresh of 60Hz.
b. How much memory is required for frame buffer of this system?
c. Suppose you are given that the system has a horizontal retrace of 0.005 seconds and a vertical retrace of 0.25seconds. How much time is wasted in retrace in 1 minute?

4.

a. Outline the steps of the Bressenham for rasterizing a line.
b. You are using the algorithm above to scan convert the line $y = 5x + 2$ from (0, 0) to (5, 7). Show the set of points that will be selected.
c. Show that decision parameter P_k in b above is exactly the one generated when using the Midpoint algorithm. Take note of the gradient of the line.

5.

a. When drawing primitives, a number of attributes are taken into account. Describe three attributes of a line.
b. Describe how each of the attributes above is realized.
c. Consider the following Java code in a JFrame class.

```
public void paint(Graphics g){
        g.setColor(Color.BLUE);
        g.drawOval(12, 13, 80, 80);
}
```

   i. Briefly explain what the piece of code does. What is the centre and radius of the circle drawn in this method?

d. Write a piece of code in the JFrame class that draws a filled circle of colour red and radius 20 centred at (0,0)

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

The University of Zambia

School of Natural Sciences

Department of Mathematics & Statistics

Second Semester Examinations - May 2011

EM312 - Engineering Mathematics IV

Time allowed : Three (3) hours Full marks : 100

Instructions:
- This paper consists of **two** sections, **Section A** and **Section B**. Attempt **any three** questions from **Section A** and **any two** from **Section B**. All questions carry equal marks.
- **Full credit** will only be given when **necessary work** is shown.
- Indicate your **computer number** on all answer booklets.

This paper consists of 4 pages of questions.

Section A

1. a) A surface in $\mathbb{R}^3$ is described in spherical coordinates by $\rho \sin^2 \phi = \cos \phi$. Sketch the surface and give its equation in both rectangular and cylindrical coordinates.

   b) Let R be the region enclosed between the sphere $x^2 + y^2 + z^2 = 9$ and the cone $z = \sqrt{x^2 + y^2}$.

   (i) Sketch the region R and describe it using spherical coordinates.

   (ii) Calculate the volume of the region R.

   c) Evaluate the integral

$$\int_0^{\frac{1}{\sqrt{2}}} \int_{x^2}^{\frac{1}{2}} x \sec^2 y^2 \, dydx \ .$$

   d) Let $9x^2 - 36x + 4y^2 + 8y - 18z^2 + 108z - 158 = 0$ be the equation of a surface. Identify the surface and write down the centre.

2. a) Suppose that over a certain region of space the electrical potential V is given by $V(x, y, z) = 5x^2 - 3xy + xyz$.

(i) Find the rate of change of the potential at $P(3, 4, 5)$ in the direction of the vector $V = \mathbf{i} + \mathbf{j} - \mathbf{k}$.

(ii) In which direction does V change most rapidly?

(iii) What is the maximum rate of change?

b) Calculate the surface area of the part of the paraboloid $z = x^2 + y^2$, lying in the first octant, between $z = 1$ and $z = 2$.

c) R is the region in the first quadrant bounded by the graphs of $xy = 3$, $xy = 5$, $y = x$ and $y = 2x$.

(i) The region R is transformed into the region R' under the mapping $u(x, y) = xy$ and $v(x, y) = \frac{y}{x}$. Sketch the region R'.

(ii) Find $\frac{\partial(u,v)}{\partial(x,y)}$.

(iii) Transform the integral $\int\int_R \left(\frac{y}{x}\right)^2 \sin\left(\frac{y}{x}\right)^2 dA$ into a double integral with respect to the variables u and v.

(iv) Evaluate the double integral in (iii).

3. a) Given

$$\mathbf{F}(x, y, z) = y^2\,\mathbf{i} + (2xy + e^{3z})\,\mathbf{j} + 3ye^{3z}\,\mathbf{k}\ ,$$

(i) find a function f such that $\nabla f = \mathbf{F}$.

(ii) Evaluate the line integral $\int_C \mathbf{F} \cdot dr$ where C is the straight line from $(1, 1, 0)$ to $(2, 3, 1)$.

b) Use Stoke's theorem to evaluate $\oint_C \mathbf{F} \cdot dr$, where $\mathbf{F}(x, y, z) = -y^2\,\mathbf{i} + x\,\mathbf{j} + z^2\,\mathbf{k}$ and C is the curve of intersection of the plane $y + z = 2$ and the cylinder $x^2 + y^2 = 1$.

c) Let C be the curve $\mathbf{r}(t) = \left(\frac{1}{t}, t, t^2\right)$, $t > 0$ and let S be the surface $x^2 - y^2 - 4z + 4 = 0$

(i) Find a cartesian equation of the tangent plane to S at the point $(1, 1, 1)$.

(ii) Obtain a vector equation for the tangent line to C at the point $(1, 1, 1)$.

(iii) Show that curve C intersects the surface S at the point $(1, 1, 1)$ at right angle.

4. a) Given the parametric equations

$$x = \cos t, \quad y = \sin t, \quad z = t, \quad 0 \leq t \leq 2\pi\ ,$$

(i) sketch the graph of the parametric equations.

(ii) A particle moves along the curve in (i) subject to the force $F = y \sin z$. How much work is done in moving the particle?

b) Verify the divergence theorem for the case where $\mathbf{F}(x, y, z) = (x, y, z)$ and B is the solid sphere of radius R centred at the origin.

c) Evaluate the line integral

$$\oint_C (3y - e^{\cos x})\, dx + (7x + \sqrt{y^4 + 1})\, dy \ ,$$

where C is the unit circle $x^2 + y^2 = 1$.

Section B

5. a) In a sample space, events A and B are independent, events B and C are mutually exclusive, and A and C are independent. If $P(A \cup B \cup C) = 0.9$, $P(B) = 0.5$ and $P(C) = 0.3$, find $P(A)$.

b) In rolling two fair dice, what is the probability of obtaining

(i) a sum less than five,

(ii) an even product,

(iii) a sum less than five given that the product is even?

c) John travels to work by either route A or B. The probability that he chooses route A is $\frac{1}{4}$. The probability that he is late for work if he goes via route A is $\frac{2}{3}$ and the corresponding probability if he goes via route B is $\frac{1}{3}$.

(i) What is the probability that he is late for work?

(ii) Given that he is late for work, what is the probability that he went via route B?

d) Let X be the life in hours of a light bulb with density function

$$f(x) = 0.001e^{-0.001x}, \qquad (x \geq 0) \ .$$

(i) Find the mean of X.

(ii) Find the c.d.f $F(x)$ of X and use it to find $P(1 < X < 3)$ and $P(X \leq 10)$.

6. a) Given that a random variable X has a c.d.f

$$F(x) = \begin{cases} 1 - e^{-3x} & \text{if} \quad x > 0, \\ 0 & \text{if} \quad x \leq 0, \end{cases}$$

(i) find the probability density function of X.

(ii) find x such that $F(x) = 0.9$

(iii) evaluate $E(X)$ and $\text{Var}(X)$.

b) Six fair coins are tossed simultaneously. Find the probability mass function of the random variable $X \equiv$ Number of heads, and compute the probabilities of obtaining

(i) no head.

(ii) at least 1 head.

(iii) less than 6 heads.

c) Calculate the mean and variance of the random variable X in (b).

7. a) Events A and B are such that $P(A) = 0.3$, $P(B) = 0.5$. Find $P(A \cap B)$ and $P(A \cup B)$

(i) if A and B are independent.

(ii) if A and B are mutually exclusive.

b) A random variable X has probability function $f(x)$ with $f(1) = 0.1$, $f(2) = 0.2$, $f(3) = y$, $f(4) = 0.2$, $f(5) = 0.1$. Find

(i) the value of y.

(ii) $P(X \leq 4)$

c) A random variable X has p.d.f. $f(x)$ where

$$f(x) = \begin{cases} k(1-x), & 0 \leq x \leq 1 \ , \\ 0, & \text{otherwise} \ . \end{cases}$$

Find

(i) the value of the constant k.

(ii) $P(X \geq \frac{3}{4} | X \geq \frac{1}{2})$.

d) Mathematics aptitude scores X are normally distributed with mean 500 and standard deviation 20, i.e. $X \sim N(500, 400)$. Find :-

(i) the probability that an individual's score exceeds 535,

(ii) the probability that an individual's score exceed 535, given that it exceeds 500, i.e. $P(X > 535 | X > 500)$.

END!

UNVERSITY OF ZAMBIA

INSTITUTE OF DISTANCE EDUCATION

2010 ACADEMIC YEAR DISTANCE EDUCATION FINAL EXAMINATIONS

GEO 111: INTRODUCTION TO HUMAN GEOGRAPHY I

TIME: THREE HOURS

INSTRUCTIONS: Answer Question 1 and three others. Use of an approved calculator is allowed. You are encouraged to use examples and illustrations wherever possible.

---

1. Study Table 1 which shows population sizes and gross domestic product (GDP) for selected countries in southern Africa in 2001 and then answer the questions that follow:

Table1: Population size and gross domestic product for southern African countries

S/N	Country	Population size (thousands)	Gross domestic product (GDP) (thousand dollars)
1.	South Africa	43,586	466,370
2.	Mozambique	19,371	23,245
3.	Zambia	9,770	78,160
4.	Malawi	10,548	63,288
5.	Botswana	1,586	13,957
6.	Angola	10,366	19,695
7.	Namibia	1,798	12,766
8.	Zimbabwe	11,365	21,593

Source: Based on information from CIA (2001). The World Factbook

(a) Construct a Lorenz curve to depict disparities in the distribution of GDP as an economic proxy in the southern African sub-region. [20 Marks]

(b) Explain the pattern that emerges. [10 Marks]

(c) Explain how the inequalities depicted by the graph can be addressed. [10 Marks]

2. Apply Alfred Weber's factors of industrial location to the location of industries in Zambia. [20 Marks]

3. With regard to migration, outline the causes and effects of the following:
   (a) Brain drain
   (b) Refugees
   (c) Human trafficking
   (d) Rural flight [20 Marks]
4. Compare and contrast the biblical and evolutionary perspectives of the origin of life on Earth. [20 Marks]
5. 'Today's modern cultural hearths include world cities like London, Paris and Tokyo and places such as the United States'. Discuss. [20 Marks]
6. Explain the meaning and importance of the following basic concepts in the Central Place Theory (GPT):
   (a) Threshold population
   (b) Central goods and services
   (c) Range of a good
   (d) Complementary region [20 Marks]

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

CANDIDATE'S COMPUTER NUMBER: .....

2010 ACADEMIC YEAR SECOND SEMESTER DEFERRED EXAMINATIONS

GEO 175: INTRODUCTION TO MAPPING TECHNIQUES IN GEOGRAPHY

PAPER 1: PRACTICAL
AIR PHOTOGRAPHS, MAP READING AND MAP INTERPRETATION

TIME: Three Hours

INSTRUCTIONS: Answer **all** the questions. The use of a Philip's University Atlas and a certified calculator is allowed. Candidates are encouraged to make use of illustrations wherever appropriate.

MATERIALS PROVIDED:

Topographic Map Sheet 1131 C4
A4 Metric Graph Paper
A4 Tracing Paper

FOR USE BY EXAMINER

Question	Mark
Q1	
Q2	
Q3	
Q4	
Total	

IMPORTANT

Please read the instructions carefully before attempting any question in this Examination. Failure to follow instructions will lead to automatic loss of marks.

SECTION A: GENERAL QUESTIONS

Answer all questions in this section in the spaces provided on this question paper

1. Write short explanatory notes on **all** of the following:

(a) Stereoscopic pairs [5 marks]

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(b) Oblique aerial photographs [5 marks]

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(c) Sheet Reference number [5 marks]

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.....

(d) Quantitative methods of showing relief on maps [5 marks]

(e) Calculation of gradient on a map [5 marks]

2 (a) Express 1:500,000 as a scale in words [5 marks]

(b) Express 2cm to a kilometre as a scale in figures [5 marks]

(c) Using a scale of 1:40,000, draw a line scale in metric units given that the maximum space available is 17 centimetres. [5 marks]

(d) What do you understand by the term 'vertical exaggeration' and briefly explain why the vertical scale on a profile is always exaggerated. [5 marks]

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(e) With the help of a diagram, describe a dendritic drainage pattern and briefly explain the characteristics of the area in which it develops. [5 marks]

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SECTION B: MAP BASED QUESTIONS

3. Use Topographic Map sheet 1131 C4 to answer this question

(a) When was Map Sheet 1131 C4 published and by whom? [2 marks]

.....

.....

(b) In which district is Chief Luchembe's Headquarter in Grid Square 1093 located? [2 marks]

.....

.....

(c) If you were driving northwards to Isoka along the main tarred road from Serenje, what other map sheet would you require? [2 marks]

.....

.....

(d) What pieces of evidence are there on map sheet 1131 C4 to explain the absence of cultivation in Grid Square 2594. [2 marks]

.....

.....

(e) What is the approximate distance in kilometres along the main tarred road from the road junction in Grid Square 2784 to another road junction at Grid Square 2988? [2 marks]

.....

.....

(f) What is the Grid Bearing of the trigonometrical station in Grid Square 3490 from Grid Reference point 300940? [2 marks]

.....

.....

(g) Map Sheet 1131 C4 uses a vertical interval of 20 metres, what does it mean? [2 marks]

.....

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(h) What is the scale of Map Sheet 1131 C4 and what does it mean? [2 marks]

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(i) In which direction does the Chabuluma River generally flow? [2 marks]

.....

.....

(j) What is the latitude and longitude of the south eastern corner of Map Sheet 1131 C4? [2 marks]

.....

.....

(k) According to map evidence only, what human induced drainage feature is associated with Westhill in Mpika Township area? [2 marks]

.....

.....

(l) Assuming that you drew a straight line profile from the triangulation station in Grid Square 2974 to the source of the Munjesa stream in grid Square 3372. Would the triangulation station and the source of the Munjesa Stream be intervisible? [1 marks]

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(j) What is the approximate size of the township area of Mpika in square kilometres and state the method that you have used to calculate the area. [2 marks]

(k) Calculate the average gradient along a straight line between grid reference point 300770 and the triangulation station in Grid Square 3490. [2 marks]

(l) Using map evidence only, explain how one could read a four figure grid reference on map sheet 1131 C4. [3 marks]

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5. On the sheet of either graph or plain paper provided, draw a map on a scale of 1:100,000 extending from eastings 20 to 30 and northings 90 to 00. On your map show the following features: [20 marks]

(a) The Tan-Zam Railway

(b) The Lwitikila/Mukungwa river

(c) The road from Mpika to Kasama

(d) The power line

(e) Chitulika School in Grid Square 2991

(f) Shade the area below 1320 metres.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
INSTITUTE OF DISTANCE EDUCATION

2010 ACADEMIC YEAR DISTANCE EDUCATION FINAL EXAMINATIONS

GEO 211: GEOGRAPHY OF AFRICA

TIME: Three Hours

INSTRUCTIONS: Answer any FOUR questions. Candidates are advised to make use of Illustrations and examples wherever appropriate. Use of a Philips University Atlas is allowed.

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1. With the aid of a diagram, illustrate the general extent of the rift valley system and explain the theories regarding its origin.

2. Discuss the main factors, both natural and human, which lead to soil erosion in Tropical Africa and show in what ways it is being combated.

3. "Although still a controversial topic, it appears likely that it was in Africa that man began to develop as a separate being, distinct from the animal primates..." (Pritchard, 1979:44). Discuss this statement with regard to early man in Africa.

4. With the aid of appropriate examples explain the challenges that African people face in forging national unity due to linguistic and religious diversity on the continent.

5. Discuss the significance of Africa's natural resource endowment in promoting socio-economic development in the continent during the present times.

6. Outline and evaluate the major differences in economic strategies that were followed by Kenya and Tanzania after the attainment of political independence.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2010 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS
GEO 272: QUANTITATIVE TECHNIQUES IN GEOGRAPHY II

TIME: **Three hours**

INSTRUCTIONS: **Answer any FOUR questions**
All questions carry equal marks
Use of certified calculator is allowed

Q1. Write short explanatory notes on all of the following:

a) Characteristics of statistics
b) Limitations of statistics
c) Descriptive and inferential statistics
d) Parameter and statistic
e) Measures of central tendency

Q2. Does temperature affect human performance? To answer this question, use the data presented in Table 1, which shows the winning times (minutes) for UNZA male marathon runners and the temperature (°F) on the day the race was run.

Table 1: Winning times and temperature

Winning Times (minutes)	Temperature (°F)
132.2	75
131.7	80
129.683	50
128.217	54
129.483	52
128.983	59
134.883	79
131.567	72
131.1	65
131.017	64
128.333	67
128.017	56

Source: Keller (2001)

Assuming the samples are random and normally distributed, what conclusion would you draw at 0.05 level of significance?

Q3. Under the Agricultural Support Programme (ASP) in the Ministry of Agriculture, the government has been encouraging farmers to diversify their crop production and more so to focus on the growing of cash crops instead of maize. A geographer measured the yields of beans produced by small scale farmers for two consecutive years as illustrated in Table 2.

Table 2: Yields of Beans (in kg) by small scale farmers in 2008/2009 and 2009/2010

2008/2009	2009/2010
16.5	16.5
7.2	25.7
16.4	7.8
8.6	22.3
10.0	17.8
11.8	9.9
9.8	28.4
16.3	16.3
12.6	29.8
4.8	14.5
11.6	32.7
13.9	18.8
20.6	6.4
17.8	21.7
6.6	

Source: Hypothetical

Assuming that the data for both years were normally distributed, would one be justified to conclude that there was a significant improvement in the yields of beans in the year 2010 as compared to the year 2009? Use the 95% accuracy level.

Q4. Who is more likely to ask for directions when lost, men or women? The conventional wisdom overwhelmingly favours women. However, conventional wisdom may be wrong. The 2010 Geo 272 class conducted a Lusaka-wide survey that asked 503 men and 502 women what they do when they are lost while driving a car. The responses are shown in Table 3.

Table 3: Actions of men and women when lost

Responses	Gender	
	Men	Women
Consult a map	129	99
Ask someone for directions	164	305
Continue driving until location or direction determined	181	51
Other	29	47

Source: Keller (2001)

At 0.01 level of significance, can we infer that men and women differ in their actions when lost?

Q5. A Social geographer aimed at determining whether significantly older sex workers frequented social places in Solwezi than in Livingstone. The results are shown in Table 4.

Table 4: Age of sex workers who frequent social places in Livingstone and Solwezi

Livingstone	Solwezi
15.03	19.00
14.08	29.50
18.50	28.30
12.30	38.24
20.25	33.50
19.00	33.00
25.40	35.80
33.00	25.60
13.70	16.00
28.50	36.24
16.00	30.32
21.50	34.80
18.30	40.30
15.40	27.50
26.40	34.80
	41.30
	42.4
	35.1
	37.8

Source: Hypothetical

Use the 0.01 level of significance to test this hypothesis.

Q6. From a study of agricultural land use in an area west of Mpangwe Hill in Katete, it appeared that land given over to rough pasture varied according to altitude. The results are given in Table 5.

Table 5: Relationship between altitude and pastureland.

Height (m)	147	125	160	118	149	128	150	145	115	140	152	155
Rough pasture (%)	56	42	72	36	63	47	55	49	38	42	68	60

Source: Hypothetical

(a) Plot the data provided in Table 5
(b) Conduct a regression analysis so as to come up with a regression equation related to data provided in Table 5.
(c) Draw a line of best fit in your scatter diagram.
(d) Define your regression equation

END OF EXAMINATION

Q1, Q2, Q6, Q4

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2010 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS
GEO 272: QUANTITATIVE TECHNIQUES IN GEOGRAPHY II

TIME: **Three hours**

INSTRUCTIONS: **Answer any FOUR questions**
All questions carry equal marks
Use of certified calculator is allowed

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Pearson

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Source: Keller (2001)

Assuming the samples are random and normally distributed, what conclusion would you draw at 0.05 level of significance?

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T-test

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4.8	14.5
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20.6	6.4
17.8	21.7
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Source: Hypothetical

Assuming that the data for both years were normally distributed, would one be justified to conclude that there was a significant improvement in the yields of beans in the year 2010 as compared to the year 2009? Use the 95% accuracy level.

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Chi square

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	42.4
	35.1
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Source: Hypothetical

Use the 0.01 level of significance to test this hypothesis.

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Source: Hypothetical

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(c) Draw a line of best fit in your scatter diagram.
(d) Define your regression equation

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATION

GEO 912: GEOGRAPHY OF MIGRATION AND REFUGEES

TIME: **THREE HOURS**
INSTRUCTIONS: **Answer any question FOUR questions.**
All questions carry equal marks

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1. Discuss the challenges of Article 1 and 33 of the 1951 the United Nation Refugee Convention in dealing with refugees of the contemporary period.

2. Elucidate Mabogunje's (1970) systems schema of migration in relation to Zambia.

3. Examine how decolonisation of Zimbabwe and Angola contributed to the escalation of refugees in the region and how Zambia managed to help out.

