THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

SECOND SEMESTER EXAMINATIONS

<u>2007-2009 ACADEMIC YEARS</u>

1. BS 222 –Form Function and Diversity of Animals Theory Paper

2. BS 329 –Biostatistics Theory Paper

3. BS 322 –Ecology

4. BS 332 –Animal Physiology (Theory)

5. BS 342 –Mycology

6. BS 349 –Microbiology

7. BS 352 –Parasitology

8. BS 362 –Genetics (I)

9. BS 412 –Applied Entomology

10. BS 432 –Advanced Parasitology II

11. BS 435 –Medical Microbiology

12. BS 442 –Advanced Molecular Biology

13. BS 445 –Ecophysiology of Plants I

14. BS 455 –Wildlife Ecology II (Practical Paper)

15. BS 455 –Wildlife Ecology (Theory Paper)

16. BS 492 –Fisheries Biology (Practical)

17. BS 492 –Fisheries Biology (Theory Paper)

18. BS 925 –Biology Of Terrestrial Vertebrates (Theory)

19. BS 925 –Terrestrial Vertebrate Biology (Practical)

20. C102 –Introductory Chemistry II

21. C225 –Analytical Chemistry I

22. C252 –Organic Chemistry II

23. C265 –Basic Physical Chemistry

24. C 312 –Biochemistry II

26. C322 –Analytical Chemistry III

27. C342 –Inorganic Chemistry III

28. C352 –Organic Chemistry IV

29. C362 –Colloids and Electrochemistry

30. C412 –Advanced Biochemistry II

31. C 422 –Applied Analytical Chemistry: Organic Compounds

32. C452 –Advanced Organic Chemistry II

33. C492 –Organic Industrial Chemistry

34. CST2012 –Programming II

35. CST 2032 –Fundamentals of Computer Architecture (CST2032)

36. CST2032 –Fundamentals of Computer Architecture

37. CST 2042 –Introduction to Databases and File Systems

38. CST3032 –Artificial Intelligence Fundamentals

39. CST 3141 –Object Oriented Analysis and Design

40. CS 4012 –Advanced Operating and Distributed Systems

41. CST 4122 –Fundamentals of Compilers

42. CST 4132 –Computer Graphics

43. CST 4252 –Electronics for Computing IV

44. GEO 112 –Introduction to Human Geography II

45. GEO 175 –Introduction to Mapping Techniques in Geography

46. GEO 211 –Geography of Africa

47. GEO 212 –Geography of Zambia

48. GEO 272 –Techniques in Geography II

49. GEO 482 – Environment and Natural Resources Management II.

50. GEO 492 – Natural Resources Economics

51. GEO 495 –Environmental Hazards and Disasters

52. GEO 922 –Geography of Regional Planning and Development

53. GEO 932 –Urban Geography

54. GEO 952 –Geographical Hydrology

55. GEO 955 –Geomorphology

56. GEO 967 -Biogeography

57. GEO 971 –Air photography (Paper I)

58. GEO 971 –Air photography (Paper II)

59. GEO 972 –Satellite Remote Sensing and Geographic Information Systems

60. GEO 995 –Environment and Natural Resources Management

61. GG 322 –Stratigraphy and Remote Sensing (Practical Paper II)

62. M III   - Mathematical Methods I

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2007/8 ACADEMIC YEAR: SECOND SEMESTER FINAL EXAMINATIONS

BS 222   FORM FUNCTION AND DIVERSITY OF ANIMALS THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: Attempt two questions in **Section A** and **two** questions in **section B**. Questions 1 in **section A** and question 4 in **sections B** are **compulsory**. Answers for each section should be in separate booklets.

SECTION A

1. **Q1**   Write **brief** and **concise** notes on the following:

   (i)   Linnaean classification in invertebrate zoology
   (ii)   General biology of the Phylum: Porifera
   (iii)   Cnidarian body forms
   (iv)   Nutrition in molluscs
   (v)   The coelom and hemal system in annelids

Q2   "There are far more arthropods than all other metazoan species combined". Discuss this statement highlighting the arthropod external structures in relation to their habitats.

Q3   Compare and contrast structural features in parasitic nematodes and platyhelminthes.

SECTION B

Q4   Define the following terms and phrases as used in the study of Chordates

i)	Apoda	ii)	Chondrichthyes
iii)	Ornithischia	iv)	Monotremes
v)	Sirenia	vi)	Edentata
vii)	Cetacea	viii)	Canivora
ix)	Nothobranchus	x)	Schilbe

Q5 Briefly state key functions of the following organs or structures among vertebrates. Support your answers by providing appropriate diagrams:

    i)   Pharynx in Urochordata
    ii)   Cloaca in the order Chelonia
    iii)   Gill slits in Petromyzoniformes
    iv)   Pelvic appendages in the Order Anura
    v)   Lung in the Order Anura
    vi)   Trunk in the Squamata
    vii)   Proventiculus among Columbiformes
    viii   Air sacs among the Psittaciformes
    ix)   Antlers in *Infaoder*
    x)   Pouch in the Marsupialia

Q6 Assess the validity of the statement that, "the Class Amphibia is the true representative of the Sub-phylum Gnathostomata".

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2007/8 ACADEMIC YEAR: SECOND SEMESTER FINAL EXAMINATIONS

BS 222   **FORM FUNCTION AND DIVERSITY OF ANIMALS PRACTICAL PAPER**

TIME: **THREE HOURS**

INSTRUCTIONS: Attempt all both the questions: **Question 1 in Section A;** and **question 2 in section B. Answers for each section should be in separate booklets.** At the end of the examination, hand in all the answer sheets and question papers.

SECTION A

Q1   You are provided with 10 specimens numbered A 1 to A 10. For each specimen answer the following questions:

     i)   What structure(s) does this specimen use for locomotion?
     ii)   Give its ecological and economic importance.
     iii)   Give its Phylum and Class.
     iv)   Describe key identification features that members of this class possess.
     v)   Name the key digestive structures in this specimen.

SECTION B

Q2   You are provided with 10 specimens Labelled **B 1** to **B 10**. For each specimen provided attempt to give the information requested:

     i)   Make a detailed drawing showing key external features;
     ii)   Assign the specimen to its Class;
     iii)   Name the taxonomic order of the specimen;
     iv)   Significance of the order from an evolution point of view; and
     v)   Type of natural habitants the specimen could be found in.

END OF EXAMINATION

BS 319: BIOSTATISTICS
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS

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1. Data for a completely randomized design with 3 treatments and 4 replications per treatment are shown below. The data represent protein percentages in maize at 2, 4 and 9 weeks after December 1 in Lusaka province for the 2008-2009 crop-growing season.

Replications	Weeks after December 1, 2008 (= Treatments)		
	2 Weeks	4 Weeks	9 Weeks
1	33	15	11
2	25	21	9
3	21	14	7
4	29	18	13

Test the Null Hypothesis (H_o) that there are no significant differences in the protein content of maize for the three treatments (i.e. periods in weeks).

2. The following data describe the state of grief of 66 mothers who have suffered a neonatal death (death of a baby within one month of birth). The table relates this to the amount of support given to them by hospitals and relatives:

Grief State	Type of Support		
	Good	Adequate	Poor
I	17	9	8
II	6	5	1
III	3	5	4
IV	1	2	5

TURN OVER

Test the Null Hypothesis (H_o) that there is no association between the state of grief in the mothers and the support they receive from hospitals and relatives.

3. The results of a Randomized Block Design (RBD) experiment are presented below in which for some unknown reasons, two cells, a and b are blank (i.e. with no results).

TREATMENTS	BLOCKS (Replicates)		
	1	2	3
1	11	13	16
2	18	20	b
3	a	29	30
4	29	30	31

a. Estimate the values of the missing data in cells a and b.
b. Conduct an ANOVA of the complete data.

4. The height in metres of third year male students (n=15) were measured against their age and the following were the results:

Height (m)	Age (years)
1.58	28
1.60	34
1.62	24
1.64	23
1.66	33
1.68	29
1.70	30
1.72	26
1.74	24
1.76	27
1.78	31
1.80	22
1.82	21
1.84	32
1.86	25

(a) Derive the linear regression equation
(b) Determine the variability of the deviations of y from the regression line.
(c) What would be the height of a 36 year old male student?

5. Two samples of the Kafue weed, with 6 plants each, were collected from two locations of the Kafue River between Mazabuka and Kafue gorge dam. The lengths of the root systems of the plants (cm) were as follows:

SAMPLE 1	SAMPLE 2
97	88
104	101
17	87
101	67
31	65
98	43

a. Examine the significance of the difference between the mean root lengths, assuming that the population variances of the samples are equal.
b. Test the equality of variances of the two root system samples.

6. The number of elephants was counted in relation to proximity to human settlements (kilometres) in 6 different National Parks. The following were the results:

National Park	Number of Elephants	Distance of nearest settlement (km)
Kafue	28	8.0
Blue Lagoon	16	5.5
South Luangwa	14	4.5
Kasanka	20	3.5
Lochinvar	20	5.0
Mosi-oa-tunya	27	3.3

(a) Find the covariance between the number of elephants and proximity to human settlements.
(b) Determine whether there is correlation between the number of elephants and proximity to human settlements.
(c) Test the Null Hypothesis (H_o) that $\rho=0$.

7. (a) Explain how a normal distribution curve looks like and why is it important.
   (b) State two parameters that fix or characterize the binomial distribution.
   (c) Explain when a t-distribution must be used instead of a normal distribution.
   (d) State the relationship of χ^2 to $N(0, 1)$.
   (e) Five coins are tossed at once. Let, **r**, represent the number of heads in the toss. Thus, **r**, can have values 0,1,2,3,4 5. Determine the distribution of **P(r)** in the toss of the five coins.

TURN OVER

8. The following measurements of length (in mm) of the antennae of 10 males and 10 females of the 6th developmental stage of the Armoured ground cricket, *Acanthoplus speiseri* Brancsik, collected in bushes, west of Kaunda Square Stage I, in Lusaka, were recorded by a researcher at the Department of Biological Sciences:

Specimen Number	1	2	3	4	5	6	7	8	9	10
Sex										
Male	76.1	67.0	61.0	62.5	53.0	52.0	66.4	60.0	59.0	73.6
Female	77.6	57.4	66.0	65.0	65.6	69.3	66.0	58.0	65.0	63.0

(a) Calculate the 95% confidence limit of the mean antennal length of each sex.

(b) Test the Null Hypothesis (H_o) that the two sexes have antennae of the same length.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

UNIVERSITY SECOND SEMESTER ~~DEFERRED~~ EXAMINATIONS –
FEBRUARY/MARCH 2008

BS322

ECOLOGY

(PRACTICAL PAPER)

TIME: THREE (3) HOURS

INSTRUCTIONS: ANSWER ALL FIVE QUESTIONS AND USE
ILLUSTRATIONS WHEREVER POSSIBLE.

Question 1. A researcher monitored the development of a grassland
community in a 1 x 1 m quadrat that was tilled in November 1996 by recording
grass species on the quadrat for nine years and obtained the results shown in
the Table below.

Number of grass species recorded annually in a tilled quadrat from 1997 to
2005.

Year	1	2	3	4	5	6	7	8	9
Species	0	3	3	2	4	6	6	9	8

Using a species-time relationship, discuss the development of this grassland
community and its significance to the concept of succession.

Question 2. What ecological gradients or structural components do
photographs G, H, I and J represent and give reasons for your answers.

Question 3. What Raunkiaer's life forms do photographs K, L, M and N
represent and give reasons for your answers.

Question 4. What types of species interactions are represented by
photographs X, Y, Z and AA and give reasons for your answers.

Question 5. Photograph S represents a trophic structure at a savanna habitat
near Lusaka. Describe and illustrate the trophic structure.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 – 2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 322: ECOLOGY
PRACTICAL PAPER

TIME: THREE HOURS
INSTRUCTIONS: ANSWER **ALL** FOUR QUESTIONS. ILLUSTRATE YOUR
ANSWERS WHERE NECESSARY.

1. The following data represent the percentage catch of prey and predatory fish in the Zambian portion of Lake Tanganyika from 1975 to 1980.

	1975	1976	1977	1978	1979	1980
Prey fish	79	60	31	56	60	19
Predatory fish	6	27	57	26	30	57

Analyse the data and describe the results using the Lotka – Voltera model.

2. Gross primary productivity (GPP) in Lochinvar National Park on the Kafue Flats is estimated at 16 tonnes/km^2/year and the large herbivore productivity is 0.4 tonnes/km^2/year. If 20% of the GPP is used by plants in metabolism, and the consumption and assimilation efficiencies of large herbivores are 30% and 25% respectively, calculate:
   (a) net primary productivity (NPP)
   (b) amount in kg of plant biomass consumed by herbivores
   (c) amount in kg of plant biomass assimilated by herbivores
   (d) the production efficiency of large herbivores

3. The following are the life form spectra in biomes A and B as indicated in Figures 1 and 2 respectively. Compare and contrast the life forms in the two biomes.
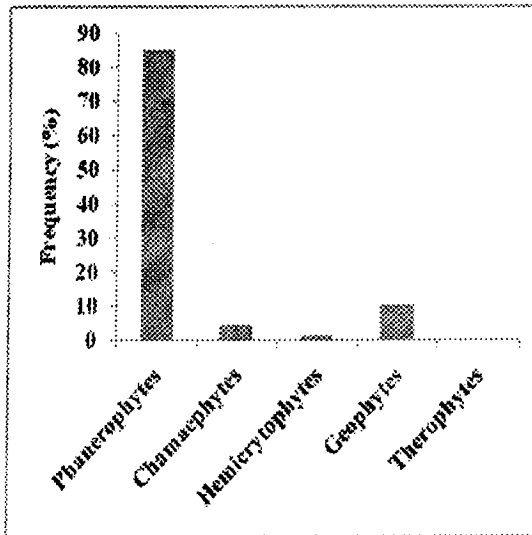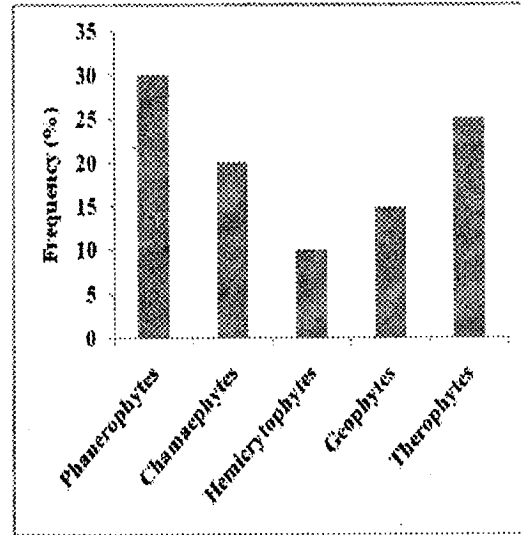
Figure 1

Figure 2

4.   The data below were collected in two 50m x 100m quadrats established on Great East Road Campus. Determine the importance value of the tree species.

Species	Frequency	Density	Basal area (m^2)
Delonix regia	2	29	44.37
Ficus elastica	1	53	113.95
Ficus religiosa	1	43	309.33
Gmelina arborea	2	59	237.77
Spathodea campanulata	1	6	10.44

END OF EXAMINATION

2008 – 2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 322: ECOLOGY
THEORY PAPER

TIME: THREE HOURS
INSTRUCTIONS: ANSWER QUESTION 1 AND ANY OTHER **FOUR** QUESTIONS.

ILLUSTRATE YOUR ANSWERS WHERE NECESSARY.

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1. An ecologist carried out a census of grasshoppers on a 50m x 50 m grassland plot using the capture-recapture method. In the first random sample, 49 grasshoppers were caught, 45 were marked and released into the population. In the second random sample, 45 grasshoppers were captured out of which 10 were recaptures. Estimate the grasshopper population size and explain the assumptions associated with this method.

2. Explain the structure of energy pyramids in ecosystems using the laws of thermodynamics.

3. Discuss the intermediate disturbance hypothesis.

4. Describe how community patterns are estimated and their relevance in community dynamics.

5. Summarise the following:
   (a) the fate of energy and matter in the grazing food chain
   (b) open and cybernetic ecosystems

6. Compare and contrast each of the following pairs in relation to succession:
   (a) pioneer and late seral plants
   (b) facilitation and inhibition

7. Describe the characteristics of the savanna biome.

8. Describe the different types of ecological efficiencies and their relevance to food chains.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
UNIVERSITY SECOND SEMESTER DEFERRED EXAMINATIONS – MARCH 2008

ANIMAL PHYSIOLOGY (THEORY)
BS 332

TIME: THREE HOURS
INSTRUCTIONS: ANSWER ANY **FIVE** QUESTIONS
                ALL QUESTIONS CARRY EQUAL MARKS

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1. a.) What is a nephron?
    b.) List and discuss the processes used by the mammalian kidney to achieve the final composition of urine.

2. List and discuss the factors that regulate energy intake.

3. a.) What is hypoxia?
    b.) Explain the processes involved in the acclimation of mammals to reduced availability of oxygen.

4. Describe the different types of muscle fibre proteins and discuss their functions.

5. State important anterior pituitary gonadotropins. Explain their functions in the reproductive cycle of a female mammal.

6. Give some examples of symbiotic micro-organisms in the alimentary canal of the herbivore and explain how they benefit their host.

7. a.) What is a receptor?
    b.) Classify different types of receptors.
    c.) Explain their properties.

8. Write short notes on the following:
    a.) Bile
    b.) Basal ganglia
    c.) Pancreatic enzymes
    d.) Leptin

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCENCES

2008-2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 332: ANIMAL PHYSIOLOGY
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS WITH AT LEAST TWO
QUESTIONS FROM EACH SECTION. USE SEPARATE ANSWER BOOKS FOR
EACH SECTION. USE ILLUSTRATIONS WHERE NECESSARY

SECTION A

1. (a) Describe the structure of the nephron.
   (b) Discuss the three major processes used by the vertebrate kidney to produce the
   final composition of urine.

2. Summarize the following:
   (a) Hering-Breuer reflex
   (b) Capillary membrane fluid exchange
   (c) Renal clearance
   (d) Normal electrocardiogram (ECG).

3. Discuss the cardiovascular responses during exercise.

4. Discuss the processes involved in the acclimation of mammals to environmental
   hypoxia.

SECTION B

5. Discuss the physiological mechanisms that enable animals to survive in environments
   whose parameters markedly differ from those of their own internal environments.

6. Discuss the signal transduction cascade triggered during the visual response.

7. (a) Compare and contrast the biochemical mechanisms of steroid and non-steroid hormones.
   (b) Discuss the roles, functions and regulation of the hormones of the hypophysis.

8. Compare and contrast hearing in humans and echolocation in *Myotis lucifugus*, the brown bat.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

UNIVERSITY SECOND SEMESTER EXAMINATIONS – FEBRUARY 2008

BS 332

ANIMAL PHYSIOLOGY (THEORY)

TIME: THREE HOURS

INSTRUCTIONS: ANSWER ANY FIVE QUESTIONS. ALL QUESTION CARRY EQUAL MARKS

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1.   (a)   What is osmoregulation?
      (b)   Describe in detail the physiological adaptations involved in osmoregulation in different animal groups.

2.   Cyclic adenosine monophasphate (cAMP) is not the only second messenger system used by different hormones. Two other important ones are (1) the calcium – calmodulin second messenger system, and (2) the phopholipid second messenger system (diacylglycerol, inositol triphosphate, and phosphatidylinositol triphosphate).

Explain in detail the:

    a)   cAMP second messenger mechanism, and either
    b)   calcium-calmodulin second messenger system, or
    c)   phopholipid second messenger system,

3.   a)   What are receptors
      b)   Classify them
      c)   Explain their properties

4.   a)   What is puberty?
      b)   Discuss the gonadotropic hormones and their effects on ovaries.

5.   Write short notes on:

    a)   Glucostatic theory of hunger.
    b)   Fever.
    c)   Capillary membrane fluid volume exchange.
    d)   Synaptic transmission.

6.   Discuss the compensatory measures that occur in response to a fall in core body temperature as a result of cold exposure and in response to the rise in core body temperature as a result of heat exposure.

7.   Describe the sliding – filament mechanism of skeletal muscle contraction. How do cross-bridge power strokes bring about shortening of the muscle fibre.

8.   Describe the cardiovascular changes during exercise.

THE UNIVERSITY OF ZAMBIA

SECOND SEMESTER UNIVERSITY EXAMINATIONS
FEBRUARY 2008

BS 342: MYCOLOGY
PRACTICAL PAPER

ANSWER ALL QUESTIONS:
ALL QUESTIONS CARRY EQUAL MARKS

TIME: THREE HOURS

1. (i)   Give the proportions of potatoes, dextrose and water required for the preparation of potato dextrose agar medium.
    (ii) At what stage of medium preparation is autoclaving required. State the temperature and pressure required for this purpose.
    (iii) How do you determine the minimum amounts of agar medium to be poured in a Petri dish?

2. Compare and contrast the extent of growth and colony texture of specimens P, Q and R. Give metabolic reasons for the differences observed.

3. Examine microscopic preparations labelled S, T, U and V. Make a drawing of each specimen to illustrate their reproductive features. Compare and contrast their reproductive features.

4. The following are hypothetical results of an experiment using one fungus species.

    Table of the total number of conidia produced (x 10^8) per centimetre cubed of soil per month.

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Sterilised soil	8	15	25	50	80	90	88	91	89	85
Unsterilised soil	10	20	30	55	60	55	56	70	60	66

    (i)   Plot graphs of the results on the graph paper provided.
    (ii) What type of growth is demonstrated by the fungus growing in sterilised soil between November and March.?
    (iii) Give reasons for the fungus growth shown in sterilised soil between April and July.
    (iv) Explain the difference in growth of the fungus between April and July in sterilised and unsterilised soil.

END OF EXAMINATION

BS 342: MYCOLOGY
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS. ANSWERS TO QUESTIONS
1-5 AND 6-8 SHOULD BE MADE IN SEPARATE ANSWER BOOKS. ALL QUESTIONS
CARRY EQUAL MARKS.

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1.   (a)   Distinguish between plasmogamy and karyogamy.
      (b)   Describe the sexual life cycle of a named Zygomycotina.
      (c)   Explain how this fungus is adapted to survive unfavourable conditions.

2.   Describe the formation of septa in fungi and explain their significance in the
      success of fungi.

3.   Discuss the phenomenon of differentiation as an adaptive feature in *Beauveria
      bassiana* (Bals.) Vuill. an insect pathogen.

4.   Describe the different kinds of methods used to assess growth in fungi and
      explain the advantages and disadvantages of each one of them.

5.   (a)   Describe catabolite repression with respect to carbon nutrition.
      (b)   Explain how a mixture of carbohydrates in the environment are utilised
             by fungi as a source of nutrients.

6.   (a)   Compare and contrast fungal predation and parasitism.
      (b)   Describe the mechanisms by which fungi capture their prey.

7.   Explain food contamination and spoilage by fungi and discuss the associated
      health problems in humans.

8.   Describe dermatophytes and their role in human health.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2006-2007 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

Theory Paper

BS 349:   MICROBIOLOGY

TIME: THREE HOURS

INSTRUCTIONS:

Answer Section A (Compulsory). Answer Two questions each from Section B & C.
A total of FIVE questions should be answered.

Answer each section in a SEPARATE answer book.

SECTION A

Question 1.   Write brief notes on any **FOUR** of the following:

    i.   Microbial ecology as a science
    ii.   History of Microbial ecology
    iii.   Nutrition of soil bacteria
    iv.   Significance of actinomyces
    v.   Ecology of soil fungi
    vi.   Microbial communities and ecosystems

SECTION B

Question 2 a. How does Carl Woese divide organisms into domains in his universal phylogenetic tree? List at least three major Characteristics that differentiate the domains.

2 b. Briefly discuss natural, phenetic and phylogenetic classification systems.

Question 3 a. What is meant by Biochemical Pathways of energy production?

3 b. Chemoheterotrophic organisms produce energy by several pathways. Discuss the generation of energy in glycolysis, respiration and fermentation.

Question 4 a. What data is required to calculate the generation time of a bacterial culture in the exponential phase of growth?

4 b. Calculate the generation time time of a bacterial culture when its population increases from 10^6 to 10^{12} cells in 10 hrs?

Question 5.a. Classify microorganisms according to

    (i) their preference for temperature and
    (ii) their oxygen requirement.

5 b. Explain how oxygen becomes toxic to some microorganisms when they grow in its presence. How do organisms that tolerate oxygen differ from those that are poisoned by it?

SECTION C

Question 6.   What is glycocalyx? Describe the structure and function of glycocalyx in bacteria and explain how its presence can be microscopically revealed.

Question 7.   Discuss bacterial cell wall appendages with reference to types, structure and function.

Question 8.   What are the characteristics of viruses? Why are viruses considered so important? Describe virus structure and their genome types.

Question 9.   Write short notes on any **FOUR** of the following:

    i.   Baculovirus
    ii.   Botulism
    iii.   Prosthecae
    iv.   Transformation
    v.   Nucleiod
    vi.   Enveloped viruses

END OF EXAMINATION

The University of Zambia
School of Natural Sciences
Second Semester University Examinations

February, 2008

BS 352
PARASITOLOGY
PRACTICAL PAPER

Time: Three (3) Hours

Instructions:

1.   Answer **ALL** questions
2.   For each specimen provided, labelled specimen I (SI) to specimen II (S II) and provide the following information:

a.   Species name
b.   Developmental stage
c.   Sex (where applicable)
d.   Vector species (where applicable)
e.   Intermediate host species (where applicable)
f.   Definitive host
g.   The role it plays in transmission
h.   Type of life-cycle for each species.

END OF EXAMINATION

BS 352   : PARASITOLOGY
                    THEORY

TIME   : THREE HOURS

INSTRUCTIONS   : ANSWER ANY **FIVE** QUESTIONS AND USE ILLUSTTRATIONS
                        WHEREVER POSSIBLE. ANSWER EACH QUESTION ON A
                        SEPARATE ANSWER SHEET

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1. Describe in detail the life-cycle of Giardia intestinalis. Relate this to the pathology it causes in its definitive host and the resultant clinical symptoms.