4. Ascertain how collective behaviour has been crucial in determining migratory forces, class, type of, selectivity and destinations of migrants in the world.

5. 'There have been disparities in international assistance to refugees in many parts of the world'. Discuss this statement with reference to any two regions of your choice.

6. Explain how the tripartite approach is used when resettling and repatriating refugees in the world.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2010 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 922: GEOGRAPHY OF REGIONAL PLANNING AND DEVELOPMENT

TIME: Three Hours

INSTRUCTIONS: **Answer any FOUR questions. All questions carry equal marks.**

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1. With reference to Zambia, discuss the validity of the statement that 'production output is an indicator of economic development of a nation'.

2. Examine the statement that 'globalisation should be considered in regional development planning in any developing country'.

3. 'Cumulative regional economic growth potential may be quantified by examining a region's employment base and its propensity to engage in production for export'. Discuss.

4. Using Zambia as an example, discuss the notion that regional development planning cannot be delinked from politics.

5. Explain the merits and demerits of the conservative approach to economic development.

6. Outline and discuss the strengths and weaknesses of decentralisation as a mode of regional planning.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2010 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS
GEO 932: URBAN GEOGRAPHY

TIME: **Three hours**

INSTRUCTIONS: **Answer any FOUR questions**
All questions carry equal marks

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1. Write short explanatory notes on all of the following:

   a) Industrial and post-modern cities
   b) Harris and Todaro's (1970) model of rural-urban growth
   c) Defining urban as an entity
   d) National and global hierarchies
   e) Urban planning and party politics

2. With examples, discuss five ways in which global cities influence their hinterlands as 'command and control centres'. What are the major limitations of the global approach in ranking cities?

3. Discuss Clark and Onaka's (1983) classification of reasons for household moves and relocation. How relevant are these reasons in explaining household movements in Zambia?

4. 'Urban informality', a common feature of most cities in the developing world may be there to stay. With examples, discuss the problems associated with the urban informal sector and show how these can be overcome.

5. With examples, discuss the major urban planning problems in developing countries and suggest solutions.

6. Discuss the different paradigms and theories used in the development of urban geography.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2010 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 952: GEOGRAPHICAL HYDROLOGY

TIME: THREE (3) HOURS

INSTRUCTIONS: ANSWER ANY FOUR (4) QUESTIONS.

ALL QUESTIONS CARRY EQUAL MARKS.

---

1. Write short explanatory notes on **ALL** of the following:

   (a) Runoff

   (b) Factors that influence infiltration.

   (c) Soil moisture measurement

   (d) Hydrological drought

   (e) Concept of River Basin Development

2. Discuss the concepts of Integrated Water Resources Management (IWRM) and Water Efficiency (WE) and their application to the Zambian context.

3. Describe the three balances encountered in hydrology and explain their roles in the transfer of mass and energy around the globe.

4. 'The Penman equation is one of the models which has been extensively used worldwide to estimate potential evaporation and evapotranspiration'. Discuss.

5. In what way and to what extent is hydrology a multidisciplinary science?

6. (a) With the aid of a diagram, describe the underground water profile.
   (b) Explain the importance of groundwater in the hydrological cycle.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2010 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 962: BIOGEOGRAPHY

TIME: Three hours

INSTRUCTIONS: Answer any four questions. Candidates are encouraged to make use of illustrations wherever appropriate.

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1. Write short explanatory notes on all of the following:
   (a) Principal marine biomes
   (b) Habitats and niches
   (c) Ecological effects of fire on tropical savannas
   (d) Vicariance biogeography
   (e) Importance of process in biogeography

2. 'When we think in terms of flow of energy and recycling of nutrients, it is impossible to divorce the living organisms from their physical environment'. Discuss.

3. "In natural situations it is often almost impossible to tell which of many possible limiting factors is mainly responsible for the distribution of a particular species" (Cox and Moore, 1985:40). Discuss.

4. Examine the contemporary interactions of humans and biota in the world.

5. 'Biogeographers readily accepted the theory of continental drift, whereas geologists initially treated it with skepticism'. Briefly, explain why geologists initially took such a stance.

6. With reference to the statement 'generally, pressures reduce the number of organisms but rarely eliminate the last surviving individuals', explain how endangered species finally become extinct.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2010 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 971: AERIAL PHOTOGRAPHY AND AERIAL PHOTO INTERPRETATION – PAPER II

TIME: Three hours

INSTRUCTIONS: Answer All questions

All question carry equal marks

Use of an approved calculator is allowed.

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1. What steps are carried out in flight planning?

2. 'The "effective area" is important in aerial photo-interpretation'. Explain how the area is established and what may cause its variation.

3. Outline and discuss the steps that you would undertake in soil mapping using aerial photographs and other data types.

4. (a) A project area at an elevation of 500m above sea level is 50km long in the north-south and 35km wide in the east-west direction. The air-base is 2.3km, the side-lap is 25%, the focal length of the camera to be used is 150mm, the negative format is 230mm x 230mm and the flying height is 4,200m above sea level. Calculate the following:

    (i) The scale of the photographs. [5 marks]
    (ii) The ground dimensions of an individual photograph. [5 marks]
    (iii) The number of photographs required to cover the project area. [10 marks]

    (b) A set of vertical aerial photographs at a scale of 1:25 000, were acquired for a forest plantation at sea level. A superwide angle lens of 83mm was used. What would be the relief displacement of a 20m *Eucalyptus* tree if it is 150mm away from the photo centre? [5 Marks]

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS – MAY 2011

GG332: REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM

TIME: 3 HOURS

ANSWER: FIVE (5) QUESTIONS. ALL QUESTIONS CARRY EQUAL MARKS (WILL BE MARKED OUT OF 20 MARKS). NEATLY DRAWN SKETCHES/ DIAGRAMS RECOMMENDED FOR A FULL MARK.

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1. With neatly labeled sketches or diagrams, **EXPLAIN** difference between the following:
   (i) Vector Model and Raster Model.....(8 marks)
   (ii) Geographic Coordinate System (GCS) and Projected System.....(8 marks)
   (iii) Atmospheric Blind and Atmospheric Window.....(8 marks)
   (iv) Passive and Active Sensors.....(8 marks)
   (v) Real-time and Post-processing differential corrections applicable to GPS.....(8 marks)

2. You have just been hired to work for Science and Technology Council of Zambia. The Council would like to introduce Remote Sensing in Zambia and your task is to convince the Chief Executive Officer (CEO) of the Council to buy in this new emerging technology. The CEO has requested you to outline the following:

   (a) The value of Remote Sensing to Zambia.....(10 marks)
   (b) The value of GIS to Zambia.....(6 marks)
   (c) The value of GPS..... (6 marks)
   (d) The data sources i.e. various forms of data that you could enter into a GIS project.....(4 marks)
   (f) What are the possible misconceptions?.....(4 Marks)

3. (a) What is a model in GIS, and define their characteristics.....(5 marks)
   (b) List the advantages for having a Polar Orbiting Earth Resources satellite (6 marks)
   (c) What does a Digital Image Data File consists of.....(4 marks)
   (d) Outline the anatomy of a GIS..... (6 marks)
   (f) What is the value of GIS?.....(6 marks)

4. (a) Briefly describe the procedure one will use to be able to obtain a stereovision i.e. able to see the objects in three dimensions.....(5 marks)

(b) In satellite image interpretation, a number of imagery recognition elements are used. Explain these elements.....(20 marks)

5. (a) Outline the advantages of manual map digitizing.....(8 marks)
   (b) What steps should you take when digitizing – List them.....(7 marks)
   (c) Give a formula for the spectral fingerprint of a target.....(2 marks)
   (d) Using GPS Data in ArcGIS, what software did you use in order to bring your data in ArcGIS..... (2 marks)
   (d) Differentiate between Database and Database Management Systems (4 marks)

6. (a) What does following abbreviations stand for?
   (i) RDMS.....(1 mark)
   (ii) UV.....(1 mark)
   (iii) EMR.....(1 mark)
   (iv) NDVI.....(1 mark)
   (v) DEM.....(1 mark)

   (b) Differentiate between the following:
   (i) Radiometric Resolution and Spectral Resolution.....(4 marks)
   (ii) Band Sequential (BSQ) and Band Interleaved (BIL) .....(4 marks)
   (iii) Path and Samples..... .....(4 marks)
   (iv) False Colour Composite and True Colour Composite.....(4 marks)
   (v) Coordinates and Attributes .....(4 marks)

7. (a) Define the following terms:
   (i) Shape files.....(2 marks)
   (ii) Datum ..... (2 marks)
   (iii) ArcMap .... (2 marks)
   (iv) Coverage..... (2 marks)
   (v) Geoid..... (2 marks)
   (b) Give the Spatial Resolution of the Following:
   (i) Landsat TM Multi-spectral system..... (1 mark)
   (ii) Quickbird Multi-spectral..... (1 mark)
   (iii) SPOT Panchromatic ..... (1 mark)
   (c) Give the components of a Geographic Coordinate System..... (3 marks)
   (d) Give the Wavelength of Blue, Green and Red Light. What is the name given to these Bands in Remote Sensing? .....(4 marks)

END -- GOOD LUCK

THE UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS – MAY 2011

GG332: REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM

TIME: 3 HOURS

ANSWER: FIVE (5) QUESTIONS. ALL QUESTIONS CARRY EQUAL MARKS (WILL BE MARKED OUT OF 20 MARKS). NEATLY DRAWN SKETCHES/ DIAGRAMS RECOMMENDED FOR A FULL MARK.

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THE UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS – MAY 2011

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ANSWER: FIVE (5) QUESTIONS. ALL QUESTIONS CARRY EQUAL MARKS (WILL BE MARKED OUT OF 20 MARKS). NEATLY DRAWN SKETCHES/ DIAGRAMS RECOMMENDED FOR A FULL MARK.

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1. With neatly labeled sketches or diagrams, **EXPLAIN** difference between the following:
   (i) Vector Model and Raster Model.....(8 marks)
   (ii) Geographic Coordinate System (GCS) and Projected System.....(8 marks)
   (iii) Atmospheric Blind and Atmospheric Window.....(8 marks)
   (iv) Passive and Active Sensors.....(8 marks)
   (v) Real-time and Post-processing differential corrections applicable to GPS.....(8 marks)

2. You have just been hired to work for Science and Technology Council of Zambia. The Council would like to introduce Remote Sensing in Zambia and your task is to convince the Chief Executive Officer (CEO) of the Council to buy in this new emerging technology. The CEO has requested you to outline the following:

   (a) The value of Remote Sensing to Zambia.....(10 marks)
   (b) The value of GIS to Zambia.....(6 marks)
   (c) The value of GPS..... (6 marks)
   (d) The data sources i.e. various forms of data that you could enter into a GIS project.....(4 marks)
   (f) What are the possible misconceptions?.....(4 Marks)

3. (a) What is a model in GIS, and define their characteristics.....(5 marks)
   (b) List the advantages for having a Polar Orbiting Earth Resources satellite (6 marks)
   (c) What does a Digital Image Data File consists of.....(4 marks)
   (d) Outline the anatomy of a GIS..... (6 marks)
   (f) What is the value of GIS?.....(6 marks)

4. (a) Briefly describe the procedure one will use to be able to obtain a stereovision i.e. able to see the objects in three dimensions.....(5 marks)

(b) In satellite image interpretation, a number of imagery recognition elements are used. Explain these elements.....(20 marks)

5. (a) Outline the advantages of manual map digitizing.....(8 marks)
   (b) What steps should you take when digitizing – List them.....(7 marks)
   (c) Give a formula for the spectral fingerprint of a target.....(2 marks)
   (d) Using GPS Data in ArcGIS, what software did you use in order to bring your data in ArcGIS..... (2 marks)
   (d) Differentiate between Database and Database Management Systems (4 marks)

6. (a) What does following abbreviations stand for?
   (i) RDMS.....(1 mark)
   (ii) UV.....(1 mark)
   (iii) EMR.....(1 mark)
   (iv) NDVI.....(1 mark)
   (v) DEM.....(1 mark)

   (b) Differentiate between the following:
   (i) Radiometric Resolution and Spectral Resolution.....(4 marks)
   (ii) Band Sequential (BSQ) and Band Interleaved (BIL) .....(4 marks)
   (iii) Path and Samples..... .....(4 marks)
   (iv) False Colour Composite and True Colour Composite.....(4 marks)
   (v) Coordinates and Attributes .....(4 marks)

7. (a) Define the following terms:
   (i) Shape files.....(2 marks)
   (ii) Datum ..... (2 marks)
   (iii) ArcMap .... (2 marks)
   (iv) Coverage..... (2 marks)
   (v) Geoid..... (2 marks)
   (b) Give the Spatial Resolution of the Following:
   (i) Landsat TM Multi-spectral system..... (1 mark)
   (ii) Quickbird Multi-spectral..... (1 mark)
   (iii) SPOT Panchromatic ..... (1 mark)
   (c) Give the components of a Geographic Coordinate System..... (3 marks)
   (d) Give the Wavelength of Blue, Green and Red Light. What is the name given to these Bands in Remote Sensing? .....(4 marks)

END -- GOOD LUCK

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

Department of Mathematics and Statistics

2010 Academic Year

Semester II

M112 Mathematical Methods II – A

FINAL EXAMINATION

Time Allowed: Three (3) Hours **May, 2011.**

Instructions:

1. You must write your **Computer Number**, and your **TG Number** on each answer booklet you have used.

2. There are Seven (7) questions in this paper, Attempt **Any Five (5)** questions. All questions carry equal marks

3. Calculators are **Not** allowed.

4. Should you have any problem or if you need more answer booklet, put up your hand an invigilator will come to attend to you.

(1) (a) Let $A=\begin{pmatrix}3 & 0\\ -1 & 5\end{pmatrix}$, $B=\begin{pmatrix}4 & -2 & 1\\ 0 & 2 & 3\end{pmatrix}$, $C=\begin{pmatrix}1 & 2\\ 3 & 4\\ 5 & 6\end{pmatrix}$, $D=\begin{pmatrix}0 & -3\\ -2 & 1\end{pmatrix}$.

Find

(i) A + 2D

(ii) $B-C^T$

(iii) AB

(b) The function $f(x)=ax^3-bx+c$ passes through the origin, $f(-1)=\frac{4}{3}$ and it has an extreme point at $x=1$.

(i) Find the values of a, b and c.

(ii) Sketch the graph of $f(x)$

(iii) Find the area bounded by the graph of $f(x)$ and the $x-$axis between the lines $x=-1$ and $x=1$

(c) A is the point $(-1,2)$, B is the point $(2,3)$ and C is the point $(3,5)$. P is a point which divides BC in the ratio 3 : 4 and Q lies on AB such that $AQ=\frac{2}{5}AB$.

(i) Find the coordinates of P

(ii) Find the coordinates of Q.

2. (a) (i) Solve the equation $\log_3 x-\frac{4}{\log_3 x}+3=0$

(ii) Find the center and the radius of the circle given by the equation $4x^2+4y^2-6x+10y-1=0$.

(b) The number of units N, of electricity used by a household after t months is given by $N=30(1+e^{kt})$ where k is a constant.

(i) Find the value of k if 270 units were used by the household at the end of one month.

(ii) Find in simplified form ,the exact value of the number of units used by the household at the end of three months.

(c) Let $f(x)=\frac{2x-3}{x-2}$ be a rational function.

(i) Find all the vertical and horizontal asymptotes of $f(x)$

(ii) Sketch the graph of $f(x)$

3. (a) (i) Differentiate $y=a^{x^2}-\cos\left(\frac{1}{x}\right)$

(ii) Find $f'(3)$ given that $f(x)=\ln(x^3-3x)$

(b) (i) Find the inverse of the matrix $A=\begin{pmatrix}3 & -1 & 2\\ 1 & 1 & 1\\ 2 & 2 & -1\end{pmatrix}$

(ii) Use your inverse to solve the system of linear equations

$$3x-y+2z=4$$
$$x+y+z=2$$
$$2x+2y-z=3$$

(c) Evaluate the following integrals

(i) $\int\frac{1}{\sqrt{x}}dx$

(ii) $\int\frac{x+3}{x^2-4}dx$

(iii) $\int xe^{3x}dx$

4. (a) (i) The first three terms in the expansion of $\left(1+\frac{x}{p}\right)^n$ in ascending powers of x are $1+x+\frac{9}{20}x^2$. Find the values of n and p.

(ii) Find the modulus and the argument of the complex number $z=\dfrac{\left[\sqrt{3}\left(\cos\frac{\pi}{6}+i\sin\frac{\pi}{6}\right)\right]^4}{\left(\cos\frac{\pi}{4}-i\sin\frac{\pi}{4}\right)^2}$.

(b) (i) Prove the identity $\sinh 2x=2\sinh x\cosh x$

(ii) Solve the equation $3\sinh x-\cosh x=1$

(c) (i) Find the derivative of $f(x)=\tan^{-1}x$

(ii) The derivative of a function $f(x)$ is $f'(x)=x^2-\frac{2}{x}$. If $f(1)=\frac{7}{3}$, find the function $f(x)$.

5. (a) (i) Factorize the determinant $\begin{vmatrix}x & x & x\\ x & y & y\\ x & y & z\end{vmatrix}$

(ii) Use Cramer's rule to solve the system of linear equations

$$x+2y+3z=6$$
$$2x+y+z=5$$
$$3x+y-2z=1$$

(b) (i) Express $\frac{x+5}{(1+3x)(2-x)}$ into partial fractions

(ii) Find the first three terms in the expansion in ascendind powers of x of $\frac{x+5}{(1+3x)(2-x)}$ and state the range of values for which your expansion is valid.

(c) (i) Find the equation of the tangent and the equation of the normal to the graph of the function $f(x)=x+\frac{1}{x}$ at the point $P(1,2)$.

(ii) Find $\frac{dy}{dx}$ given that $x^2y-y^2-x=2$

6. (a) (i) Sketch the graph of the function $f(x)=x(x-2)$ for values of x in the interval $-2\le x\le 4$

(ii) Find the area bounded by the curve $f(x)=x(x-2)$ and the $x-$ axis between $x=-1$ and $x=2$

(b) Let $f(x)=(x^2-9)^2$

(i) Find the relative maxima and minima points of $f(x)$

(ii) Determine intervals where the function is increasing.

(c) (i) Evaluate $(1+i)^{10}-(1-i)^{10}$

(ii) Find the square roots of $z=\frac{1}{2}(-1+i\sqrt{3})$

7. (a) A circle C_1 has its center at $(-2,5)$ and is tangent to the line $x+3y-9=0$

(i) Find the equation of the circle C_1

(ii) Another circle C_2 concentric with the circle C_1 passes through the point $(2,2)$. Find the equation of the circle C_2

(b) Given that $2\log_y x+2\log_x y=5$

(i) show that $\log_y x$ is either 2 or $\frac{1}{2}$

(ii) Hence find all values of x and y which also satisfy simultaneously the equation $xy=27$

(c) Evaluate the following integrals

(i) $\int_0^{2\sqrt{3}}\frac{3x}{\sqrt{x^2+4}}dx$

(ii) $\int_{\frac{\pi}{6}}^{\frac{\pi}{2}}\sin^2 x\,dx$

UNIVERSITY OF ZAMBIA

UNIVERSITY SECOND SEMESTER EXAMINATIONS
APRIL - 2010

MATHEMATICS M114 – MATHEMATICAL METHODS II B

INSTRUCTIONS: Attempt any five (5) questions. You are required to show all your working for full credit. Calculators are not allowed.

TIME ALLOWED: ~~Answer All Questions~~. Three Hours

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1. (a) (i) State the period and amplitude of the function $f(x) = \cos 2x$.

(ii) Sketch the curves of $f(x) = \cos 2x$, $g(x) = 7\cos x$ and $h(x) = 7\cos x + 3$ on the same plot.

(iii) Mark the points of intersection of curves $f(x)$ *and* $h(x)$ on your graph without specifying them.

(iv) Find all solutions of the equation $\cos 2x = 7\cos x + 3$ for $0 \leq x \leq 360°$.

(b) Consider a parallelogram $ABCD$ in which $\overrightarrow{AB} = \vec{a}$ and $\overrightarrow{AD} = \vec{b}$

(i) Find $\overrightarrow{AC}$ and $\overrightarrow{BD}$ in terms of $\vec{a}$ and $\vec{b}$.

(ii) Assuming scalar product of vectors distributes addition, show that $(\vec{a} + \vec{b}).(\vec{b} - \vec{a}) = |\vec{b}|^2 - |\vec{a}|^2$

(iii) If $|\vec{b}| = |\vec{a}|$ in (ii), what would you conclude for parallelogram $ABCD$?

(c) Find the solution of the differential equation $(1 + \cos x)\,dy + \sin x\,dx = 0$, given that $y = 0$ at $x = \frac{\pi}{2}$

2. (a) Find $\frac{dy}{dx}$ given that:

(i) $y = x\sin x^2$

(ii) $y = x\sin^2 x$

(iii) $y = \frac{\sqrt{x^2+1}}{x}$

(b) Consider the function $f(x) = \frac{x}{1+x^2}$:

(i) Show that f is an odd function

(ii) Find the intervals on which the graph of f is increasing and/ or decreasing.

(iii) Find the intervals on which the graph of f is concave up and/ or down.

(iv) Compute $\lim_{x\to\infty} \frac{x}{x^2+1}$

(v) Find horizontal asymptotes to the curve if there is any

(vi) Sketch the graph of $f(x)$.

(vii) Find the area bounded by the curve $f(x)$, the x −axis and the ordinates $x = -1$ and $x = 1$

(c) A capacitor is discharging with a growth factor of 0.5 per second. Let I_0 represent the charge at $t = 0$ (initial charge) and $I(t)$ denote the charge after t seconds.

(i) Write down the charge after 1 second, 2 seconds and t seconds.

(ii) Find the time when the charge will be $\frac{1}{8}$ of the initial change.

3. (a) (i) Sketch the graph of $y = e^{-x}, x \geq 0$

(ii) Sketch the graph of $y = -e^{-x}, x \geq 0$ and state the horizontal asymptote to the curve y

graph

(iii) Draw the of $y = 1 - e^{-x}, x \geq 0$ indicating the point where the graph cuts the y −axis

(iv) Find the area bounded by the curve $y = 1 - e^{-x}$, the x −axis and the ordinate $x = 1$

(b) Evaluate the following integrals:

(i) $\int \frac{\sec^2 x}{1+\tan x} dx$

(ii) $\int \frac{\sec^2 x}{1+\tan^2 x} dx$

(iii) $\int \cos^3 t \, dt$

(c) (i) expand $\sqrt{1+x}$ as far as the term in x^3

(ii) Can you approximate $\sqrt{50}$ by writing $\sqrt{50} = \sqrt{1+49}$ and using expansion of part (i). Explain.

4. (a) (i) Find r and α such that $\cos\theta - \sin\theta = r\cos(\theta + \alpha)$

(ii) Find the maximum value of $f(\theta)$ where $f(\theta) = \cos\theta - \sin\theta$ and find θ at which $f(\theta)$ is maximum

(b) (i) Given the points $A(2,0,0)$, $B(0,1,1)$ and $C(1,2,1)$, find the area of the triangle ABC

(ii) Show that the vectors $\vec{U} = 2i - j + k$ and $\vec{V} = -i + j + 3k$ are perpendicular to each other

(iii) Find the work done by the force $F = 3i + j + k$ in moving an object from $A(2,0,0)$ to $B(2,1,1)$.

(c) The height in meters, of a rocket t minutes after blast-off is given by $h(t) = \frac{1}{4}t(24t - t^3)$.

(i) Find the velocity of the rocket at time t.

(ii) Find the maximum velocity.

5. (a) Given $\left(2x - \frac{1}{x^2}\right)^5$

(i) State the r^{th} term in the binomial expansion of the above expression

(ii) Find the coefficient of the term in $\frac{1}{x}$ in the binomial expansion of the above expression.

(b) Evaluate the following integrals:

(i) $\int_0^{\pi/2} x \sin 2x \, dx$

(ii) $\int \frac{x+2}{x^2+1} dx$

(iii) $\int \frac{x+2}{x^2-1} dx$

(c) (i) Sketch the graphs of $f(x) = \log_{\frac{1}{2}} x$ and $g(x) = \left(\frac{1}{2}\right)^x$ on the same plot

(ii) Find values of x which satisfy the inequality $\log_{\frac{1}{2}} x > \log_{\frac{1}{2}} 2$

(iii) Write the following as a single term: $2 \ln x + \ln 5 - \ln 3 \log_2 x$

6. (a) given matrix $A = \begin{pmatrix} -2 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & \frac{1}{2} \end{pmatrix}$, find the following:

(i) $det\ A$

(ii) A^{-1}

(iii) A^2 and A^3

(iv) Prove the following by mathematical induction:

$A^n = \begin{pmatrix} (-2)^n & 0 & 0 \\ 0 & (5)^n & 0 \\ 0 & 0 & \left(\frac{1}{2}\right)^n \end{pmatrix}$ where n is a positive integer.

(b) (i) The volume of a spherical balloon is $V = \frac{4}{3}\pi r^3$, where r is the radius. If $r = 5$ and $\frac{dr}{dt} = 2$ at time $t = 1$, find $\frac{dv}{dt}$ at that instant. State if the balloon is expanding or contracting

(ii) The curve $x^2 + xy + y^2 = 3$ has two tangents at $x = 1$. Find the equations of these two tangents.

(c) Given the function $f(x) = arc\sin x$

(i) State the domain and range of f

(ii) Find values of $arc\sin 1$, $arc\sin -\frac{\sqrt{3}}{2}$ and $arc\sin\left(\frac{1}{2}\right)$

(iii) Find $\frac{d}{dx}(arc\sin x)$

(iv) Using your formula of part (iii), find $\frac{d}{dx}(arc\sin x^2)$

END OF EXAMINATION

$$\frac{dV}{dt} = \frac{dr}{dt} \times \frac{dV}{dr}$$

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF MATHEMATICS AND STATISTICS

2010 ACADEMIC YEAR
SECOND SEMESTER EXAMINATIONS

M162: INTRODUCTION TO MATHEMATICS, PROBABILITY AND STATISTICS II

TIME ALLOWED: Three (3) Hours

INSTRUCTIONS:
1. Answer any **Five** (5) Questions
2. Show All Essential Working
3. Calculators are NOT allowed
4. Express All Answers in Simplest Form

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1. (a) (i) Evaluate $\lim_{x \to -2} \dfrac{x^3+8}{x^2-4}$

(ii) Find the derivative of $f(x) = \dfrac{x-2}{x}$ from first principles.

(b) Find the gradient of the curve $y = 2x^3 - x + 5$ at the point A(1, 6). Hence or otherwise, find the
(i) equation of the normal to the curve at point A.
(ii) point at which the normal in (i) meets the line $y = x - 1$.

(c) Evaluate $\int_{-2}^{-1} \dfrac{x}{\sqrt{x+2}}\, dx$

2. (a) Find $\dfrac{dy}{dx}$ if $y = \dfrac{2x+3}{4x-1}$

(b) Find all the critical points of the function $f(x) = x^3 - 3x^2 - 6$, stating whether they are minimum, maximum or inflection points. Hence or otherwise sketch the graph of $f(x)$.

(c) Find
(i) $\int \dfrac{2x-3}{(x^2-3x+1)^2}\, dx$
(ii) $\int \sin^3 x \; dx$

3. (a) Given the function $f(x) = \begin{cases} x+1 \ , & x < -1 \\ (x+1)^2, & x \geq -1 \end{cases}$

(i) Determine if $f(x)$ is continuous at $x = -1$.

(ii) Sketch the graph of $f(x)$.

(b) The probability function for a discrete random variable X is given by

x	-2	-1	0	1	2	3
$P(X = x)$	0.05	0.2	k	0.25	0.1	0.1

Find

(i) the value of k.

(ii) the cumulative distribution function of X .

(iii) $P(-1 \leq X < 2)$

(iv) $E(X)$

(c) Evaluate $\int \frac{dx}{x^2 + 4}$

4. (a) The following data represent marks of 20 students in a statistics quiz.

11 26 16 22 13 19 13 24 20 16
18 21 17 20 19 14 10 16 18 15

(i) Construct a grouped frequency distribution table taking equal class intervals 10 – 12, 13 – 15, ...

(ii) Construct a frequency histogram using the classes in (i).

(iii) Construct a frequency polygon as a separate graph using the classes in (i).

(b) A continuous random variable X has the following probability density function $f(x) = \begin{cases} k(1-x^2), & -1 \leq x \leq 1 \\ 0 \ , & \textit{otherwise} \end{cases}$

(i) Show that $k = \frac{3}{4}$.

(ii) Find $P(-1 \leq X \leq 0)$

(iii) Find $E(X)$

(c) Find $\frac{dy}{dx}$ if $y = \tan^{-1}\left(\frac{1}{\sqrt{1-x^2}}\right)$

5. (a) Given the set of numbers

4 6 5 2 1 9 5 8

Find the

(i) range
(ii) mode
(iii) median
(iv) mean using an assumed mean of $\bar{x}_a = 5$
(v) variance

(b) A bag contains 10 counters of which 4 are blue, 3 are green and 3 are yellow. Counters are removed at random, one at a time without replacement. Find the probability that the

(i) first one drawn is green.
(ii) second one drawn is blue, given that the first one drawn is yellow.
(iii) first two counters are of the same colour.
(iv) first counter drawn is green, given that the second one is blue.

(c) Evaluate $\int x\, e^{2x}\, dx$

6. (a) From a group of 10 people with different ages, 4 are to be chosen to serve on a committee.

(i) In how many ways can the committee be chosen?
(ii) Among the 10 people there is one married couple. Find the probability that both husband and wife are chosen.
(iii) Find the probability that the 3 youngest people will be chosen.

(b) Consider the word SIMMS. Find the

(i) number of ways of arranging all the letters of this word in a line.
(ii) probability that 3 letters chosen from this word are all consonants.
(iii) probability that 4 letters chosen from the word contain a vowel.

(c) Evaluate $\int \frac{x+2}{x^2-1}\, dx$

END OF EXAMINATION

UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2011 ACADEMIC YEAR

SECOND SEMISTER FINAL EXAMINATIONS

M212: MATHEMATICAL METHODS IV

TIME ALLOWED: Three (3) Hours

INSTRUCTIONS: Answer any **Five** (5) questions. All questions carry equal marks. You must show detailed working for full credit.

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1. a) Find the general series solution of the given differential equation.

$$(3x + 2x^2)\frac{dy}{dx} = 6y(1 + x)$$

b) Find the length of one arc of the Cycloid

$$R = a(t - sint)i + a(1 - cost)j,\ 0 \le t \le 2\pi$$

c) State if a function has a limit, if not state why?.

$$\lim_{\substack{x\to 0\\ y\to 0}} \frac{\sin(2x^2+2y^2)}{x^2+y^2}$$

2. a) Let $f(t) = t^2$, $\gamma(t) = ti + t^2j + 2tk$, $\beta(t) = (1 + t^2)i + (2 - t)j + 3k$,

$d(\gamma \cdot \beta)/_{dt}$ in two different ways and confirm your solution

b) Given the curve whose vector is

$R = (3cost)i + (3sint)j + t^2k$. Compute the curvature.

c) The legs of a right Triangle were measured and found to be 120 ft and 160 ft with an error of at most $1ft$. Find an approximation for the maximum error when the area and the hypotenuse are computed from these measurements.

3. a) Show that the distance from the point P to the plane through the three points A , B and C is given by the formula

$D = \frac{AP \cdot AB \times AC}{|AB \times AC|}$. Hence find the distance given that $P(2,2,9)$, $A(2,1,3)$, B $(3,3,5)$ and $C(1,3,6)$.

b) Find the point of intersection of the line $\frac{x-7}{3} = \frac{y-3}{1} = \frac{z+1}{-2}$ with the plane $2x + y + 7Z - 3 = 0$

c) Prove that the given differential equation is exact and solve

$$(3x^2y^2 + 2xy^4)dx + (2x^3y + 4x^2y^3 + 1)dy = 0$$

4. a) Use Chain rule for partial derivative to calculate $\frac{\partial \omega}{\partial t}$

$$\omega = e^{x^2+y^2} \quad , \; x = sint \, , \quad y = cost.$$

b) Find three positive numbers whose product is as large as possible, and such that the first plus twice the second plus three times the third is 54

c) Find a function $g(x)$ such that the function

$$f(x.y) = \begin{cases} \frac{x^2-4y^2}{x-2y} & if \; x \neq 2y \\ g(x) & if \; x = 2y \end{cases}$$ is continuous at every point in R^2.

5. a) Solve the given differential equation

$$x^2dy + (y^2 - xy)dx = 0$$

b) Solve the initial value problem

$$y'' - y' - 2y = 10sinx \, , \; y\left(\tfrac{1}{2}x\right) = -3 \, , \; y'\left(\tfrac{1}{2}x\right) = -1$$

c) State the Bernoulli's equation and solve the differential equation

$$y' - \frac{2}{x}y = y^4x$$

6. a) Solve the given differential equation using Variation of parameters

$$y'' + 2y' + y = e^x$$

b) Find the Volume of the parallelepipiped if one vertex is at the origin and three of the edges are the vectors

$$A = i - j - k, \quad B = i + 3j + k \; and \; 2i + 3j + 5k$$

c) Find the Critical point of the given function and determines it's maxima, and minima or saddle point $f(x,y) = x^2 + 6xy + 2y^2 + 16x + 6y.$

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2011 ACADEMIC YEAR

SECOND SEMISTER FINAL EXAMINATIONS

M222: **LINEAR ALGEBRA II**

TIME ALLOWED: Three (3) Hours

INSTRUCTIONS: Answer any **Five** (5) questions and **show** all necessary working

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1. (a) Define /state the following terms.

   (i) Inner product of a vector space V.

   (ii) Diagonalizable matrix A.

   (b) (i) Prove this inequality $|\langle v, w\rangle| \leq \|v\| \cdot \|w\|$ with the standard inner product where $v, w \in V_n(\mathbb{R})$.

   (ii)Using the inner product $< w, z >= w_1\bar{z_1} + 2w_2\bar{z_2} + 3w_3\bar{z_3}$ on $V_4(\mathbb{R})$.Verify the inequality in b(i) where $w = (i, -i, 1 + 2i)$ and $z = (1, -i, 1 + i)$.

   (c) Compute the spectral decomposition of the matrix $A = \begin{pmatrix} 0 & 0 & -2 \\ 0 & -2 & 0 \\ -2 & 0 & 3 \end{pmatrix}$ with eigenvalues $\lambda = -2, 4, -1$.

2. (a) Define/state the following terms.

   (i) Orthogonal basis

   (ii) Eigenspace of a Matrix A.

   (b)Find the orthonormal basis of the subspace U of $V_4(\mathbb{R})$ such that

$$U = \left\{ \begin{pmatrix} x \\ y \\ z \\ w \end{pmatrix} | x - y - z + w = 0 \text{ and } x + z = 0 \right\}.$$

(c)If $\{u_1, u_2, \ldots, u_n\}$ is an orthonormal basis, prove that every vector in $v \in V$ can be expressed as $v = \sum_{i=1}^{n} \langle v, u_i \rangle u_i$.

3. (a) Define the terms.

(i) Direct sum of two subspaces of a vector space V.

(ii)Orthogonal complement of a subspace U of a vector space V.

(b) Prove that

(i) *if* W is a subspace of V, then $W^{\perp}$ is also a subspace of V.

(ii) If $V = U + W$, then $V = U \oplus W$ if and only if $U \cap W = \{0\}$.

(c) Obtain the QR-decomposition of the matrix $A = \begin{bmatrix} 1 & 3 \\ 1 & -1 \end{bmatrix}$.

4. (a) Define the following terms

(i) a linear transformation T.

(ii) an eigenvector of a linear transformation T.

(b)Prove that if V and W are finite dimensional vector spaces over K and T a linear transformation from V into W, then

$$dim_K \ker T + \dim_K Im\, T = dim_K V \ (nullity\, T + rank\, T = dim_K V).$$

(c) Find an orthogonal matrix P for which the matrix PAP^t *or* P^tAP is diagonal where

$$A = \begin{pmatrix} 0 & 2 & 2 \\ 2 & 0 & 2 \\ 2 & 2 & 0 \end{pmatrix}.$$

5. (a) Define/state the following .

(i) Orthogonal matrix A.

(ii) Principal axis theorem.

(b)If A is an orthogonal matrix. Prove that,

(i) the determinant ,$\det(A) = \pm 1$

(ii)$\|Ax\| = \|x\|$ for all $x \in V_n(\mathbb{R})$.

(c)(i)Prove that, if λ is an eigenvalue of a matrix A with eigenvector x. If k is a positive integer, then λ^k is an eigenvalue of A^k with corresponding eigenvector x.

(ii)Show that any two similar matrices have the same characteristic polynomials.

6. (a)Define the following terms.

(i) Symmetric bilinear form.

(ii) Quadratic form on V.

(b)Suppose q is a quadratic form and f be the underlying symmetric bilinear form.

If $u, v \in V$, Show that

$$f(u,v) = {}^1/_2\big(q(u+v) - q(u) - q(v)\big).$$

(c)(i)Determine the definiteness of the following quadratic forms.

(a) $q(x,y) = 5x^2 - 4xy + 5y^2$ (b) $q(x,y) = 2x^2 + 2xy$

(ii)Draw the graph of the conic section $27x^2 - 18xy + 3y^2 = 3$.

END OF EXAM

The University of Zambia
School of Natural Sciences
Department of Mathematics & Statistics

2010/11 ACADEMIC YEAR
SECOND SEMESTER FINAL EXAMINATIONS

M232 – REAL ANALYSIS II

27th May, 2011

INSTRUCTIONS: 1. Answer any **Five (5)** Questions Only.

2. All questions carry equal marks.

3. Indicate the question number for each question answered on the cover of the main answer book.

TIME ALLOWED: **Three (3)** hours.

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1. (a) (i) Give the definition of a sequence.

(ii) When does a sequences $\{x_n\}_{n=1}^{\infty}$ of real numbers diverge to $+\infty$?

(iii) Give the definition of a convergent sequence of real numbers.

(b) Prove each of the following:

(i) The sequence $\{x_n\}_{n=1}^{\infty}$ defined by $x_n = \dfrac{n^2-1}{2n+3}, (n \in \mathbf{N})$ has the property that $x_n \to +\infty$ as $n \to +\infty$.

(ii) If $|x| < 1$ then $\lim_{n\to\infty} x^n = 0$.

(c) Let $\{x_n\}_{n=1}^{\infty}$ be a non-decreasing sequence of real numbers. Prove that either

(i) $\{x_n\}_{n=1}^{\infty}$ is bounded above and convergent, or

(ii) $\{x_n\}_{n=1}^{\infty}$ is not bounded above and $x_n \to \infty$ as $n \to \infty$.

2. (a) Let $\{x_n\}_{n=1}^{\infty}$, $\{y_n\}_{n=1}^{\infty}$ and $\{z_n\}_{n=1}^{\infty}$ be three sequences of real numbers such that $x_n \le z_n \le y_n$ for all $n > N_0$, for some positive integer N_0. Prove that if $\lim_{n\to\infty} x_n = l$ and $\lim_{n\to\infty} y_n = l$, then $\lim_{n\to\infty} z_n = l$.

(b) For $\alpha \in \mathbf{R}$, let $\{n^{\alpha}\}_{n=1}^{\infty}$ be a sequence of real numbers. Prove that

$$\lim_{n\to\infty} n^{\alpha} = \begin{cases} \infty \text{ if } \alpha > 0 \\ 1 \text{ if } \alpha = 0 \\ 0 \text{ if } \alpha < 0 \end{cases}$$

(c) Prove that a sequence $\{x_n\}_{n=1}^{\infty}$ converges to l if and only if every subsequence of $\{x_n\}_{n=1}^{\infty}$ converges to l.

3. (a) Give the definition of each of the following:

(i) A Cauchy sequence.

(ii) A limit superior.

(iii) A limit inferior.

(b) Prove that every Cauchy sequence in **R** is convergent in **R**.

(c) Let $\{x_n\}_{n=1}^{\infty}$ be a bounded sequence in **R** and l is a real number. Prove that $\lim_{n\to\infty} x_n = l$ if and only if $\limsup_{n\to\infty}\{x_n\} = l = \liminf_{n\to\infty}\{x_n\}$.

4. (a) Give the definition of a convergent infinite series of real numbers.

(b) Let $\{a_n\}_{n=1}^{\infty}$ be a sequence of positive real numbers and p be any positive integer. Prove that the two infinite series $\sum_{n=1}^{\infty} a_n$ and $\sum_{n=p}^{\infty} a_n$ converge together.

(c) Let $\sum_{n=1}^{\infty} c_n$ be an infinite series of positive terms that converges to a real number.

(i) If $\{\gamma_n\}_{n=1}^{\infty}$ is a bounded sequence of positive real numbers, prove that $\sum_{n=1}^{\infty} \gamma_n c_n$ converges.

(ii) Let $\sum_{n=1}^{\infty} a_n$ be an infinite series of positive terms such that there exists a positive integer M and for all $n \geq M$, $a_n \leq c_n$. Prove that $\sum_{n=1}^{\infty} a_n$ converges.

5. (a) Let $\{b_n\}_{n=1}^{\infty}$ be a sequence of positive real numbers and p a positive integer. Prove that the two infinite series $\sum_{n=1}^{\infty} b_n$ and $\sum_{n=p}^{\infty} b_n$ diverge together.

(b) Let $\sum_{n=1}^{\infty} d_n$ be an infinite series of positive terms that diverges to $+\infty$.

(i) If $\{\delta_n\}_{n=1}^{\infty}$ is a bounded sequence of positive real numbers, prove that terms $\sum_{n=1}^{\infty} \delta_n d_n$ diverges.

(ii) Let $\sum_{n=1}^{\infty} a_n$ be an infinite series of positive terms such that there exists a positive integer M such that if $n \geq M$ then $d_n \leq a_n$. Prove that $\sum_{n=1}^{\infty} a_n$ diverges.