2. Describe the life-cycle of Trypanosoma (brucei) rhodesience. Suggest the control measures of the disease caused by this parasite

3. a. Describe the structure of sporulated Eimeria tenella oocyst.
   b. State the mode of locomotion of the following parasites:
   I.   Balantidium
   II. Trichomonas vaginalis
   III. Plasmodium falciparum
   IV. Toxoplasma gondii
   V.   Entamoeba histolytica
   c. Distinguish between salivaria and stercoraria

4. Discuss the development and life-cycle of an acanthocephalan

5. Describe in detail the part of life-cycle of plasmodium in mosquito. Suggest some important central measures

6. a. Describe the life cycle of a parasite in which Retro-infection transmission is involved.
   b. Discuss the process that makes *Stongyloides stercoralis* infection life-threatening in immunocompromised hosts.

7. Write short notes on each of the following:

   a. Development of elephantiasis in *Wuchereria bancrofti* infections.
   b. Development of Cysticercosis in human hosts

c. Granulomous formation in humans infected with schistosomes.

8. Describe:

   a. The host, parasite and environmental features important in the transmission of human schistosomes.
   b. Pathogenesis in *Onchocerca vulvulus* infections
   c. Pathogenesis in hookworm and *Ascaris lumbricoides infections*

THE UNIVERSITY OF ZAMBIA
SECOND SEMESTER EXAMINATIONS

FEBRUARY 2008

BS 362 GENETICS (I)

THEORY PAPER

TIME : Three (3) Hours

INSTRUCTIONS : Answer Two (2) Questions from Section A and Three (3) questions from Section B. All questions carry equal (20) marks. Inclusion of relevant diagrams, illustrations, labels, drawings and tabulated information will enhance your answer. Answers to Sections A and B must be written in separate answer booklets. A scientific calculator may be used.

SECTION A. Answer any two questions.

Question 1

(a) Define the following terms:

    (i)   Mutation
    (ii) Genetic recombination
    (iii) Plasmids
    (iv) Transposons
    (v) Prototrophic and auxotrophic nutrition

(b) Use diagrams to illustrate the experimental design by Lederberg and Tatum involving genetic recombination between bacterial cells

(c) Distinguish among the following: F^+ cell/ Hfr cell/ F^- cell

Question 2

(a) Describe the remarkable properties of the bacterial fertility factor F.

(b) Define conjugation and use diagrams to illustrate the possible outcome of F^+ / F^- mating.

Question 2 continued

(c) Match each item in column A with the appropriate one in column B

#	Column A	#	Column B
A	Frameshift mutagen	1	A mutagen that is incorporated into DNA in place of a normal base
B	Nucleoside analogue	2	A mutagen that causes the formation of highly reactive ions
C	Base-pair mutagen	3	A mutagen that causes the formation of pyrimidine dimers
D	Ionization radiation	4	A mutagen that alters adenine so that it base pairs with cytosine
E	Non-ionization radiation	5	A mutagen that causes insertions

Question 3

(a) What are the components of R plasmids?

(b) Draw a diagrammatic representation of an R plasmid isolated from *E. coli* as seen by electron microscopy.

(c) Define transduction and explain the mechanism of generalised transduction. Draw a diagram to illustrate your answer.

SECTION B. Answer any three questions.

Question 4

(a) Explain the relationships among the following concepts: linkage, recombination frequency, chiasma frequency and genetic maps.

(b) In an experiment, markers were transferred from five Hfr bacterial strains to F⁻ strains in the following order:

Hfr strain	Order of entry
1	BKARM
2	DLQEOC
3	OEQLDN
4	MCOEQLDN
5	RAKBN

(i) Draw a circular map showing the sequence of these markers on the chromosome
(ii) For each strain, indicate on the map the site of insertion of the fertility factor
(iii) Briefly explain the experimental design employed for this kind of gene mapping

Question 5

(a) Distinguish between:
   (i) Homologous and homeologous chromosomes.
   (ii) Hyperploids and hypoploids.
   (iii) Polysomics and polyploids.
   (iv) Double trisomics and tetrasomics.

(b) Explain the common types of aneuploids.

(c) Outline the origin of amphidiploidy in *Brassica* species and the origin of allohexaploidy in bread wheat (*Triticum aestivum*).

Question 6

(a) The hardy-Weinberg law was discovered by two scientists working independently in the early 20th Century.
   (i)   State the assumptions made in the Hardy-Weinberg Law
   (ii) Briefly explain the consequences of the failures of the assumptions
   (iii) Briefly outline the applications of the Hardy-Weinberg Law

(b) The genetic locus that leads to haemophilia, a blood disorder, is on the human X chromosome. The frequency of haemophilia, caused by a recessive allele (h) at this locus, is 2.8% in the males from a sample population.
   (i) Estimate the frequency of female carriers in the population
   (ii) Estimate the frequency of haemophiliac females

Question 7

Two pure lines of a crop plant were crossed to produce F_1 hybrids. The total variance of one polygenetic trait of the F_1 hybrids was estimated to be 8.76. For the F_2 plants, the total variance of the trait was 40.96 while the variance due to dominance effects was 10.4.

(a) Estimate the broad sense heritability of this trait
(b) Estimate the narrow sense heritability of this trait
(c) Predict the genetic variance of the F_4 generation of this plant
(d) Suggest why it is important to estimate the heritability of a polygenic trait

Question 8.

(a) Give a brief account of genetic diseases
(b) Briefly explain the modern techniques which are employed in the diagnosis of genetic diseases
(c) Explain the significance of genetic counselling

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008-2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 412: APPLIED ENTOMOLOGY
PRACTICAL PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **ALL** QUESTIONS. ANSWER EACH SECTION IN
A SEPARATE BOOKLET.

SECTION A

1. You are provided with an identification key to the termite genera based on the soldier caste. Also provided are specimens **A** and **B**.
   (a) Draw and label specimens **A** and **B**.
   (b) Identify specimens **A** and **B** to genus level.
   (c) State the pest status of specimen **A** and **B**.

2. Specimens labelled **C, D, E, F** and **G** are of agricultural importance.
   (a) Draw and label the diagnostic characteristics of each specimen.
   (b) Identify each of these specimens to order level.
   (c) State the pest status of each specimen.

SECTION B

3. You have been provided with equipment **H**.
   (a) Describe the equipment.
   (b) State the types of nozzles that can be used appropriately on this equipment.
   (c) Describe field situations under which this equipment can be used.

4. An experiment was carried out to determine the pathogenicity of a fungus *Metarhizium anisopliae* (Metchnikoff) on a named insect pest. Outline the steps you would take to evaluate the efficacy of this entomopathogenic fungus.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES

SECOND SEMESTER UNIVERSITY EXAMINATIONS

FEBRUARY 2008 EXAMINATIONS

BS 412 APPLIED ENTOMOLOGY

PRACTICAL PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER ALL QUESTIONS.

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1. You are provided with an Identification Key to the genera based on the soldier caste.
   - i.   Identify and draw specimens **A** and **B** indicating the distinguishing diagnostic features.
   - ii.   Briefly outline collecting and preservation methods of these specimens.
   - iii. What is the pest status of specimen **A** and **B**?

2. On the benches are specimens **C, D, E, F** and **G** believed to be of agricultural importance. For each specimen;
   - i.   Draw and label the diagnostic characteristic features
   - ii.   Identify the drawn specimen
   - iii. State the pest status of each specimen

3. On the benches are specimens **H** and **I** believed to be of medical importance. For each specimen;
   - i.   Draw and label the diagnostic characteristic features
   - ii.   Identify the drawn specimen
   - iii. Write brief notes about the biology and life cycle of each specimen.

4. On the bench you are provided with specimen **J**.
   - i.   Draw and label the diagnostic features of this specimen.
   - ii.   Identify the drawn specimen
   - iii. What type of mouth parts does this specimen possess?

5.   On the bench you are provided with specimen **K**.
      i.   Name this specimen
      ii.   What kind of nozzles can appropriately be used
      iii.   In what situations can this specimen be appropriately used?

END   OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008-2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 412: APPLIED ENTOMOLOGY
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **TWO** QUESTIONS FROM EACH SECTION WITH
THE **FIFTH** QUESTION FROM EITHER SECTION. USE SEPARATE
BOOKLETS FOR EACH SECTION.

SECTION A

1. Discuss malaria vector control in Zambia.

2. Beneficial insects and their products can be used to improve rural livelihoods
    in Zambia. Argue for or against this statement.

3. (a) Explain the concept of Integrated Pest Management (IPM).
    (b) Discuss the prospects and constraints of introducing IPM programmes
        among small-scale farmers in Zambia.

4. A cotton field has been attacked by insect pests in Kanakantampa farming
    block area.
    (a) State the potential major pests you would expect to find in this field.
    (b) Describe the control measures you would recommend to the farmer.

SECTION B

5. Discuss the concept of economic injury level and its relevance to Integrated
    Pest Management (IPM).

6. In developing economic thresholds in pest management, several approaches
    are devised. Discuss the major classes in which these approaches can be
    grouped.

7. Describe in detail how pest intensity and the types of pest damage would
    influence crop yield loss.

8. (a) Describe the life cycle of the silkworm (*Bombyx mori* L.).
    (b) Explain in detail how silk is produced by *B. mori*.

END OF EXAMINATION

Second Semester University Examinations

February 2008

BS 432

Advanced Parasitology II

Theory Paper

Time: Three (3) Hours

Instructions: Answer <u>Five (5)</u> questions only. Only One (1) question from Section A, two (2) from section B and two (2) questions from Section C. Answers from each section should be in a separate answer book.

All questions carry equal marks. Illustrations (diagrams, graphs and tables) may enhance the quality of your answers.

Section A

Q1.   **A.**   What is the basic function of cellular respiration? Why is cellular respiration so critical to cells?

        B.   Discuss the major pathways of carbohydrates degradation and their end products in *Trypanosoma brucei*.

Q2.   **A.**   Distinguish between Lysosomes and Peroxisomes.
              Explain the functions of each structure.

        B.   Discuss the major pathways of energy metabolism in *Trichomonas vaginalis*.

Q3. A.   Draw the tegument of the Cercaria of *Schistosoma* mansoni and label its structure. Give the function of its surface coat.

      B.   Discuss the generalized pathways of carbohydrates in the adult stage of *Ascaris Lumbricoides*.

Q4. A.   Draw a labeled diagram to show the organs of a molluscan body.

      B.   An outbreak of intestinal *Shistosomiasis* has broken out among Primary Schools children in a highly endemic area. You have been offered the following drugs for treatment.

    a.   Sodium antimony tartrate
    b.   Melarsoprol
    c.   Praziquantel
    d.   Metrifonate

(i)   Which drug should be most effective against the parasite being tested.
(ii)   Which drug would you recommend for large-scale treatment? Explain why?
(iii)   State, to which group of drugs, does each drug belong
(iv)   State the mode of action of your chosen drug
(v)   Write the chemical structure of your recommended drug.

Q5. A.   Write short notes on the following *Schistosome* stages:

    (i)   egg
    (ii)   miracidium
    (iii)   sporocyst

      B.   Onchocerciasis is a filarial infection which causes blindness and debilitating skin lesions.

(i)   Give the scientific names of both the parasite that causes the above mentioned disease and its Vector.
(ii)   List the names of three (3) drugs that could be used for the treatment of Onchocerciasis.
(iii)   What is the drug of choice that is suitable for large-scale onchocerciasis.
(iv)   State the impact of the recommended drug on the eye and skin lesions.

Section C

Q6. **A.** Draw and describe the structural and biological functions of the external surface of Cestodes.

B. Fill the following table:

No.	Drug	Synthetic or natural product	Made from	Half-life	Principal Use
1.	Artmisinin				
2.	Mefloquine				
3.	Chloroquine				
4.	Ivermectin				

Q7. **A.** **(i)** What is the infective stage of the *Eimeria tenella* parasite?

(ii) Draw a labeled diagram to show the ultra-structure of its infective stage.

(iii) Discuss the process of hatching and activation of the infective stage of *Eimeria tenella* parasite in the host.

B. State the major problems in developing successful anti-parasitic drugs.

Q8. **A.** Draw diagrams to show the development of *Taenia solium* stages in the life-cycle.

B. **(i)** Explain the mode of action of Metronidazole on *Entamoeba histolytica*.

(ii) Write the chemical structure of metronidazole and state its side effects.

(iii) Write a balanced bio-chemical equation for the conversion of Pyruvate to Lactate and name the enzyme that is involved in the chemical reaction.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008-2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATION

BS 432: ADVANCED PARASITOLOGY II
        THEORY

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS. USE ILLUSTRATIONS
              WHEREVER POSSIBLE. ANSWER EACH QUESTION ON A
              SEPARATE ANSWER BOOKS.

---

1. (a) Discuss the structure and function of a parasitic cell membrane.
    (b) Explain the mode of action of quinoline drugs that are used in the treatment of malaria.

2. (a) Discuss the carbohydrate and energy metabolism of the African Trypanosome, *Trypanosoma brucei*.

    (b) State one available drug for the treatment of early stage of human sleeping sickness and another drug for late stage cases. Explain the mode of action of each drug.

3. (a) Describe the ultra structure and functions of the following:
         (i)   Flagella
         (ii) Glycosome
         (iii) Hydrogenosome

    (b) Discuss the carbohydrate and energy metabolism of the malaria parasite, *Plasmodium*.

4. (a) Discuss the carbohydrate and energy metabolism in Helminthes.

    (b) Describe the Variant Surface Glycoprotein of *Trypanosomes* (V. S. G).

5. (a) Describe the function of the following structures:
        (i)   Pellicle
        (ii) Contractile Vacuole
        (iii) Cytopharynx

    (b) Explain why further development of *Fasciola hepatica* metacercaria only takes place in the gut of the final host and neither within the tissues of its intermediate host nor attached to vegetation.

    (c) Name the drug of choice for *Fasciola* infection. Draw its chemical structure.

6. (a) Draw and describe the tegumentary structure and functions of the cestodes

    (b) Differences in Folate metabolism in man and protozoa have led to the development of anti-malaria drugs. Discuss the mechanism of action, therapeutic uses and adverse effects of these drugs. Support your answer by drawing the tree diagram of folate inhibitors.

7. (a) Discuss the migratory patterns of parasites that have invaded the host's body. Support your answer by drawing the process of migration.

    (b) List three (3) different drugs available for the treatment of gastro-intestinal nematode infestation of humans. State the mode of action and the side effect of each drug.

8. (a) Discuss the functional changes in the tegument (the parasitic surface) during transformation of the Schistosome from Cercaria to Schistosomulum and eventually to adult worm.

    (b) Discuss the major problems in developing successful anti-parasitic drugs. Explain the new approach that is being investigated for discovery and development of new anti-parasitic drugs.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008-2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 435: MEDICAL MICROBIOLOGY
PRACTICAL PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **ALL** QUESTIONS

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1. Examine specimens **A** and **B.**
   (a) Identify and describe the test that has been used on these specimens
   (b) Interpret the results of the test
   (c) Compare the sensitivity of the organsms in the test

2. Describe the growth characteristics of the organism growing in specimen **C.**

3. Two organisms are growing on MacConkey agar, specimen **D**.
   (a) Describe the growth characteristics
   (b) Explain why MacConkey agar is used
   (c) Explain the function of the components of this medium
   (d) Carry out microscopic examination of isolated colonies to determine the morphology of the organisms.

END OF EXAMINATION

BS 435: MEDICAL MICROBIOLOGY
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS

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1 (a) Discuss the mechanisms by which antibacterial agents act to destroy bacteria.

   (b) Explain why antiviral and antifungal drugs have limited spectrum of activity.

2. Explain the role played by the following bacterial structures and products in the pathogenesis of infectious diseases:

   (a) fimbriae

   (b) capsule

   (c) plasmids

   (d) verotoxin

   (e) leucocidin

3. Describe the diarrhoeal syndromes caused by:

   (a) Enterotoxigenic *Escherichia coli*

   (b) *Shigella dysenteriae*

   (c) *Clostridium perfringens*

   (d) *Vibrio cholerae*

4. Discuss the procedures carried out by a clinical microbiology laboratory for the purpose of identifying pathogenic organisms and other agents of disease from clinical specimens.

5. Describe the attributes required for an organism to be pathogenic and how virulence is expressed.

6. Discuss the infection caused by varicella-zoster virus.

7. Distinguish tinea capitis and cryptococcosis with regard to their aetiology, pathogenesis, diagnosis, treatment and control

8. Summarise any four of the following;
    (a) opportunistic pathogen
    (b) infectious disease
    (c) cytopathic effects
    (d) virulence determinants
    (e) therapeutic index
    (f) pathogenicity islands

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008-2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 442: ADVANCED MOLECULAR BIOLOGY
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS. **QUESTION 1 IS COMPULSORY.** ANSWER AT LEAST TWO QUESTIONS FROM SECTION A AND B. USE SEPARATE ANSWER BOOKS FOR EACH SECTION.

SECTION A

1. Imagine you isolated a plasmid from bacteria and digested the DNA with several restriction endonucleases, you analysed it on 0.9% agarose gel and got the picture in Figure 1. Draw the restriction map of the plasmid.
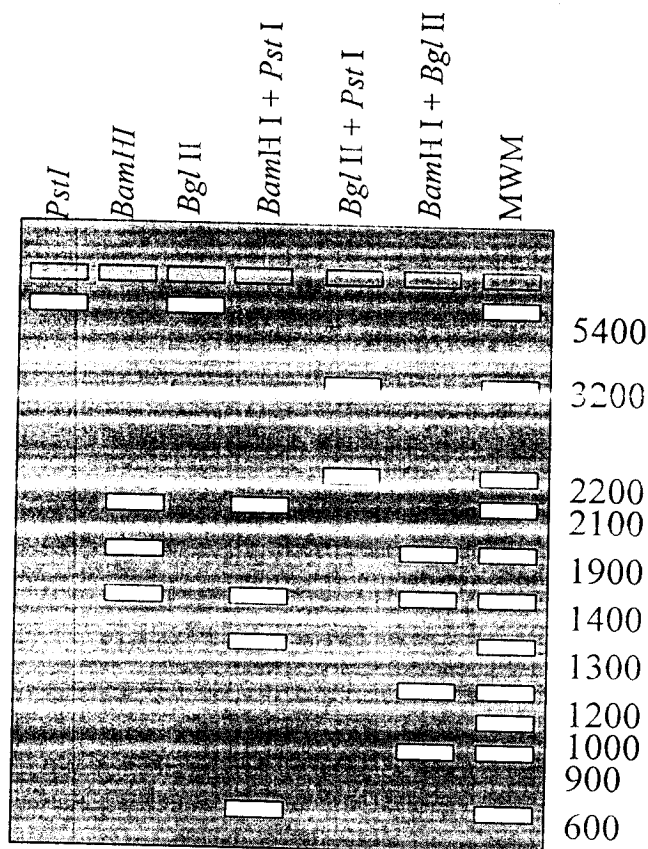
Figure 1. Agarose gel electrophoresis diagram for question 1. MWM = molecular weight marker. DNA fragment sizes in kilobase pairs are on the right hand side.

2. Discuss why *Agrobacterium tumefaciens* has been described as a natural genetic engineer and design a generic experiment using *Agrobacterium tumefaciens* to over-express a gene in a model plant.

3. If you were given a mixture of ten tobacco (*Nicotiana tabacum*) seedlings containing a number of them believed to be expressing a foreign gene under an inducible promoter, discuss an approach that you would take to distinguish the transgenic from non-transgenic lines.

4. Explain the following and their applications in recombinant DNA technology:
   (a) Antisense Technology
   (b) Gene therapy
   (c) Phage Display technology
   (d) Glyphosate

SECTION B

5. Discuss any FOUR (4) DNA-based markers and how they are detected indicating the role polymorphisms play in the identification of species.

6. Discuss the methods used in the sequencing of the human genome and the benefits to research that have been gained in the publishing of the human genome as well as that of other organisms.

7. Giving specific examples, evaluate the expression of recombinant proteins in eukaryotes highlighting the significance of eukaryotic protein expression systems.

8. (a) Evaluate ONE methodological adaptation made to conventional PCR outlining the usefulness of this method.

   (b) Given the following sequence, design primers that would enable you to amplify cDNA from animal tissue highlighting the necessary steps that you would take to ensure that the primer sequences are correct. Illustrate where the designed primers will begin amplifying in RT-PCR.

```
1   agactcagct *cctggtgaag ctcccagcca tcagccatga* gggtcttgta tctcctcttc
61  tcgttcctct tcatattcct gatgcctctt ccaggtattt ttggtggtat *aggcgatcct
121 gttacctgcc ttaagagtgg* agccatatgt catccagtct tttgccctag aaggtataaa
181 caaattggca cctgtggtct *ccctggaaca aaatgctgca aaaagccatg* aggaggccaa
241 gaagctgctg tggctgatgc ggattcagaa agggctccct catcagagac *gtgcgacatg
301 taaaccaaat* taaactatgg tgtccaaaga tacgca
```

Note: * sequence* marks the start and end of exons. The sequence has 4 exons.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SECOND SEMESTER EXAMINATIONS

FEBRUARY 2008

BS 442 ADVANCED MOLEULAR BIOLOGY II

THEORY PAPER

TIME : Three (3) Hours

INSTRUCTIONS : Answer two (2) questions from Section A and three (3) questions from Section B. All questions carry equal (20) marks. Inclusion of relevant diagrams, illustrations, labels, drawings and tabulated information will enhance your answer. Answers to Sections A and B must be written in separate answer booklets.

SECTION A. Answer any two questions.

Question 1

(a) The following are names of some restriction enzymes commonly used in DNA cloning: *Bam* III, *Sal* I , *Taq* I, *Pst* I, *Hae* III and *Eco*RI. For each of the enzymes:

   (i)   Give the name of the organism from which it is derived
   (ii) The sequence targeted by the enzyme

(b) Explain the relationship between restriction and modification in recombinant DNA technology.

Question 2

   (a) Briefly describe the Sanger dideoxy method of DNA sequencing
   (b) Suppose that you determine the DNA sequence of 3'- CGGTCCCGT -5' by the Sanger dideoxy method, sketch the gel pattern that would reveal the sequence of this oligonucleotide.
   (c) Sketch the gel pattern that would reveal the DNA sequence in (b) above when the determination is done by the Maxam-Gilbert method.
   (d) Outline the steps of the modern automated DNA sequencing method.

Question 3

Write short notes on each of the following cloning vectors:
(a) Phasmids
(b) YACs
(c) Insertional inactivation
(d) Polycloning sites
(e) α-complementation in the *Lac* operon

SECTION B. Answer any three questions.

Question 4

What is Biosafety?
Highlight the concerns that have been raised in the use of DNA technology and explain the regulation(s) in place to overcome these concerns.

Question 5

(a)   What is the importance of gene cloning in mammals?
(b)   Outline the strategies involved in gene transfer in animal cells.
(c)   Using a named example, describe how transgenic animals have been used to make recombinant proteins.

Question 6

Biotechnologists have used DNA techniques to develop transgenic maize using *Bt* toxins.
(a)   Explain the basis of this technology.
(b)   What strategies have been used to achieve this?
(c)   What has been done to counteract the development of resistance to the toxins?

Question 7

In understanding the function of a given protein, you decided to carry out an *in vitro* manipulation of the DNA sequence of the protein in question. Fully describe how you would achieve this and outline all the necessary techniques available for use. What benefit does this have in Research?

Question 8

It is the nature of nature for organisms to employ means and ways to survive within their environments. Fully describe how Biotechnology has made use of these means and ways.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

UNIVERSITY SECOND SEMESTER EXAMINATIONS –
FEBRUARY/MARCH 2008

BS445

ECOPHYSIOLOGY OF PLANTS

(PAPER)

TIME: THREE (3) HOURS

INSTRUCTIONS: ANSWER FIVE QUESTIONS CONSISTING OF AT LEAST TWO QUESTIONS FROM EACH SECTION AND USE ILLUSTRATIONS WHEREVER POSSIBLE. USE SEPARATE ANSWER BOOKS FOR EACH SECTION.

SECTION A

Question 1. Discuss the ecophysiology of crassulacean acid metabolism with reference to carbon dioxide, water, light and temperature.

Question 2. Describe how C_3 and C_4 subtypes of photosynthesis are affected by environmental conditions, such as carbon dioxide concentration, water supply and nitrogen availability.

Question 3. Discuss the role of phytochrome in morphogenesis.

Question 4. How does light, other than in photosynthesis, affect plant growth and development?

SECTION B

Question 5. Discuss phenological plasticity in Zambian plants.

Question 6. Discuss the likely responses of savanna trees and grasses to climate warming in Zambia.

Question 7. Describe how plants respond to stress.

Question 8. Discuss the classification and usefulness of pollution indicators.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SECOND SEMESTER UNIVERSITY EXAMINATIONS

FEBRUARY 2008

BS 455
WILDLIFE ECOLOGY

PAPER TWO (PRACTICAL)

TIME: THREE HOURS

INSTRUCTIONS: ANSWER <u>ALL</u> QUESTIONS. ILLUSTRATE YOUR ANSWERS WHERE NECESSARY.

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1. Study the specimens provided and answer the following questions.

Specimen A:

      (i)   Class

      (ii)   Order

      (iii) Family

      (iv) Species

Specimen B:

      (i)   Describe appropriate census methods

      (ii)   Sexual dimorphism

      (iii) Habitat preference

      (iv) Describe Food habits

Specimen C:

    (i)   Give Species Name

    (ii)   Describe Breeding habits

    (iii)   Describe Distribution in Zambia

    (iv)   Describe capturing methods

Specimen D:

    (i)   Order

    (ii)   Describe Breeding habits

    (iii)   Dental formula

    (iv)   Conservation status

Specimen E:

    (i)   Scientific Name

    (ii)   Field impression

    (iii)   Distribution in Zambia

    (iv)   Habitat preference

2. Biologists monitoring populations of Impala (*Aeopyceros melampus*) on Chete island in lake Kariba, Sinazongwe between 1958 and 1985 gave figures as given in the table below. The island is approximately $5km^2$ and is generally covered by a thicket of *Combretum* sp. Mean annual rainfall is 900mm. The island is a protected area and is regularly patrolled by game scouts. However, artisanal fishermen in the lake are allowed to land fish in certain parts of the island. For nearly 12 years the island was exposed to liberation war between 1968 and 1980, and part of the island was defoliated with herbicides. Impalas are polygamous and only a male breeds with a herd of females. Non breeding males form a bachelor herd. Using the information and data provided, explain the population trends, and discuss factors which could be most significant to this population on the island.

Table: Impala population at Chete island, lake Kariba, based on transect ground counts.

Year of Census	Total Population	Juveniles	Males	Females
1958	75	8	20	47
1968	136	6	54	76
1972	150	10	40	100
1975	308	40	58	210
1980	263	65	60	138
1985	232	72	65	95

3. Zambezi - Samaki Farms Ltd is considering establishing a Game Ranch in the Choma District along the Munyeki 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, Food and Fisheries (MAFF) in Choma, the soils are generally excellent for the game ranch. Also results from your preliminary estimates indicate that the production of key forage species averages about 200kg/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) how many 230 kg Sable antelopes can you stock as your base herd in the area and (b) State the main advantages and disadvantages of using mechanical animal capture method, and discuss difficulties associated with the translocation and restocking operations in wildlife management.

4. You are required to use the map provided to answer this question. Study the map carefully. It is assumed that you have just completed an ecological study of the area, and from this study answer the following questions:

    (i)   Which habitats are important for the following species and why?

        (a) Sitatunga *(Tragelaphus spekei)*
        (b) Zebra *(Equus burchelli)*
        (c) Tsessebe *(Damaliscus lunatus)*
        (d) Porcupine *(Hystrix africaeaustralis)*

(ii)   Describe the process which you might recommend in establishing this area as a wildlife sanctuary or a Protected Area within the community.

INFORMATION FOR QUESTION TWO (4)

THE MAP AND THE DESCRIPTION OF THE AREA:

Vegetation types:

    A: Termitaria grassland

    B: Munga woodland

    C: Chipya woodland

    D: Miombo woodland

    E: Hyparrhenia grassland

    F: Swamp

The area is located in the western part of Mpika District in Chief Chiundaponde, Northern Province of Zambia. Average annual rainfall is approximately 1300 mm. Lake Bakabaka is a fresh water lake, and has fish. The river is perennial with riparian vegetation mainly *Diospyros sp* and *Zyzygium sp.* The Hot spring is salty. There is only one village of about seven household (or about 40 people). Its main activity is fishing. Farming is done at a low scale in vegetation type E. Hunting is important. The area is being considered for protection because of its importance to biodiversity. You have been asked to carry out an ecological study of the area. And from your study information, answer question three (4).

FIG. 1. for question 4
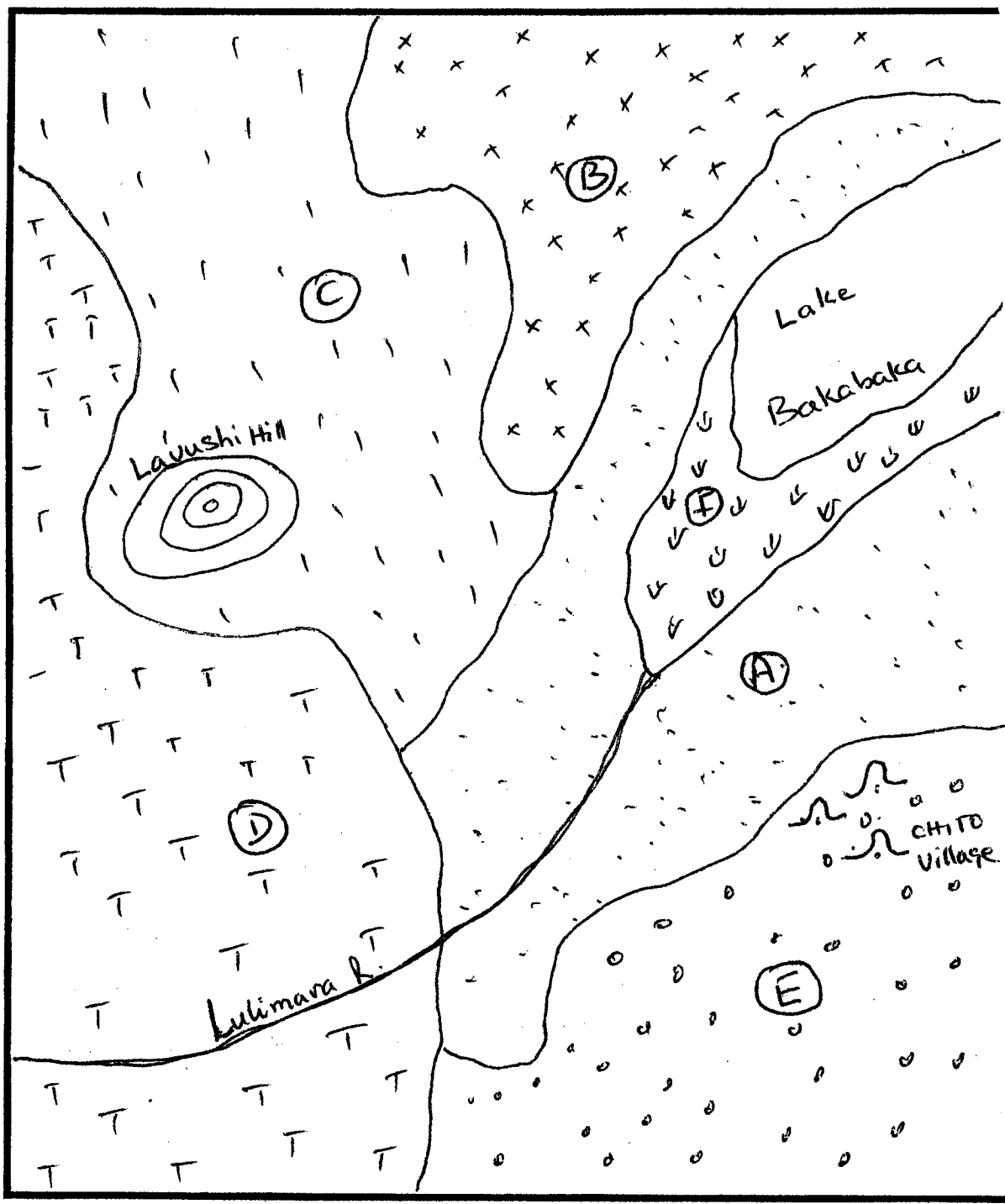
B

C

Lavushi Hill

Lake
Bakabaka

F

A

D

CHITO
Village

Lulimava R.

E

5

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008-2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 455: WILDLIFE ECOLOGY
PRACTICAL PAPER

TIME: THREE (3) HOURS

INSTRUCTIONS: ANSWER **ALL** QUESTIONS. ILLUSTRATE YOUR
ANSWERS WHERE NECESSARY.

1. Each species listed below is an indicator for each habitat type. Complete the table by assigning each species (by marking with an X) to its <u>one</u> appropriate habitat type.

	SPECIES	Wetland habitat	Miombo woodland	Munga habitat	Mopane habitat	Combretum thicket
	Plant species					
1	*Acacia polyacantha*					
2	*Combretum imberbe*					
3	*Cyperus papyrus*					
4	*Diospyros senensis*					
5	*Echinochloa pyramidalis*					
6	*Julbernardia paniculata*					
7	*Oryza barthi*					
8	*Piliostigma thonningi*					
9	*Typha latifolia*					
10	*Vossia cuspidata*					
	Animal Species	Wetland habitat	Open grasslands	Hilly and rocky	Mopane woodland	Combretum thicket
1	*Aepyceros melampus*					
2	*Connochaetes taurinus*					
3	*Damaliscus lunatus*					
4	*Diceros bicornis*					
5	*Equus burcheli*					
6	*Kobus leche*					
7	*Oreotragus oreotragus*					
8	*Tragelaphus scriptus*					
9	*Tragelaphus spekei*					
10	*Wattled Crane*					

2. Study the specimens provided and answer the following questions.

Specimen 1:
a) Give species name of this specimen

b) Describe habitat requirement of this species

c) Discuss conservation status of this species

d) Discuss economic importance of this species

Specimen 2:

a) Give species name of this specimen

b) Describe feeding habits of this species

c) Discuss general distribution of this species in Zambia

d) Discuss census method most appropriate for this species ·

Specimen 3:
Species A and **species B** are sympatric. Compare and contrast their habitat requirements

TURN OVER

3. Biologists monitoring populations of Impala (*Aepyceros melampus*) on Chete Island in Lake Kariba, Sinazongwe between 1958 and 1985 gave figures as given in the table below. The island is approximately 5km² and is generally covered by a thicket of *Combretum* sp. Mean annual rainfall is 900mm. The island is a protected area and is regularly patrolled by Game Scouts. However, artisanal fishermen in the lake are allowed to land fish in certain parts of the island. For nearly 12 years the island was exposed to liberation war between 1968 and 1980, and part of the island was defoliated with herbicides. Impalas are polygamous and only a male breeds with a herd of females. Non breeding males form a bachelor herd. Using the information and data provided, explain the population trends, and discuss factors which could be most significant to this population on the island.

Table: Impala population at Chete island, lake Kariba, based on transect ground counts.

Year of Census	Total Population	Juveniles	Males	Females
1968	136	6	54	76
1972	150	10	40	100
1975	308	40	58	210
1980	263	65	60	138
1985	232	72	65	95

4. You are required to use the map (**Figure 1**) provided to answer this question. Study the map carefully, and then answer the following questions:
   a) Describe in detail each habitat type as indicated by the vegetation types.
   b) List and rank habitats according to the preference of the following species:

      i.   Impala *(Aepyceros melampus)*
      ii.   Water Buck (*Kobus defassa*)
      iii. African Buffalo *(Syncerus caffer)*
      iv. Kudu *(Tragelaphus strepsiceros)*

END OF EXAMINATION

Fig. 1. Vegetation of Lower Zambezi

LEGEND

Mioabo
Hill Miombo ⎤ Miombo
Mopane
Munga — Combretum thicket
Grassland
Riverine
River
National Park Boundary

0   20 Km

Figure 1: Lower Zambezi National Park

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

BS 455: WILDLIFE ECOLOGY (Theory Paper)

TIME: THREE (3) HOURS
INSTRUCTIONS: ANSWER FIVE (5) QUESTIONS. ILLUSTRATE YOUR ANSWERS WHERE NECESSARY.

1. Discuss the management application of the following terms as used in wildlife ecology: **(i)** Kidney/ Fat Ratio Index **(ii)** King Census method

2. Give a brief history of the Protected Area System in Zambia from the colonial era to the present, and give reasons why populations of most wildlife species are declining.

3. Provide brief definitions of the following terms as used in wildlife studies:

   a) Fecundity
   b) Dispersal mechanism
   c) *M 99*
   d) Animal Unit

4. Describe the main characteristics of a wildlife habitat and relate these to the significance of the *Mopane woodland* habitat in the conservation of wildlife species in Zambia.

5. Describe the process of determining the $1 - e^{-H}$ in the exploitation of wildlife populations, and discuss the assumptions and limitations of this model

6. Describe the procedure for establishing a Protected Area, and discuss limitations and difficulties in the management protected areas in Zambia.

7. The energy available to, and utilized by, an animal can serve many different functions. Suppose a herd of Impala *(Aepyceros melampus)* consists of a juvenile, adult female and a male in a game sanctuary within a Mopane woodland habitat, how would their energy demand be partitioned over the course of the year? Detail the patterns of energy flow from the environment to these animals, showing those resulting in either positive or negative energy balance.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008-2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 455: WILDLIFE ECOLOGY
THEORY PAPER

TIME: THREE (3) HOURS

INSTRUCTIONS: ANSWER QUESTION **ONE (1)** AND ANY OTHER **FOUR (4)**
QUESTIONS. ILLUSTRATE YOUR ANSWERS WHERE NECESSARY.

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1. a) Zambezi - Samaki Farms Ltd is considering establishing a Game Ranch in the Choma District along the Munyeki 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 excellent for the game ranch. Also results from your preliminary estimates indicate that the production of key forage species averages about 200kg/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, how many 230 kg Sable antelopes can you stock as your base herd in the area

   b) Describe the procedure for establishing a Game Ranch in Zambia.

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

2. Describe the process for determining the $1 - e^{-H}$ in the exploitation of wildlife populations, and discuss the assumptions and limitations associated with this model.

3. Explain the concept of carrying capacity in wildlife species populations as applied to a single population model, and discuss the assumptions and limitations associated with this model.

4.
   a) Describe features which would indicate that a wildlife species population was being overexploited

   b) Discuss the significance of the Community Based Natural Resources Management (CBNRM) in the governance of wildlife resources.

5. Discuss the significance of (**r**) in a wildlife population and the assumptions and limitations associated with it.

6.
   a) Describe the main characteristics of a wildlife habitat and relate these to the ecology the Water Buck (*Kobus defassa*)

   b) Discuss the implications of island biogeographic theory in selecting an area for establishing a wildlife reserve in Zambia

7.
   a) Discuss features that would indicate that a wildlife habitat was being over utilised in an arid environment

   b) Describe a rehabilitation plan for a wildlife habitat of the following species:
      (i)   Sitatunga (*Tragelaphus spekei*)
      (ii)   Bush Buck (*Tragelaphus scriptus*)

8. Discuss in detail the management application of the following terms as used in wildlife ecology:

   (i)   Kidney / Fat Ratio Index
   (ii)   King Census method
   (iii)   Invasive species
   (iv)   Struthio camelus

END OF EXAMINATION

2008-2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 482: FOOD MICROBIOLOGY
PRACTICAL PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **ALL** QUESTIONS.

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1. Illustrate the conventional cultural protocol for isolation and identification of *Staphylococcus aureus* in a food product.

2. Examine specimen **A** provided.
   (a) Describe the growth medium used to culture the microorganism
   (b) Conduct microscopic and biochemical tests on the microorganism
   (c) Identify the microorganism

3. The bacterium growing on specimen **B** was isolated from a food sample and and from a faecal specimen obtained from a patient who complained of stomach cramps and diarrhoea six hours after consuming a food. Based on the growth characteristics,
   (a) Identify the microorganism
   (b) Explain the significance of the presence of this organism in the food sample

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END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2007/8 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

BS 492   FISHERIES BIOLOGY: PRACTICAL PAPER

TIME: THREE HOURS

INSTRUCTIONS: Attempt **all** the three questions in this paper. At the end of the examination, please hand in your answer sheets together with the question paper.

Q1   Scale samples of the Tiger fish, *Hydrocynus vittatus* caught from Lake Kariba gave a total length of 1.4 cm. The total fish length was 180 cm. From reading the scale rings the following lengths were estimated for each year:

Table 1 Scale length for each year

Scale length (cm)	0.2	0.4	0.6	0.8	1.0	1.2	1.4
Year	1	2	3	4	5	6	7

Given that $L_n = \dfrac{S_n \times L}{S}$

i)   Estimate total fish lengthfrom year one (1) to year six (6);

ii)   Construct a graph to show body length and scale length relationship.

iii)   Construct an equation to show the relationship between body length and scale length;

iv)   How is the information generated useful in assessing fish growth in real situations.

Q2   An experimental trawl fishing for catching the Bukabuka, *Lates stapernsii*, was conducted in the southern part of Lake Tanganyika and a trawl net was used. The codend of the trawl was covered with a special cover of fine meshes to insure that the fish that managed to escape from the coded was retained. At the end of two hours fishing, the following results were obtained:

Table 2 Fish length for each length interval

Fish Length (cm)	Codend	Cover	Total	Proportion in codend
10	0	2		
11	3	24		
12	8	27		
13	11	26		
14	26	35		
15	47	22		
16	72	12		
17	67	5		
18	48	0		

i) Compute the total number of fish caught in both the codend and the cover
ii) Estimate the proportion of the fish retained in the fishing gear
iii) Construct a selection curve for the experimental trawl net used to catch the Latids in Lake Tanganyika
iv) Estimate the L_c for the *Lates starpensii*.

Q3 A sample of fish, *Oreochromis andersonii*, was caught from the Kafue Floodplain by use of a beach seine. It was assumed that the sample represents the fish in the wild in terms of its age composition. The results from aging of the fish, is shown in the table below:

Table 3 Age and number if fish sampled by age group.

Age	3	4	5	6	7	8	9	10	11	12	13	14
Number	200	403	348	365	305	153	100	71	33	21	12	7
In												

i) Compute the natural logarithm of the number sampled for each age group
ii) Low numbers were obtained for age groups 3 & 4. Does this reflects relatively small numbers in the natural population?
iii) Construct an age based catch curve;
iv) At what age are the fish fully recruited into the fishery?
v) Estimate the total mortality coefficient for the stock of *Oreochromis andersonii* under investigation

END OF THE EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2007/8 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

BS 492   **FISHERIES BIOLOGY:**   **THEORY PAPER**

TIME: **THREE HOURS**

INSTRUCTIONS: Attempt **both** questions in **Section A** and **two** questions in **section B**. At the end of the examination please hand in your answer sheets together with the question paper.

SECTION A

Q1   Briefly describe the following terms or parameters relating to individual fish or fish populations and explain how they could be estimated:

        i)   Length at recruitment
        ii)   Standard length
        iii)   Asymptotic weight
        iv)   Condition factor
        v) B_∞
        vi)   Fecundity
        vii)   Total Mortality Rate
        viii) Fishing effort
        ix)   CPUE
        x)   Exploitation ratio

Q2   A Fisheries Biologist assigned to assist in the management of Lake Itezhi tezhi observed that there has been a continuous decline of important *Oreochromis andersonii* stock in the fishery over the years preceded by decrease of young fish sampled in experimental fish catches. It is suspected that fish breeding patterns for the stock are being interfered with by fishing activities in the area.

Describe a study that should be undertaken in the fishery to confirm that fish breeding ecology is being disturbed. The study proposed should also form basis for protecting fish breeding areas and seasons if any for the *Tilapia rendalii* fishery that is perceived as important by local fishers and the market in the area.

SECTION B

Q3 Knowledge of the life cycle of any given fish species and its growth rate are important in management of the stock. Describe methods that could be used to estimate growth rates of any given fish stock. .

Q4 Attaining the Maximum Sustainable Yield can be an objective for managing and developing a fishery.

Describe key aspects of managing a fishery based on attaining the MSY.
What are the advantages and disadvantages for exploiting a given fish stock at MSY.

Q5 Estimating fish stock abundance is important in fisheries management and assessments. Fish stock abundance can be estimated using a method based on fish tagging:

  i)   Explain how a fish tagging survey could be undertaken to estimate the population size f a given fish stock

  ii)   Explain the rationale for the tagging method in estimating fish stock sizes; and

  iii   What are the weaknesses and strengths of tagging methods in estimating fish stock sizes.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 – 2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 925: BIOLOGY OF TERRESTRIAL VERTEBRATES
THEORY PAPER

TIME: THREE HOURS
INSTRUCTIONS: ANSWER QUESTION **1** AND ANY **FOUR** QUESTIONS.
ILLUSTRATE YOUR ANSWERS WHERE NECESSARY.

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1. Study Figure 1 below and answer the questions that follow.
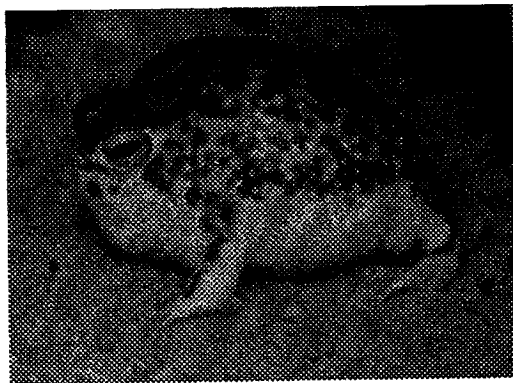
Figure 1: Photograph of a terrestrial vertebrate

   (a) name the class and family to which the animal in Figure 1 belongs
   (b) describe the characteristics of the class to which the animal belongs

2. Explain how ancestral terrestrial vertebrates dealt with the following during their transition from water to land :
   (a) abundant supply of oxygen on land compared to water
   (b) limited supply of water on land
   (c) lack of thermal stability on land compared to the aquatic environment
   (d) reproduction on land

3. Discuss the characteristics of different mammals that have enabled them to adapt successfully to a range of environments from the polar to desert environments?

4. Compare and contrast each of the following pairs as used in taxonomy
   (a) homologous and analogous structures
   (b) classification and identification

    (c) phenetics and cladistics

    (d) analytic and synthetic characters

5. Summarise the following as used in the study of terrestrial vertebrates:
    (a) neoteny
    (b) amplexus
    (c) urostyle
    (d) autotomy

6. Describe the characteristics that Sub-orders Amphisbaenia and Serpentes share in common and discuss how the two groups can be differentiated in the field.

7. Discuss the taxonomic differences of Prototheria, Metatheria and Eutheria.

8. Discuss characteristics of Class Aves which have enabled its members acquire the ability to fly.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SECOND SEMESTER UNIVERSITY EXAMINATIONS

February, 2008

BS 925
TERRESTRIAL VERTEBRATE BIOLOGY

PAPER TWO (PRACTICAL)

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **ALL** QUESTIONS. ILLUSTRATE YOUR
ANSWERS WHERE NECESSARY.

ID#

EXAMINATION ANSWER BOOK
For Question Ones 1 to 54

CANDIDATE'S COMPUTER EXAMINATION

NUMBER...

1. Full-time or Part –time...

2. Qualifications for which registered.....................................

3. Course number......................

4. Date of Examination.........................

1

QUESTION S 1- 54

Complete each statement by answering the question for each specimen examined from **1 to 54,** and use the answer sheet provided.

SPECIMEN 1:
    a) Class _____

    b) Family _____

SPECIMEN 2:
    a) Species _____

    b) Reproductive habits

SPECIMEN 3:
    a) Species _____

    b) Habitat :

SPECIMEN 4:
    a) Genus _____

    b) Species _____

SPECIMEN 5:
    a) Order _____

    b) Family _____

SPECIMEN 6:
    a) Class _____

    b) Species _____

SPECIMEN 7:
    Dental formula _____

_____

SPECIMEN 8:

    a) Class _____

    b) Feeding habits:_____

SPECIMEN 9: Respiratory mechanism:

SPECIMEN 10:
      Dental characteristics:

SPECIMEN 11:
      a) Suborder _____

      b) Species _____

SPECIMEN 12:

      a) Class _____

      b) Genus _____

SPECIMEN 13:
      Draw and label specimen **M**

SPECIMEN 14:

    a. Species _____

    b. Conservation status in
       Zambia:_____

SPECIMEN 15:

    a) Species _____

    b) Economic importance

_____

SPECIMEN 16:

    a) Species 1_____

    b) Species 2 _____

SPECIMEN 17:
    a) Class _____

    b) Order _____

SPECIMEN 18: Field Impression:

SPECIMEN 19:

      a) Order _____

      b) Family _____

SPECIMEN 20;

      a) Family _____

      b) Species _____

SPECIMEN 21; Give the main differences between specimen (i) and
           specimen (ii)

SPECIMEN 22; Give the main characteristics that distinguish specimen (a) from
           Specimen (b)

SPECIMEN 23; Give the main characteristics that distinguish specimen (a) from specimen (b)

SPECIMEN 24; Give the main differences between specimen (i) and specimen (ii)

SPECIMEN 25; Scientific Name

SPECIMEN 26: Draw and label the dorsal region of the specimen

SPECIMEN 27: Scientific Name

SPECIMEN 28: Reproductive habits

8

SPECIMEN 29: Give functions of structure marked

SPECIMEN 30: a) Order--

b) Scientific Name--

SPECIMEN 31: Label the marked areas

SPECIMEN 32: Economic and Social importance

SPECIMEN 33: Feeding habits

SPECIMEN 34: Draw and label ventral view

SPECIMEN 35: Rproductive habits

SPECIMEN 36: Draw and label

SPECIMEN 37;

      (a)Family

      (b)Order

SPECIMEN 38: Breeding habits

SPECIMEN 39: Feeding habits

SPECIMEN 40: Sexual dimorphism

SPECIMEN 41: Methods of collection

SPECIMEN 42: potential enemies

SPECIMEN 43: Habitat

SPECIMEN 44: Describe digestive system

SPECIMEN 45: Distribution in Zambia

SPECIMEN 46: Number of occipital condyle

SPECIMEN 47: Dental formula

SPECIMEN 48: Respiratory system

SPECIMEN 49: Describe Uro-Genital system

SPECIMEN 50: Construct a simple key for identifying this specimen

SPECIMEN 51: Scientific Name

SPECIMEN 52: Reproductive habits

ID #

SPECIMEN 53: Breeding habits

SPECIMEN 54: Draw and label the ventral structure of this specimen

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 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 SECTION A QUESTIONS IN ONE 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

Gas constant R

$8.3145 \text{ J mol}^{-1} \text{K}^{-1}$
$0.083145 \text{ L bar mol}^{-1} \text{K}^{-1}$
$0.08206 \text{ L atm mol}^{-1} \text{K}^{-1}$
$62.364 \text{ L torr mol}^{-1} \text{K}^{-1}$
$62.364 \text{ L mmHg mol}^{-1} \text{K}^{-1}$

Pressure

$$1 \text{ atm} = 1.01325 \times 10^5 \text{ Pa}$$
$$= 1.01325 \times 10^5 \text{N m}^{-2}$$
$$= 760 \text{ torr}$$
$$= 760 \text{ mmHg}$$
$$= 1.01325 \text{ bar}$$

$$1 \text{ bar} = 1.00000 \times 10^5 \text{ Pa}$$
$$= 1.00000 \times 10^5 \text{ N m}^{-2}$$

Acceleration due to gravity
$g = 9.80665 \text{ m s}^{-2}$

Density of water

$\rho = 1.00 \text{ g cm}^{-3} = 1.00 \times 10^3 \text{ kg m}^{-3}$

Question A1

The initial rate of the reaction between compounds **X** and **Y** was measured in a series of experiments at a fixed temperature. The following rate equation was deduced.

$$\text{rate} = k[\mathbf{X}]^2[\mathbf{Y}]^0$$

Experiment	Initial [X] mol dm^{-3}	Initial [Y] mol dm^{-3}	Initial rate /mol dm^{-3}s^{-1}
1	1.20×10^{-3}	3.3×10^{-3}	2.68×10^{-3}
2	1.20×10^{-3}	6.60×10^{-3}	A
3	2.40×10^{-3}	6.60×10^{-3}	B
4	C	9.90×10^{-3}	8.04×10^{-3}

What is the value of A, B, and C in the Table above?

Question A2

A buffer solution contains 0.250 mol of propanoic acid and 0.190 mol of sodium propanoate in 1000 cm^3 of solution. Calculate the pH of the buffer solution. K$_a$, for propanoic acid is 1.35×10^{-5}.

Question A3

A sample of 0.0020 moles of F$_2$ was sealed into a 2.0 L reaction vessel and heated to 1000 K to study the dissociation into F atoms:

$$F_2(g) \rightleftharpoons 2 F(g)$$
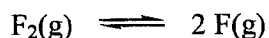
At this temperature, $K_c = 1.2 \times 10^{-4}$. What are concentrations of F$_2$ and F at equilibrium? What is the percent dissociation of F$_2$?