(c) Show that the harmonic series $\sum_{n=1}^{\infty} \frac{1}{n}$ diverges. Deduce that if p is a real number less than 1 then the harmonic series $\sum_{n=1}^{\infty} \frac{1}{n^p}$ diverges.

6. (a) Let $\sum_{n=1}^{\infty} c_n$ be an infinite series of positive terms that converges to a real number. Suppose that the terms of a given infinite series $\sum_{n=1}^{\infty} a_n$, also of positive terms, satisfies that there exists a positive integer M such that if $n \geq M$ the condition $\frac{a_{n+1}}{a_n} \leq \frac{c_{n+1}}{c_n}$ holds. Prove that $\sum_{n=1}^{\infty} a_n$ converges to a real number.

(b) Let $\sum_{n=1}^{\infty} d_n$ be an infinite series of positive terms that diverges to $+\infty$. Suppose that the terms of a given infinite series $\sum_{n=1}^{\infty} a_n$, also of positive terms, satisfies that there exists a positive integer M such that if $n \geq M$ the condition $\frac{a_{n+1}}{a_n} \geq \frac{d_{n+1}}{d_n}$ holds. Prove that $\sum_{n=1}^{\infty} a_n$ diverges to $+\infty$.

(c) Let $\sum_{n=1}^{\infty} a_n$ be an infinite series of positive terms and let a be a real number such that $0 < a < 1$.

(i) Suppose that there exists a positive integer M such that if $n \geq M$ then $\frac{a_{n+1}}{a_n} \leq a < 1$. Prove that $\sum_{n=1}^{\infty} a_n$ converges.

(ii) Suppose that there exists a positive integer M such that if $n \geq M$ then $\frac{a_{n+1}}{a_n} \geq 1$. Prove that $\sum_{n=1}^{\infty} a_n$ diverges.

7. (a) Let $\sum_{n=1}^{\infty} a_n$ be an infinite series of real numbers that converges to a real number.

(i) Prove that $\lim_{n\to\infty} a_n = 0$

(ii) If $r_n = \sum_{k=n+1}^{\infty} a_k$, prove that $\lim_{n\to\infty} r_n = 0$.

(b) Define each of the following:

(i) An absolutely convergent infinite series of real number terms.

(ii) A conditionally convergent infinite series of real number terms.

(c) Prove that every absolutely convergent infinite series of real number terms is unconditionally convergent.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2010 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

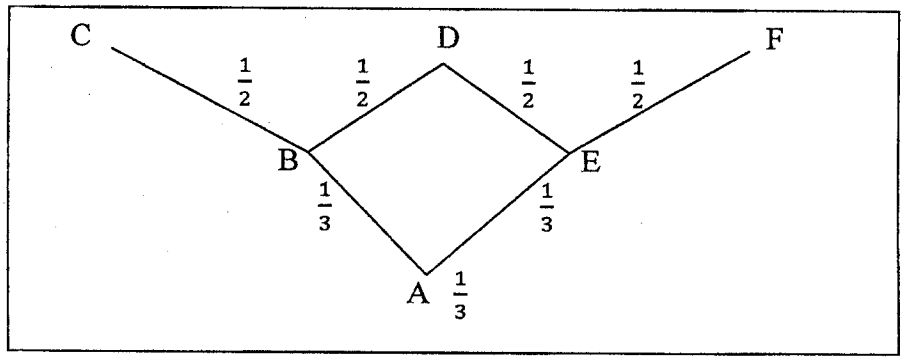
M292: INTRODUCTION TO PROBABILITY

INSTRUCTIONS:

1. Answer any FIVE (5) questions.
2. Calculators are allowed.
3. You may use statistical tables provided if necessary.
4. Show all your work to earn full marks.

TIME: THREE (3) Hours

Q [1] In the picture below a woman is at point A which is her home. If she makes a 1 step trip she will be at B or E. If she makes a 2 step trip from her home she will be at C or D or F.



The probability of her decision to move from one point to another are indicated along the paths. The probability that she does not move from her home is $\frac{1}{3}$.

(a) She intends to either make a 2 step trip to go and sell some products or sell them at her home.

(i) Copy and complete the probability table below.

Selling Point	**A**	**C**	**D**	**F**
Probability of being there				

(ii) Her possible earning at each selling point (in 100,000 of Kwacha) are shown below. Find her expected sales if she had to sell at these points.

Selling Point	**A**	**C**	**D**	**F**
Possible Earnings	K1	K2	K3	K1.8

(b) Calculate the standard deviation of her earnings from the sales.

(c) Given that she decides not to sell at home but make a 2 step trip, carry out the following.

(i) Copy and complete the conditional probability table below.

Selling Point	**C**	**D**	**F**
Probability of being there	$Pr(C/A^C)$	$Pr(D/A^C)$	$Pr(F/A^C)$

(ii) Find her expected sales if she does not sell at home.
(iii) Would her decision not to sell at home be profitable?

Q[2] (a) Suppose that in a soccer game ZANACO beat Kabwe Warriors 3 to 2.

(i) Determine the number of ways in which the goals could have been ordered (i.e. scoring order).
(ii) Find the probability that the goals were scored in the order KZZZK, where Z stands for a ZANACO goal and K stands for a Kabwe Warriors goal.
(iii) Find the probability that the score was 2-2 at some stage.

(b) Suppose that A and B are events in the sample space S:
(i) If $B \subset A$ show that $Pr(A \cap B^C) = Pr(A) - Pr(B)$
(ii) If A and B are disjoint, under what conditions are A^C and B^C disjoint?

(c) A campus student club distributed material about membership to new students attending an orientation meeting. Of those receiving this material 40% were men and 60% were women. Subsequently, it was found that 7% of the men and 9% of the women who received this material joined the club.

(i) Find the probability that a randomly chosen new student who receives the membership material will join the club.
(ii) Find the probability that a randomly chosen new student who joins the club after receiving the membership material is a woman.

Q[3] (a) Suppose that two random variables X and Y have joint probability density function given by,

$$f(x,y) = \begin{cases} \frac{1}{6}e^{-\left(\frac{x}{2}+\frac{y}{3}\right)} & \text{for } 0 < x < \infty \text{ and } 0 < y < \infty \\ 0, & \text{otherwise} \end{cases}$$

(i) Determine the marginal distribution of X.
(ii) Determine the marginal distribution of Y.
(iii) Are X and Y independent random variable?
(iv) Find Pr(1< X, 2< Y)

(b) Suppose that the Road Transport and Safety Agency (RTSA) determines that on average, 4 breakdowns occur along the Great East Road per day. Assume that the number of breakdowns X, follows a Poisson distribution.
(i) Write down the probability density function of X.
(ii) Find the probability that on any given day there will be fewer than two breakdowns on the Great East Road.
(iii) Find the probability that on any given day there will be more than five breakdowns on the Great East Road.

(c) Suppose that a team of five athletes from a group of four women athletes and five men athletes is to be chosen to represent the nation at some international event. Determine the following:
(i) The number of ways officials can select the five athletes.
(ii) The number of ways officials can select the five athletes if two are to be women and the rest men.
(iii) Find the probability that a particular woman athlete, who is so excited, will be selected if the team consists of two women and three men.

Q[4] Suppose that a random variable X has the following probability density function.

$$f(x) = \begin{cases} x, & for\ 0 < x < 1 \\ 2 - x, & for\ 1 < x < 2 \\ 0, & otherwise \end{cases}$$

(a) (i). Draw the graph of the probability density function f(x).
(ii) Show that f(x) is indeed a probability density function.

(b) Find Pr(1.5 < X/1< X)

(c) (i) Find the expected value of X.
(ii) Find the Variance of X.

Q[5] (a) Mention one major property of the normal distribution.

(b) (i) State, do not derive, the moment generating function, $M_X(t)$ of the normal random variable X with mean μ and variance σ^2.

(ii) Show that: $\left.\frac{d^2M_X(t)}{dt^2}\right|_{t=0} - \left(\left.\frac{dM_X(t)}{dt}\right|_{t=0}\right)^2 = \sigma^2$

(c) Suppose that the weight of Nshima a randomly selected hungry man takes with beef follows a normal distribution with mean 800 g and standard deviation 190 g.

(i) Determine the proportion of men who will take beyond 600 g of Nshima in a given meal with beef.

(ii) What proportion of men will take Nshima within 300 g of the mean?

(iii) 70% of the men will eat less than what weight of Nshima?

Q[6] (a) A discrete random variable X has a moment generating function $M_X(t)$ given by $M_X(t) = (0.8 + 0.2e^t)^{10}$. Determine the following:

(i) The value of E[X(X-1)]

(ii) The value of its Coefficient of Variation given by $CV = \frac{\text{Mean of X}}{\sqrt{\text{Variance of X}}} \times 100$

A researcher suspects that the number of between-meal snacks eaten by students in a day during final examination might depend on the number of tests a student had to take on that day. The table below show joint probabilities, estimated from a survey. For question (b) and (c) refer to the table below.

	Number of Tests (X)			
Number of Snacks (Y)	0	1	2	3
0	0.07	0.09	0.06	0.01
1	0.07	0.06	0.07	0.01
2	0.06	0.07	0.14	0.03
3	0.02	0.04	0.16	0.04

(b) (i) Find the marginal distribution of X

(ii) Find Pr($1 < X \leq 3, 0 \leq Y \leq 2$)

(c) (i) Find Pr(Y| X=2), the probability distribution of Y given X = 2. Keep the probability values in proper fraction form i.e., $\frac{a}{b}$.

(ii) Find E(Y|X=2), the expected value of Y given X = 2.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2011 ACADEMIC YEAR

SECOND SEMISTER FINAL EXAMINATIONS

M325-**GROUP AND RING THEORY**

TIME ALLOWED: Three (3) Hours

INSTRUCTIONS: Answer **Five** (5) questions, 4 from **section A** and one from **section B** .**Show** all necessary working

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SECTION A : GROUP THEORY

1. (a) Define/state the following

   (i) A group

   (ii) Center of a group.

   (b)Prove the following.

   (i) the intersection of two subgroups, is also a subgroup

   (ii)The center Z(G) of a group G is a normal subgroup of G.

   (c)(i)Determine whether the set $\langle \mathbb{Q}^+, * \rangle$ is a group or not where for any elements

   $a, b \in \langle \mathbb{Q}^+, * \rangle$ the binary operation $(*)$ is defined by $a * b = {}^{ab}/_{5}$.

   (ii)Determine the center of the symmetric group S_3.

2. (a) Define/state the following

   (i) Lagrange's theorem.

   (ii) Group homomorphism.

   (b) State and prove the first isomorphism theorem.

   (c)(i)Find the gcd(840,231) and express it as a linear combination $840s + 231t$ where s and t are integers.

   (ii) State the division algorithm theorem for integers.

3. (a) Define/state the following

(i)A normal subgroup

(ii) Sylow's third theorem.

(b)Prove the following

(i) A subgroup N is normal in a group G if and only if $gNg^{-1} = N$.

(ii) If every element in a group G is its own inverse, then the group is Abelian.

(c) Show if G is a group of prime order, then G is simple.

4. (a) Define/state the following

(i) Factor group.

(ii)An external direct product of groups $H_1, H_2, \ldots, H_n$.

(b)Let G be a group and Z(G) be the centre of G .Prove that if $G/Z(G)$ is cyclic, then G is an abelian

(c)(i)Let H be a subgroup of a group G of index 2.Show that H is a normal subgroup G.

(ii)Given $G = S_3$.If $H = \langle(12)\rangle$ and $K = \langle(13)\rangle$ are subgroups of S_3.Find HK and determine with reason whether or not HK is a subgroup of G.

5. (a) Define/state the following

(i) A Cycle on S_n .

(ii) Cayley theorem

(b)Prove the following.

(i)Let G be a group. For each $g \in G$, define a mapping $\alpha_g: G \to G$ by $\alpha_g(x) = gxg^{-1}$ for all $x \in G$. Show that for $g, h \in G$, $\alpha_g * \alpha_h(x) = \alpha_{gh}(x)$.

(ii)Evaluate the number of permutations in S_5 with same cycle structure as $\sigma = (142)(35)$.

(c) Let σ and τ be two disjoint cycles on S_n , show that $\sigma\tau = \tau\sigma$.

SECTION B: RING THEORY

6. (a) State/define the following.

(i)Integral domain

(ii) Sub-ring of a ring R .

(ii) Ideal of a ring R.

(b)Prove the following

(i) the intersection of two sub-rings is a sub-ring.

(ii)If φ is a ring homomorphism from R into $\tilde{R}$ with kernel $\varphi(I)$, then $\varphi(I)$ is an ideal of R.

(c)(i)Show that $R = \{a + b\sqrt{2} | a, b \in \mathbb{Z}\}$ is a field.

(ii) Prove that the residue class of $\mathbb{Z}$ modulo 5 ($\mathbb{Z}_5$) is an integral domain.

7. (a) define/state the following.

(i) Eisenstein Criterion for irreducibility.

(ii) Unique factorization domain.

(b) Show that If R is an integral domain, then R[x] is also an integral domain.

(c)(i)Determine the irreducibility in $\mathbb{Q}$[x] of polynomials $f(x) = 2x^4 + 3x^3 + 3x^2 + 9x + 6$ and $g(x) = x^4 + 15x^3 + 7$.

(ii)Find the roots of the equation $x^2 + 1 = 0$ in $\mathbb{Z}_5$.Hence show that the set

$\{a + bx | a, b \in \mathbb{Z}_5\}$ where $x^2 + 1 = 0$ in $\mathbb{Z}_5$, is not an integral domain.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

Department of Mathematics & Statistics

SECOND SEMESTER FINAL EXAMINATIONS

May, 2011

M412—FUNCTIONS OF A COMPLEX VARIABLE II

Time allowed : THREE(3) HOURS

Instructions : There are seven(7) questions. Answer **ANY FIVE (5)** questions. All questions carry equal marks. Show all your working to earn full marks.

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1. (a) State the Maximum Modulus Principle.

   (b) Use elementary methods to verify that $f(z) = 1 + \sin z$ satisfies the Maximum Modulus Principle in the unit disk $|z + \frac{\pi}{2}| \leq 1$.

   (c) In each case below write the principal part of the function at its isolated singularity. Then determine if that singularity is a pole, an essential singularity, or a removable singularity.

   (i) $f(z) = \frac{1}{z}e^z$.

   (ii) $f(z) = \frac{\sin z}{z}$.

2. (a) State and prove Jordan's Inequality.

   (b) Find the Laurent series expansion of

$$f(z) = \frac{1}{z(z^2 - 3z + 2)}$$

   in the annular domain $0 < |z| < 1$.

   (c) (i) State the Mean Value theorem.

   (ii) Hence, considering the function $f(z) = \sin z$ on the unit circle, show that

$$\int_0^{2\pi} \cos(\cos\theta)\sinh(\sin\theta)\mathrm{d}\theta = 0.$$

3. (a) State, without proof, Jordan's Lemma.

(b) By evaluating

$$\int_{\Gamma_R} \frac{(z+1)e^{iz}}{z^2 - \pi z + 1 + \frac{\pi^2}{4}} dz,$$

where Γ_R is a semi-circular arc of radius R centred on the origin in the upper half plane, and letting $R \to \infty$, find

$$I = \int_{-\infty}^{\infty} \frac{(x+1)\cos x}{x^2 - \pi x + 1 + \frac{\pi^2}{4}} dx.$$

(c) Use Contour integration to show that

$$\int_0^{\infty} \frac{x^2}{(x^2+1)(x^2+4)} dx = \frac{\pi}{6}.$$

4. (a) State and prove the Cauchy Inequality theorem.

(b) Verify the Cauchy Inequality theorem for the function $f(z) = \frac{2}{3z-1}$ if z lies on the circle $|z+1| = 1$.

(c) Show that the function

$$f_1(z) = \frac{1}{z^2+1}, \quad (z \neq \pm i)$$

is the analytic continuation of the function

$$f(z) = \sum_{n=0}^{\infty} (-1)^n z^{2n}$$

into the domain consisting of all the points in the complex plane except $z = \pm i$.

5. (a) Locate and identify the nature of the zeros of the function $f(z) = z \cot n\pi z$.

(b) State and prove the Residue Theorem.

(c) Use the Residue Theorem to show that

$$\int_0^\infty \frac{\sin x}{x(\pi^2 - x^2)} dx = \frac{1}{\pi}.$$

6. (a) (i) State Rouche's theorem.

(ii) Using Rouche's theorem, show that the roots of the equation $z^4 + 6z + 1 = 0$ lie within the circle $|z| < 2$ but one root lies inside the circle $|z| < \frac{3}{2}$.

(b) Evaluate

$$\int_C \frac{f'(z)}{f(z)} dz$$

if C is the circle $|z| = 3\pi$ for

$$f(z) = \frac{\sqrt{2} \sin z - 1}{(z-1)^2(z+5)}.$$

(c) (i) Find the Laurent series expansion of

$$f(z) = \frac{e^{-z}}{(z-2)^4}$$

in the domain $0 < |z - 2| < R$, for arbitrarily large R.

(ii) Hence find the residue of $f(z)$ at its singularity.

7. (a) By using the expansion of $\frac{1}{1+z}$, find the Maclaurin series expansion of

$$\text{Arctanz} = \int_0^z \frac{dt}{1+t^2}.$$

(b) Show that the equation $e^z - \lambda z^5 = 0$ with $|\lambda| > \frac{e^R}{R^5}$ has five roots inside the circle $|z| = R$.

(c) Evaluate the integral

$$I = \int_0^{2\pi} \frac{1}{(3 + 2\cos\theta)^2} d\theta.$$

END.

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF MATHEMATICS & STATISTICS

2010/2011 ACADEMIC YEAR
SECOND SEMESTER FINAL EXAMINATIONS

M462 Bayesian Inference and Discrete Analysis

Time Allowed: Three (3) Hours

Instructions:

1. You must write your **Computer Number** on each answer booklet used
2. There are Five (5) questions in this paper, Attempt **Any Four (4)** questions.
3. Show all the necessary working to get full credit
4. All questions carry equal marks

---

1. (a) Define the following:
   (i) Risk function
   (ii) Minmax decision function
   (iii) Bayes decision function

   (b) (i) Let T be a discrete lifetime random variable which takes the values t_j, $j = 1, 2, 3, \ldots\ldots$, show that

$$s(t) = \prod_{j:t_j<t}\left(1 - h(t_j)\right)$$

   (ii) Prove that if there is a function $d(x)$ that minimizes the posterior risk, then $d(x)$ is a Bayes decision function.

   (iii) Given the following loss function

	State of Nature	
Decision	H_0 true	H_0 false
Accept H_0	0	b
Reject H_0	a	0

Show that the Bayes action is to reject H_0 if and only if $\text{Prob}\{\theta \in \Omega_1 \mid \underline{X}\} > \frac{a}{a+b}$ for testing $H_0 : \theta \in \Omega_0$ *vs* $H_a : \theta \in \Omega_1$, $\Omega_0 \cap \Omega_1 = \phi$, and $\Omega_0 \cup \Omega_1 = \Omega$ the parameter space.

(c) A case – control study was conducted to investigate the relationship between physical activity and myocardial infarction (MI), (heart problem). A case is one with MI and a control is one without MI. The data is given below with Exposed = physical activity index ≤ 25000k cal/day.

Physical Activity	Cases	Controls	
≤ 25000 kcal/day	176	157	
> 25000 kcal/day	190	266	
			789

Cigarette smoking was suspected to be a confounder. To control for this , the data was separated into four categories; Never smoked, Exsmoker more than 10 years, Exsmoker less than 10 years and current smoker.

Never Smoked

Physical Activity	Cases	Controls	
≤ 25000	46	52	
> 25000	41	84	
			223

Ex smoker more than 10 years

Physical Activity	Cases	Controls	
≤ 25000	30	39	
> 25000	41	80	
			190

Ex smoker less than 10 years

Physical Activity	Cases	Controls	
≤ 25000	21	26	
> 25000	22	34	
			103

Current Smoker

Physical Activity	Cases	Controls	
≤ 25000	79	40	
> 25000	170	68	
			273

(i) Compute the crude odds ratio and interpret it
(ii) Compute the crude odds ratio for each of the four levels of smoking and interpret each
(iii) Compute the adjusted odds ratio and interpret it.

2. (a) Define the following:
(i) Mean risk
(ii) Domination of a decision function by another
(iii) Admissible decision function

(b) (i) Prove that if Ω is an interval and d^* is a Bayes estimator with respect to the prior *pdf* $g(\theta)$ such that $g(\theta) > 0$ for all $\theta \in \Omega$ and $R(\theta, d)$ is a continuous function of θ for all decision function d, then d^* is admissible.

(ii) Let T be a continuous lifetime random variable and hazard function $h(t) = g(t)e^{\eta}$, show that

$$f(t) = g(t)e^{\eta - G(t)e^{\eta}}$$

(iii) Derive the hazard function from its definition.