Question A4

Intermolecular forces are responsible for holding of molecules together and can explain the physical properties of substances.

(a)   List any three intermolecular forces.

(b)   Why are London dispersion forces found in all substances?

Question A5

From each of the following groups of substances, choose one that show the given physical property and give a reason for your answer.

Property	Group
(a) Highest boiling point	$CH_3N(CH_3)CH_3$, $CH_3CH_2CH_2NH_2$, CH_3NHCH_3
(b) Largest vapour pressure	SiO_2, NH_3, PH_3
(c) Lowest boiling point	NaF, PF_3, PCl_5
(d) Lowest vapour pressure	$NaCl$, H_2O, CH_3OH

Question A6

Calculate the concentration of CO_2 gas dissolved in a coca-cola soft drink if the manufacturer uses 2.4 atm to carbonate it. The Henry's constant for CO_2 gas at 25 °C is 3.36 x 10^{-2} mol L^{-1} atm^{-1}.

Question A7

Estimate the osmotic pressure (in atmospheres) of a 10.0 g L^{-1} solution of a non-electrolytic macromolecules, of molar mass of 1.00 x 10^4 g mol^{-1} at 25 °C.

Question A8

The following names are incorrect. Give the correct IUPAC name for each compound.

(a)   4-Ethyl-5,5-dimethylpentane

(c)   4-Methyl-3-hexene

Question A9

Describe the type of bonds present in the following molecule.

$$H-C\equiv C-\overset{\overset{\displaystyle O}{\|}}{C}-O-H$$
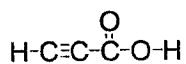
Question A10

Indicate the kind of hybridization you would expect for the carbon atoms labeled **1, 2** and **3** and state geometric configuration about each atom in the following molecules.

(a) $\overset{1}{C}H_2=\overset{2}{C}H\overset{3}{C}HO$

(b) $H-\overset{1}{C}\equiv\overset{2}{C}-\overset{3}{C}O_2H$

3
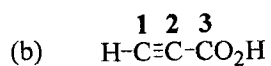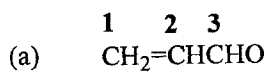
Question B1

In Experiment VII – "Estimation of ammonia in an ammonium salt" a C102 student dissolved 1.355 g of unknown ammonium salt to prepare 250 cm^3 of the solution. She measured 25.00 cm^3 of this solution in a conical flask and added to 5.00 cm^3 of formaldehyde and 3 drops of phenolphthalein indicator to measured ammonium salt solution. The chemical reaction is:

$$6HCHO(aq) + 4NH_4^+(aq) \rightarrow C_6H_{12}N_4(aq) + 4H^+(aq) + 6H_2O(l)$$
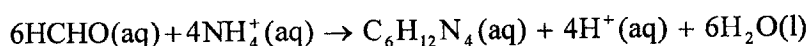
After two minutes she titrated the above mixture with 0.100 M NaOH solution until a permanent light pink colour appeared.

(i)   Write the chemical equation taking place during the titration.

(ii)   If she used 25.35 cm^3 of NaOH solution calculate the mass % of ammonium ion in the salt.

(iii)   Name the glassware used for measuring 25 cm^3 of ammonium salt solution.

Question B2

(a)   Plot concentration and time graph using data in the Table.

Time (s)	0	100	200	300	400	500	600	700	800
[X] mol L^{-1}	1.000	0.749	0.561	0.420	0.315	0.236	0.177	0.132	0.099

(b)   Use the graph to calculate the half-life of the reaction.

(c)   What is the order of reaction? Give reasons.

(d)   How long will it take for concentration of the reactant X to fall to 40% of the original concentration.

4

Question B3

A chemical **C** is made by reacting chemical **A** with chemical **B** in a reversible reaction. **A, B** and **C** are all gases under the reaction conditions. C102 students wanted to know the optimum conditions to use in the manufacture of **C**. They carried out a series of reactions under different conditions of temperature and pressure. The percentage conversion of **A** at equilibrium is shown in Table

Pressure (MPa)	Temperature (°C)	% conversion
10	350	8
	450	12
	550	16
20	350	11
	450	20
	550	29
40	350	18
	450	
	550	49

(a)   Give **two** features of a reversible reaction, when a dynamic equilibrium has been set up.

(b)   Suggest the percentage of **A** that is converted at 450 °C and 40MPa.

(c) (i)   Use the data in Table above to state the effect of increasing pressure on the percentage of **A** converted.

    (ii)   What can be deduced, from this change, about the total number of moles of reactants **A** and **B** compared with the number of moles of product **C** in the equation for the reaction? Explain how you reached your conclusion.

(d)   Use the data in Table above to deduce whether the reaction between **A** and **B** is exothermic or endothermic. Explain how you reached your conclusion.

5

(e)   It was found necessary to use a catalyst in the production of **C**.

    (i)   What is meant by a *catalyst*?

    (ii)   How does the catalyst affect the position of equilibrium?

(f)   Conditions were used that should have given a conversion of **A** of 39% at a pressure of 40 MPa. In the manufacture, using these conditions, it was found that only 20% conversion was achieved. Suggest why the conversion was much less than theory suggested.

Question B4

An enzyme (E) is activated by the binding of adenosine 50-monophosphate (AMP) according to the reaction

$$E + AMP \; \rightleftharpoons \; E\text{-}AMP$$
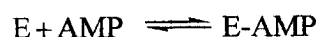
The equilibrium constant for this association was determined at two temperatures:
$$T_1 = 22.00 \,°C \qquad K_1 = 1.83 \times 10^3$$
$$T_2 = 38.00 \,°C \qquad K_2 = 5.78 \times 10^3$$

(a)   Use the van't Hoff equation to calculate ΔH_{rxn} for the above reaction, assuming that ΔH_{rxn} remains constant over the small temperature range examined.

(b)   Calculate ΔS_{rxn} using the van't Hoff equation at $T_1 = 22.00 \,°C$ and $K_1 = 1.83 \times 10^3$.

Question B5

(a)   Draw all possible structures of constitutional isomers represented by the molecular formula $C_4H_{10}O$ and classify them according to their functional groups.

(b)   Nitromethylene anion, structure shown below, is an important synthetic intermediate in organic synthesis.
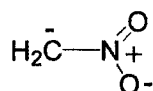
Nitromethylene anion

    (i)   Draw all possible resonance structures for the nitromethylene anion.

    (ii)   State which resonance structure contributes most to the hybrid.

END OF FINAL EXAMINATION

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic number
X
Atomic mass
Name of the element X

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
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** 63.65 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 Iridium	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 Thalium	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

Department of Chemistry-UNZA

The University of Zambia
School of Natural Sciences
Department of Chemistry
2008 Academic Year Final Examinations
Second Semester.

C 225: Analytical Chemistry 1

Time: 3 Hours.

Instructions:
[This Paper Contains Six (06) Questions. <u>Answer</u> Question <u>No.1</u> and Any <u>Three</u> (03) Others. Each Question carries 15 marks.]

Question 1.
a. Riboflavin (Vitamin B_2) is determined in cereal samples by measuring fluorescence intensity in a 5% acetic acid solution. From analytical data given below, use the method of least squares to:
   Standards concentration (ppm):   0.000; 0.100; 0.200; 0.400; 0.800
   Fluorescence intensities (I):   0.000; 5.8; 12.2; 22.3; 43.3
   i). obtain the equation for the best-fit line for the calibration curve
   ii). calculate the concentration of riboflavin in a sample for I was found to be 15.4
b. Absorbance readings of a blank were made in a spectrophotometric method as follows:
   0.002; 0.000; 0.006; 0.008; 0.003 and 0.000.
A standard solution of 1ppm analyte solution gives an absorbance reading of 0.069. What is the detection limit?

Question 2.
a. Describe 3 causes of inclusion of impurities during precipitation.
b. The first and second acidity constants of H_2S are 10^{-7} and 10^{-15} respectively. Calculate:
   i). The acidity constant (K_a) for the reaction $H_2S + 2H_2O \rightarrow 2H_3O^+ + S^{2-}$
   ii). $[S^{2-}]$ of a 0.1 M H_2S solution at pH 2.
c. A C 229 student determined the molarity of an acid by titrimetry, and obtained the following results 0.1067; 0.1071; 0.1066 and 0.1050. Can we discard 0.1050 as due to accidental error at 95% CL?

Question 3.
a. i). What do you understand by the terms Von Weirman ratio; masking agent; and, gravimetric factor?
   ii). What mass of solute is needed to prepare 1 L of 0.8 N potassium dichromate
b. What is a buffer solution? Calculate the pH of a solution that is 0.050 M in formic acid, [HCOOH], and 0.10 M in sodium formate (Formic acid, $K_a = 1.76 \times 10^{-4}$).
c. Distinguish between the following pairs of terms:
   i). Qualitative and quantitative analysis ii). Complete and partial analysis
   iii). Sample and analyte   iv). Major and minor constituents of a sample

Question 4.

a. i). What mass of solute is present in 500 cm^3 of 6.0 M HCl? $Ca(OH)_2$

   ii). How much of the solution in 4a (i). will neutralise 750 cm^3 of 5.0 N H$_2$SO$_4$?

b. A solution contains 2.50 x 10^{-4} M Cu(NO$_3$)$_2$. What is:

   i. the solution's concentration in ppm

   ii. the concentration of NO$_3^-$ in this solution given that Cu(NO$_3$)$_2$ is a strong electrolyte

c. What is the solubility of PbI$_2$ in g/L if solubility product is 7.1 x10^{-9}?

Question 5.

a. Calculate the ratio of free ions to Ag(CN)$^-$ complex in a NaCN solution in which [CN$^-$] = 0.01 M (K$_f$ = 1.0 x 10^{-21}).

b. Oxalic acid is a diprotic acid with K$_{a1}$ = 1.13 x 10^{-3} and K$_{a2}$ = 3.9 x 10^{-6}. Determine the following:

   i). the meaning of 'diprotic'

   ii). equilibrium constant expression for the loss of one proton

   iii). equilibrium constant expression for the loss of two protons

   iv). equilibrium fractional concentration of A^{2-} ion in a 0.05 M solution at pH 1.

c. Calculate K$_a$ for (NH$_4^+$), and the pH of a solution containing 2.34g NH$_4$Cl in 250 cm^3 given that at 25^0 C (K$_b$ for NH$_3$ = 1.75 x 10^{-5}).

Question 6.

a. A company trading in chemicals discovered that it had 1.300 kg of expired alkali in stock (0.500 kg of NaOH and 0.800 kg of KOH) to dispose of. To ensure safe disposal, they decided to neutralize an aqueous solution of the alkalis (dissolved in 5.0L of water) with 0.1 M H$_2$SO$_4$ acid.

   i). Calculate the normality of the alkaline solution.

   ii). What volume of 0.01 M H$_2$SO$_4$ would be required to neutralize the mixture?

b. The ionisation constant (K$_a$) for benzoic acid (HC$_6$H$_5$O$_2$) is 6.6 x 10^{-5}. Calculate the pH and degree of ionisation of a 0.2M solution of the acid.

c. What fraction of total Fe (III) concentration is present as Fe^{3+} in a solution that was initially 0.10 M Fe^{3+} and 1.0 M SCN$^-$ (for Fe(SCN)$^+_2$, K$_f$ = 2.3 x10^3)?

............................**END OF XAMINATION**............................

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR FIRST SEMESTER
FINAL EXAMINATIONS

C252: ORGANIC CHEMISTRY II

TIME: THREE HOURS

INSTRUCTIONS:
1. **Answer any four questions.**
2. **Marks allocation for questions is shown [x]**

QUESTION 1

(a) Given that the heat of hydrogenation of cyclooctene to cyclooctane is -23.3 Kcal/mole and the heat of hydrogenation of cyclooctatetraene to cyclooctane is -100.9 Kcal/mole, calculate the empirical resonance energy for cyclooctatetraene and interpret your result in relation to the resonance energy of benzene.

[6]

(b) The following known reaction of cyclopropenone does not occur with the corresponding five-membered ring analog. Explain why?
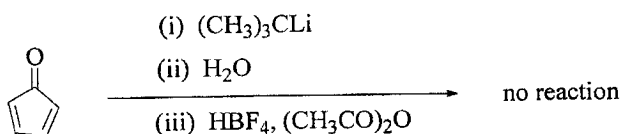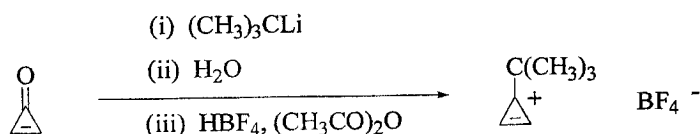
[8]

(c) Starting from benzene, show how each of the following compounds can be prepared. Assume that the ortho- and para- substitution products can be separated.
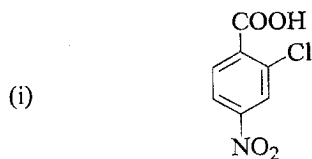
(i) 2-Chloro-4-nitrobenzoic acid
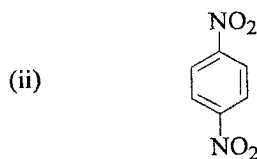
(ii) 1,4-Dinitrobenzene

[16]

QUESTION 2

(a) Cyclohexenones can be prepared by Robinson annulation. For example:
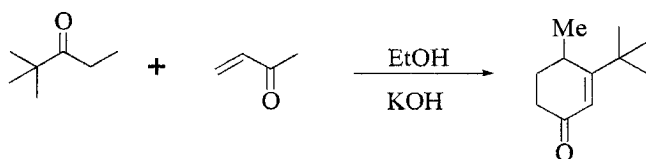
Give the mechanisms of all steps that occur in this reaction.

[12]

(b) Deduce the structure of the sex pheromone of the Egyptian cotton leafworm, **E**, from the following synthesis and show the structures of the intermediates **A – D**.
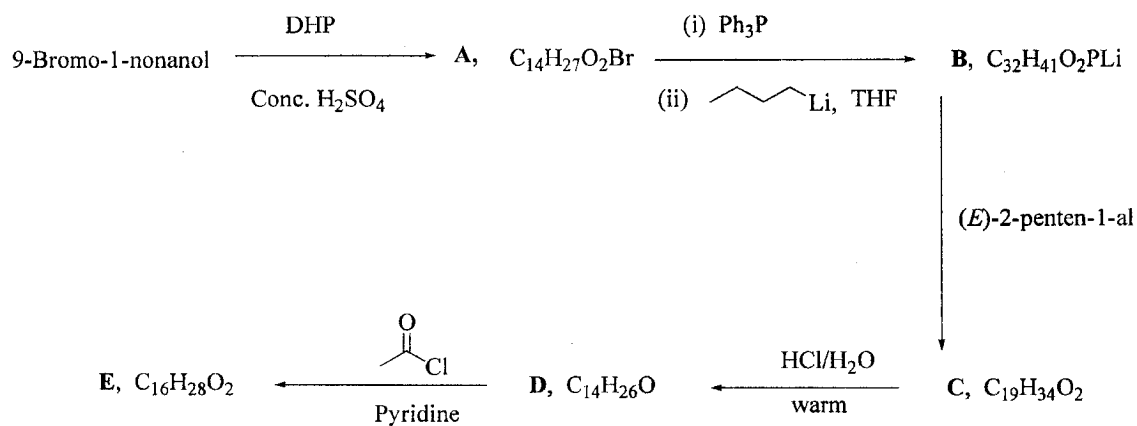
[8]

(b) Suggest plausible reaction mechanisms to account for the observed product of the following reaction.
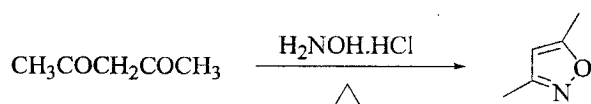
[10]

QUESTION 3

(a) Consider the following reaction sequence:
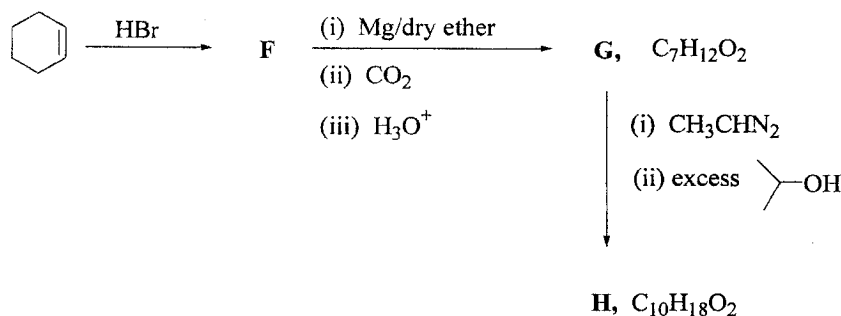
(i) Provide the structures for the compounds **F – H**.

(ii) Give the reaction mechanisms for the transformation of **F** into **G**; and **G** into **H** .

[15]

(b) The reaction of (S)-2-methylbutanamide, structure shown below, with sodium hydroxide & bromide
followed by aqueous hydrolysis gave an optically active amine.
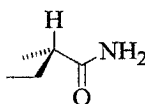
(S)-2-Methylbutanamide

(i) Give the stereochemical structure, including the configurational label, of the amine and the mechanism of its formation.

(ii) What product would you expect to obtain, if the optically active amine was treated with benzenesulfonyl chloride in the presence of pyridine? Show the reaction mechanism.

[15]

QUESTION 4

Predict the major organic products and give the mechanisms of the following reactions.

(i)

2-methylcyclohexanone
(i) LDA, THF
(ii) propylene oxide (Me epoxide)
(iii) H_3O^+

?

(ii)

pyrrole-2-carbaldehyde + but-2-enal (crotonaldehyde)

$\xrightarrow[\substack{H_2O \\ \triangle}]{KOH}$

?

(iii)

$$H-\overset{O}{\underset{\parallel}{C}}-\overset{O}{\underset{\parallel}{C}}-H$$

(i) 25% aq KOH, $\triangle$

(ii) H_3O^+

?

(iv)

cyclohexanone

$\xrightarrow[\text{H}_3\text{C}-\text{C}_6\text{H}_4-\text{SO}_3\text{H}]{\text{HCHO, piperidine (N-H)}}$

A Mannich base **?**
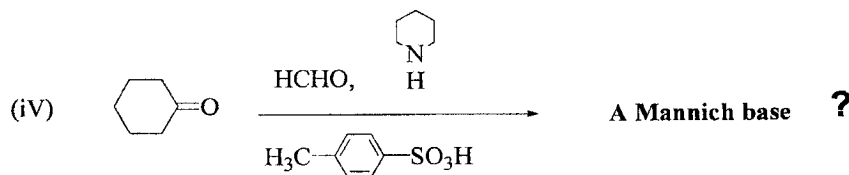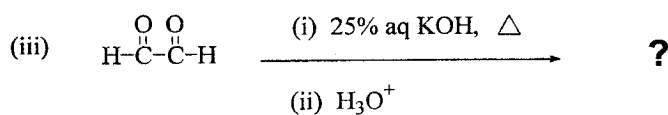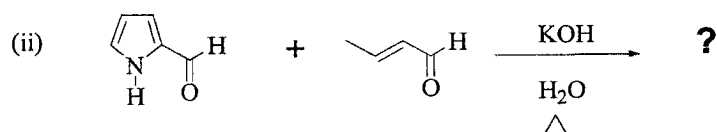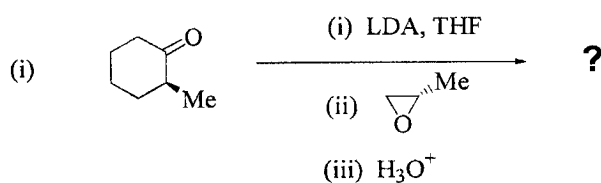
[30]

QUESTION 5

(a) Ethanol is allowed to react with 1-(1-bromocyclopentyl)ethene, structure shown below.

cyclopentyl with Br and $=CH_2$
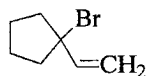
1-(1-Bromopentyl)ethene

(i) Show the products and provide the reaction mechanisms for their formation.

(ii) State which is the kinetic product and which is the thermodynamic product.

[8]

(b) When 1, 3-butadiene is allowed to react with hydrogen ~~bromide~~ in acetic acid at room temperature, there is produced a mixture of 22 % 1-chloro-2-butene and 78 % 3-chloro-1-butene. On treatment with ferric chloride, this mixture is converted into 75 % 1-chloro-2-butene and 25 % 3-chloro-1-butene. Explain.

[8]

(c) Propose a synthesis of the following compounds from the indicated starting materials. Show the reagents, including solvents, if any, and the reaction conditions for each step of your proposed synthesis clearly. Reaction mechanisms are not required to be shown.

(i)   from
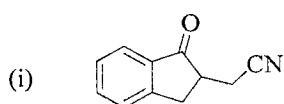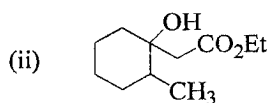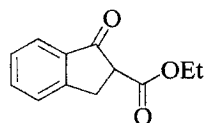
(ii)   from   any alcohol containing up to six carbon atoms as the source of carbons

[14]

END OF THE EXAMINATION

UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF CHEMISTRY
SEMESTER II, 2008
BASIC PHYSICAL CHEMISTRY C265

Duration: Three (3) Hour

Instructions:

This question paper is divided in two sections: **A (40) & B (60)**.
Answer **all questions** in section **A**.
Answer **4 questions** in Section **B**.
Answer Section A and B in **separate answer booklets**.
Answer **each question** in **Section B** in a separate booklet.

You are reminded to answer questions in a clear and logical manner.

Useful Information and Constants:

R= 8.314 Jmol^{-1} K^{-1}, Molar volume of gas at STP = 22.4 dm^3 mol^{-1}, STP = 273 K and 1 bar (10132 Pa), A= 0.509 kg$^{1/2}$mol$^{-1/2}$ at 298.15 K, $\frac{2.303RT}{F} = 0.05916V$, F = 96485 C mol^{-1}

Question A1

At 100 °C and 16 kPa, the mass density of sulphur vapour is 0.6388 kg m^{-3}. What is the molecular formula of phosphorous under these conditions?

Question A2

A sample of argon, mass 6.56 g, occupies 18.5 L at 305 K. Calculate the work done when the gas expands isothermally against a constant external pressure of 7.7 kPa until its volume has increased by 2.5 L.

Question A3

A sample of a perfect gas initially occupies 11.0 L at 270 K and 1.2 atm is compressed isothermally. To what volume must the gas be compressed to reduce its entropy by 3.0 J K^{-1}?

Question A4

The enthalpy of combustion for H_2, C (graphite) and CH_4 are -285.8, -393.5, and -890.4 kJ mol^{-1} respectively. Calculate the standard enthalpy of formation ΔH_f for CH_4.

Question A5

(a)   A fixed mass of marble is reacted with dilute hydrochloric acid at constant temperature. Explain why the rate of reaction is increased if the lumps are reduced in size.

(a)   State the difference between homogeneous and heterogeneous catalysis.

Question A6

At 2000 K, 1 mole of water is 2 % dissociated at 1 bar according to the reaction

$$H_2O(g) \rightleftharpoons H_2(g) + \frac{1}{2}O_2(g)$$
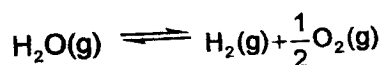
What is its K$_P$?

Question A7

Carbonic acid, HCOOOH, is a weak acid, with K$_a$ = 4.5x10^{-7}, and dissociate as

$$HCOOOH(aq) \rightleftharpoons H^+(aq) + HCOOO^-(aq)$$
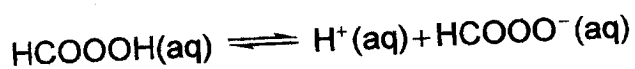
Use the Debye-Hückel limiting law to calculate the pH of 0.01 m HCOOOH when its degree of dissociation is 6.71 %.

Question A8

The limiting molar conductance at infinity dilution of CH_3CH_2COONa, NaCl, and HCl are 0.00854367, 0.012645 and 0.042616 $\Omega^{-1}m^2mol^{-1}$ respectively. What is the limiting molar conductance at infinity dilution of CH_3CH_2COOH?

Page | 2

Question B1

(a) (i) Dalton's law of partial pressures states that the total pressure of a mixture of gases is the sum of the partial pressures of the components of the mixture. Which assumption of the kinetic molecular theory justifies this law? Explain in brief.

(ii) 200 mL of oxygen is collected over water at 25 °C and 1 atm. If the oxygen obtained is dried at constant temperature of 25 °C and 1 atm, what volume will it occupy?

(iii) What volume will be occupied by the water removed from the oxygen if maintained at 25 °C and 1 atm? (The equilibrium vapour pressure of water at 25 °C is 0.04 atm)

(b) 0.167 g of ethanol, C_2H_5OH, was injected into a gas syringe and the syringe placed in a boiling water bath for several minutes. The atmospheric pressure was 101300 Pa and the temperature of the bath was 100 °C.

(i) Calculate the volume, in cm^3, of ethanol vapour that would have been produced under these conditions (use $R = 8.314$ J K^{-1} mol^{-1}.)

(ii) Explain why the gas syringe of 100 cm^3 capacity was found to be unsuitable.

Question B2

The feasibility of a chemical reaction depends on the standard free energy change, $\Delta G°$, which is related to the standard enthalpy and entropy changes by $\Delta G° = \Delta H° - T\Delta S°$. Use this information this information, where relevant, in answering the questions below.

(a) Ice melts at atmospheric pressure only if temperature rises above 0 °C.

(i) State the signs of the enthalpy and entropy changes during melting.
(ii) Explain why ice does not melt at temperatures below 0 °C.

(b) When sodium hydrogen carbonate is added to dilute hydrochloric acid, the temperature drops. Despite this, the reaction is spontaneous. Explain how this can be achieved.

(c) Give the signs of enthalpy, entropy and free energy change for combustion of propane. In **each** case give a reason for your answer.

Question B3

(a) A C265 a student obtained the following graph using data obtained from a kinetics experiment. The decomposition of a gas was studied at different temperatures (T) and the value, k, obtained at each temperature. Values were calculated for $1/T$ and for $\ln k$. A plot of $\ln k$ against $1/T$ is shown below.

$\frac{1}{T}$ / K⁻¹
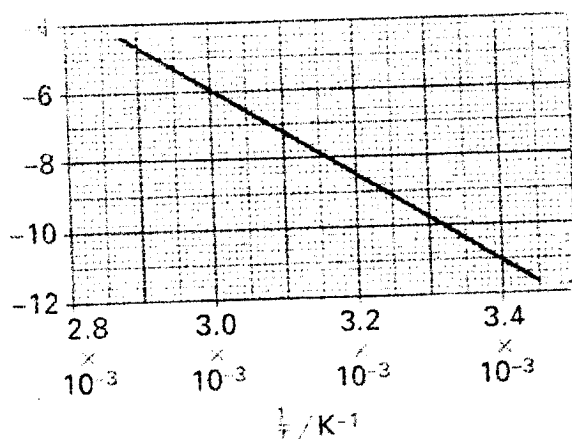
(i)   What do the symbols k and A in the Arrhenius equation represent?
(ii)   Determine the gradient for the graph and hence deduce the value of the activation energy, E_a.

(b)   In separate reactions between sulphur dioxide and oxygen, an increase in concentration of SO_2 from 0.180 mol dm⁻³ to 0.540 mol dm⁻³ was found to increase the initial rate by a factor of 9.

(i)   What is meant by order of reaction?
(ii)   Explain why the rate of the reaction above increased by an increase in the concentration of SO_2.
(iii) Deduce, using the information above the order of reaction with respect with to SO_2.

Question B4

Methanol is produced at 500 K from the reaction:

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$
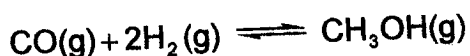
If CO gas and H₂ gas in the above reaction comes from reaction:

$$C_{graphite}(s) + H_2O(g) \rightarrow CO(g) + H_2(g)$$
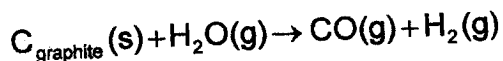
the initial moles of CO and H₂ in methanol production are one mole each. At 500 K

$\Delta G_f^{\circ}(CH_3OH(g)) = -134.27 \times 10^3$ Jmol⁻¹, $\Delta G_f^{\circ}(CO(g)) = -155.414 \times 10^3$ Jmol⁻¹ and $\Delta G_f^{\circ}(H_2(g)) = 0.00$ Jmol⁻¹.

(a)   Calculate ΔG_r°
(b)   Determine the equilibrium constant, K_P using information in (a).
(c)   What pressure is required to convert 25 % CO to CH_3OH?

Question B5

The electromotive force (EMF) of the cell

$$Pt|H_2(1bar)|HCl(0.01m)|AgCl(s)|Ag$$
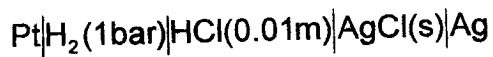
at various temperatures is

T(in K)	273.15	288.15	298.15	308.15
E (in V)	0.45780	0.46207	0.46419	0.46565

The E°_{cell} and $\partial E/\partial T$ are 0.2223 V and +1.902 $\times 10^{-4}$ V/K respectively at 298.15 K.

   (a)   Write the cell reaction.
   (b)   Calculate the EMF of the cell at 298.15 K using the mean activity coefficient calculated from the Debye-Hückel limiting law.
   (c)   Use the measured EMF of the cell at 298.15 K in the table above to calculate ΔH of the cell reaction.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER

FINAL EXAMINATIONS

C312:   BIOCHEMISTRY II

TIME: THREE HOURS

INSTRUCTIONS:

1. THERE ARE SIX (6) QUESTIONS IN THIS EXAMINATION PAPER
2. ANSWER ANY FIVE (5) QUESTIONS ONLY
3. ALL QUESTIONS CARRY EQUAL MARKS
4. MAKE SURE YOU HAVE 2 PRINTED PAGES OF THIS EXAMINATION PAPER

- **Question 1** The fixation of ammonia (or ammonium) as carbomyl phosphate is an initial process in the series of reaction steps leading, via arginine, to the final metabolic product of human and mammalian nitrogen metabolism, urea.

  Write down the chemical reactions and enzymes to show how this series of reaction steps leads to urea synthesis in humans and some domestic animals.

[20 marks]

- **Question 2** The aromatic amino acids are derived from four and two carbon atoms provided by erythrose 4-phosphate and phosphoenolpyruvate, respectively.

  a) **Describe** and **show** the various steps of the biosynthetic pathway involving erythrose 4-phosphate and phosphoenolpyruvate as the starting materials and leading to the formation of amino acid tyrosine (provide names and structures of biomolecules and the names of the enzymes involved).

  b) **Discuss** the fact that the first step in this multibranched biosynthetic pathway involving erythrose 4-phosphate and phosphoenolpyruvate

leading to the formation of tyrosine is subject to multiple feedback inhibition and control by the three amino acids.

[20 marks]

- **Question 3** Using the Lynen Cycle, **show** how you would break down stearic acid. **How** many cycles does it take it take to completely break down stearic acid?

[20 marks]

- **Question 4** **Describe** the biosynthesis of cholesterol. **What** factors regulate it and what factors influence cholesterol content in man?

[20 marks]

- **Question 5**   **Give** a detailed account of the mechanism of prokaryotic protein synthesis on the ribosomes.

[20 marks]

- **Question 6** **Write** an essay on the functions of all enzymes involved in the replication of DNA and transcription (including post transcriptional processing) in both eukaryotic and prokaryotic cells. Show equations/structures where possible.

[20 marks]

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

C322 ANALYTICAL CHEMISTRY 111

TIME: 3 HOURS

INSTRUCTIONS:
1. ANSWER ANY FOUR of the questions in this paper.
2. All questions carry equal marks (15 Marks)
3. Show all your working and reasoning clearly

QUESTION 1

(a) What is an electroactive species? Give three (03) examples of electroactive species used in analytical chemistry, complete with appropriate equilibrium equations of each.

(b) Describe the operation principles of: differential refractometer, fluorometric and uv detectors.

(c) For the chromatogram shown in fig.1, determine the resolution between peaks B and C and also determine value for α for the same peaks.

(d) Methods of isotope dating rely on conversions of $^{40}_{19}K$ to $^{40}_{18}Ar$ and $^{87}_{37}Rb$ to $^{87}_{38}Sr$. (i) What are the nuclear equations for the conversions? (ii) Write out change in full, $^{27}_{13}Al(\alpha, p)\,^{30}_{14}Si$.

(e) What do you understand by the terms: transducer, Geiger-Muller counter and Compton scattering?

(15 Marks)

QUESTION 2

(a) The relative times for several compounds measured from sample injection are: air, 45 secs, propane, 1.5 min; pentane, 2.35 min; acetone, 2.45 min, xylene, 15 min. What are the relative times of the compounds using pentane as a standard? Calculate resolution between acetone and pentane if their base widths are 2 and 3 mins respectively.

(b) In the TLC analysis of amino acids, ninhydrin was used to visualise the separated spots. What is the formed product and what other technique could be used in the analysis of amino acids?

(c) In potentiometry, discuss the uses and applications of Nernst equation and ion selective electrodes..

(d) Using specific chemical reactions and equations, discuss two (02) similarities and two (02) differences between electrolytic and voltaic cells.

(e) Equivalence conductance of a 0.0125N HOAC solution done at 25^0C was found to be 14.4. Calculate both degree of dissociation and the ionization constant of HOAC. (Limiting equivalence conductance of HOAC is estimated to be 390.7 cm^2/eq-ohm).

(15 marks)

QUESTION 3

(a) Describe 3 ways in which chemical species are transported in solution when using electrochemical methods.

(b) Discuss the main differences between x-ray emission and x-ray diffraction techniques and also include the uses of these techniques in analysis.

(c) A conductance cell was filled with KCl solution with specific conductance of 0.01288 mho/cm. The measured resistance at 25^0C was 48.3 ohms. (i) What is the cell factor K? When the same cell was filled with 0.100N $CdCl_2$, a resistance of 123.7 ohms was found, (ii) what is the equivalent conductance of $CdCl_2$ solution?

(d) How many grams of copper will be deposited on a cathode if a constant current of 0.5 A is passed for 5 minutes?

(e) What do you understand by the terms: NAA, DIDA and elastic scattering?

(15 Marks)

QUESTION 4

(a) Describe the 3 methods of extraction of samples using fractional process of solvent extraction.

(b) What are amperometric titrations and describe 2 classifications of such titrations.

(c) Octane and iso-octane give retention times of 800 and 815 seconds on a column known to have 8100 theoretical plates. (i) What resolution will be found if a sample containing these compounds is run on this column?, (ii) assuming the retention times remain unchanged, how many theoretical plates are needed to achieve baseline resolution of R = 1.5?.

(d) What is the potential of a half-cell obtained by mixing 30.0ml of 1.0 x 10^{-1}M Fe^{2+} and 60 ml of 1.0 x 10^{-3}M Fe^{3+} (E^0 $_{Fe2+/Fe3+}$ = + 0.77V).

(e) Compound A has molecular weight (MW) of 98.4 and heat of fusion of 1.63 Kcal/mol. Compound B has MW of 64.3 and melts at similar temperature as compound A. 500mg of each sample yields DTA peak areas of 60 and 45 cm^2 for A and B respectively. What is the heat of fusion for B?

(15 Marks)

QUESTION 5

(a) Discuss the differences between oscillometry and conductometry as applied to analysis..

(b) Calculate the cell voltage, and give the polarity of the right electrode of the cell: $Pt|Ti^{3+}$ (1.0 x 10^{-1}), TiO^{2+} (1.0 x 10^{-3}), H^{+} (1.0 x 10^{-1})||V^{2+} (1.0 x 10⁻ ⁱM)|Pt. ($E^{0}_{V2+/V3+}$ = -0.26V; $E^{0}_{TiO2+/TiO3+}$ = +0.10V).

(c) Describe the differences in the following terms used in polarography: kinetic currents; catalytic currents and absorption currents.

(d) Component Y is eluted in 15 minutes. Component Z needs 25 minutes and non-retarded substance X needs 2 minutes. (i) What is relative retention Z with respect to Y? (ii) What is the capacity factor for Y on this column? (iii) What fraction of total time does Y spend in the mobile phase?

(e) Describe what determines the rate of travel of an average molecule in a chromatographic system?

(15 Marks)

$V^{2+} \left(1.0 \times 10^{-2} M \right)$; $V^{3+} \left(1.0 \times 10^{-1} M \right) | Pt$
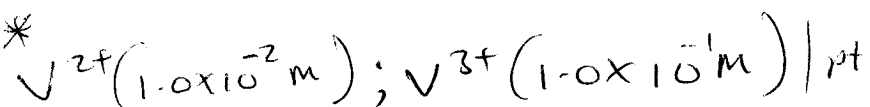
END OF EXAMINATION QUESTIONS
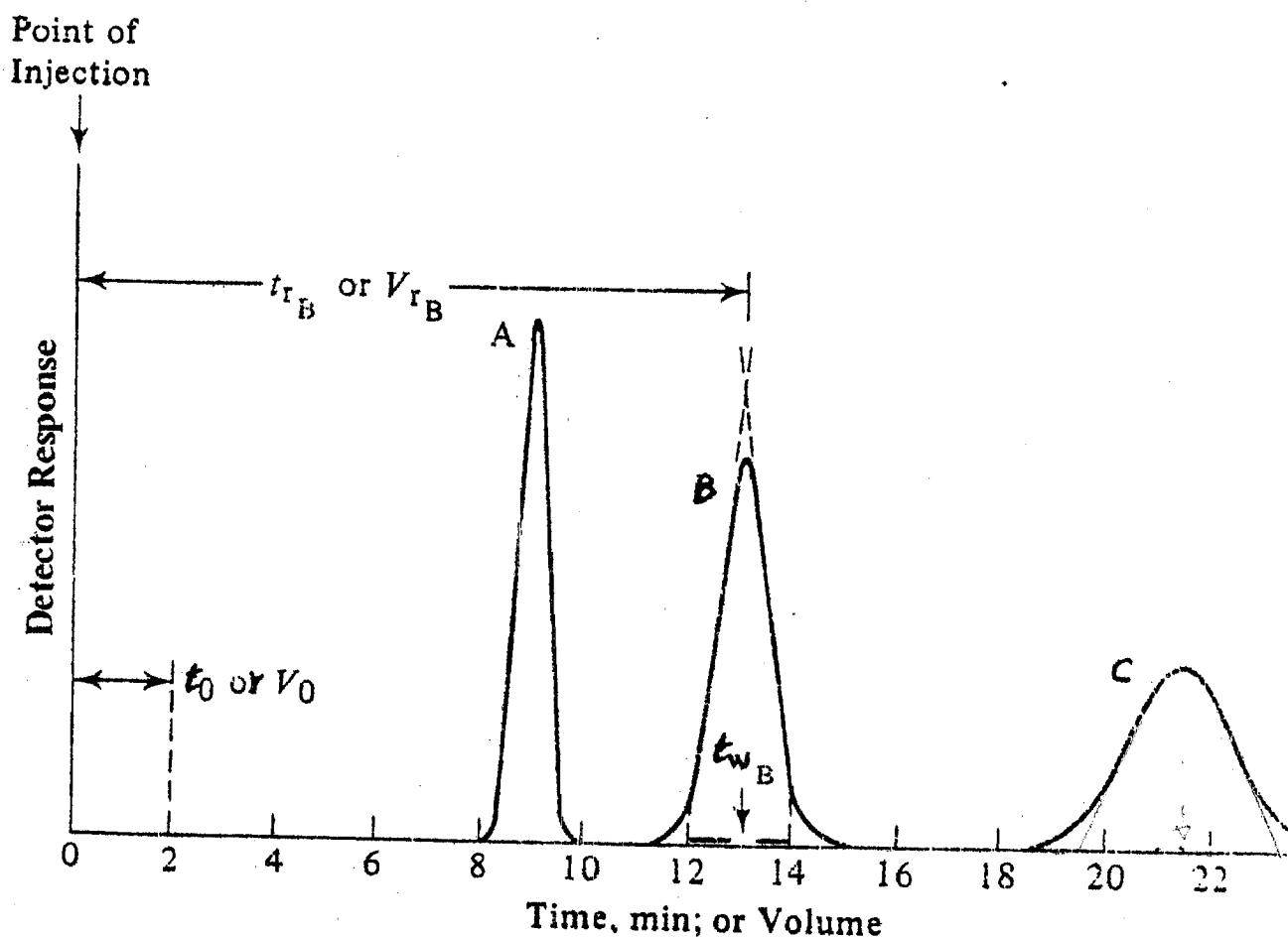
FIGURE . **1**   *Chromatogram of the three-component mixture .*

t_0 *= time for solvent to traverse the column,* t_{r_B} *= retention time of substance B,* t_{w_B} *= peak basewidth of substance B,* h *= peak height. Units can also be given in terms of volume rather than time:* V_0, V_{r_B}, V_{w_B}, *and so forth.*

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

C342: INORGANIC CHEMISTRY III

TIME: THREE HOURS

INSTRUCTIONS: ANSWER ANY FOUR QUESTIONS

Question 1.

(a). Discuss the salient features of inner sphere mechanism for electron transfer reaction.

(b) The intermediate $[Fe(SCN)(OH_2)_5]^{2+}$ can be detected in the reaction of $[Co(NCS)(NH_3)_5]^{2+}$ with Fe^{2+}(aq) to give Fe^{3+}(aq) and Co^{2+}(aq). What does this observation suggest about the mechanism.

(c) During the phosphane exchange reaction of $[CoBr_2(PPh_3)_2]$ there involves a large negative value of ΔS. What could be the probable mechanism involved. Justify your answer.

Question 2.

(a) Propose a suitable structure for the actinium complex $K_3[UO_2F_5]$ and support using necessary arguments.

(b) Lanthanides have similar chemical properties, then which property is used in the separation of Lanthanides. How is it done?

(c) Give a balanced equation for the reaction of any of the lanthanide metals with aqueous acid (H^+). Justify your answer with redox potential and oxidation states.
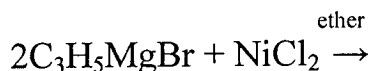
Question 3.

(a) What is the principle behind atom bomb? How does it differ from Hydrogen bomb?

(b) What is meant by critical mass in relation with nuclear reactor? Why does it vary?

(c) Draw a diagram to illustrate how binding energy per nucleon varies with mass number. Comment on the shape of the curve.

Question 4.

(a) In the tetrahedral series $v_{(CO)}$ decreases and $v_{(MC)}$ increases in going from $Ni(CO)_4$ to $[Co(CO)_4]^-$ to $[Fe(CO)4]^{2-}$. Explain why?

(b) Complete the reaction

$$2C_3H_5MgBr + NiCl_2 \xrightarrow{\text{ether}}$$

Draw the structures of $Fe(\eta^1\text{-}C_3H_5)(CO)_2(\eta^5\text{-cp})$ and $Co(\eta^3\text{-}C_3H_5)(CO)_3$.

(c) Give the equation for a workable reaction that will convert $Fe(\eta^5\text{-}C_5H_5)_2$ into $Fe(\eta^5\text{-}C_5H_5)(\eta^5\text{-} C_5H_4COCH_3)$.

Question 5.

(a) Using the 18 electron rule as a guide, indicate the probable number of carbonyl ligands in (1) $W(\eta^5\text{-}C_6H_6)(CO)_n$ (2) $Rh(\eta^5\text{-} C_5H_5)(CO)_n$ and (3) $Ru_3(CO)_n$

(b) Predict the products of these reactions.
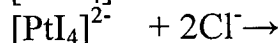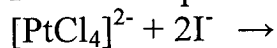
$$[PtCl_4]^{2-} + 2I^- \rightarrow$$
$$[PtI_4]^{2-} + 2Cl^- \rightarrow$$

(c) It is possible to prepare different isomers of Pt(II) complexes with four different ligands. Predict the products expected if 1mole of $[PtCl_4]^{2-}$ is reacted successively with the following reagents.[the product of reaction (i) is used in reaction (ii)].

(i)2 moles of NH_3. (ii) 2 moles of py.(iii) 2 moles of Cl^-. (iv) 1mole of NO_2^-.

Question 6.

(a) Describe, what requirements must meet any solvent.

(b) Write down the physical and chemical properties of liquid sulphuric acid, sulphur dioxide and ammonia.

(c) Write down the reactions production of non-aqueous solvents: H_2SO_4, SO_2, and NH_3.

(d) Describe the production of sulfites of sodium and barium using the liquid sulphur dioxide. Write down the reactions between liquid SO_2 and H_2S at room temperature and at -70

END OF EXAMINATION

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic number	X	Atomic mass	Name of the element X

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 27.99 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 63.65 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

Department of Chemistry-UNZA

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

C342: INORGANIC CHEMISTRY III
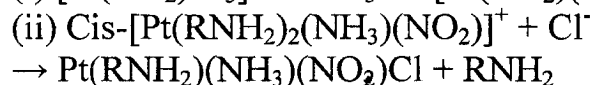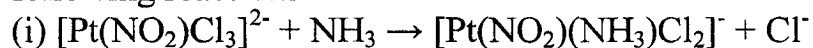
TIME: THREE HOURS

INSTRUCTIONS: ANSWER ANY FOUR QUESTIONS

Question 1. (a) The Irving-William series summarizes the variation in thermodynamic stability of complexes with the change in the central metal ion. Explain.

(b) The formation of a cadmium complex with Br^- from a hexa aqua complex exhibits the stability constants $K_1 = 1.56$, $K_2 = 0.54$, $K_3 = 0.06$, $K_4 = 0.37$. Suggest an explanation of why K_4 is larger than K_3.

(c) When CO becomes co-ordinated to BH_3 its stretching frequency increases, but when CO becomes co-ordinated to $Ni(CO)_3$ its stretching frequency decreases. Explain.

Question 2. (a) Predict the geometries of complexes, which result from the following reactions

(i) $[Pt(NO_2)Cl_3]^{2-} + NH_3 \rightarrow [Pt(NO_2)(NH_3)Cl_2]^- + Cl^-$

(ii) $Cis\text{-}[Pt(RNH_2)_2(NH_3)(NO_2)]^+ + Cl^-$
$\rightarrow Pt(RNH_2)(NH_3)(NO_2)Cl + RNH_2$

(b) The reaction of $CrCl_3$ with liquid NH_3 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) $MeMn(CO)_5 + L \rightarrow (MeCO)Mn(CO)_4L$
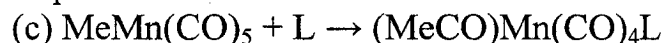
What are the possible mechanisms for the above reaction.

Question 3. (a) Show that the following compounds obey the effective atomic rule [EAN]

(i)$Fe_3(CO)_{12}$ (ii) $MeMn(CO)_4NO^+$

(iii) $Fe(CO)_2(\acute{\eta}^1\text{-}C_5H_5)(\acute{\eta}^5\text{-} C_5H_5)$
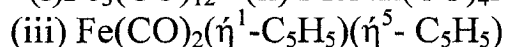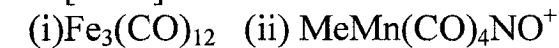
(b) Determine the M-M bond order consistent with the 18 electron rule for the following.:
  (i) $[(\eta^5\text{-} C_5H_5)Fe(CO)_2]_2$ (ii) $[(\eta^5\text{-} C_5H_5)Mo(CO)_2]^{2-}$
(c) Identify the most likely 2nd row transition metal for each of the following.
(i) $[M(CO)_3(NO)]^-$ (ii) $[M(PF_3)_2(NO)_2]^+$ (contains linear M-N-O)
(iii) $[M(CO)_4(\mu_2\text{-}H)]_3$ (iv) $M(CO)(PMe_3)_2Cl$ (square planar complex)

Question 4. (a) Based on observed value of magnetic moment what should be the number of unpaired electrons in Pr^{3+} ion. (Pr^{3+} magnetic moment = 3.6 BM). How can you account for any anomaly if present? Write its ground state electronic configuration.
(b) Mention some important features of lanthanide β- diketones.
(c) (i) What is the product obtained by dissolution of U_3O_8 in HNO_3?
(ii) How would you attempt the following conversion?
   (1) UO_3 to UO_2 (2) UH_3 to UO_2
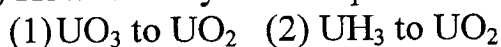
Question 5. (a) What is the binding energy of $_{26}Fe^{56}$ expressed in MeV? Masses of proton, neutron, and iron are 1.008, 1.009 and 55.934 amu respectively. Where is this on the binding energy versus mass number curve? Why don't we have to worry about an enemy that claims they have developed the iron bomb?
(b) A sample of Uranium mineral was found to contain 0.214 gm of Lead-206 for every gram of uranium. Calculate the time when the mineral was formed in the earth's crust. The $t^{1/2}$ of U-238 is 4.5×10^9 years.
(c) Lead 208 is known and stable. What is the reason behind the non - existence of lead 164?

Question 6. (a) Write down the reactions, indicating temperature, pressure and catalysts for production of liquid non-aqueous solvents: Ammonia, Suphuric acid and Sulphur dioxide.
(b) Describe some useful non-aqueous solvents.
(c) Write balanced decomposition and chemical reactions of non-aqueous Suphuric acid with HNO_3, $(NO+NO_2)$, $HClO_4$, PCl_5 and SO_3.

END OF EXAMINATION

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic number **X**
Atomic mass
Name of the element X

Group →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H 1.01 Hydrogen																	2 He 4.00 Helium
2	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
3	11 Na 23.00 Sodium	12 Mg 24.31 magnesium											13 Al 27.99 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
4	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 63.65 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
5	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 Iridium	50 Sn 118.71 Tin	51 Sb 121.76 Antimony	52 Te 127.60 tellurium	53 I 126.90 Iodine	54 Xe 131.2 Xenon
6	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 222.0 Radon
7	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									

Lanthanides (57 – 71)

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

Actinides (89 – 103)

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

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

C352: ORGANIC CHEMISTRY IV

TIME: THREE HOURS

INSTRUCTIONS:

1. Answer any FOUR questions.
2. Present your answers in a logical manner.
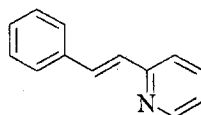3. Mark allocation for questions is shown, (x)

QUESTION ONE

(a) The synthesis of a broad spectrum antibiotic **C** is shown below. The stages are the Gould Jacobson quinoline synthesis to give **B** and the displacement reaction to afford **C**. What are the mechanisms of these reactions?
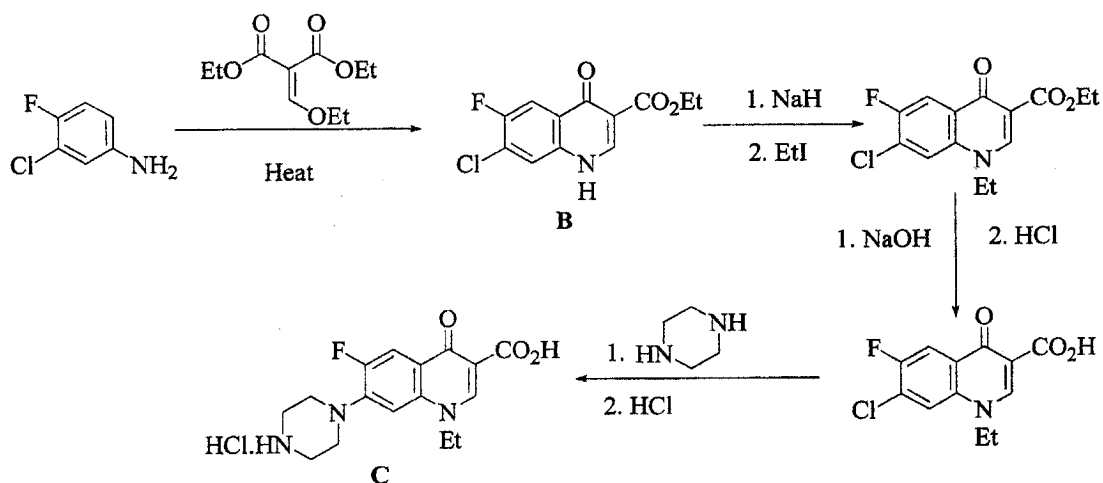
[12]

(b) (i) Provide a synthesis of stilbazole, structure shown below, from 2-methylpyridine.

Stilbazole

(ii) Account for the fact that alkyl groups at C-2 and C-4 positions of quinoline can be easily deprotonated by strong bases.