(c) Let T be a continuous lifetime random variable with the extreme value distribution, i.e

$$f(t) = \frac{1}{\beta} e^{\frac{1}{\beta}(t-\mu) - e^{\frac{1}{\beta}(t-\mu)}}, \quad \begin{matrix} -\infty < t < \infty, \beta > 0 \\ -\infty < \mu < \infty \end{matrix}$$

Find the following
(i) Cumulative distribution function
(ii) Survival function
(iii) Hazard function.

3. (a) Define the following:
(i) Survival function
(ii) Hazard function
(iii) Incidence

(b) (i) Derive the log – likelihood function for the Binomial data with complementary log – log function as the link function as a function of regression coefficients.

(ii) Let $x_1, x_2, \ldots, x_n$ be a random sample from a Bernoulli with parameter P. If P has a prior distribution given by

$$g(P) = \frac{P^{\alpha-1}(1-P)^{\beta-1}}{B(\alpha, \beta)}, \quad P \in (0,1)$$

Derive the Bayes estimator for P.

(c) The lifetimes T, following a heart surgery is exponentially distributed, but the hazard function λ varies across individuals. In particular, suppose the distribution of T given λ has the *pdf* $f(t/\lambda) = \lambda e^{-\lambda t}$, $t > 0, \lambda > 0$, and λ itself has the following *pdf*

$$g(\lambda) = \frac{\lambda e^{-\frac{\lambda}{k}}}{k^2}, \lambda > 0, k > 0$$

(i) Find the unconditional *pdf* of T
(ii) Find the unconditional survival function

(iii) Find the unconditional hazard function
(iv) Sketch the graphs of $s(t)$ and $h(t)$ on the same graph.

4. (a) Define the following:
(i) Prior odds ratio
(ii) Posterior odds ratio
(iii) Bayes factor

(b) (i) Let T be a continuous lifetime random variable. Given that the survival function can be given by

$$s(t) = e^{-\int_0^t h(u)du} \qquad (*)$$

Derive the expression of the hazard function from (*) and use it to show that the *pdf* of T can be given as

$$f(t) = h(t)e^{-\int_0^t h(u)du}$$

(ii) Let T be a discrete lifetime random variable with probability function

$$P(T=t) = p(1-p)^t \ , \ t = 0, 1, 2, ...$$

Find the survival and hazard functions of T

(c) A manufacturer produces items in lots of 21. One item is selected at random and is tested to determine whether or not it is defective. If the selected item is defective, either the remaining 20 items can be sold at \$1 per item with a double – year money back guarantee on each item or the whole lot can be discarded at a cost of \$1. Consider the following decisions:

d_1: sell if the item selected is good, discard if defective

d_2: sell in either case.

If k denotes the number of defectives in a lot of 21, and x be 1 or 0 if the tested item is good or defective respectively.

Thus $P(X=0) = \dfrac{k}{21}$.

(i) Show that the loss functions are

$$L(k, d_1(x)) = \begin{cases} -20+2k & \text{if } x=1 \\ 1 & \text{if } x=0 \end{cases}$$

and

$$L(k, d_2(x)) = \begin{cases} -20+2k & \text{if } x=1 \\ -20+2(k-1) & \text{if } x=0 \end{cases}$$

(ii) Calculate the risk functions of d_1 and d_2.

(iii) Which of these decisions is minimax? Justify your answer.

(iv) Let us assume that the prior distribution of k is Binomial with probability p. i.e $k \sim B(21, p)$. Evaluate the Bayes risk as a function of p.

5. (a) Explain the following:

(i) Generalized linear model

(ii) Proportional hazard model

(iii) Cox's proportional hazard model.

(b) Let T be a lifetime random variable with log – normal distribution. i.e

$$f(t) = \frac{1}{\sqrt{2\pi\sigma^2 t^2}} e^{-\frac{1}{2}\left(\frac{\ln t - \mu}{\sigma}\right)^2}, \quad t > 0$$

(i) Derive the *cdf* of T

(ii) Find the survival function of T

(iii) Find the hazard function of T

(c) A matched case – control study was conducted to investigate the relationship between postmenopausal estrogen and endometrial cancer. A case was a woman with endometrial cancer and matched to a control, a woman with other gynecologic problem but no cancer. The match control for each case was chosen on the basis of age and other characteristics to eliminate confounding. Exposure was defined as at least 6 months of postmenopausal estrogen use. There were 39 pairs in which both the case and the control used estrogen, 150 pairs in which both the case and the control didn't use estrogen, 113 pairs in which the case used estrogen while the control didn't use estrogen, and 15 pairs in which the case didn't use estrogen while the control did use estrogen.

(i) Display the given data in an appropriate two – by – two table.

(ii) Test the hypothesis of no relationship between endometrial cancer and estrogen use at 0.05 level of significance.

(iii) Compute an estimate of the relative risk and interpret it.

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

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

Department of Mathematics and Statistics

2010 Academic Year

Semester II

M912 Mathematical Methods VI

FINAL EXAMINATION

Time Allowed: Three (3) Hours **19th May, 2011.**

Instructions:

1. You must write your **Computer Number**, on each answer booklet you have used.

2. There are Six (6) questions in this paper, Attempt **Any Four (4)** questions. All questions carry equal marks

3. Should you have any problem or if you need more answer booklet(s), put up your hand, an invigilator will come to attend to you.

1. (a) Evaluate the following line integrals:

(i) $\int_\gamma y\sin z ds$, where γ is the circular helix given by the equations $x=\cos t$, $y=\sin t$, $z=t$, $0\le t\le 2\pi$.

(ii) $\int_\gamma 2x ds$, where γ is an arc of the parabola $y=x^2$ from $(0,0)$ to $(1,1)$.

(b) A periodic function is defined in one period by the equation $f(x)=4-x^2$, $-2\le x\le 2$.

(i) Determine whether the function is even, odd or neither

(ii) Find the Fourier series expansion of the function $f(x)$.

(iii) Use your series expansion of the function $f(x)=4-x^2$, $-2\le x\le 2$ in (ii) to find the sum

$$1-\frac{1}{2^2}+\frac{1}{3^2}-\frac{1}{4^2}+\frac{1}{5^2}-\text{.....}$$

(c) (i) Find the general solution of the Euler equation $x^2y''-2xy'-4y=0$

(ii) Use the method of variation of parameters to solve the initial value problem $x^2y''-2xy'-4y=5x^2$, $y(1)=y'(1)=0$

2. (a) Find the Laplace transform of each function below:

(i) $f(x)=\begin{cases}-1 \text{ , if } 0<x<1\\ 1 \text{ , if } x\ge 1\end{cases}$

(ii) $f(x)=\dfrac{e^{-3x}\sin 2x}{x}$

(b) Consider the differential equation $x^2\dfrac{d^2y}{dx^2}-x\dfrac{dy}{dx}+y=\ln x$

(i) By the substitution $t=\ln x$, use the chain rule of differentiation and show that the equation reduces to $\dfrac{d^2y}{dt^2}-2\dfrac{dy}{dt}+y=t$.

(ii) Use the method of Laplace transform and take $y(0)$ and $y'(0)$ to be constants, to find the general solution of the equation $\dfrac{d^2y}{dt^2}-2\dfrac{dy}{dt}+y=t$ in (ii).

(iii) Hence find the general solution of the equation $x^2\dfrac{d^2y}{dx^2}-x\dfrac{dy}{dx}+y=\ln x$ in (i).

(c) Use the method of Frobenius to find two independent solutions to the differential equation $xy'' + 2y' + xy = 0$. Write at least two terms for each solution.

3. (a) Let $f(x) = y(x) + \int_0^x k(x-t)y(t)dt$ be an integral equation where $y(x)$ is the unknown function

(i) Show that $L[y(x)] = \dfrac{L[f(x)]}{1 + L(k(x))}$ where $L[y(x)]$ is the Laplace transform of $y(x)$

(ii) Hence solve the integral equation $3\sin 2x = y(x) + \int_0^x (x-t)y(t)dt$.

(b) (i) Show that the integral $\int_C (6xy^2 - y^3)dx + (6x^2y - 3xy^2)dy$ is independent of the path from the point $(1, 2)$ to the point $(3, 4)$.

(ii) Evaluate the line integral $\int_C (6xy^2 - y^3)dx + (6x^2y - 3xy^2)dy$ where C is any path joining the points $(1, 2)$ and $(3, 4)$.

(c) Solve the system of linear differential equations

$$\begin{cases} \dfrac{dx}{dt} = -4x - y \\ \dfrac{dy}{dt} = x - 2y \end{cases}$$

4. (a) (i) Use the convolution theorem to find the particular integral of the differential equation $y'' + a^2 y = f(t)$, $y(0) = y'(0) = 0$

(ii) Find the Wronskian of the functions: $y_1(x) = e^{2x}\sin x$ and $y_2(x) = -e^{2x}\cos x$

(b) (i) Find $L^{-1}\left[\dfrac{2s+3}{s^2 - 4s + 20}\right]$

(ii) Use Green's theorem to evaluate the line integral $\int_\gamma (x^2 + 2y^3)dy$, where γ is the circle $(x-2)^2 + y^2 = 4$.

(c) A surface S is given parametrically by the equation $\mathbf{r}(u, v) = u\cos v\mathbf{i} + u\sin v\mathbf{j} + u^2\mathbf{k}$, $0 \le u \le 4$, $0 \le v \le 2\pi$.

(i) Calculate $\dfrac{\partial \mathbf{r}}{\partial u} \times \dfrac{\partial \mathbf{r}}{\partial v}$

(ii) Hence calculate the surface area of the surface S.

5. (a) Use the method of power series to find the general solution of the differential equation $y'' + xy = 0$. Write at least four terms in each bracket.

(b) (i) Use the Divergence theorem to evaluate the integral $\iint_S xz^2\,dydz + (x^2y - z^3)\,dzdx + (2xy + y^2z)\,dxdy$, where S is the entire surface of the hemisphere region bounded by $z = \sqrt{a^2 - x^2 - y^2}$ and $z = 0$.

(ii) Evaluate using Stokes theorem the integral $\oint_{\partial S} \mathbf{F}(x, y, z).\mathbf{T}\,dS$ where $\mathbf{F}(x, y, z) = 3y\mathbf{i} - xz\mathbf{j} + yz^2\mathbf{k}$, $\mathbf{T}$ is the unit tangent to the curve and S is the surface of the paraboloid $2z = x^2 + y^2$ bounded by the plane $z = 2$

(c) Let $C[0, 1]$ be the space of continuous functions on the interval $[0, 1]$. Define an inner product on $C[0, 1]$ by $(x_m, x_n) = \int_0^1 x_m(t)\,x_n(t)\,dt$ for $x_m, x_n \in C[0, 1]$.

(i) Show that the polynomials $x_0(t) = 1$, $x_1(t) = 2t - 1$ and $x_2(t) = 6t^2 - 6t + 1$ are orthogonal.

(ii) Find $\| x_1(t) \|$

6. (a) Let S be the surface of the paraboloid $z = 2 - (x^2 + y^2)$ above the xy – plane.

(i) Evaluate the surface area of the surface S

(ii) Calculate the mass of S if the density is $\rho(x, y, z) = x^2 + y^2$.

(b) Let $f(x) = x, 0 < x < 2$

(i) Find the half range cosine series expansion of $f(x)$

(ii) Find the half range sine series expansion of $f(x)$

(c) Solve the system of linear differential equations

$$\begin{cases} \dfrac{dx}{dt} = 5x + 4y \\ \dfrac{dy}{dt} = x + 2y \end{cases}$$

The University of Zambia

School of Natural Sciences

Department of Mathematics & Statistics

Second Semester Examinations - April/May 2010

M912 - Mathematical Methods VI

Time allowed : Three (3) hrs Full Marks : 100

Instructions:
- Attempt **any five (5)** questions. All questions carry equal marks.
- **Full credit** will only be given when **necessary work** is shown.
- Indicate your **computer number** on all answer booklets.
- **Calculators** are **not** allowed.

This paper consists of 3 pages of questions.

---

1. a) Given

$$\mathbf{F}(x,y,z) = y^2\,\mathbf{i} + (2xy + e^{3z})\,\mathbf{j} + 3ye^{3z}\,\mathbf{k}\,,$$

(i) find a function f such that $\nabla f = \mathbf{F}$.

(ii) Evaluate the line integral $\int_C \mathbf{F}\cdot dr$ where C is the straight line from $(1,1,0)$ to $(2,3,1)$.

b) Evaluate $\oint_C \mathbf{F}\cdot dr$, where $\mathbf{F}(x,y,z) = -y^2\,\mathbf{i} + x\,\mathbf{j} + z^2\,\mathbf{k}$ and C is the curve of intersection of the plane $y+z=2$ and the cylinder $x^2+y^2=1$.

c) The surface S consists of that part of $x^2+y^2=4$ which lies in the first octant, between $z=0$ and $z=3$. Find the mass of the surface S if the density is given by $\rho(x,y,z) = x^2yz$.

2. a) Given the parametric equations

$$x = \cos t, \quad y = \sin t, \quad z = t, \quad 0 \le t \le 2\pi\,,$$

(i) sketch the graph of the parametric equations.

(ii) A particle moves along the curve in (i) subject to the force $F = y \sin z$. How much work is done in moving the particle?

b) Verify the divergence theorem for the case where $\mathbf{F}(x, y, z) = (x, y, z)$ and B is the solid sphere of radius R centred at the origin.

c) Evaluate the line integral

$$\oint_C (3y - e^{\cos x})\, dx + (7x + \sqrt{y^4 + 1})\, dy \ ,$$

where C is the unit circle $x^2 + y^2 = 1$.

3. a) Find the Laplace transforms of the following functions:

(i) $f(t) = \sin^2 t$ (ii) $f(t) = \int_0^t (e^t - \cos 2t) dt$.

b) Find $f(t)$ given that

$$\mathcal{L}\{f(t)\} = \ln\left(\frac{s^2 + 1}{s\,(s + 1)}\right) \ .$$

c) (i) Sketch the graph of the function $f(t)$ given by

$$f(t) = e^t.U(t) + (e - e^t).U(t - 1) - (e + e\cos t).U(t - \pi) + e\cos t.U(t - 2\pi) + U(t - 2\pi) \ ,$$

where e is the number $e = 2.718\ldots$

(ii) Find $\mathcal{L}\{f(t)\}$.

4. a) (i) Find the Fourier series expansion of the periodic function

$$f(x) = \begin{cases} -1, & -\pi < x < 0 \\ 1, & 0 < x < \pi \end{cases}$$

with period 2π.

(ii) Hence deduce that

$$\frac{\pi}{4} = 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \ldots\ldots$$

b) Find the Fourier Sine integral of

$$f(x) = \begin{cases} x^2, & 0 < x < 1 \ , \\ 0, & x > 1 \ . \end{cases}$$

c) Find the Fourier Cosine transform of the function

$$f(x) = \begin{cases} 1, & 0 < x < \frac{\pi}{2} \ , \\ 0, & x > \frac{\pi}{2} \ . \end{cases}$$

5. a) Given that m and n are integers, prove that

$$\int_{-\pi}^{\pi} \cos mx \sin nx = \begin{cases} 0 & \text{when } m \neq n \\ \pi & \text{when } m = n \end{cases}$$

b) Use Laplace transforms and the result

$$\mathcal{L}^{-1}\left(\frac{1}{s(s^2+1)^2}\right) = \int_0^t \frac{1}{2}(\sin\tau - \tau\cos\tau)\, d\tau$$

to solve the differential equation

$$\frac{d^3y}{dt^3} - \frac{d^2y}{dt^2} + \frac{dy}{dt} - y = \cos t + \sin t - 1 ,$$
$$y(0) = y''(0) = 0 , \qquad y'(0) = 1 .$$

c) i) Let the Laplace transform of the function $f(t)$ be denoted by $F(s)$, that is, $\mathcal{L}(f(t)) = F(s)$. Given that

$$\mathcal{L}\left\{\int_0^t f(\tau)\, d\tau = \frac{1}{s} L(f(t))\right\} ,$$

find $f(t)$ if $\mathcal{L}(f(t))$ is given as

$$\frac{1}{s^4 - 2s^3} .$$

ii) Find the inverse transform of

$$\mathcal{L}(y(t)) = \frac{s+1}{s^2 + s - 6} .$$

6. a) Given the differential equation

$$9x(1-x)y'' - 12y' + 4y = 0 ,$$

(i) show that $x = 0$ is a regular singular point of the differential equation.

(ii) Hence find series solutions of the given differential equation.

b) Find a general solution of the following linear system

$$y_1' = -3y_1 + y_2 + 3\cos t$$
$$y_2' = y_1 - 3y_2 - 2\cos t - 3\sin t$$

END!

The University of Zambia
Physics Department
University Examinations 2011
P-192: Introductory Physics- II
(Option A)

All questions carry equal marks. The marks are shown in brackets. <u>Question 1 is compulsory</u>. Attempt <u>four more</u> questions. Clearly indicate on the answer script left column on the cover page the questions you have answered.

Time : Three hours. **Maximum marks = 100.**

Do not forget to write your computer number clearly on the answer book as well as on the answer sheet for Question 1. Tie them together.

==========

Wherever necessary use :

$g = 9.8 m/s^2$ 1 metric ton = 1000 kg

$P_A = 1.01 \times 10^5$ N/m^2

1 cal. = 4.18 J

$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/Nm^2

$c = 3 \times 10^8$ m/s

$h = 6.63 \times 10^{-34}$ J-s

1 pascal =1 N/m^2

1eV = 1.6×10^{-19} J

$e = 1.6 \times 10^{-19}$ C

$m_e = 9.11 \times 10^{-31}$ kg

$k = 9 \times 10^9$ Nm^2/C^2

$\mu_0 = 4\pi \times 10^{-7}$ N/A^2

$\rho_{water} = 1000$ kg/m^3

$G = 6.67 \times 10^{-11}$ Nm^2/kg^2

Question 1 : For each correct answer, 2 marks. For each wrong answer, 0.67 will be deducted. No answer, zero mark. The minimum total mark for Question 1 is zero.]

(A) For a gas approximating the ideal gas, the velocity of sound is.

a) Proportional to the absolute temperature.
b) Proportional to the square of the absolute temperature.
c) Proportional to the square root of the absolute temperature.
d) Independent of the absolute temperature.

(B) For capacitors connected in series:

a) The difference of the potential is the same for all.
b) The charge on each capacitor is the same.
c) The resultant capacitance is greater than the sum of the individual capacitances.
d) The resultant capacitance is equal to the sum of the individual capacitances.

(C) A Carnot engine that operates between the absolute temperatures T_1 and T_2:

a) Has an efficiency of T_1/T_2.
b) Is 100% efficient.
c) Has an efficiency of a non-reversible engine.
d) Has the maximum efficiency possible for the given temperatures.

(D) In simple harmonic motion it is found that the total energy of the system:

a) Depends on the amplitude squared.
b) Is inversely proportional to the amplitude.
c) Is independent of the mass.
d) Is independent of the amplitude.

(E) Ohm's law states that;

a) The current through a resistor is directly proportional to the applied voltage.
b) The voltage across a resistor is directly proportional to the current passing through.
c) Resistance is the constant of proportionality between the voltage and current.
d) All of the above.

(F) In natural convection a heated portion of fluid moves because:

a) of molecular vibrations about the equilibrium
b) its density is less than that of the surrounding fluid.
c) of molecular collisions within it.
d) its molecular motions become aligned.

(G) The force per unit charge is known as:

a) Electric potential.
b) Electric current.
c) Electric field intensity.
d) Test charge.

(H) The equivalent resistance of resistors in parallel is always:

a) Greater than the sum of the separate resistances.
b) Less than the sum of the reciprocals of the separate resistances.
c) Less than the resistance of any of the separate resistances.
d) In between the values of the lowest and the highest resistor.

(I) The temperature coefficient of a resistance of a material of a wire is 0.00125 $^{\circ}C^{-1}$. Its resistance at 300 K is 1Ω. At what temperature will the resistance of the wire be 2Ω.

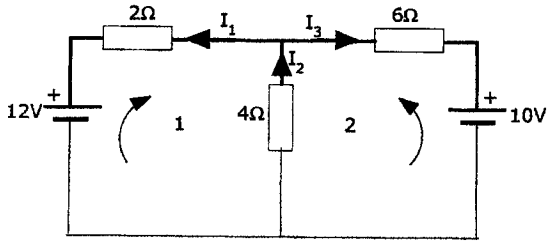
a) 1154 K
b) 1100 K
c) 1400 K
d) 1127 K

(J) In an adiabatic process there is no:

a) Work done.
b) Internal energy change.
c) Temperature change.
d) Heat exchanged.