[10]

(c) Dihydroisoquinoline **E**, shown in the scheme below, is an intermediate in the Bischler-Napieralski synthesis of isoquinolines. Give the structure of the product **D** and provide a mechanism for the formation of the dihydroisoquinoline **E** from **D**.
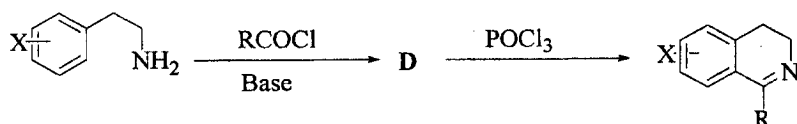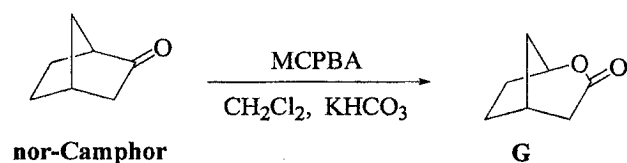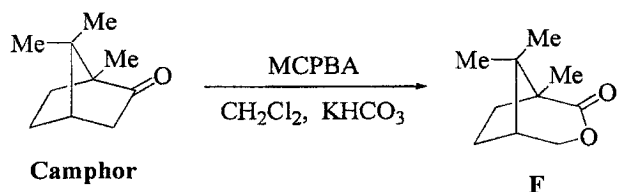

E: Dihydroisoquinoline

[8]

QUESTION TWO

(a) Baeyer-Villiger oxidation of Camphor gave an unexpected product **F** in 30 % yield; where as norcamphor gives the expected product **G** as shown below. Provide a mechanistic explanation for these experimental results.

[10]

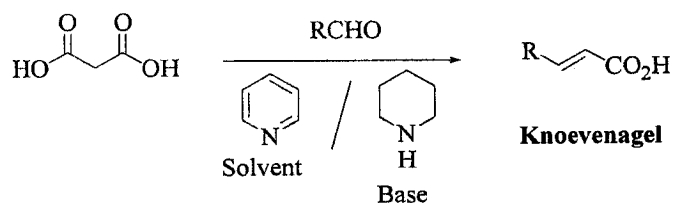**(b)** Sugget plausible reaction mechanisms to account for the observed products of the following reactions.

(i)

$$\text{OHC(CH}_2)_4\text{CHO} \quad + $$

(ii)

(i) CH_2N_2

(ii) NaN_3, H_2SO_4
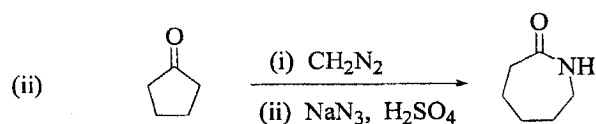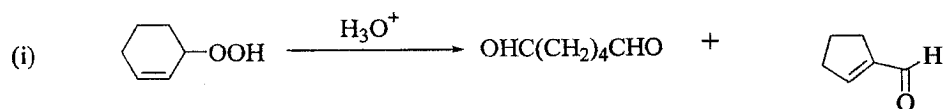
[20]

QUESTION THREE

(a) (i) With the aid of an example, state two ways in which a carbanion can be generated.

[8]

**(b)** Propose a mechanism to account for the reaction shown below.

$$R\text{—}CO_2H$$

Knoevenagel

Solvent / Base

[10]

(c) Suggest synthetic sequences for the following transformations:

(i)

(II)
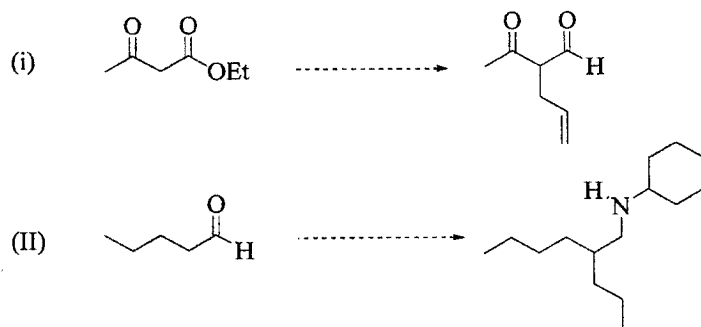
QUESTION FOUR

(a) A general method for homologation of cyclic ketones is shown below. The last step of this reaction sequence is known as Tiffaneu-Demyanov reaction, a variant of Pinacol rearrangement.
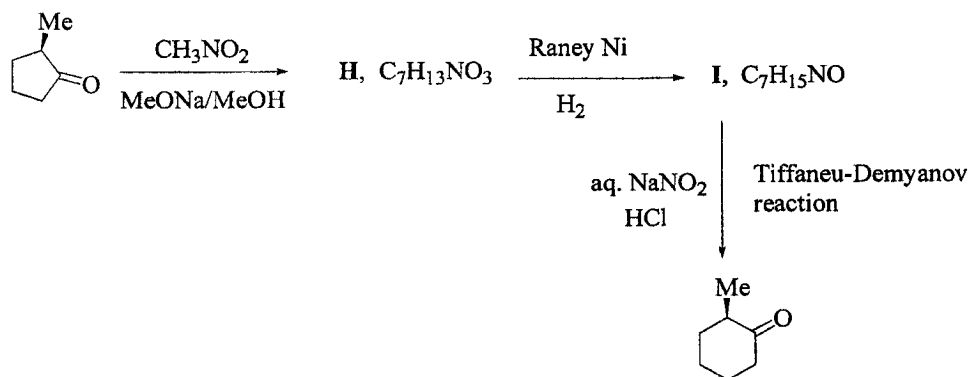
(i) Identify the intermediates **H** and **I**.

(ii) Suggest the most likely mechanism for the Tiffaneu-Demyanov reaction shown above.

(iii) Give the structure of one other possible product that can be expected to be formed in the last step of the above reaction sequence.

[12]

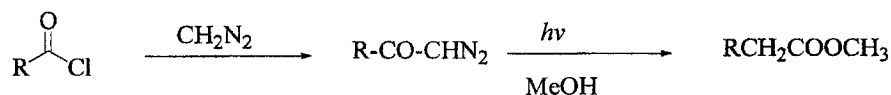**(b)** Predict the major organic products and give mechanisms of the following reactions.
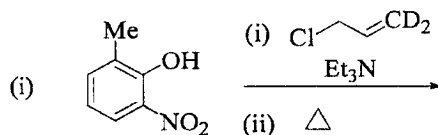
[10]

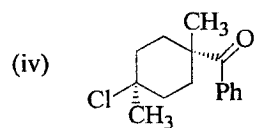**(c)** A general method for extending carbon chains of carboxylic acids is shown below.
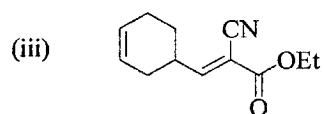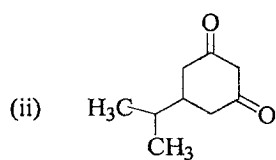

Give the mechanisms of the above reactions.

QUESTION FIVE

Suggest the most probable synthesis for **any three (3)** of the following compounds.

(i)

(ii)

(iii)

(iv)
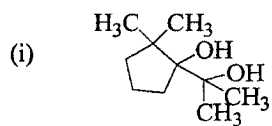
30 marks

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
DEPARTMENT OF CHEMISTRY
SEMESTER II 2007 SESSIONAL EXAMINATIONS
C 362: COLLOIDS AND ELECTROCHEMISTRY
20TH FEBRUARY 2008

TIME: THREE HOURS

INSTRUCTIONS: 1. ANSWER *ANY FIVE (5)* OF SIX QUESTIONS

2. USE *SEPARATE* ANSWER BOOKS FOR SECTION A AND SECTION B

DATA
$R = 8.314$ J K^{-1} mol^{-1} $= 8.314 \times 10^{-2}$ L bar K^{-1} mol^{-1} ; $N_A = 6.022 \times 10^{23}$ mol^{-1};
Atomic masses Cd = 112, I = 127, Bi = 209; F = 96485 C mol^{-1}

SECTION A

QUESTION 1

a) The equation F = C - P + 2 is an important one in Physical Chemistry. Identify the equation and explain all the symbols and the number 2 in the equation.

b) The following are cooling curves for mixtures of the two component cadmium-bismuth system indicating percentages of bismuth. The melting point of cadmium is 596 K.
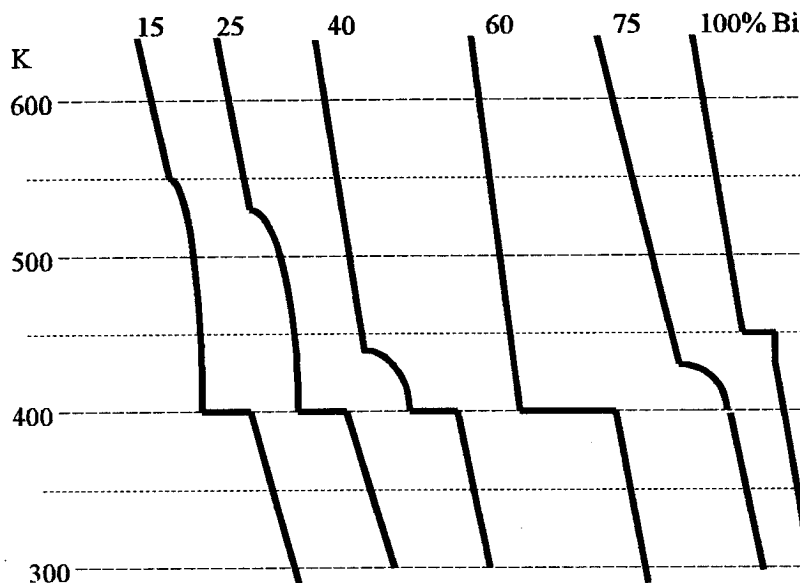
(i) Draw the phase diagram. (ii) On the diagram indicate the melting point of each component and label each region to indicate what phases are present in that region. (iii) Label the eutectic point. (iv) calculate the mole fraction of cadmium in the eutectic composition.

QUESTION 2.

Consider one mole of nitric acid at its normal boiling point.

a) Write a complete equation for this change of state.

b) Derive the Clausius-Clapeyron equation for nitric acid at its normal boiling point. Clearly state all the assumptions made in its derivation.

c) The vapour pressure, P, of nitric acid was measured and found to vary with temperature as follows:

t($^\circ$C)	0	20	50	70	90
P (bar)	0.0192	0.0638	0.2271	0.6220	1.2481

Using the equation derived in part b) calculate the boiling temperature, the enthalpy of vaporization, the entropy and the Gibbs free energy of nitric acid at its normal boiling point.

QUESTION 3.

One of the laboratory experiments that you performed during the semester was a conductometric titration of a solution of hydrochloric and copper(II) chloride with sodium hydroxide.

a) Explain the general theory underlying the conductometric titration of sodium hydroxide against a solution of hydrochloric and copper(II) chloride. State what parameter(s) was(were) measured. Also state the advantage(s) of conductometric titrations over other titration methods.

b) A mixture of exactly 50 cm^3 of 0.0200 M HCl and 50 cm^3 of 0.0200 M acetic acid was titrated conductometrically with 1.00 M NaOH. The following data were obtained during the titration, with conductance expressed in arbitrary units:

V(NaOH):	0.0	0.40	0.80	1.20	1.60	1.80	2.20	2.60	2.80
Conductance:	37.0	28.0	16.0	12.0	14.5	15.5	20.0	27.5	31.5

Plot the experimental points of the titration curve and extrapolate the line segments to locate the end points. (i) state the values of the end points and (ii) the equivalence points. (iii) Explain the shape of this titration curve.

QUESTION 4.

The determination of transference numbers of cadmium and iodide ions by Hittorf's method gave the following data. A stock solution of cadmium iodide was prepared and by precipitation of iodide as AgI its concentration was determined as 0.002763 g of cadmium iodide per gram of solution. Another sample of this solution was placed in a Hittorf transference number cell and current was passed through the cell. It was found that 0.03462 g of cadmium was deposited at the cathode by the passage of current. Furthermore, analysis of the anode compartment solution, which weighed 152.643 g, indicated the presence of 0.3718 g of cadmium iodide.

a)   What are the electrode reactions?

b)   Indicate diagrammatically, using t_+ and t_- to represent the transference numbers, the changes in amounts of ions in the anode and the cathode compartments as a result of migration and electrode reactions.

c)   How many coulombs of charge were passed through the cell in the experiment?

d)   Calculate the transference numbers of Cd^{2+} and I^- in this cadmium iodide solution.

e)   What was the change in the moles of CdI_2 in the cathode compartment?

QUESTION 5.

a)   The limiting current density is given in terms of ionic diffusion coefficient D_+ which can be related to ionic conductivity λ_+. Derive an expression for the limiting current in terms of λ_+, the concentration of the ion c_+, and the thickness of the diffusion layer δ.

b)   The ionic conductivity of Fe^{2+} is 40 S cm^2 mol^{-1}. The limiting current of platinum electrode of an area 40 cm^2 dipping into a solution of iron(II) chloride at 25 °C was measured at various concentrations whose results are given below:

$[FeCl_2]$ / M	0.250	0.125	0.063	0.031
I / mA	215	107	49	23

What was the thickness of the diffusion layer at each concentration?

QUESTION 6.

The resistance of a series of aqueous sodium chloride solutions, formed by successive dilution of a sample, were measured in a cell with a cell constant (the constant K in the relation $\kappa = \dfrac{K}{R}$) equal to 0.2063 cm^{-1}. The following values were found:

c /mol L^{-1}	0.00050	0.0010	0.0050	0.010	0.020	0.050
R / Ω	3314	1669	342.1	174.1	89.08	37.14
Conductivity κ						
Molar conductivity Λ						

a)   Copy and complete the above table.

b)   Verify that the molar conductivity follows Kolhrousch's law.

c)   Determine the molar conductivity at infinite dilution and the coefficient *b*.

d)   Use the determined value of *b* and the information given below to predict the molar conductivity, the conductivity, the resistance it would show in the cell, of 0.01 mol L^{-1} sodium iodide at 25 °C.

$\lambda(Na^+) = 5.01$ *m*S m^2 mol$^-$; $\lambda(I^-) = 7.68$ *m*S m^2 mol$^-$.

------------------------------------END OF C362 EXAMINATION----------------------------

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF CHEMISTRY

SEMESTER II: 2008 SESSIONAL EXAMINATIONS

C 362: COLLOIDS AND ELECTROCHEMISTRY

24 APRIL 2009

TIME: THREE HOURS
ANSWER QUESTION 1 AND ANY FOUR (4) OUT OF FIVE OTHERS.
THIS EXAMINATION QUESTION PAPER HAS FIVE PAGES.

DATA
$R = 8.314$ J mol^{-1} K^{-1}; $F = 96485$ C mol^{-1}; 1 atm. $= 101325$ Pa
C = 12.01, H = 1.01, Ca = 40.08, Mg = 24.31

QUESTION 1(*TOTAL 40 MARKS: 8 marks for each part*)
a).   (i) Consider a system in which the following reaction occurs:

$$CaCO_3(s) \rightleftarrows CaO(s) + CO_2(g)$$

For this system, state the number of phases, the number of chemical constituents, the number of components and use Gibbs Phase Rule to calculate the number of degrees of freedom.

(ii) Now consider a system in which the following reaction occurs:

$$NH_4Cl(s) \longrightarrow NH_3(g) + HCl(g)$$

Does Gibbs Phase Rule apply to this system? Explain your answer.

b).   Calculate the limiting molar conductivity of silver chloride from the following data:

Salt	Limiting molar conductivity, S cm^2 mol^{-1}
KCl	149.9
KNO$_3$	145.0
AgNO$_3$	133.4

After correction for water conductivity, the conductivity of a saturated solution of silver ion is 1.887×10^{-6} S cm^{-1} at 25° C. Calculate the solubility and the solubility product of silver chloride at this temperature.

1

c). A mixture of methylbenzene, MB ($C_6H_5CH_3$) and benzene, B (C_6H_6) contains 30% by weight of methylbenzene. At 303.15 K, the vapour pressure of methylbenzene is 4892 Pa and that of benzene is 15744 Pa. Assuming that they form an ideal mixture, calculate the total pressure and the partial pressure of each component above the solution at 303.15 K.

d). Estimate the limiting current density at an electrode in which the concentration of the silver ion is 2.5 $mmol$ at 25° C. The thickness of the Nerst diffusion layer is 0.40 mm. The ionic conductivity of silver ion at infinite dilution and 25° C is 6.19 mS m^2 mol^{-1}.

e). (i) Distinguish between specific viscosity and relative viscosity? What are their units?

(ii) The intrinsic viscosities of various fractions of nylon–6 (polycaprolactam) in m-cresol were measured at 298.15 K (Reimschussel and Dege 1971). The results were as follows:

$[\eta]$ $(dm^3\ g^{-1})$	M_v $(g\ mol^{-1})$
0.43	4,460
1.10	17,600
1.59	30,800

Determine the values of the Mark-Houwink constants a and K. What are the units of K?

QUESTION 2 (15 MARKS)

Liquid naphthalene, $C_{10}H_8$ has a vapour pressure of 1.3 kPa at 358.35 K and 5.3 kPa at 392.45 K.

a). Calculate: (i) the molar heat of vaporization ΔH_{vap}; (ii) the normal boiling point, T_b; and (iii) the molar entropy of vaporization, ΔS_{vap} at its normal boiling point. What assumption(s) have you made in each calculation?

b). The triple point temperature, T_{tr} of naphthalene is 353.65 K. Calculate its triple point pressure, P_{tr}.

c). The density of $C_{10}H_8$ (s) is 1000 kg m^{-3} and that of $C_{10}H_8$ (l) is 980 kg m^{-3}. Will the melting point temperature at 101325 Pa be less than 353.65 K? Derive, but do not solve, an explicit equation for calculating this temperature.

QUESTION 3 (15 MARKS)

a). Derive an expression for dissociation constant, K for a weak electrolyte AB. Modify the equation so that it can be used to test experimental values of Λ at various concentrations by means of a straight line plot.

b). Kraus and Callis, [J. Amer. Chem. Soc., **45**, 2624 (1923) obtained the following electrolytic conductivities, κ for the dissociation of tetra-methyl tin chloride, $(CH_3)_4SnCl$ in ethanol solution at $25°$ C and at various concentrations c:

$c/10^{-4}$ mol dm^3	1.566	2.600	6.219	10.441
$\kappa /10^{-6}\ \Omega^{-1}$ cm^{-1}	1.788	2.418	4.009	5.336

By the use of the linear plot you devised in part a), determine Λ^o and K.

QUESTION 4 (15 MARKS)

Acetone and carbon disulfide do not form an ideal solution. The vapour pressures of acetone, $(CH_3)_2CO$ and carbon disulfide CS_2 at 308 K were measured and found as follows:

Mole fraction of CS_2, $X(CS_2)$ in the liquid phase.	Partial pressure $(CH_3)_2CO$ (bar)	Partial pressure CS_2 (bar)
0.00	0.45	0.00
0.05	0.45	0.11
0.10	0.41	0.24
0.20	0.39	0.37
0.40	0.36	0.47
0.60	0.31	0.54
0.80	0.26	0.57
0.90	0.20	0.65
0.95	0.13	0.66
1.00	0.00	0.67

a). Draw the *Pressure – Composition* phase diagram for acetone and carbon disulfide.

b) On the same diagram (i) draw plots to show the validity of both Raoult's and Henry's laws for each component; (ii) draw a plot for the total pressure to show the validity of Raoult's law if the solution were ideal. Label the plots appropriately; and (iii) what type of deviation does the phase diagram exhibit? Briefly explain your answer.

c) Calculate the change in the chemical potential, μ of CS_2 when its mole fraction in the mixture changes from 0.20 to 0.80.

QUESTION 5 (*15 MARKS*)

An early study of hydrogen overpotential is that of H. Bowden and T. Redeal [*Proc. Roy. Soc.*, **A120**, 59 (1928)], who measured the overpotential for hydrogen evolution with a mercury electrode in dilute aqueous solutions of sulfuric acid at 25° C. Determine the exchange current density and transfer coefficient, α from their data:

J /mA^{-2}	2.9	6.3	28	100	250	630	1650	3300
η / V	0.60	0.65	0.73	0.79	0.84	0.89	0.93	0.96

Explain any deviation from the results expected from Tafel equation.

QUESTION 6 (15 MARKS)

The following is a *Temperature – Composition* phase diagram for the system magnesium-calcium:
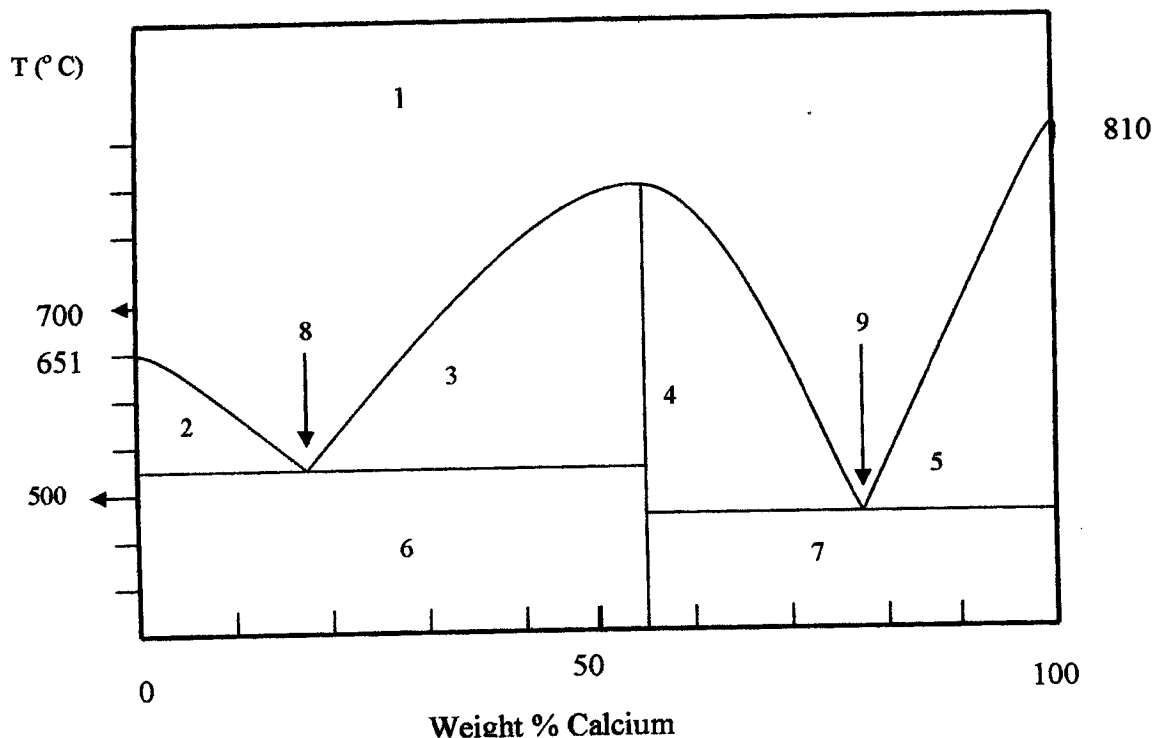
Magnesium melts at 651 °C and calcium melts at 810 °C. A compound with calcium composition of 55 % weight calcium is formed and melts at 721 °C.

a) Calculate the formula of the compound formed.

b). Identify all the numbered regions of the phase diagram. Use Gibbs Phase Rule to indicate the degree(s) of freedom for each numbered region. In identifying the regions indicate the *actual phases* present; for example: Region X: Ca (s), F = 2.

c). Sketch cooling curves for compositions of 40 % weight and 55 % weight calcium from 850 to 450 °C. On the sketch, indicate the temperature at which a phase change occurs. Estimate the temperature of the phase changes from the phase diagram and indicate these on the curves.

_____END OF EXAMINATION FOR C 362_____

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER

FINAL EXAMINATIONS

C412: ADVANCED BIOCHEMISTRY II

TIME: THREE HOURS

INSTRUCTIONS:

1. PLEASE NOTE THAT THERE ARE TWO (2) SECTIONS IN THIS EXAMINATION PAPER, *SECTION A* AND *SECTION B*
2. ANSWER ANY FOUR (4) QUESTIONS FROM *SECTION A* AND ANY ONE QUESTION (1) FROM *SECTION B*
3. MAKE SURE YOU HAVE 5 PRINTED PAGES OF THIS EXAMINATION PAPER
4. FAILURE TO FOLLOW THESE INSTRUCTIONS WILL RESULTS IN LOSS OF MARKS

Section A

- Question 1

    Total length of DNA in a human cell is approximately 2 metres long. The cell nucleus is about a million times smaller in diameter relative to length of DNA and yet the entire length of DNA must be packed inside the nucleus.

    a) With above facts in mind **discuss** in detail how DNA is packaged inside a human cell.
    b) **Explain** how the DNA so packed in the cell is replicated or transcribed.

[20 marks]

Cont'd on the next page

1

Question 2

a) The following pair of primers in PCR has a problem with it. Briefly **explain** why these primers would not work well.

5'-GCCTCCGGAGACCCATTGG-3'
5'-TTCTAAGAAACTGTTAAGG-3' -

b) Briefly **describe** how you would use site-directed mutagenesis to change a *BamHI* (GGATCC) restriction site into a *HindIII* site (AAGCTT).

c) Suppose you did an experiment in which you placed a plasmid containing a PCR generated DNA insert into *E. coli*. Briefly **describe** the method you would use to test for the uptake of the plasmid.

[20 marks]

Question 3

A yeast genomic library was constructed by inserting *BamHI* digested yeast chromosomal DNA fragments into the *BamHI* site of the plasmid pBR322.

PBR322 has 4363 nucleotide pairs (bp) and it encodes an ampicillin resistance gene (containing a *PstI* site) and a tetracycline resistance gene (containing a *BamHI* and *SalI* site). The map positions of the resistance enzyme sites are *EcoRI* 4361, BamHI 375, *SalI* 651, *PstI* 3609, *BglII* does not cut.

40,000 ampicillin-resistant colonies were obtained, of these 37,000 were tetracycline-sensitive. The library was screened with an oligonucloetide encoding part of gene X and 3 positive colonies were obtained. One of these was retained for further study and subjected to restriction endonuclease mapping. The following results were obtained:

Cont'd on the next page

2

Restriction Enzyme(s)	Fragment sizes in kilobase pairs (Kbp)		
EcoRI	10.5		
EcoRI + BamHI	0.37	6.1	4.0
PstI	2.22	0.4	7.9
BglII	10.5		
EcoRI + BglII	5.4	5.1	
SalI	10.5		
BglII + SalI	1.4	9.1	

a) **What** proportion of the colonies contains inserts?
b) Using the formula $p = 1 - (1 - f)^n$, where p = probability of the library containing a particular gene, f = fraction of the genome in each recombinant clone and n = number of colonies, **calculate** the probability that the library contains any particular gene (Yeast genome size is 4×10^{10} bp and the average insert size in the library is 5×10^3 bp).
c) **Draw** a restriction map of the recombinant plasmid.
d) Suppose you were given an antibody which cross-reacted with protein X, instead of the oligonucleotide. **Explain** how you would use this to isolate gene X.

[20 marks]

- Question 4
    a) Briefly **describe** any 5 preservation methods.
    b) **Which** of the five is used in preservation of

    i)   beer
    ii)   milk

[20 marks]

Cont'd on the next page

3

- Question 5 **Identify** all (a to f) the cyt P450 reaction types shown in Fig. 1

a Testosterone

b

c Chlorpromazine

d Aminopyrine + HCHO
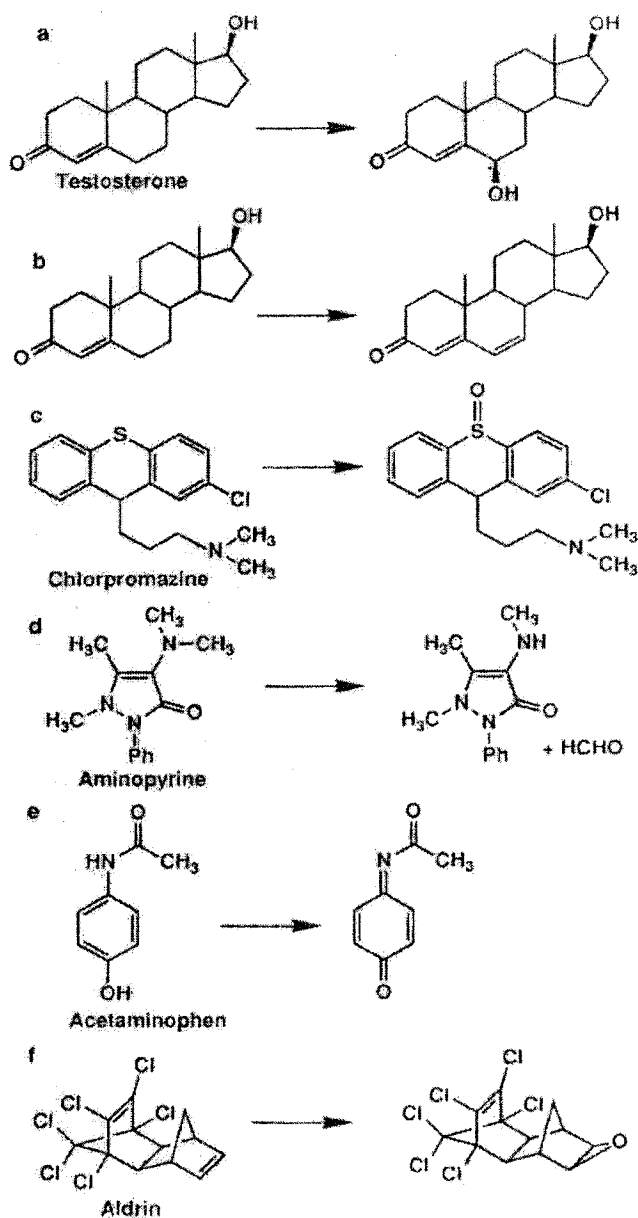
e Acetaminophen

f Aldrin

Fig. 1

[20 marks]

Cont'd on the next page

4

Section B

- Question 6

    Describe in detail the chemistry of HIV infectivity. What drugs are clinically approved for treatment of AIDS (use formulae)?

[20 marks]

- Question 7

    What is the complement system? Describe the mode of action of this system.

[20 marks]

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF CHEMISTRY

2008 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATION

C 422: APPLIED ANALYTICAL CHEMISTRY: ORGANIC COMPOUNDS

TIME: THREE HOURS

INSTRUCTIONS: ANSWER ANY 4 QUESTIONS FROM THE 5 QUESTIONS IN THIS PAPER
ALL QUESTIONS CARRY EQUAL MARKS
SHOW ALL YOUR WORKING AND REASONING CLEARLY

QUESTION 1

(a) Pesticides are an important element to national development, particularly to agriculture. However, the chemicals may have detrimental effects. Give 3 attributes of an ideal pesticide.

(b) 0.2g Urea sample ((NH_2)$_2$CO) was analysed by the Kjeldahl method. NH_3 was collected in 50ml 0.05M H_2SO_4 and the excess titrated with 0.05M NaOH, a procedure requiring 3.40ml. Calculate %urea in the sample.

(c) 3 Antioxidants are allowed to be used in fat-based foods by Zambian regulations. Name them and describe how to detect any two of them in such foods.

(d) Describe or explain the following terms: detergency, emulsifier, antioxidant and agglutination. Include in your answer their uses if any.

(e) Describe 3 reactions used in the identification of amines in organic compounds.

(15 MARKS)

QUESTION 2

(a) Potassium chromate in basic solution exhibits an absorption maxima at 372nm. A basic solution containing 3.00×10^{-5}M potassium chromate transmits 71.6% of incident radiation at 372nm, when placed in a 1cm cell. (i) What is the absorbance of this solution (ii) what is the molar absorptivity of potassium chromate at 372nm?

(b) What are the basic differences between detergents and soap? Outline how quality of these products can be evaluated.

(c) The phosphorous content was analysed by the gravimetric quinolinium phosphomolybdate method. If 3.114g of quinolinium phosphoate, $(C_9H_7)_3PMo_{12}O_{40}$ were obtained from a 1.00g sample. Find the $\%P_2O_5$ in the sample (use P = 30.97, O = 16, N = 14.01, Mo = 95.94).

(d) Describe an appropriate pre-treatment method that would effectively deal with the analysis in drug samples in which you have both alkaloids and barbiturates.

(e) Describe 3 methods of determining "crude fat" in foods.

(15 MARKS)

QUESTION 3

(a) A Sample of mineral ash gave a meter reading of 37. Solutions B and C containing the same quantity of unknown solution plus 40 and 80μg/ml of added K, respectively meter readings of 65 and 93. Calculate the quantity of unknown K in the original sample.

(b) Name 2 water- soluble vitamins found in food and briefly describe how to determine them in fruits and vegetables.

(c) What is the difference in principles of operation between dialysis, osmosis and ultrafilteration. Where would you apply such type of techniques?

(d) Describe the Van Slyke method used in gas analysis. What other method can be used instead of Van Slyke method in blood analysis?

(e) Discuss some reactions associated with vinyl as well as propenyl organic compounds.

(15 MARKS)

QUESTION 4

(a) The determination of SO_2 in a fruit drink was done thus: SO_2 gas was bubbled at a rate of 20L/minute through a trap containing H_2O_2. The H_2SO_4 produced in 30 minutes was treated with 5.62ml of 0.01M NaOH. What was the concentration of SO_2 in the sample in ppm given that the density of SO_2 is 2.86mg/ml (S = 32).

(b) Discuss the determination of a sweetener and caffeine in a soft drink.

(c) Sources of pesticides residues in soil are numerous. Presented with a soil sample suspected to contain an organo-mercurial pesticide, what test would you carry out to determine the nature of the contaminant.

(d) You have just made an N containing compound and you would like to know whether it is an amine or a nitro compound. What tests would you carry out to try and identify the compound?

(e) Describe how a health soap is made and discuss how its qualities are established.

(15 MARKS)

QUESTION 5

(a) Discuss the 3 ways of how to determine electrolytes in blood serum.

(b) H_2O_2 solution was analysed by adding excess standard $KMnO_4$ solution and back-titrating the unreacted $KMnO_4$ with Fe^{2+}. A 0.587g sample of H_2O_2 solution is taken in 25ml of 0.0125M $KMnO_4$ and back-titration needed 5.10ml of 0.112M Fe^{2+} solution. What $\%H_2O_2$ is in the sample. What other method can be used to determine the concentration of H_2O_2 solution?

(c) Describe the important components of _Mazoe_ drink and discuss the determination of one of the minor components of this popular drink.

(d) Define the following terms: hydroxyl value, iodine value, peroxide value and include their uses in foods.

(e) For people living in malaria prone and tsetse fly infected areas, name 2 types of pesticides that could be used to protect both livestock and people.

(15 MARKS)

<u>END OF EXAMINATION QUESTIONS</u>

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

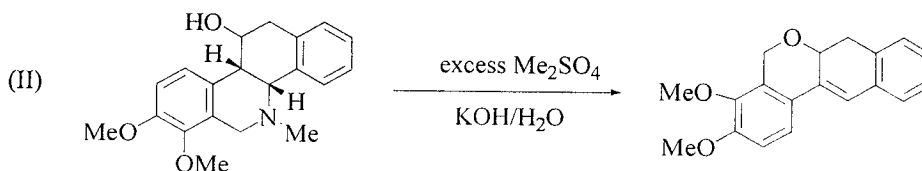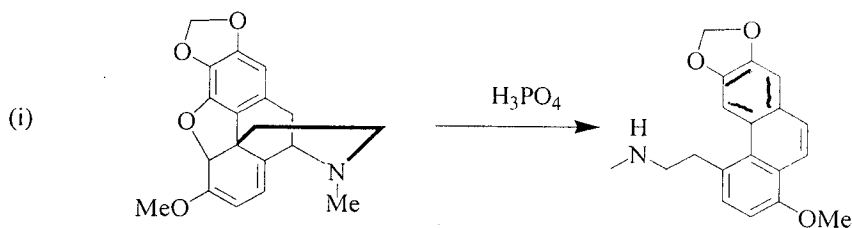## C452: ADVANCED ORGANIC CHEMISTRY II

TIME: THREE HOURS

INSTRUCTIONS:

1. Answer any FOUR (4) questions.
2. Present your answers in a logical manner.
3. All questions carry equal marks (30).

Max. Marks: 120

QUESTION ONE

(a)   Propose plausible reaction mechanisms to account for the unanticipated products of the following reactions.

(i)

(II)

[20]

(b)   The picryl substituent, $(NO_2)_3C_6H_2$, of the picrylbenzoic acid, $(NO_2)_3C_6H_2C_6H_4COOH$, has δ_m and δ_p values of 0.43 and 0.41 respectively. What conclusion can you draw from the above two values regarding the inductive effect transmitted from the m-position compared with that from the p-position? Show the structures of picrylbenzoic acids.

[10]

QUESTION TWO

(a)   Deduce the structure of a disaccharide **B**, $C_{12}H_{22}O_{11}$, from the following data. Show your reasoning clearly.

Acidic hydrolysis of **B**, gave D-glucose and a D-hexose **C**, which gave a positive reaction with Tollen's reagent. Exahaustive methylation of **B** followed by mild acid hydrolysis gave 2,3,4-tri-O-methylglucose and 2,3,4,6-tetra-O-methyl derivative of **C** in equimolar ratio. Sodium borohydride reduction of **C** gave an optically inactive compound **D**, $C_6H_{14}O_6$. Ruff degradation of **C** produced an aldopentose **E**, which was oxidized by dilute nitric acid to an optically inactive dicarboxylic acid **F**, $C_5H_8O_7$. The proton nmr spectrum of **B** showed two doublets, δ (ppm): 5.62 (d, 1H, J = 7.8 Hz) and 5.41 (d, 1H, J = 7.4 Hz), plus other signals at δ 4.5 – 3.4 ppm integrating for the remaining oprotons.

[16]

(b)   The effect of substituents on the relative rates, *log K/K₀*, of phenyltrimethylsilanes with aqueous methanolic perchloric acid at 51°C is given in the table below.

Substituent	δ^+	Log K/K_0
p-N(CH$_3$)$_2$	-1.70	7.50
p-OCH$_3$	-0.78	3.18
p-CH$_3$	-0.31	1.32
m-CH$_3$	-0.07	0.36
H	0.00	0.00
p-Cl	0.11	-0.87
p-Br	0.15	-1.00

(i)   Demonstrate the correlation of the reaction with δ^+ values and provide the value of its constant, the p value.

(ii) Name the type of the reaction in (b) (i) above and show its mechanism.

[14]

2

QUESTION THREE

(a) Using disconnection approach, propose a synthesis of the alkaloids **G** and **H**, structures shown below from readily available non-heterocyclic starting materials. Show the reagents, including solvents (if any), reaction conditions and the products for each step of your proposed synthesis.

G

H
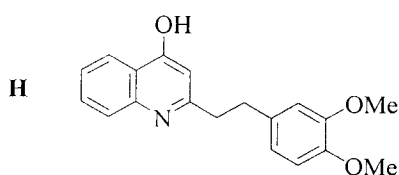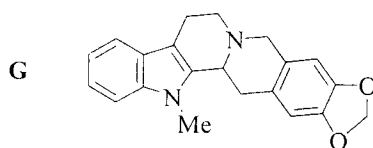
[20]

(b) How would you carry out the following transformations in good yield. Show all steps clearly.

(i) D-glucose $\longrightarrow$

(ii) D-galactose $\longrightarrow$
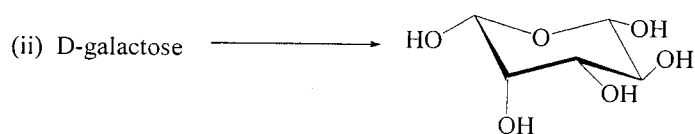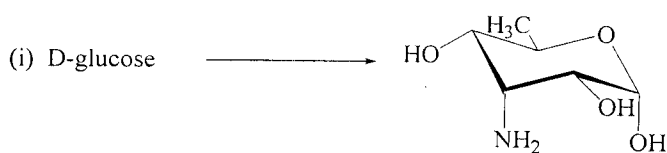
[10]

QUESTION FOUR

(a) Explain the reactions involved in the following synthesis of the alkaloid **M**. Show the reaction mechanisms.

Successive treatment of a solution of 3.4-dimethoxyacetonitrile, structure shown below, in dimethylsulphoxide with dimethylsulphoxide anion and 1,2-dibromoethane gave **I**, $C_{12}H_{13}NO_2$, which showed a prominent absorption band at 2233 cm^{-1} in the **ir** spectrum.
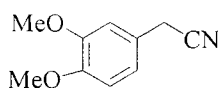
3,4-dimethoxyacetonitrile

Reduction of **I** under controlled conditions with one(1) molar equivalent of DIBAL-H followed by acidic hydrolysis of the reaction mixture yielded a nitrogen free compound **J**, $C_{12}H_{14}O_3$. The **ir** spectrum of compound **J** showed three prominent bands, a strong band at 1715 cm^{-1}, a medium band at 2850 cm^{-1} and a weak band at 2750 cm^{-1} while the ^{1}**Hnmr** spectrum showed, among other features, a singlet at 9.2 ppm (1H).

Codensation of **J** with methylamine gave **K**, $C_{13}H_{17}NO_2$, which isomerised to an enamine **L**, $C_{13}H_{17}NO_2$, upon short heating to 160 °C in the presence of ammonium chloride. Treatment of **L** with methyl vinyl ketone in ethanolic potassium hydroxide gave the alkaloid **M**, structure shown below.
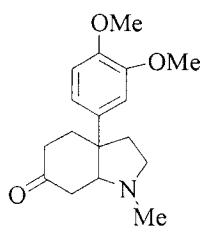
Alkaloid M:

[18]

(b) A herbal traditional medicine for treatment of syphilis is claimed to contain alkaloids.

(i) How would you test for the presence of alkaloids in this medicine?

(ii) Briefly outline a procedure for the isolation of alkaloids.

[12]

4

QUESTION FIVE

(a) On the first experiment, the δ_m and δ_p values for the formyl substituent were estimated to be 0.36 and 0.44 respectively by measurement of the pK$_a$ values of m- and p-formylbenzoic acids. On the second experiment, the δ_m and δ_p values for the same formyl substituent were estimated to be 0.35 and 0.22 respectively by measurement of the rate of alkaline hydrolysis of m- and p-formylethylbenzoates in 56% aqueous acetone. Give an explanation to account for the observed discrepancy in the δ_m and δ_p values. **Note: it may be necessary to show the last reaction-the alkaline hydrolysis.**

[10]

(b) Isotopic labeling experiments have shown that in plants (-)- reticuline, structure shown below, is derived from the aminoacid phenylalanine and it is the key intermediate in the biosynthesis of the alkaloid **N**, structure shown below. On this basis propose a biogenetic pathway for (-)- reticuline and the alkaloid **N**.

(-) - Reticuline   Alkaloid N:
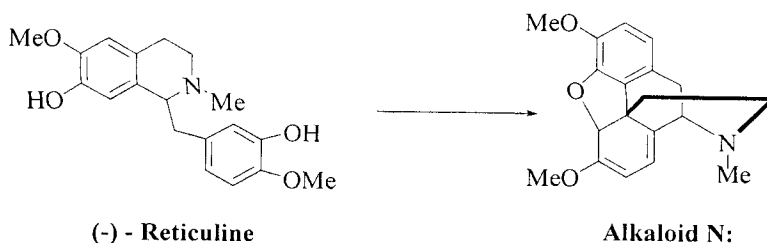
[20]

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
SEMESTER II 2007 SESSIONAL EXAMINATIONS

C492: ORGANIC INDUSTRIAL CHEMISTRY   **19 FEBRUARY 2008**

Time	: 3 hours
Instructions	: Answer all questions

Question 1

(a)   Briefly define explosives? What are the major differences between explosives meant for military purpose and those for civilian use?

(b)   By means of a diagram show the relative positions of the number-average, weight-average and z-average molar masses on a molar mass distribution plot of a polymer.

(c)   Suggest two advantages of the carbonatation process over the phosphatation process.

(d)   By means of a reaction scheme show how an azo dye may be prepared.

(e)   Mixed-acid nitration is a commonly used technique for effecting nitration. Why is the presence of sulfuric acid in quantity important?

Question 2

(a)   Define the following terms as applied to plastics

(i)   Crystallinity   (ii)   Glass transition temperature

(b)   Compare and contrast the two types of polymerization systems: bulk and solution. For each case, clearly indicate major advantages of the techniques.

(c)   The skeletal structure of polymeric materials affects the properties of polymers formed. Use schematic diagrams to illustrate (i) linear (ii) branched and (iii) crosslinked structure in polymers. Explain how these structures affect the physical properties of polymers.

Question 3

(a)   Outline factors attributed to poor affination in sugar refining.

(b)   (i)   Comment briefly on mechanical and chemical methods of clarification in the sugar industry.

(ii)   What are the disadvantages of using the mechanical method of clarification?

(c)   Explain the term *false grain* and indicate factors that can lead to the formation of false grains.

Question 4

(a) Controlled drug release can be effected using a number of techniques. List these techniques with a note to explain how drug release is achieved using polymer based drug release systems.

(b) Draw a fully labeled diagram to illustrate the manufacturing process of three common antibiotics: penicillin, Erythromycin and Streptomycin.

(c) Write brief notes to describe the use and preparation of the drug class known as barbiturates.

Question 5

(a) (i) What is the purpose of tanning in the leather industry?

(ii) Describe in brief steps involved in vegetable tanning and give the key characteristics of leather processed using this method.

(b) Explain what the soaking process following drying in the production of leather achieves.

(c) Outline in a flow diagram the major elements involved in converting raw hides to leather for various applications.

End of Examination
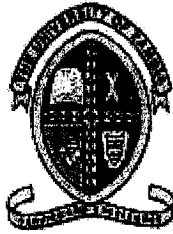
THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

DEPARTMENT OF COMPUTER STUDIES

CST2012 PROGRAMMING II

SEMESTER TWO EXAM 2008/2009

MONDAY, APRIL 27TH, 2009

Instructions:

Answer All Questions in Section A and B.

Answer any two questions in Section C

Duration: 3 hours.

Make sure that you write your name and computer number on all your answer sheets.

- GOOD LUCK -

Section A.

Answer all Questions.

1. Assume that in the current directory test.txt file is already exist. What will happen when you execute the following code?

```
import java.io.*;
class Test
{
        public static void main(String args[])
        {
                try
                {
                        File file = new File("test.txt");
                        file.createNewFile();
                }
                catch (IOException ex)
                {
                        ex.printStackTrace();
                }
        }
}
```

A. text.txt will be created and overwrite the old file

B. file will not be created

C. exception will be thrown

D. none of the above.

2. The _____ statement identifies a block of statements that potentially may throw an exception.

A. catch

B. throw

C. finally

D. try

3. The input/output package usually used with Java is:

A. java.input

B. java.io

C. java.file

D. java.inout

4. Can data flow through a given stream in both directions?

A. No; data in a stream flows in only one direction.

B. No; streams only work for output.

C. Yes; only one stream is needed to read and write a file

D. Yes; but only one direction at a time.

5. What is the ancestor class of streams that do character-oriented output?

   A. Writer

   B. Reader

   C. OutPutStream

   D. characterStream

6. What does the flush() method of a stream do?

   A. It erases all the data in the file.

   B. It initializes the output methods.

   C. It summons the garbage collector.

   D. It ensures that all pending output operations are completed.

7. What data type does readLine() return?

   A. char

   B. byte[]

   C. String

   D. int

8. In practice, is it always possible to know how to interpret the bytes in a given file?

   A. No---because byte patterns can mean almost anything and often documentation is poor or missing.

   B. No---files from one type of computer can't be read by any other type.

   C. Yes--data and file formats are the same with all programs on all computers.

   D. Yes--all you need to do is try all possible interpretations until you find the one that works.

9. What is the default priority of a newly created Thread?

   A. MIN_PRIORITY (which is defined as 1 in the Thread class.)

   B. NORM_PRIORITY (which is defined as 5 in the Thread class.)

   C. MAX_PRIORITY (which is defined as 10 in the Thread class.)

   D. A Thread inherits the priority of its parent Thread.

10. Will the following code compile correctly?

```
File file = new File("temp.txt");
FileReader in = new FileReader( file );
```

   A. No—the constructor for FileReader is used incorrectly.

   B. No—the constructor for File must have an absolute path name.

   C. Yes—everything is correct.

   D. Yes—But the compiler will check first that "temp.txt" already exists.

11. What should be done to invoke the run() method on a thread for an object derived from the Thread class.

   A. The run() method should be directly invoked on the Object.

   B. The start() method should be directly invoked on the Object.

   C. The init() method should be directly invoked on the Object.

   D. The creation of the object using the new operator would create a new thread and invoke its run() method.

12. What happens in a method if an exception is thrown in a try{} block and there is NO MATCHING catch{} block?

   A. This is not legal, so the program will not compile.

   B. The method throws the exception to its caller, exactly if there were no try{} block.

   C. The program halts immediately.

   D. The program ignores the exception

13. How many finally{} blocks may there be in a try/catch structure?

   A. There must always be one, following the last catch{} block.

   B. There can be zero or one immediately after each catch{} block.

   C. There can be zero or one, following the last catch{} block.

   D. There can be any number, following the last catch{} block.

14. In what methods do you place the code be executed by a thread or call the code to executed.

   A. init().

   B. start().

C. run().

D. main().

15. Can the source code for your applet be compiled by the usual javac compiler?

   A. No---because applets have no main()

   B. No---the web browser compiles the code.

   C. Yes---an Applet is just another class as far as the compiler is concerned.

   D. Yes---if you are going to run it from the DOS prompt.

SECTION B (30%)

Short answer questions - Answer all questions.

1. Why can you ignore some exceptions, but not others? **[2 Marks]**

2. What makes execution skip over the **catch** block?**[1 Marks]**

3. What does the code block following **finally** do? **[2 Marks]**

   A. If there is an exception.

   B. If there was no exception.

4. (True or False)Applets can run only within a browser or appletviewer. **[1 Mark]**

5. (True or False)An applet uses the println() method to display text. **1 Mark]**

6. What dangers, if any, are involved when using a code segment such as new FileWriter("autoexec.bat"). **[2 Marks]**

7. What is the difference between character-level and byte-level data files? **[2 Marks]**

8. If 8 bits are used to represent one character, how many different characters can be represented at most? **[2 Marks]**

9. If you create a program that needs to read data from a file, would you use an input stream or an output stream? **[2 Marks]**

10. What is the basic difference between the 2 approaches to exception handling.

    1> try-catch block and

    2> specifying the candidate exceptions in the throws clause? **[2 Mark]**

11. What class and interface does Java provide to support Multithreading? **[2 Marks]**

12. Why is a buffered reader or writer recommended over non-buffered i/o stream? **[2 Marks]**

13. What do you use the **start()** method for in an Applet? **[1 Mark]**

14. Which methods would you use in a multithreading programming to achieve synchronised communication amongst threads (At least 2)? **[2 Marks]**

15. Why is it not recommended to use **suspend ( ), resume ( )**, and **stop ( )** for new programs? **[2 Marks]**

16. Explain clearly what the role of the **repaint()** method is in Applets. **[2 Marks]**

17. Java has two types of streams: character streams and byte streams. Why? What is the difference between the two types of streams? **[2 Marks]**

SECTION C (40%)

Answer any two Questions.

1. **Question 1**

   1.1. Write a program that illustrates re-throwing of an exception. Define methods **someMethod()** and **someMethod2()**. Method someMethod2 should initially throw an exception. Method someMethod should call method someMethod2, catch the exception and re-throw it. Call someMethod from the main method, and catch the re-thrown exception. **[15 Marks]**

   1.2. Given that the following java statement is correct. Why would one want to use 2 streams i.e. BufferedReader and InputStreamReader instead of just using InputStreamReader. **[2 Marks]**
   - `BufferedReader inFromUser = new BufferedReader(new InputStreamReader(System.in));`

   1.3. Can an Applet Make a network connection to the server from which it came and can send to and receive arbitrary data from that server - explain. **[2 Marks]**

   1.4. Can an Applet Write data on any of the host's disks - explain. **[1 Mark]**

2. **Question 2**

2.1. Write a complete Java program that will create a file named "squares.dat" containing the sentence "*Using FileWriter to write text to a file*". You will need to use the *FileWriter plus any other classes you feel are needed.* Don't forget that the creation of a *FileWriter* can produce an *IOException,* so you will need to use appropriate exception recovery statements when creating and writing to the file. **[14 Marks]**

2.2. What is the Requirement for a class to be treated as a user defined Exception class? **[2 Marks]**

2.3. Which keyword indicates that only one thread at a time should execute an object? **[2 Marks]**

2.4. Can an Applet Receive input from the user through the keyboard or the mouse. **[2 Marks]**

3. Question 3

3.1. Write a complete program that will display the first ten lines from a text file. The lines should be written to standard output, System.out. The file name is given as the command-line argument args[0]. You can assume that the file contains at least ten lines. Don't bother to make the program robust. **[15 Marks]**

3.2. In multithreading Not all threads are created equal. Sometimes you want to give one thread more time than another. What would you do to achieve this? **[3 Marks]**

3.3. What would you do to pause a thread that is running for 2 minutes. **[2 Marks]**

4. Question 4

4.1. Write an HTML file that you would use to run an Applet named "MyApplet" whose length should be 300 and height 300. Pass a parameter to this applet whose value is "Example Applet". **[5 Marks]**

4.2. In the life cycle of a thread what are the states in which a thread can be and what state transition would a thread have to make from any of the states before it can be executed. **[5 Marks]**

4.3. Explain, in your own words, the following terms: **[10 Marks]**

    4.3.1. BufferedInputStream

    4.3.2. FileInputStream

    4.3.3. try-catch block.