ATTEMPT ANY FOUR QUESTIONS FROM BELOW:

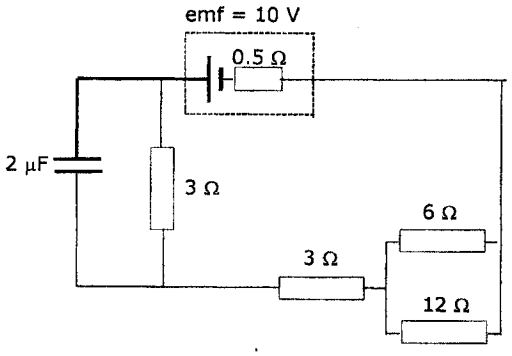
Q.2 (a) Find the currents I_1, I_2 and I_3 in the circuit shown below. Follow the loop directions indicated on the diagram. **[13]**



(b) A mass m attached to spring vibrates freely with a period of 2.0 seconds. When the mass is increased by 2.0 kg the period of vibration increases to 3.0 seconds. Find the value of the mass m. **[7]**

Q.3 (a) For the circuit below find:

i) the current drawn from the battery;
ii) the terminal potential difference of the battery;
iii) the power dissipated by the 6 Ω resistor; and
iv) the charge stored in the capacitor. **[11]**



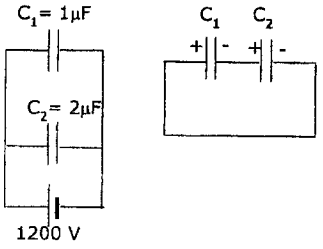
(b) A cube of ice is taken from the freezer at -8.5 °C and placed in a 95 g aluminium calorimeter filled with 310 g of water at room temperature of 20 °C. The final temperature of the water is observed to be 17 °C. What is the mass of the ice cube? [Given c_{ice} = 2100 J/kg.C, c_{Al} = 900 J/kg. °C, $H_f = 3.35 \times 10^5$ J/kg] **[10]**

Q.4 (a) A police car with its 300 Hz siren is moving toward a warehouse at 30 m/s, intending to crash through the door.

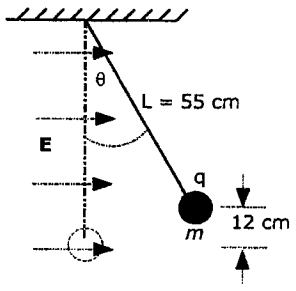
i) What frequency does the driver of the police car hear reflected from the warehouse?
ii) Suppose the police car is moving away at 20 m/s, what frequency does the driver hear reflected from the warehouse? **[10]**

(b) A 1 μF capacitor and a 2 μF capacitor are connected in parallel across a 1200 V source.

i) Find the charge on each capacitor.
ii) The charged capacitors are disconnected from the source and each from other and then reconnected with terminals of unlike sign together. Find the final charge on each capacitor, see diagrams below. **[10]**



Q.5 (a) A point charge (m = 1.0 g) at the end of an insulating string of length 55 cm is observed to be in equilibrium in a uniform horizontal electric field of 12,000 N/C when the pendulum's position is as shown below, with the charge 12 cm above the lowest (vertical) position. If the field points to the right, determine the magnitude of the charge. **[11]**



(b) A car engine has an efficiency of 25% and produces an average of 30,000 J of mechanical work per second during operation.

i) How much heat input is required in kW, and
ii) How much heat is discharged as waste heat from this engine, per second? **[6]**

(c) A police siren emits a sinusoidal wave with a frequency f = 300 Hz. The speed of sound is 340 m/s.

i) Find the wavelength of the waves if the siren is stationary, and
ii) if the siren is moving at 30 m/s, find the wavelengths in front and behind the source. **[3]**

Q.6 (a) The temperature of the glass surface of a 60 W light-bulb is 65 °C when the room temperature is 18 °C. Estimate the temperature of a 150 W light-bulb with a glass bulb the same size, if only 90% of the energy is given out as radiation. **[10]**

b) A storage tank contains 21.6 kg of nitrogen (N_2 , molecular mass = 28 kg/mol) at an absolute pressure of 3.65 atm. What will be the pressure if nitrogen is replaced by an equal mass of carbon dioxide (CO_2, molecular mass = 44 kg/mol)? **[6]**

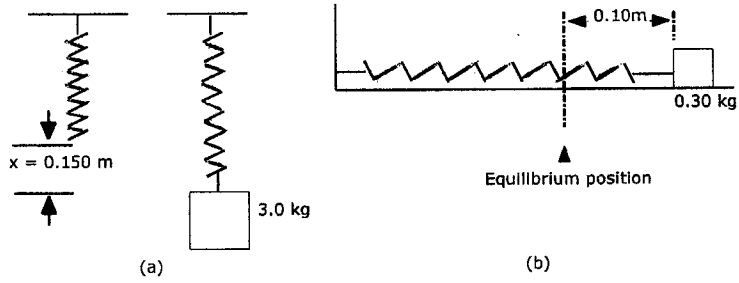
c) Workers around jet aircraft typically wear protective devices over their ears. Assume that the sound level of a jet plane engine, at a distance of 30 m, is 140 dB, and that the average human ear has an effective radius of 2.0 cm. What would be the power intercepted by an unprotected ear at a distance of 30 m from the jet plane engine? **[4]**

Q.7 (a) A spring stretches 0.150 m when a 3 kg mass is gently hung on it as shown in figure (a) below. The spring is then setup horizontally with 0.30 kg mass resting on frictionless table as in figure (b) below. The mass is pulled so that the spring is stretched 0.100 m from equilibrium point, and released from rest. Determine:

i) the spring constant of the spring;
ii) the amplitude of the horizontal oscillation of the 0.30 kg mass;
iii) the magnitude of the maximum velocity;

iv) the magnitude of the velocity when the mass is 0.05 m from equilibrium; and

v) the maximum acceleration of the mass. **[8]**



(b) Two point charges are separated by a distance of 9 cm. One has a charge of -20 μC and the other 45 μC.

i) Determine the direction and magnitude of the electric field at a point *P* between the two charges that 2.0 cm from the negative charge, see the diagram below.

ii) If an electron is placed at point *P* and then released what will be its initial acceleration (direction and magnitude)? **[10]**

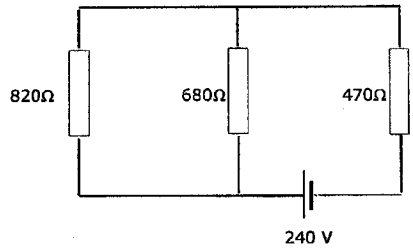
(c) Name any two factors that affect the resistance of an ohmic conductor. **[2]**

Q.8 (a) A wire stretched between two poles 2 m apart is seen to vibrate in the wind with 3 nodes in the middle. The sound produced by the vibrating wire has a frequency by the vibrating wire has a frequency of 90 Hz. If the wire has a mass of 500 g. What tension must the wire have? **[8]**

(b) Determine:

i) the equivalent resistance of the circuit shown below, and

ii) the voltage across each resistor. **[7]**



(c) A steel ring of 3.000 mm inside diameter at 20 °C is to be heated and slipped over a brass shaft measuring 3.0002 mm in diameter at 20 °C. To what temperature should the ring be heated? (α_{steel} = 1.2 x 10^{-5}/°C and α_{brass} = 2.0 x 10^{-5}/°C)? **[5]**

END OF EXAMINATION

Some useful equations

Thermal properties of matter:

$Q/t = e\sigma AT^4$ $Q/\Delta t = (kA\Delta T)/\Delta L$ $\Delta Q = mc\Delta T = nC\Delta T$ $\Delta L = \alpha L\Delta T$

$\Delta V = \gamma V\Delta T$ $\Delta W = P\Delta V$ $\Delta W = nRT.ln(V_f/V_i)$ $C_v = C_p - R$

$PV = nRT$ $P_1V_1^{\gamma} = P_2V_2^{\gamma}$

Thermodynamics:

$Q = \Delta U + W$ Carnot engine, $e = 1 - T_2/T_{1=} \frac{\text{work done}}{\text{input heat at high temperature}}$

$S = k\ln\Omega$ $\Delta S = Q/T$ $Efficiency = W/Q_h$ $COP_{fridge} = Q_c/W_{in}$

$COP_{heat\ pump} = Q_h/W_{in}$ $COP_{max\text{-}fridge} = T_c/(T_h-T_c)$ $COP_{max\ h.\ pump} : T_h/(T_h-T_c)$

Waves and vibrations:

$F = -kx$ $\omega = 2\pi f$ $f = (1/2\pi)\sqrt{(g/L}$ $a_c = \omega^2 x_0$

$P.E. = (1/2)kx^2$ $1/2)kx^2 + (1/2)mv^2 = (1/2)kx_0^2$ $\omega = \sqrt{(k/m}$

$f = (1/2\pi)\sqrt{(k/m)}$ $v = f\lambda$ $f_n = v/\lambda_n = n(v/2L)$ $L = n(\lambda_n/2)$

Sound waves:

$v = \sqrt{(Y/\rho)}$ $v = \sqrt{(B/\rho)}$ $I_o = 10^{-12}\ W/m^2$ $I(dB) = 10\ \log(I/I_o)$

$I(r) = P/4\pi r^2$ $f' = f\left(\frac{v + v_l}{v - v_s}\right)$ *(moving source and moving listener)*

Electric forces and fields, electric potential:

$\boldsymbol{F} = q\boldsymbol{E}$ $\boldsymbol{E} = kQ/r^2$ $\boldsymbol{F} = (k\ q_1\ q_2\ )/r^2$ $V_{AB} = Ed$

$V = kq/r$ $\Delta PE = qEd$ $C = (\varepsilon_o A)/d$ $W = qV_{AB}$

$Energy = \frac{\frac{1}{2}q^2}{C} = \frac{1}{2}qV = \frac{1}{2}CV^2$ $C_{par} = C_1+C_2+..+C_n$ $C_{ser} = 1/C_1+1/C_2+...$

$C = Q/V$

Direct current circuits:

$V = IR$ $R = \rho\frac{L}{A}$ $\Delta R = R_o\alpha\Delta T$ $P=IV=I^2R=V^{@}/R$

$V_{terminal}=\varepsilon-Ir$ $R_{eq}= R_1+R_2+....series$ $1/R_{eq}=1/R_1+1/R_2+...parallel$

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF PHYSICS

UNIVERSITY EXAMINATIONS -2011

P272 - GEOMETRICAL AND PHYSICAL OPTICS

TIME:	THREE HOURS
ANSWER:	FIVE QUESTIONS ALL ANSWERS CARRY EQUAL MARKS
MAX. MARKS:	100

1. (a) Using Fermat's principle, establish the laws of reflection.

[8 Marks]

(b) A convex surface of radius 30 cm separates two media of refractive indices 4/3 and 1.5. An object is placed at a distance of 20 cm from the surface in the first medium. Calculate the position of the image.

[5 Marks]

(c) An object is situated on the optical axis of a convex spherical surface. A ray of light starting from the object subtends an angle of 5^{o} with the optical axis and intersects the spherical surface at a height of 2.5 cm. If the radius of curvature of the surface is 5 cm and the refractive index of the material is 1.5, find the angle which the refracted ray makes with the optical axis.

[7 Marks]

2. (a) Derive an expression for lateral magnification.

[10 Marks]

(b) A converging lens of refractive index 1.52 has a focal length of 40 cm in air. Find its focal length when it is immersed in water which has a refractive index of 1.33.

[6 Marks]

(c) Two thin convex lenses having focal lengths of 0.05 m and 0.02 m are coaxial and separated by a distance of 0.03 m. Find the equivalent focal length.

[4 Marks]

3. (a) Derive an expression for the equivalent focal length of two thin lenses separated by a distance d.

[10 marks]

(b) The incident face of a glass block is bounded by a concave surface of radius 0.03 cm. A small object 2×10^{-2} m high is situated in air at a distance 0.1 m from the vertex. Find the first and second focal lengths, given that refractive index of glass is 1.5.

[5 Marks]

(c) The dispersion powers of crown and flint glasses are 0.03 and 0.05 respectively. If the difference in the refractive indices of blue and red colours is 0.014 for crown glass and 0.023 for flint glass, calculate the angles of the two prisms for a deviation of 10^{o} (without dispersion). **[5 Marks]**

4. (a) Drive a relation connecting μ_1, the refractive index of the first medium, μ_2 the refractive index of the second medium, u the object distance, v the image distance, and R the radius of curvature of the refracting surface, when refraction takes place at a concave spherical surface and a virtual image is formed.

[10 Marks]

(b) Show that the minimum distance between an object and its real image in a convex lens is four times the focal length of the lens.

[6 Marks]

(c) Calculate the focal length of a lens of dispersive power 0.031 which should be placed in contact with a convex lens of focal length of 0.88 m and dispersive power of 0.022 to make the combination achromatic.

[4 Marks]

5. (a) Derive an expression for longitudinal chromatic aberration.

[5 Marks]

(b) An achromatic doublet of a convex lens of focal length 0.30 m is to be formed out of flint and crown glass whose dispersive powers are 0.03 and 0.02 respectively. Calculate the focal length of the two lenses.

[6 Marks]

(c) The dispersive power of crown and flint glass are 0.015 and 0.030 respectively. The refractive index for the mean ray are 1.52 and 1.65. If one of the surfaces of the flint glass is plane, calculate the radii of curvature of the other two surfaces of the two lenses which form an achromatic combination of focal length 30 cm.

[9 Marks]

6. (a) The inclined faces of a bi-prism of refractive index 1.50 make angle of 2° with the base. A slit illuminated by monochromatic light is placed at a distance 10 cm from the bi-prism. If the distance between the two dark fringes observed at a distance of one metre from the bi-prism is 0.18 mm, find the wavelength of light used.

[7 marks]

(b) In a typical bi-prism experiment, the fringe width is 10^{-3} m for a wavelength of 5893 Å. If $y = 20x$, where y is the distance between the bi-prism and the screen and x the distance between the slit and the bi-prism, calculate the refracting angle of the bi-prism, given $\mu = 1.5$.

[7 Marks]

(c) Interference fringes are produced by Fresnel's bi-prism in the focal plane of a reading microscope which is 1.0 m from the slit. A lens interposed between the bi-prism and the microscope gives two images of the slit in two positions. If the images of the slits are 4.05 mm in one position and the wavelength of the sodium light is 5893 Å, find the distance between consecutive interference bands.

[6 Marks]

7. (a) Fringes of equal thickness are formed when two glass plates are kept over each other with a small gap in between. If a parallel beam of light of wavelength 6000 Å is used and fringe separation is 3 mm, what is the angle between the plates in seconds?

[6 Marks]

(b) A wedge-shaped air film having an angle of 40 seconds is illuminated by monochromatic light and fringes are observed vertically through a microscope. The distance measured between consecutive bright fringes is 0.12×10^{-2} m. Calculate the wavelength of light used.

[6 Marks]

(c) When a thin sheet of thickness 7.2×10^{-6} m is introduced in the path of one of the interfering beams, the central fringe shifts to a position occupied by the sixth bright fringe. If $\lambda = 6\times10^{-7}$ m, find the refractive index of the sheet.

[8 Marks]

==End of P-272 Examination==

The University of Zambia
School of Natural Sciences
Physics Department
University Examinations 2011
Second Semester
P-412: Nuclear Physics

Attempt <u>any four</u> questions. All questions carry equal marks. The marks are shown in brackets. Clearly indicate on the answer script cover page which questions you have attempted.

Time: Three hours. **Maximum marks = 100.**

Do not forget to write your computer number clearly on the answer book.

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Wherever necessary use:

$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/Nm^2	$m_{hydrogen\ atom}$ = 1.007825 a.m.u.
m_n = 1.008665 a.m.u. = 939.551 MeV	m_{alpha} = 4.002603 a.m.u.
1 a.m.u. = 931.5 MeV = 1.6604×10^{-27} kg	$m_p = 1.67 \times 10^{-27}$ kg = 938.28 MeV
$c = 3 \times 10^8$ m/s	$m_e = 9.11 \times 10^{-31}$ kg = 0.511 MeV
$h = 6.63 \times 10^{-34}$ J-s	$e = 1.6 \times 10^{-19}$ C
$\hbar = 6.58 \times 10^{-22}$ MeV-s $= 1.05 \times 10^{-34}$ J-s	1eV = 1.6×10^{-19} J
1 fermi = 10^{-15} m	1 barn = 10^{-28} m^2
Avogadro's constant = 6 x 10^{23} per mole	Velocity of light = 3 x 10^8 m.sec^{-1}.
$\frac{e^2}{4\pi\varepsilon_0}$ = 1.44 MeV-fermi	$\hbar c$ = 197.33 MeV-fermi $m = \frac{m_0 c^2}{c^2} \equiv \frac{MeV}{c^2}$

$(1s_{½})^2$, $(1p_{3/2})^4$, $(1p_{½})^2$, $(1d_{5/2})^6$, $(2s_{½})^2$, $(1d_{3/2})^4$, $(1f_{7/2})^8$, $(2p_{3/2})^4$, $(1f_{5/2})^6$, $(2p_{½})^2$, $(1g_{9/2})^{10}$, [50]. $E = \frac{\hbar^2}{2\Im}\left[J(J+1) - BJ^2(J+1)^2\right]$. $\Delta E_C = \frac{3}{5}\frac{e^2}{R}\left[Z^2 - (Z+1)^2\right]$

Q1(a) (i) Name the four basic interactions known in nature and give a number characterizing the strength of each interaction. [10]

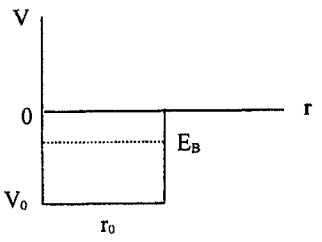
(ii) Discuss the range of each of these interactions and explain how each one is believed to arise. [4]

(iii) List a few important processes for which each one of these interactions is essential. [4]

(b) The electrostatic energy of a charge q uniformly distributed throughout a sphere of radius R is $U = \frac{3}{5}\frac{e^2}{R}\frac{1}{4\pi\varepsilon_0}$, [$W_{Coul.} = \frac{3}{5}\frac{q^2}{R}$].

Using this in the case of positron beta decay, derive an expression for the decrease in Coulomb energy. [7]

Q2 A neutron is bound in the lowest possible state ($l = 0$) to a heavy nucleus. The binding energy is E_B = 20 MeV (E_B = - 20 MeV). The potential acting on the neutron is V_0 = 40 MeV; the radius r_0 of the well is not known:



i) solve the radial wave equation for $l = 0$ inside and outside the well, and sketch the wave function u

ii) apply boundary conditions at $r = r_0$ to obtain an equation between the pertinent wave numbers and r_0

iii) find the numerical values of the wave numbers and solve the equation mentioned under (ii) for r_0.

(For the reduced mass use $m = 1$ *a.m.u.).* [8+8+9]

Region I: $E = -E_B$ $V = -V_0$. We have $\frac{d^2u}{dr^2} + k_1^2 u = 0$ where $k_1 = \frac{\sqrt{2\mu(V_0 - E_B)}}{\hbar}$

Q3(a) The semi-empirical formula for binding energy is given by

$B(N,Z) = aA - bA^{2/3} - s\frac{(N-Z)^2}{A} - d\frac{Z^2}{A^{1/3}} - \frac{\delta}{\sqrt{A}}$, where a = 15.835MeV, b = 18.33 MeV, s = 23.20 MeV, d = 0.714 MeV, δ = 11.2 MeV for odd-odd nuclei and δ = -11.2 MeV for even-even nuclei and = 0 for even-odd or odd-even nuclei.

Explain each of the terms in this formula. [15]

(b) Assume that the expression for the average binding energy of a nucleus having Z protons, N neutrons and A nucleons may be written as: [10]

$-B.E. = f(A) + \frac{0.083}{A}\left(\frac{A}{2} - Z\right)^2 + 0.000627\frac{Z^2}{A^{1/3}} \pm 0.036A^{-3/4}$ a.m.u. (+ for Z odd, and – for Z even). Where $f(A) = Z.M_H + (A-Z)M_n$

Determine the number of stable nuclides of mass $A = 36$.

Take $A^{1/3} = 3.3$, $A^{1/4} = 2.45$ and confine your attention to the range $13 \leq Z \leq 20$.

Q4(a) Describe briefly the independent particle approximation and the collective approximation.

What properties and types of nuclei are described by them? [10]

(b) Show that an alpha particle with total energy E_o incident on a potential barrier of energy V ($V > E_o$) and of thickness b has a quantum probability of penetrating [8]

Sketch the energy diagram showing the incident and transmitted waves of the particle. [2]

(c) An alpha particle is trapped inside a nucleus whose radius is $r_0 = 1.4 \times 10^{-15}$ m. What is the probability that the alpha particle will escape from the nucleus if its energy is 2.0 MeV. The potential barrier at the surface of the nucleus is 4.0 MeV. [5]

$$\text{Probability } P = \exp\left[\frac{-2\sqrt{2m}}{\hbar}\sqrt{V-E}\times t\right]$$

Q5(a) Give short explanations of the terms *allowed, super allowed, first forbidden,* and *second forbidden* in beta transitions in terms of the nuclear matrix element $|M_{if}|$, log fT values and the nuclear shell model. [12]

(b) Distinguish between the Fermi and the Gamow-Teller selection rules in beta decay of nuclei. [7]

(c) On the basis of these selection rules, deduce:

(i) the degree of forbiddenness, and
(ii) the type (Fermi, G-T, or mixed) of the following beta transitions:

$0^+ \rightarrow 1^+$ $\quad \frac{5}{2}^+ \rightarrow \frac{7}{2}^+$ $\quad \frac{1}{2}^+ \rightarrow \frac{1}{2}^+$ $\quad 0^+ \rightarrow 0^+$ [6]

Q6(a) Explain the origin of electric and magnetic multipole transitions in gamma decay of a nucleus. [6]

(b) Explain *nuclear isomerism*. Under what conditions can this effect manifest itself? Given an example of nuclear isomerism. [5]

(c) $^{108}_{47}Ag$ has a spin and parity 1^+. It is beta-unstable with a mean life-time of 3.4 minutes. It has an excited state at 109keV excitation energy, spin and parity 6^+, which is an isomeric state with a mean life of 180 years.

Explain how an excited state of a nucleus can be more stable than the ground state. [5]

(d) What multipole types of gamma ray transitions are likely to be predominant if the J^π of the initial and final nuclei are given as below: [9]

(i) $1^- \rightarrow 0^+$ (ii) $\frac{3}{2}^+ \rightarrow \frac{5}{2}^+$ (iii) $\frac{3}{2}^- \rightarrow \frac{1}{2}^-$

(iv) $\frac{3}{2}^- \rightarrow \frac{1}{2}^+$ (v) $(3/2)^+$ to $(½)^+$ (vi) $\frac{3}{2}^+ \rightarrow \frac{5}{2}^-$

==End of P-412 Exam==

UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

DEPARTMENT OF PHYSICS

UNIVERSITY SECOND SEMESTER EXAMINATIONS

P 422: SOLID STATE PHYSICS II

DATE: MAY 24, 2011

DURATION: THREE HOURS

TOTAL MARKS: 100

ANSWER ANY FOUR QUESTIONS

ALL WORKING SHOULD BE SHOWN CLEARLY TO EARN FULL CREDIT.

A SHEET OF FORMULAE IS ATTACHED AT THE BACK OF THE QUESTION PAPER.

QUESTION ONE

(a) Explain why metallic bodies are always opaque. [4]

(b) The electron and hole mobilities in a Si sample are 0.135 and 0.048 m^2/Vs respectively.

(i) Determine the conductivity of intrinsic Si at 300 K if the intrinsic carrier concentration is 1.5×10^{16} atoms/m^3. [3]

(ii) The sample is then doped with 10^{23} phosphorus atoms/m^3. Determine the equilibrium hole concentration, the conductivity and the Fermi level relative to the intrinsic level [6]

(iii) Hence find the resistance of an Si rod 1 cm long, 1 mm wide and 1 mm thick at temperature 300K. μ_n =1350 cm^2/Vs and μ_h =480 cm^2/Vs [2]

(c) Show that the conductivity of a semiconductor is minimum when it is lightly doped with P type impurity such that

(i)

$$P = n_i\sqrt{\frac{\mu_n}{\mu_p}}$$

[6]

(ii) Show that the minimum conductivity is $2n_i\sqrt{\mu_n\mu_p}e$. [2]

(iii) Hence determine the value of the minimum conductivity of Si. [2]

QUESTION TWO

(a) What is the difference between a conductor cooled to 0 K and a superconductor? Explain in terms of the Meissner effect and the disappearance of resistivity. [5]

(b) Apply Hund's rules to calculate the quantum numbers S, L and J for the spin, orbital and total angular momenta respectively and hence the effective number of Bohr magnetons for the following configurations

(i) Eu^{+} $4f^{8}\,5s^{2}\,p^{6}$ (ii) Er^{3+} $4f^{11}\,5s^{2}\,p^{6}$ (iii) Gd^{3+} $4f^{7}\,5s^{2}\,p^{6}$

[13]

(c) The London penetration depths for a superconductor at 3 K and at 7 K are 39.6 nm and 173 nm respectively. Show that the superconducting transition temperature is 7.19 K.

[7]

QUESTION THREE

(a) What are the differences between an antiferromagnet and a ferrimagnet? Supplement your brief answer with pertinent diagrams

[6]

(b) Nickel has an atomic number of 28. Compute the effective number of Bohr magnetons for nickel ion Ni^{2+}

(i) if the orbital angular momentum is not quenched **[5]**

(ii) if it is quenched. **[3]**

(b) (i) Show that the exchange integral (coefficient) J_e is given by

$$J_e = \frac{3k_B T_C}{2ZS(S+1)}$$

for a ferromagnet with Curie temperature T_C. Each atom has Z identical nearest neighbours and each has spin S. **[6]**

(ii) Hence calculate the exchange integral for nickel which has a face centred cubic structure (with lattice constant 3.52 Angstroms) and a Curie temperature of 631 K. **[3]**

(iii) Calculate the internal field also. **[2]**

QUESTION FOUR

(a) What is the Bloch theorem? **[4]**

(b) Using the Kronig-Penney model, where

$$p\frac{\sin\alpha a}{\alpha a}+\cos\alpha a=\cos ka \quad \text{and} \quad \alpha^2=\left(\frac{2mE}{\hbar^2}\right)^{\frac{1}{2}}$$ show that for $P<<1$, the energy of the lowest energy band is

$$E=\frac{\hbar^2 P}{ma^2}$$ **[5]**

(c) Show that for the tightly bound electron approximation, the energy $E(k)$ for a simple cubic of lattice constant a is

(i)

$$E(k)=E_\varphi-\gamma_0-2\gamma\left(\cos k_x a+\cos k_y a+\cos k_z a\right)$$ **[6]**

(ii) Show that for small values of k the energy varies with k^2 and hence find the expression for the effective mass of the electron. **[5]**

(iii) Determine the maximum energy range for this dispersion. **[5]**

QUESTION FIVE

(a) (i) What is the relationship between the ***s-shell*** and a ***d-shell*** in terms of magnetism and electrical conductivity? **[2]**

(ii) Explain the difference between type I and type II superconductors using the Meissner effect. Prove that the Meissner effect and the disappearance of resistivity are mutually consistent. **[5]**

(b) The transition from the normal to the superconducting state results in a discontinuity in specific heat capacity given by

$$c_n - c_s = \frac{T_c}{4\pi}\left[\left(\frac{dH_c}{dT}\right)^2 + H_c\left(\frac{d^2H_c}{dT^2}\right)\right]_{T=T_c}$$

If

$T_c = 1.18K$, $H_c(0) = 99$ Gauss and γ(specific heat constant at normal state)=$1.35\text{x}10^4$ ergs/mol.K, calculate the fractional change in specific heat capacity for Aluminum at T_c

[12]

(c) Determine the magnitude of the total angular momentum quantum number J for the following using the Hund rules:

(i) Ce^{3+} with outer shell configuration, $4f^15s^2P^6$; **[3]**

(ii) Pr^{3+} with outer shell configuration, $4f^25s^2P^6$. **[3]**

QUESTION SIX

(a) (i) What is the cause of the macroscopic magnetic properties of materials? **[3]**

(ii) What is spontaneous magnetization? **[2]**

(b) (i) What is the Hall Effect? State some applications of Hall Effect. **[3]**

(ii) In a particular semiconductor there are 10^{23} donors/cm^3 with an ionization energy of 1 meV and an effective mass of $0.01m_0$, where m_0 is the rest mass of an electron.

Estimate the concentration of conduction electrons at 4 K. **[6]**

Hence what is the Hall coefficient? (Assume no acceptor atoms present and that $E_g >> kT$) **[2]**

(c) The wave function of the hydrogen atom in its ground state (1s) at S.T.P is

$$\Psi(r) = \frac{1}{\sqrt{\pi a_0^{\,3}}} \exp\left(-\frac{r}{a_0}\right)$$

where $a_0 = 0.529 \times 10^{-8}$ cm is the atomic radius. Show that for this state,

$\langle r^2 \rangle = 3a_0^{\,2}$. **[6]**

Hence calculate the diamagnetic susceptibility of atomic hydrogen. **[3]**

FORMULAE AND CONSTANTS YOU MAY NEED

Electron rest mass $m_e = 9.109 \times 10^{-31}$ kg Electron charge $e = 1.602 \times 10^{-19}$ C

Planck's constant $h = 6.626 \times 10^{-34}$ Js^{-1} Bolzmann constant $k_B = 1.381 \times 10^{-23}$ JK^{-1}

Avogadro's number $N_A = 6.022 \times 10^{23}$/g mole Bohr magneton $\mu_B = 9.274 \times 10^{-24}$ Am^2

Permeability of free space $\mu_0 = 4\pi \times 10^{-7}$ Hm^{-1}

$$M = Ng\mu_B JB_J(y) \text{ where } y = \left(\frac{g\mu_B JB}{k_B T}\right) \qquad B_J(y) \approx \frac{y(J+1)}{3J} \text{ for } y << 1$$

Curie temperature for a ferromagnet,

$$T_C = \frac{\lambda N g^2 \mu_B{}^2 J(J+1)}{3k}$$

Exchange energy $U_i = -gS_{zi}\mu_B \lambda \mu_0 M$ OR $U_i = -\frac{2ZJ_e S_{zi} M}{g\mu_B N}$

$$\mu = IA$$

$N_C = 2\left[\frac{2\pi m_n^* kT}{h^2}\right]^{\frac{3}{2}}$ $N_V = 2\left[\frac{2\pi m_h^* kT}{h^2}\right]^{\frac{3}{2}}$ Effective number of electrons and holes at the conduction and valence band edge respectively.

$$n = [N_C N_V]^{\frac{1}{2}} \exp\left(\frac{E_d - E_C}{2kT}\right) \quad \text{OR} \quad n = n_i \exp\left(\frac{E_f - E_i}{kT}\right)$$

Diamagnetic susceptibility

$$\chi_{dia} = -\frac{N\mu_0 Ze^2}{6m}\langle r^2 \rangle$$

$$\int_0^\infty x^4 e^{-x} dx = 24$$

Superconductivity

$$H_c = H_{co}\left[1 - \left(\frac{T}{T_c}\right)^2\right]$$

$$\frac{\lambda_d(T)}{\lambda_d(0)} = \left[1 - \left(\frac{T}{T_c}\right)^4\right]$$

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2011 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

P442: DIGITAL ELECTRONICS II

Time: Three Hours **Maximum Marks = 100**

Attempt any four questions.
All questions carry equal marks.
The marks are shown in brackets.

8085 / 8080A Instruction summary by Functional Groups

DATA TRANSFER (COPY)

Hex	Mnemonic	Hex	Mnemonic	Hex	Mnemonic	Hex	Mnemonic
40	MOV B,B	58	MOV E,B	70	MOV M,B	1A	LDAX D
41	MOV B,C	59	MOV E,C	71	MOV M,C	2A	LHLD
42	MOV B,D	5A	MOV E,D	72	MOV M,D	3A	LDA
43	MOV B,E	5B	MOV E,E	73	MOV M,E	02	STAX B
44	MOV B,H	5C	MOV E,H	74	MOV M,H	12	STAX D
45	MOV B,L	5D	MOV E,L	75	MOV M,L	22	SHLD
46	MOV B,M	5E	MOV E,M	77	MOV M,A	32	STA
47	MOV B,A	5F	MOV E,A	78	MOV A,B	01	LXI B
48	MOV C,B	60	MOV H,B	79	MOV A,C	11	LXI D
49	MOV C,C	61	MOV H,C	7A	MOV A,D	21	LXI H
4A	MOV C,D	62	MOV H,D	7B	MOV A,E	31	LXI SP
4B	MOV C,E	63	MOV H,E	7C	MOV A,H	F9	SPHL
4C	MOV C,H	64	MOV H,H	7D	MOV A,L	E3	XTHL
4D	MOV C,L	65	MOV H,L	7E	MOV A,M	EB	XCHG
4E	MOV C,M	66	MOV H,M	7F	MOV A,A	D3	OUT
4F	MOV C,A	67	MOV H,A	06	MVI B	DB	IN
50	MOV D,B	68	MOV L,B	0E	MVI C	C5	PUSH B
51	MOV D,C	69	MOV L,C	16	MVI D	D5	PUSH D
52	MOV D,D	6A	MOV L,D	1E	MVI E	E5	PUSH H
53	MOV D,E	6B	MOV L,E	26	MVI H	F5	PUSH PSW
54	MOV D,H	6C	MOV L,H	2E	MVI L	C1	POP B
55	MOV D,L	6D	MOV L,L	36	MVI M	D1	POP D
56	MOV D,M	6E	MOV L,M	3E	MVI A	E1	POP H
57	MOV D,A	6F	MOV L,A	0A	LDAX B	F1	POP PSW

ARITHMETIC

Hex	Mnemonic	Hex	Mnemonic	Hex	Mnemonic	Hex	Mnemonic
80	ADD B	CE	ACI	D6	SUI	23	INX H
81	ADD C	90	SUB B	DE	SBI	33	INX SP
82	ADD D	91	SUB C	09	DAD B	05	DCR B
83	ADD E	92	SUB D	19	DAD D	0D	DCRC
84	ADD H	93	SUB E	29	DAD H	15	DCR D
85	ADD L	94	SUB H	39	DAD SP	1D	DCR E
86	ADD M	95	SUB L	27	DAA	25	DCR H
87	ADD A	96	SUB M	04	INR B	2D	DCR L
88	ADC B	97	SUB A	0C	INR C	35	DCR M
89	ADC C	98	SBB B	14	INR D	3D	DCR A
8A	ADC D	99	SBB C	1C	INR E	0B	DCX B
8B	ADC E	9A	SBB D	24	INR H	1B	DCX D
8C	ADC H	9B	SBB E	2C	INR L	2B	DCX H
8D	ADC L	9C	SBB H	34	INR M	3B	DCX SP
8E	ADC M	9D	SBB L	3C	INR A		
8F	ADC A	9E	SBB M	03	INX B		
C6	ADI	9F	SBB A	13	INX D		

LOGICAL

Hex	Mnemonic	Hex	Mnemonic	Hex	Mnemonic	Hex	Mnemonic
37	STC	A9	XRA C	B3	ORA E	BD	CMP L
A0	ANA B	AA	XRA D	B4	ORA H	BE	CMP M
A1	ANA C	AB	XRA E	B5	ORA L	BF	CMP A
A2	ANA D	AC	XRA H	B6	ORA M	FE	CPI
A3	ANA E	AD	XRA L	B7	ORA A	07	RLC
A4	ANA H	AE	XRA M	F6	ORI	0F	RRC
A5	ANA L	AF	XRA A	B8	CMP B	17	RAL
A6	ANA M	EE	XRI	B9	CMP C	1F	RAR
A7	ANA A	B0	ORA B	BA	CMP D	2F	CMA
E6	ANI	B1	ORA C	BB	CMP E	3F	CMC
A8	XRA B	B2	ORA D	BC	CMP H		

BRANCHING

Hex	Mnemonic	Hex	Mnemonic	Hex	Mnemonic
C3	JMP	D7	RST 2	EC	CPE
C2	JNZ	DF	RST 3	F4	CP
CA	JZ	E7	RST 4	FC	CM
D2	JNC	EF	RST 5	C9	RET
DA	JC	F7	RST 6	C0	RNZ
E2	JPO	FF	RST 7	C8	RZ
EA	JPE	CD	CALL	D0	RNC
F2	JP	C4	CNZ	D8	RC
FA	JM	CC	CZ	E0	RPO
E9	PCHL	D4	CNC	E8	RPE
C7	RST 0	DC	CC	F0	RP
CF	RST 1	E4	CPO	F8	RM

CONTROL

Hex	Mnemonic
00	NOP
76	HLT
F3	DI
FB	EI
20	RIM
30	SIM

Q1. **(a)** Draw the diagram of a typical microprocessor. The diagram should include all the necessary components of a microprocessor. Show all the interconnections between components. Describe the functions of all the components. [11]

(b) **(i)** Write a program for multiplication of non-negative integers using the instruction subset shown below. [7]

Instruction	Mnemonic	Immediate	Direct	Relative	Inherent
Load Accumulator	LDA	86	96		
Clear Accumulator	CLRA				4F
Decrement Accumulator	DCA				4A
Increment Accumulator	INCA				4C
Store Accumulator	STA		97		
Add	ADD	8B	9B		
BRANCH always	BRA			20	
BRANCH if carry set	BCS			25	
BRANCH if carry zero	BEQ			27	
BRANCH if minus	BMI			2B	
HLT	HLT				3E

(ii) Include the flow diagram of your program. Translate your program into machine code. [7]

Q2. **(a)** **(i)** Explain the step-by-step procedure by which a computer executes a program. [10]

(ii) Explain the necessity for condition codes (flags) in a microprocessor. [5]

(b) **(i)** From which location will the next instruction be fetched if the BRA instruction is located at 30_{16} and the relative address is 4_{16}? [5]

30	BRA
31	4
32	–
33	–
34	–
35	–
36	-

(ii) What is the relative address if we want to jump to location A7 and the BRA instruction is located at B2? [5]

A7
A8
A9
AB
AC
AD
AE
AF
B0
B1
B2
B3
B4

Q3. (a) (i) Define a microprocessor and a microcomputer respectively. [3]

(ii) Explain the purpose of a data register and an accumulator in a microprocessor. [2]

(iii) Convert the binary coded decimal of the decimal number 9789 to gray code. [5]

(b) (i) Draw a Karnaugh map in the seven variables A, B, C, D, E, F and G. [8]

(ii) Draw the subcubes for a three variable Karnaugh map in X, Y and Z for m1+m3+m5+m0. [7]

Q4. (a) Design a **circuit** and write a **program** to read eight ON/OFF switches connected to the input port with address 01H and turn on the devices connected to an output port with address 01H. The appliances are

Air conditioner-ON [8+4]
Television-OFF
Space heater-OFF
Radio-ON
Light 1-ON
Light 2-ON
Light 3-OFF
Light 4-ON

(b) Modify the program to keep the space heater ON continuously without affecting the functions of other appliances even if someone turns off the switch. [6]

(c) Explain the output of the following program. Show the contents of the registers and memory locations after the execution of each instruction. [7]

```
        MVI B,5H
        LXI H, 2600H
        LXI D, 9000H
LOOP    MOV A,M
        STAX D
        DCX D
        DCX M
        DCR B
        JNZ LOOP
        HLT
```

Q5. (a) (i) Write the instruction and machine code to rotate the contents of the accumulator left through carry, assuming the accumulator has A7H and the carry flag is reset. Show the contents of the accumulator before and after the instruction. [4]

(ii) Which instruction is used to restore the original contents of the accumulator? Illustrate using figures. [4]

(b) Read the following program and answer the following questions given below.

Line no.	Mnemonics
1	LXI SP, 0400H
2	LXI B, 2055H
3	LXI H, 22FFH
4	LXI D, 2090H
5	PUSH H
6	PUSH B
7	MOV A,L
↓	↓
20	POP H

(i) Illustrate the contents of various registers and stack memory locations after the execution of each instruction. Use separate figures for PUSH and POP instructions. [8]

(ii) What is the memory location of the stack where the first data byte will be stored? [2]

(iii) After the execution of line 6, what is the address in the stack pointer register and what is stored in the stack memory location 03FDH? [2]

(iv) Specify the contents of register pair HL after the execution of line 20. [3]

(c) Write short notes on [6]

(i) opcode and operand (ii) stack pointer

Q6. A system is desigmed to monitor the voltage of a circuit. A set of voltage readings are stored in memory locations starting at XX60H. The end of data string is indicated by 00H. The readings are expected to be positive. Using the instruction set of 8085 microprocessor, draw a flowchart and write a program to [25]

(i) check each reading to determine whether it is positive or negative

(ii) reject all negative readings

(iii) add all positive readings

(iv) store '**FFH**'in memory location XX80H when the sum exceeds 8-bits to indicate '**ERROR**'; otherwise store the sum.

END OF P442 EXAMINATION

UNIVERSITY OF ZAMBIA

DEPARTMENT OF PHYSICS

2011 SECOND SEMESTER UNIVERSITY EXAMINATIONS

P455
QUANTUM MECHANICS II

DURATION: Three hours.

INSTRUCTIONS: Answer four questions from the six given.
Each question carries 25 marks with marks indicated in parenthesis.

MAXIMUM MARKS: 100

DATE: Friday 6th May 2011.

Formulae that may be needed:

1. Equations which give corrections to the unperturbed energy and energy eigenstates to various orders:

$$\begin{aligned}(H_0 - W^{(0)})v^{(0)} &= 0,\\ (H_0 - W^{(0)})v^{(1)} + (H' - W^{(1)})v^{(0)} &= 0,\\ (H_0 - W^{(0)})v^{(2)} + (H' - W^{(1)})v^{(1)} - W^{(2)}v^{(0)} &= 0.\end{aligned}$$

2.

$$\begin{aligned}a &= \left(\frac{m\omega_c}{2\hbar}\right)^{\frac{1}{2}} x + i\left(\frac{1}{2m\hbar\omega_c}\right)^{\frac{1}{2}} p\\ a^\dagger &= \left(\frac{m\omega_c}{2\hbar}\right)^{\frac{1}{2}} x - i\left(\frac{1}{2m\hbar\omega_c}\right)^{\frac{1}{2}} p\end{aligned}$$

3.

$$a_f^{(1)} = \frac{1}{i\hbar}\int_0^t e^{i\omega_{fi}t'} H'_{fi}(t')\,dt'$$

4. Hermite polynomials are generated by

$$H_n(\alpha x) = H_n(\xi) = e^{\xi^2/2}\left(\xi - \frac{d}{d\xi}\right)^n e^{-\xi^2/2}.$$

5.

$$\int_\infty^\infty x^2 e^{-\alpha x^2}\,dx = \frac{\sqrt{\pi}}{2\alpha^3}$$

6.

$$u_n = \frac{a(\dagger)^n}{\sqrt{n!}}\,u_0$$

7.

$$\begin{aligned}J_+ &= J_x + iJ_y, \quad J_- = J_x - iJ_y\\ J_\pm|j,m\rangle &= \hbar[j(j+1) - m(m\pm 1)]^{\frac{1}{2}}|j,m\pm 1\rangle,\end{aligned}$$

8.

$$a^\dagger u_n = \sqrt{n+1}\, u_{n+1}, \qquad a u_n = \sqrt{n}\, u_{n-1}$$

9. Hermite polynomials

$$H_n(\alpha x) = H_n(\xi) = e^{\xi^2/2}\left(\xi - \frac{d}{d\xi}\right)^n e^{-\xi^2/2}, \quad \xi = \alpha x, \quad \alpha = \left(\frac{m\omega_{10}}{\hbar}\right)^{\frac{1}{2}}$$

10.

$$\int_0^\infty x^{2m} e^{ax^2}\, dx = \frac{1.3.5\ldots(2m-1)}{2^{m+1}a^m}\left(\frac{\pi}{a}\right)^{\frac{1}{2}}$$

11.

$$\cos 2\theta = 1 - 2\sin^2\theta$$

12.

$$H_0 = -\frac{\hbar^2}{2m}\nabla^2 - \frac{z'e^2}{r}, \qquad H_0 U_{100}(x,z') = \frac{|z'|^2 e^2}{2a} U_{100}(x,z').$$

13. The Hamiltonian for a two electron atom is

$$H = -\frac{\hbar^2}{2m}\nabla_1^2 - \frac{z'e^2}{r_1} - \frac{\hbar^2}{2m}\nabla_2^2 - \frac{z'e^2}{r_2} + \frac{e^2}{r_{12}}$$

14. For $\psi(12) = U_{100}(x_1, z')U_{100}(x_2, z')$ we have

$$\int\int \psi^* \frac{e^2}{r_{12}}\psi\, dr_1 dr_2 = \frac{5e^2 z'}{8a}, \qquad \int\int \psi^* \frac{1}{r_1}\psi\, dr_1 dr_2 = \int\int \psi^* \frac{1}{r_2}\psi\, dr_1 dr_2 = \frac{z'}{a}$$

15.

$$-\frac{\hbar^2}{2m}\frac{d^2\psi(x)}{dx^2} + V(x)\psi(x) = E\psi(x)$$

QUESTION 1

(a) For the harmonic oscillator problem prove the results:

$$a^\dagger u_{n-1} = \sqrt{n}\, u_n, \qquad a u_n = \sqrt{n}\, u_{n-1}.$$

(8 marks)

(b) Find the expectation value of p^2. (8 marks)

(c) Prove that

$$J_x|jm\} = \frac{\hbar}{2}[j(j+1) - m(m+1)]^{\frac{1}{2}}|j, m+1\} + \frac{\hbar}{2}[j(j+1) - m(m-1)]^{\frac{1}{2}}|j, m-1\}.$$

Use this result to express J_x for $j = 1$ as a matrix in the angular momentum representation. (9 marks)

QUESTION 2

The Hamiltonian for the unharmonic oscillator is

$$H = \frac{p^2}{2m} + \frac{1}{2}m\omega_c^2 x^2 + \lambda x^4, \qquad \omega_c = \sqrt{k/m}.$$

Calculate the first order correction $W^{(1)}$ to the energy of the m^{th} excited state of the anharmonic oscillator and hence write down the total energy W of the m^{th} excited state. (25 marks)

QUESTION 3

Consider a particle in a two-dimensional, infinite square potential well extending from 0 to L in the x and y directions. The particle is subject to the perturbation $H' = Cxy$, where C is constant. The eigenenergies and eigenfunctions of the unperturbed system are:

$$E_{n_1,n_2} = \frac{\hbar^2\pi^2}{2mL^2}(n_1^2 + n_2^2), \quad \psi_{n_1,n_2}(x,y) = \frac{2}{L}\sin\left(\frac{\pi n_1 x}{L}\right)\sin\left(\frac{\pi n_2 y}{L}\right), \quad n_1, n_2 = 0, 1, 2\ldots$$

a) Write down the energy and the corresponding eigenfunction/s of the first excited state of the unperturbed system. State whether or not the states is degenerate giving reasons for your answer. (4 marks)

b) Derive the first of the following equations:

$$\begin{aligned} h_{11} - W^{(1)}a_1^{(0)} + h_{12}a_2^{(0)} &= 0, \\ h_{21}a_1^{(0)} + h_{22} - W^{(1)}a_2^{(0)} &= 0, \end{aligned}$$

where

$$\begin{aligned} h_{11} &= \langle\psi_{12}|H'|\psi_{12}\rangle = h_{22} = \langle\psi_{21}|H'|\psi_{21}\rangle = \frac{L^2C}{4}, \\ h_{12} &= \langle\psi_{12}|H'|\psi_{21}\rangle = h_{21} = \langle\psi_{21}|H'|\psi_{12}\rangle = \frac{256L^2C}{81\pi^4}. \end{aligned}$$

(9 marks)

(c) Use the values of the first order corrections to the energy given by

$$W_+^{(1)} = \frac{L^2C}{4} + \frac{256}{8\pi^4}L^2C, \quad \text{and} \quad W_-^{(1)} = \frac{L^2C}{4} - \frac{256}{81\pi^4}L^2C$$

to find the wavefunction or wavefunctions of the first excited state to zeroth order. (9 marks)

d) Explain the physical meaning of your results from part (c). (3 marks)

QUESTION 4

Consider a one-dimensional harmonic oscillator with angular frequency ω_0 and electric charge q. At time $t = 0$ the oscillator is in the ground state. An electric field is applied for time τ, so the perturbation is

$$W(t) = \begin{cases} -qex & 0 \le t \le \tau \\ 0 & \text{otherwise,} \end{cases}$$

where ϵ is a field strength and x is a position operator.

a) Using first-order perturbation theory, calculate the probability of transition to the state $n = 1$. (17 marks)

(b) Using first-order perturbation theory, show that a transition to $n = 2$ is impossible. (8 marks)

QUESTION 5

Consider a two electron atom or ion whose nucleus has charge ze. Use the variational method to obtain an estimate $W^{(1)}$ of the ground state of such a two-electron system. (25 marks)

QUESTION 6

a) Obtain the exact nonlinear equivalent of the Schrödinger equation used to obtain the WKB approximation. (7 marks)

(b) Using the WKB approximation reduce the nonlinear equation obtained in part (a) to series of equations of various orders of approximation. Solve the appropriate equation to obtain a formula for the zeroeth order term $S_0(x)$ and for the first order term $S_1(x)$, Hence write down the WKB formula for approximating a wave function ψ for the case $E > V(x)$. State in words only the kind of region for which the WKB approximation is a good approximation. (18 marks)

END

The University of Zambia

Department of Physics

First Semester University Examinations - 2010

The Physics of Renewable Energy & Environment – P485

Duration: Three (3) Hours Date: April 2010

Instructions

- This paper contains six (6) questions and has a total of 100 marks.
- Attempt any four (4) questions of your choice. Each question carries 25 marks.
- Show all your work clearly. Omission of essential work will result in loss of marks.
- Marks allocated for each question are indicated in square brackets [ ].

Table 1: Values of $f(x)=1/\sigma\left(\int_0^x\left(a/\left(x^5\left(e^{(b/x)}-1\right)\right)\right)dx\right)$ for different x.

x (μm-K)	$f(x)$	x (μm-K)	$f(x)$	x (μm-K)	$f(x)$
1100	0.0001	4600	0.580	8100	0.860
1200	0.0002	4700	0.594	6200	0.864
1300	0.0004	4800	0.608	8300	0.868
1400	0.0008	4900	0.521	8400	0.871
1500	0.0013	5000	0.634	8500	0.875
1600	0.0020	5100	0.646	8600	0.878
1700	0.0029	5200	0.658	8700	0.881
1800	0.0040	5300	0.669	8800	0.884
1900	0.0052	5400	0.680	8900	0.887
2000	0.0067	5500	0.691	9000	0.890
2100	0.0083	5600	0.701	9100	0.893
2200	0.101	5700	0.711	0200	0.895
2300	0.120	5800	0.720	9300	0.898
2400	0.140	5900	0.730	9400	0.901
2500	0.161	6000	0.738	9500	0.903
2600	0.183	6100	0.746	9600	0.905
2700	0.205	6200	0.754	9700	0.908
2800	0.228	6300	0.762	9800	0.910
2900	0.251	6400	0.770	9900	0.912
3000	0.273	6500	0.776	10000	0.914
3100	0.296	6600	0.783	11000	0.934
3200	0.318	6700	0.790	12000	0.945
3300	0.340	6800	0.796	13000	0.955
3400	0.362	6900	0.802	14000	0.963
3500	0.383	7000	0.808	15000	0.969
3600	0.404	7100	0.814	16000	0.974
3700	0.424	7200	0.819	17000	0.978
3800	0.443	7300	0.824	18000	0.981
3900	0.462	7400	0.830	19000	0.983
4000	0.483	7500	0.834	20000	0.986
4100	0.499	7600	0.840	30000	0.995
4200	0.516	7700	0.844	40000	0.998
4300	0.533	7800	0.848	50000	0.999
4400	0.549	7900	0.852		
4500	0.564	8000	0.856		

Table 2: The Equation of Time in Minutes

Day of Month	1	4	7	10	13	16	19	22	25	28
January	-4	-5	-6	-8	-9	-10	-11	-12	-12	-13
February	-14	-14	-14	-14	-14	-14	-14	-14	-13	-3
March	-13	-12	-11	-10	-10	-9	-8	-7	-6	-5
April	-4	-3	-2	-1	-1	0	+1	+1	+2	+2
May	+3	+3	+3	+4	+4	+4	+4	+4	+3	+3
June	+2	+2	+2	+1	0	0	-1	-2	-2	-3
July	-3	-4	-5	-5	-6	-6	-6	-6	-6	-6
August	-6	-6	-6	-5	-5	-4	-4	-3	-2	-1
September	0	+1	+2	+3	+4	+5	+6	+7	+8	+9
October	+10	+11	+12	+13	+14	+14	+15	+15	+16	+16
November	+16	+16	+16	+16	+16	+15	+15	+14	+13	+12
December	+11	+10	+9	+7	+6	+4	+3	+2	0	-2

Table 3: Some Physical Constants

Radius of the Sun, $R_\odot \simeq 6.96\times10^{8}$ m	Mass of the Sun, $M_\odot \simeq 1.99\times10^{30}$ Kg
Radius of the Earth, $R_\oplus \simeq 6.38\times10^{6}$ m	Mass of the Earth, $M_\oplus \simeq 5.97\times10^{24}$ Kg
1 Astronomical Unit , 1 AU $\simeq 149.6\times10^{9}$ m	Earth's Solar constant, $S \simeq 1352$ W.m^{-2}
Eccentricity of Earth, $\varepsilon = 0.0167$	Boltzmann constant, $k \simeq 1.38\times10^{-23}$ J.K^{-1}
Universal gas constant, $R = 8317$ J/Kg mole-K	Stefan-Boltzmann constant, $\sigma \simeq 5.67\times10^{-8}$ W.m^{-2}K^{-4}
Mean molecular mass of air, $\bar{M} = 29.0$ amu	One atomic mass unit, 1 amu $= 1.66\times10^{-27}$ Kg ,
Speed of light (vacuum), $c = 2.9979\times10^{8}$ m.s^{-1}	Planck's constant, $h \simeq 6.63\times10^{-34}$ J-s
Specific heat of water, $c_w = 4.186$ KJ.Kg^{-1}.K^{-1}	Electron charge, $e \simeq 1.60\times10^{-19}$ Coulombs

Table 4: Formulae That May Be Useful

$\delta = 23.45\sin\left[\frac{360}{365}(d_n + 284)\right]$	$r = \frac{a(1-\varepsilon^2)}{1+\varepsilon\cos\theta}$
$n_f = \sqrt{n_g}$	$dq = du + Pdv$
$J = \varepsilon\sigma T^4$	$R = Nk$
Solar time = Standard time $+ 4(\text{Long}_{st} - \text{Long}_{loc}) + \text{EOT}$	$\cos D' = \sin 23.5^\circ \sin\left(\frac{360^\circ}{365.25}n\right)$
$F_\lambda^{(dir)} = \mu S_\lambda \exp\left(-\frac{\tau_\lambda}{\mu}\right)$ where $\mu = \cos\theta$	$\nabla\cdot(\kappa\nabla T) + q_g = \rho c\frac{\partial T}{\partial t}$
$\dot{Q} = \frac{(T_1 - T_{(n+1)})}{\sum_1^n \frac{L}{kA}}$	$T_{f,e} = T_B - [T_B - T_{f,i}]\exp\left(\frac{U_L L}{\dot{m}c}\right)$
$s_f = \frac{m\lambda_0}{4n_f}$	$\text{cr} = \frac{A}{A'}$
$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$	$m = \frac{(f/p)}{(1-f/p)}$
$r_{\parallel} = \left[\frac{n_r^2\cos\theta_i - n_i\sqrt{n_r^2 - n_i^2\sin^2\theta_i}}{n_r^2\cos\theta_i + n_i\sqrt{n_r^2 - n_i^2\sin^2\theta_i}}\right]^2$	$r_{\perp} = \left[\frac{n_i\cos\theta_i - \sqrt{n_r^2 - n_i^2\sin^2\theta_i}}{n_i\cos\theta_i + \sqrt{n_r^2 - n_i^2\sin^2\theta_i}}\right]^2$
$R = r\left[1 + \frac{\alpha^2(1-r)^2}{1-\alpha^2 r^2}\right]$	$T = \frac{\alpha(1-r)^2}{1-\alpha^2 r^2}$
$J_0 = DT^3\exp\left(-\frac{\varepsilon_g}{kT}\right)$	$J = J_0\left[\exp\left(\frac{qV}{kT} - 1\right)\right]$
$(\dot{Q}_{12}) = \frac{A_1\sigma(T_1^4 - T_2^4)}{\left(\frac{1-\varepsilon_1}{\varepsilon_1}\right) + \left(\frac{1-\varepsilon_2}{\varepsilon_2}\right)\frac{A_1}{A_2} + \left(\frac{A_1 + A_2 - 2A_1F_{1-2}}{A_2 - A_1F_{1-2}}\right)}$	$\alpha = \exp\left(-\frac{n\kappa s}{\sqrt{n^2 - \sin^2\theta_i}}\right)$
$\cos Z = \sin D'\cos L' + \sin D'\sin L'\cos H$	$\tan A = \frac{\cos D'\sin H}{(\sin D'\cos L'\cos H - \cos D'\sin L')}$

1. (a) The spectrum of extraterrestrial solar radiation can be considered as a black-body at 5760 K and leads to the earth's solar constant of about $1352\ \text{W.m}^{-2}$.

(i) Define the term solar constant, **[2]**

(ii) Calculate the energy fraction of extraterrestrial solar radiation for wavelengths between $0.3\mu\text{m}$ and $0.5\mu\text{m}$. **[4]**

(b) Given that earth's albedo is 0.33 and assuming the planet to be at a uniform temperature with a thermal emissivity equal to unity,

(i) Show that its steady-state (effective) temperature would be

$$T_{\text{eff}} = \left[\frac{0.67}{4\sigma} S\right]^{1/4},$$

where S is earth's solar constant and σ is the Stefan-Boltzmann constant. **[6]**

(ii) Hence, or otherwise, estimate the effective temperature of the earth and the characteristic wavelength of its emission spectrum. **[3]**

(c) Consider an atmosphere in which temperature, density and pressure vary only with altitude z, where $z = 0$ at sea level. Show that the density profile of a dry atmosphere with a temperature profile $T = T_0 - \alpha z$ is given by

$$\rho = \frac{\rho_0}{(1-\beta z)} \exp\left[\frac{1}{\beta H} \ln[1-\beta z]\right],$$

where $\beta = \alpha / T_0$ and $H = \frac{RT_0}{Mg}$. Here, α is the temperature lapse rate, T_0 is the temperature at sea level, ρ_0 is the density of air at sea level, R is the universal gas constant and M is the molecular mass of air. **[10]**

2. (a) Find the local coordinates of the sun in terms of the zenith angle and azimuth angle at 12:00hrs noon on 25th April for an observer at Lusaka (Longitude 28°16'**E**, Latitude 15°17'**S**). **[5]**

(b) For an observer in Lusaka on 25th April, find

(i) the time of sunset and sunrise, **[5]**

(ii) the number of daylight hours, **[5]**

(iii) the noontime zenith angle, **[5]**

(iv) the sunset and sunrise azimuth angles. **[5]**

3. (a) Prove that the overall reflectance of a single glazing is given by

$$R = r\left[1 + \frac{\alpha^2(1-r)^2}{1-\alpha^2 r^2}\right],$$

where r and α are the reflection coefficient and bulk transmissivity, respectively. **[8]**

(b) A glazing 1.5 cm thick has an index of refraction of $n = 1.5$ and a bulk extinction coefficient of $\kappa = 0.2\ \text{cm}^{-1}$. Find the overall transmittance of the glazing for direct solar radiation at an incident angle of $60°$. **[7]**

(c) The insulation boards for air-conditioning purposes are made of three layers; a middle layer made of packed grass 10 cm thick and thermal conductivity $\kappa = 0.02\ \text{W/m°C}$ while the sides are made of plywood each of 2 cm thickness and thermal conductivity $\kappa = 0.12\ \text{W/m°C}$. The three layers are glued to each other. Neglecting the thermal resistance of glue, determine the heat flow per unit area if one of the exterior surfaces is at $35°\text{C}$ and the other is at $20°\text{C}$ **[10]**

4. (a) A spherical mirror has a radius of $R = 60.0\ \text{cm}$ and a rim angle of 40°.

(i) If aberrations increase the image radius of the solar disc to 6 times the minimum value, find the concentration ratio of the mirror, **[6]**

(ii) Find the average flux and the power falling on a small absorber at the focal point if the direct solar flux is 900 W/m². **[7]**

(b) A p-n junction photovoltaic is made of a semiconductor whose bandgap is $\varepsilon_g = 1.2\ \text{eV}$. It has a junction parameter $D = 0.2\ \text{amp/cm}^2\text{-K}^3$ and an average responsivity of $\bar{K} = 0.25\ \text{amp/W}$.

(i) Find the reverse saturation current of the photovoltaic when the operating temperature is 300 K, **[5]**

(ii) Find the open circuit voltage at 300 K when the intercepted flux is 1 sun. **[7]**

5. (a) A glazing of refractive index 1.6 is coated with a film to make it antireflective at normal incidence.

(i) What should the film refractive index be? **[2]**

(ii) What should its minimum thickness be if it is to produce zero reflection at $\lambda_0 = 0.6$ μm ? **[4]**

(b) A single solar heating panel uses water as the transfer fluid. The water is flowing at 0.005 Kg/sec; it enters the panel at 20°C and leaves at 50°C. The fluid is carried to a storage tank by an exterior pipe 10m long whose overall heat transfer coefficient per unit length is 0.2 W/m-°C. The ambient temperature is 15°C. Find the temperature of the water entering the storage tank and the percent of the heat produced by the panel lost by the pipe. **[6]**

(c) A square room of floor sides 3m has its floor heated to 27°C and has a ceiling at 10°C. The walls are assumed to be perfectly insulated. If the height of the room is 2.5m and the emissivity of all the surfaces is 0.8, and the ceiling to floor shape factor is 0.25, determine

(i) the net heat interchange between the floor and the ceiling, **[10]**

(ii) the wall temperature. **[3]**

6. (a) A solar heating panel is situated at a colatitude $43°$ north with surface tilt angle $\Delta = 45°$ and azimuth $\psi = 0$. If the optical thickness of the atmosphere is 0.3, find the direct flux incident on the panel at the winter solstice (codeclination angle $D' = 113.5°$) at 2:00 pm solar time. **[10]**

(b) The flow rates of hot and cold water streams running through parallel flow heat exchanger are 0.2 Kg/s and 0.5 Kg/s respectively. The inlet temperatures on the hot and cold sides are 75°C and 20°C respectively. The exit temperature of hot water is 45°C. If the individual heat transfer coefficients on both sides are 650 W/m^2.°C, calculate the area of the heat exchanger. **[8]**

(c) A reactor wall, 320mm thick, is made up of an inner layer of fire brick ($\kappa = 0.84$ W/m °C) covered with a layer of insulation ($\kappa = 0.16$ W/m °C). The reactor operates at a temperature of 1325°C and the ambient temperature is 25°C. Determine the thickness of fire brick and insulation which gives minimum heat loss. **[7]**

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