    4.3.4. ASCII code

    4.3.5. Applet tag in an HTML document.

5. Question 5

5.1. Create your own exception class that simply tells a user that *"The second number is less than the first please enter the numbers again"* on calling the **message()** method. **[10 Marks]**

5.2. Write up with a program that prompts a user for two integers and prints all the integers between the two numbers including the two integers. For example If the you supply 1 and 5, it should print 1, 2, 3, 4, 5. **[5 Marks]**

5.3. Provide a check in the program in 5.2 and throw an exception if the second value is less than the first. The exception used should the user defined exception you defined in 5.1. **[5 Marks]**

- GOOD LUCK -

The University of Zambia
School of Natural Science
Department of Computer Studies

FINAL EXAM SEMESTER II – February 2008

FUNDAMENTALS OF COMPUTER ARCHITECTURE (CST2032)

Instructions

1. There are **two sections** and a total of six questions in this question paper.

2. Each question carries **20 marks** only

3. You are required to **answer** a total of **five** questions only

4. **Section A** has **two** questions while **Section B** has **four** questions

5. **Answer** all questions in section A and any three questions in section B

Date: Tuesday, 26th February 2008

Time: 09:00hrs – 12:00hrs

Venue: Upper Dinning Hall

NOTE: Do not open this paper until you are told to do so

SECTION A – Answer all the questions in this section

1) Question One

a) Define the following   [4]
   i) Computer Architecture
   ii) Computer organisation
   iii) Computer structure
   iv) Computer function

b) Using the letter A, give the general formula for each of the following   [6]
   i) Unsigned Integer
   ii) Signed Magnitude Representation
   iii) Twos Complements Representation

c) Perform the following arithmetic conversion from   [10]
   i) Base ten to base two
      (1) 25
      (2) 491
   ii) Base sixteen to base two
      (1) ABC5
      (2) ACD
   iii) Decimal digits to the IEEE – 32 bit floating point representation
      (1) 4525.313
      (2) 0.037241

----

2) Question Two

a) Perform the following calculations using 8 bits only and twos complements representation where possible. Comment on your answer. If there is an overflow expand the number of bits to 16 bits and give the collect answer.   [10]

   i) $117 - 124 = $ ☐   iii) $-87 \div 4 = $ ☐

   ii) $21 \times (-15) = $ ☐   iv) $91 + 37 = $ ☐

b) Perform the following addition in floating point notation using IEEE 32 – bit representation. Leave your answer in normalised form as an IEEE 32 – bit representation.   [10]

   i) $137.1423 + 14.2471 = $ ☐

Section B – Answer any three questions in this section

3) Question Three [4]

a) Define the following
   i) Core
   ii) SRAM
   iii) DRAM
   iv) EEPROM

b) **List the four** basic functions of a computer, then **draw** a well labelled diagram [4] showing a functional view of the computer

c) **Draw** a well labelled diagram showing the **Top – Level Structure** of the [2] computer

d) Give two reasons why it is important to study Computer Architecture [4]

e) Draw a well labelled diagram showing the structure of the IAS Computer proposed by John Von Neumann. Give the function of each component [6]

----

4) Question Four

a) The basic function performed by a computer is execution of a program, which consists of a set of instructions stored in memory. The processor fetches the instructions from memory one at a time and executes each instruction. *Sketch* a well labelled diagram showing the **Basic Instruction Cycle**. [2]

b) Virtually all computers provide a mechanism by which other modules (I/0 memory) may interrupt the normal processing of the processor. List four common classes of interrupts and give a brief description of each. [8]

c) Although a variety of different bus implementation exists, there are a few basic parameters or design elements that serve to classify and differentiate buses. List the five elements of the Bus Design and discuss each one of them. [10]

----

5) Question Five

a) *With* the *aid* of a well labelled diagram, **describe** how the Cache Memory works. [2]

b) **Using** a well labelled diagram describe how the Cache Read Operation works [5]

c) List the eight key characteristics of computer memory system. Where possible give two examples for each characteristic. [7]

d) Although there is a large number cache implementation, there are a few basic design elements that serve to classify and differentiate cache architectures. **List the six elements** of **Cache Design** and where possible **give two examples** of each. [6]

----

6) Question Six

a) A disk is circular platter constructed of nonmagnetic material called substrate, coated with a magnetic material. Traditionally the substrate has been aluminium or aluminium alloys but recently glass substrates have been introduced. Give the five benefits of using the glass substrate. [5]

b) Peripheral devices can not and are not connected directly to the system bus (Figure 1). Give four reasons why this is so. [4]

c) The diagram below (Figure 1) shows the generic I/O module. List any four major categories of the functions of the I/O module [2]
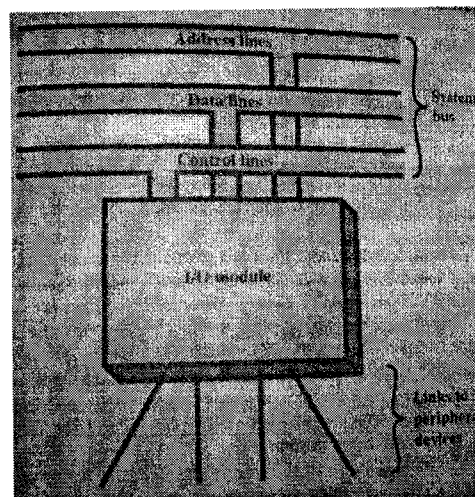
Figure 1: I/O Module and the System Bus

d) One of the key components of multiprogramming is scheduling. Briefly discuss the four types of scheduling [4]

e) Draw a well labelled diagram for Booth's Algorithm for twos complement multiplication [3]

f) The diagram below in Figure 2 shows the layers and views of the computer system in relation to the operating system. In relation to the diagram below give two objectives of an operating system [2]
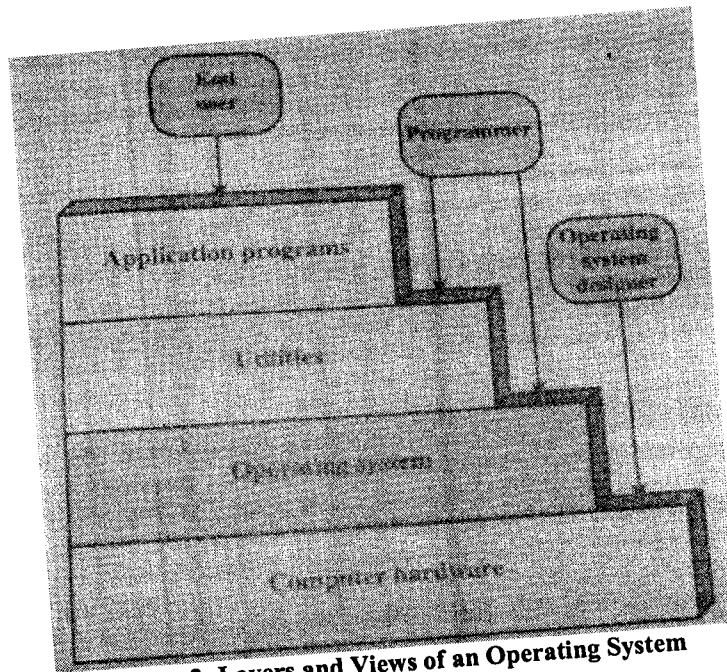
Figure 2: Layers and Views of an Operating System

ALL THE BEST

The University of Zambia
School of Natural Science
Department of Computer Studies

Instructions

1. There are **two sections**, A and B and a total of **six questions** in this question paper.

2. **Section A has two** questions while **section B has four questions**

3. You are required to **answer a total of five questions only**

4. Each question carries **20 marks**

5. **Answer all** questions in **section A** and any **three** questions in **section B**

6. Usage of **Calculators** is _**not allowed**_ in this Examination

Date: **Thursday 30ᵗʰ April 2009**

Time: **09:00hrs – 12:00hrs**

Venue: **Upper Dining Hall**

NOTE: Do not open this paper until you are told to do so

SECTION A – Answer all the questions in this section

1) QUESTION ONE

a) Define the following terms [2 Marks]
   i)   Computer Architecture
   ii) Truth Table

a) Give two reasons why it is important to study Computer Architecture. [2 Marks]

b) **List** the **four** basic functions of a computer, then **draw** a well labelled diagram showing a functional view of the computer. [3 Marks]

c) Sketch a diagram showing *Booth's Algorithm for Two's Complement Division*. Using Booth's Algorithm, perform the following calculations using 8 bits only and Twos Complements representation. Comment on your answer. If there is an overflow expand the number of bits to 16 bits and give the collect answer. [8Marks]

   i) -17 x 24 =   ☐   **ii) -87 ÷ 4 =** ☐

d) Draw the diagram that represents the expression below. Find the value of F if A=0, B=1, C=0, D=1 and E=1 [5 Marks]

   i) $F = \overline{C(B + \overline{\overline{A}})D} + \overline{E}$

   ii) $F = D\overline{(A + B)}C$

2) <u>QUESTION TWO</u>

   a) Define the following terms [2 Marks]
       i) Nibble
       ii) Word

   b) **Draw** the diagrams for the following [2 Marks]
       i) OR Gate
       ii) NOT Gate
       iii) AND Gate
       iv) NAND Gate

   e) Give the general formula for the [4]
       i) Twos Complements Representation
       ii) Signed Magnitude Representation

   c) **Draw** a well labelled diagram showing the **Top – Level Structure** of the computer [2 Marks]

   d) Perform the following arithmetic using IEEE 32-bit floating point format. [10 Marks]

       i) 112.234 – 23.971 = ☐

       ii) 57.78 x 18.021 = ☐

Section B – Answer any three questions in this section

3) QUESTION THREE

a) **Sketch** a **diagram** of the *Static RAM (SRAM) Cell*. [3 Marks]

b) Perform the following arithmetic conversion from [8 Marks]
   i) Base ten to base two
      (1) 25
      (2) 491
   ii) Base sixteen to base two
      (1) ABC5
      (2) ACD
   iii) Decimal digits to the IEEE – 32 bit floating point representation
      (1) -25.31
      (2) 9.241

c) **Simplify** the following Logic Circuits completely. Then **find** the value of Z if
   A=1, B=1, C=0, D=1 and E =1 [9 Marks]

   i) $Z = \overline{AB} + \overline{C(B + \overline{A})D} + E$

   ii) $Z = \overline{C(B + \overline{\overline{A}})D} + E + \overline{BC}$

   iii) $Z = \overline{(B + \overline{D} + \overline{C} + \overline{\overline{A}})}$

----

4) QUESTION FOUR

a) **Express** the following numbers in IEEE 32-bit floating point format [6 Marks]
   i) +23.32
   ii) 171.765

b) **Represent** the number *-179ₜₑₙ* using either eight or sixteen bits into [3 Marks]
   i) Ones complement
   ii) Twos complement
   iii) Signed magnitude

c) Although a variety of different bus implementation exists, there are a few basic parameters or design elements that serve to classify and differentiate buses. **List** the five elements of the Bus Design and **discuss** each one of them. [5 Marks]

d) The diagrams show the Boolean logics. **Come up** with the *Boolean expression* for the diagram below. **What** will be the value of Z if A=0, B=1 and C=1 D=1, E= 0 [6 Marks]

----
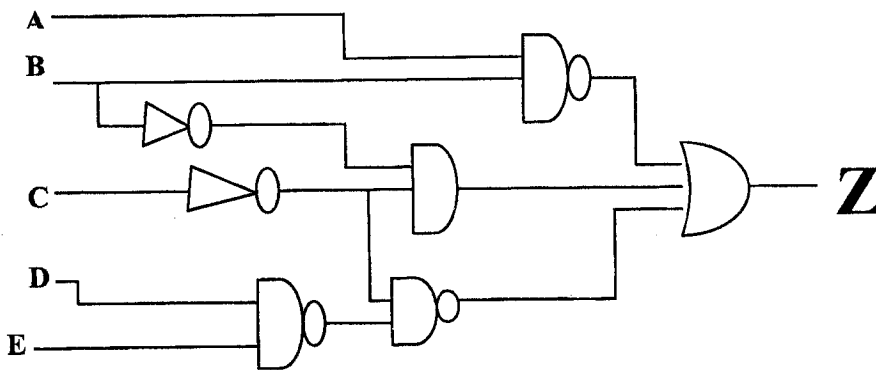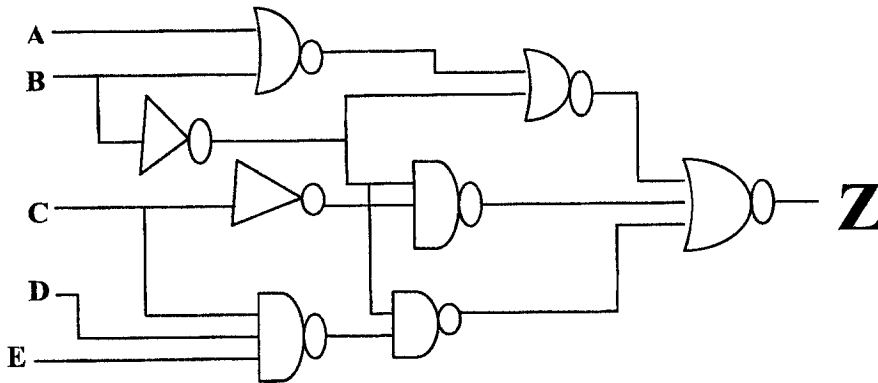
5) QUESTION FIVE

a) Although there is a large number cache implementation, there are a few basic design elements that serve to classify and differentiate cache architectures. **List** the **six elements** of **Cache Design** and where possible **give two examples** of each. [6 Marks]

b) **List** the **eight** key characteristics of computer memory system. Give an example for each characteristic. [4 Marks]

c) The basic function performed by a computer is execution of a program, which consists of a set of instructions stored in memory. The processor fetches the instructions from memory one at a time and executes each instruction. *Sketch* a well labelled diagram showing the **Basic Instruction Cycle**. [2 Marks]

d) **Draw** a well **labelled diagram** showing the structure of the IAS Computer proposed by John Von Neumann. Give the function of each component. [6 Marks]

e) **Give** *two* *reasons* why a DVD stores more information than a CD [2 Marks]

----

6) QUESTION SIX

a) **Give** *two* *advantages* and *two* *disadvantages* of using Assembly language as compared to; [8 Marks]

   i) High level languages such as Java and C++

   ii) Machine language

b) The Computer System's I/O architecture is its interface to the outside world. This architecture provides a systematic means of controlling interaction with the outside world and provides the operating system with the information it needs to manage I/O activity effectively. [6 Marks]

   i) **Draw** and **label** a **diagram** showing the *Generic Model of an I/O Module*.

   ii) **List** the **five** major functions or requirements of the I/O module.

c) **Give** the basic structure and how data is stored on the following external Memory [6 Marks]

   i) Magnetic Disk (HDD)

   ii) Magnetic Tape

   iii) CD and DVD

END OF EXAMINATION PAPER
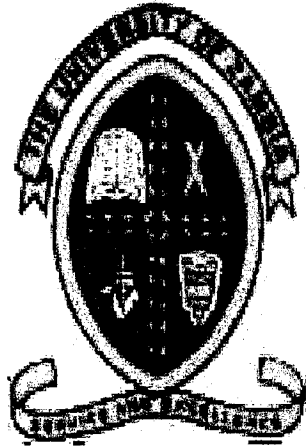
University of Zambia

School of Natural Sciences

Department of Computer Studies

CST2042 Final Exam

Introduction to Databases and File Systems

Time 3 Hours

This exam has three sections. Section A and B each have compulsory questions and each section carries 20 points. Section C has five questions and you are expected to answer any three of the five. Each question in Section C carries 20 points.

Section A (20 points)

Answer all questions in this section. Each question carries 1 point.

Elaborate the following concepts of the database environment:

1. Data Administrator
2. Database Administrator
3. Logical Database Designer
4. Physical Database Designer
5. Application Developer
6. End-Users
7. Data Storage, Retrieval and Update
8. Authorization Services
9. A User-Accessible Catalog
20. Query By Example

10. Support for Data Communication
11. Transaction Support
12. Integrity Services
13. Concurrency Control Services
14. Services to Promote Data Independence
15. Recovery Services
16. Utility Services
17. Data Definition Language
18. Data Manipulation Language
19. Structural Query Language

Section B (20 points)

Answer all questions in this section. Each question carries 2 points.

1. Compare and contrast the three levels of the ANSI-SPARC architecture.
2. Compare and contrast the three phases of database design.
3. What is a data model? State the main types of data models.
4. Discuss what a user view represents in the context of a database application.
5. Identify the stage(s) in database system implementation where it is appropriate to select a DBMS and describe an approach to selecting the 'best' DBMS.
6. Outline the various testing strategies available for testing that a database application appears to be working.

   For each of the following queries state whether the query is valid. For the invalid ones explain why the query is invalid. For the valid ones show how each of the queries would be mapped onto a query on the underlying base table given the view below which is derived from the database's schema.

```
CREATE VIEW HotelBookingCount (hotelNo, bookingCount)

AS      SELECT h.hotelNo, COUNT(*)

        FROM Hotel h, Room r, Booking b

        WHERE h.hotelNo = r.hotelNo AND r.roomNo = b.roomNo

        GROUP BY h.hotelNo;
```

7.   SELECT hotelNo
        FROM HotelBookingCount
        WHERE hotelNo = 'H001';

8.   SELECT MIN(bookingCount)
        FROM HotelBookingCount;

9.   SELECT hotelNo
        FROM HotelBookingCount
        WHERE bookingCount > 1000;

10.   SELECT hotelNo
        FROM HotelBookingCount
        ORDER BY bookingCount;

Section C [60 points]

There are five questions in this section. Answer any three questions. Each question carries a total of 20 points.

1.

   a) Describe the types of facility you would expect to be provided in a multi-user DBMS. Which ones do you think would not be needed in a standalone PC DBMS? Justify your answer. **[5 points]**

   b) Discuss the function and importance of the system catalog. **[2 points]**

   c) Describe the main components in a DBMS and suggest which components are responsible for each facility identified in Question 1 (a) above. **[5 points]**

d) What is meant by the term 'client–server architecture' and what are the advantages of this approach? Compare the client–server architecture with two other architectures. **[8 points]**

2.

a) Define a Transaction Processing Monitor? **[5 points]**

b) The objective of the three-level ANSI-SPARC architecture is to separate each user's view of the database from the way the database is physically represented. Outline five reasons why this separation is desirable? **[5 points]**

c) Describe the approach taken to the handling of data in the early file-based systems. Discuss disadvantages of this approach. **[5 points]**

d) Discuss the advantages and disadvantages of DBMSs. **[5 points]**

3.

a) Describe the main advantages of using the prototyping approach when building a database application. **[5 points]**

b) Describe the process of evaluating and selecting a DBMS **[5 points]**

c) What are the main purposes of data modeling and identify the criteria for an optimal data model. **[5 points]**

d) Discuss the main approaches for managing the design of a database application that has multiple user views. **[5 points]**

4.

a) Given the following table Part(partNo, contract, partCost). Write SQL for creating a view called ExpensiveParts which contains distinct part numbers for parts that cost more than K1,000,000. **[5 points]**

b) What is view materialization? **[5 points]**

c) Discuss how you would maintain the view in Question 4(a) above as a materialized view and in what circumstances would you be able to maintain the view without having to make changes to the base table "Part". **[5points]**

d) Given database users George and Linda, write SQL to give SELECT access to both users on a view called ZadeDBs. Assuming they violate their rights, write SQL to deny them the SELECT access to the database view. **[5 points]**

5. For the following relations (keys are shown with _s over the field name):

```
Student                        Class_Grade        Class

sname   sid   age   gpa        sid  cid  grade    cid  cdept  cnum
------------------------       -------------      --------------
Ann     1     21    3.5        1    1    A-       1    CS     1621
Bob     2     19    3.4        1    2    A        2    BIOL   1011
Cal     3     20    2.6        2    1    B        3    ECE    1315
Dee     4     22    4.0        2    3    C
                               3    1    A
                               3    2    C
                               3    3    F
                               4    2    A
```

a) How would you design the following queries in Relational Algebra: **[10 points]**
   i. The id#s of students who are 19 or 20.
   ii. The student names (sname) of those students who have taken CS 1621.
   iii. Students (names) who have taken a biology course or ECE course.
   iv. Students (names) who have taken every course in Class.
   v. Students (names) who have received an A.

b) Repeat question 2 with relational tuple calculus **[10 points]**

The University of Zambia
School of Natural Science
Department of Computer Studies

FINAL EXAM SEMESTER II – February 2008

Introduction to Database and File Systems (CS2042)

Instructions

1. There are **two sections** and a total of **six questions** in this question paper.
2. Each question carries **20 marks** only
3. You are required to **answer** a **total of five questions**
4. **Section A** has **two** questions while **section B** has **four questions**
5. **Answer all** questions in section A and any **three** questions in **section B**

Date: **Friday, 22nd February 2008**

Time: **14:00hrs – 17:00hrs**

Venue: **ROOM 2A ED**

NOTE: Do not open this paper until you are told to do so

SECTION A – Answer all the questions in this section

1) QUESTION ONE

   a) What do the following stand for?   **[4 Marks]**
      i) SQL
      ii) DDL
      iii) DML
      iv) RDMS

   b) In practice, the **DDL** statements are used to create the database structure and the access mechanisms, and then the **DML** statements are used to populate and query the tables. List the four **SQL DML** Statements and what each is used for.[4 Marks]

   c) The **SELECT** statement is the most frequently used **SQL** command. One of the statements used in the **SELECT** statement is the **FROM** statement which specifies the table or tables to be used. Name the other five statements used in the **SELECT** statements and their sequence of processing. Remember to state the function of each of the stated statements   **[5 Marks]**.

   d) The **ISO** standard defines five aggregate functions. The first one is **COUNT** which returns the number of values in a specified column. **Name** the other **four** and what they return.   **[4 Marks]**

   e) The user interacts with Microsoft Access and develops a database application using a number of objects. **List** any **6** Microsoft Objects.   **[3 Marks]**

----

2) QUESTION TWO

   a) Using the **two tables** below, **Give** the results of the following queries below. **[8 Marks]**

Branch

branchNo	street	city	postCode
B005	22 Deer Rd	London	SW1 4EH
B007	16 Argyll St	Aberdeen	AB2 3SU
B003	163 Main St	Glasgow	G11 9QX
B004	32 Manse Rd	Bristol	BS99 1NZ
B002	56 Clover Dr	London	NW10 6EU

Staff

staffNo	fName	lName	position	sex	DOB	salary	branchNo
SL21	John	White	Manager	M	1-Oct-45	30000	B005
SG37	Ann	Beech	Assistant	F	10-Nov-60	12000	B003
SG14	David	Ford	Supervisor	M	24-Mar-58	18000	B003
SA9	Mary	Howe	Assistant	F	19-Feb-70	9000	B007
SG5	Susan	Brand	Manager	F	3-Jun-40	24000	B003
SL41	Julie	Lee	Assistant	F	13-Jun-65	9000	B005

i) **SELECT** branchNO, **COUNT** (staffNO) **AS** mycount, **SUM**(salary) **AS** mysum
FROM staff
GROUP BY branchNO
HAVING COUNT (StaffNO) > 1
ORDER BY branchNO

ii) **SELECT** staffNO, fName, lName, salary
FROM staff
ORDER BY Salary **DESC**

b) Using the **two tables** above write the queries for the following;   [12 Marks]

i) Produce a list of monthly salaries for all staff showing the staff number, the first and last names, and the salary details.

ii) Find the total number of managers and their total sum.

iii) Find all staff who works in a London Branch office

3) QUESTION THREE

a) MS Access provides 5 ways to create a blank table. Name and Give a brief description for each of the five ways. [5 Marks]

b) List the ten data types used by Microsoft Access Database System [5 Marks]

c) Give a brief description of each of the following. [4 Marks]
   i) MS FORMS
   ii) MS REPORT

d) Give a brief description of the following in relation to Microsoft Access table design view [6 Marks]
   i) Field size property
   ii) Caption
   iii) Validation rule/validation Text Property

----

4) QUESTION FOUR

Represent each of the following requirements with an ER diagram:

(a) 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). Each clinic has a unique clinic number (**clinicNo**) and each member of staff has a unique staff number (**staffNo**). [4 Marks]

(b) 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. Each owner has a unique owner number (**ownerNo**) and each pet has a unique pet number (**petNo**). [5 Marks]

(c) 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. Each examination has a unique examination number (**examNo**) and each type of treatment has a unique treatment number (**treatNo**). [6 Marks]

(d) Represent the complete set of requirements in one ER diagram. [**5 Marks**]

---
5) QUESTION FIVE

(a) Two functions of a DBMS are *Transaction support* and *Concurrency control services.*

      i.   What is a transaction? Hence define *Transaction support.*   [4 marks]

      ii.   Why is *Transaction support* important?   [2 mark]

      iii.   Define *Concurrency control.*   [2 marks]

(b) Use the lost update problem to illustrate the importance of *Concurrency control.*

                                                                          [6 marks]

(c) What is a System catalogue? State four items that it stores   [6 marks]

---

6) QUESTION SIX

(a) A relational database represents a logical model in the form of a set of tables. Define the following terms associated with a relational database.

      i.   A candidate key   [3 marks

      ii.   The super key   [2 marks]

      iii.   Cardinality   [1 mark]

      iv.   The domain of an attribute   [2 marks]

      v.   Null   [2 marks]

(b) Integrity rules ensure that data is accurate. Explain the issues of Entity and Referential integrity.   [5 marks]

(c) There are restrictions on types of modifications that can be made through views. Explain the two restrictions.   [5 marks]

End of Exam

All the Best

THE UNIVERSITY OF ZAMBIA
DEPARTMENT OF COMPUTER STUDIES
CST3032 – ARTIFICIAL INTELLIGENCE FUNDAMENTALS

UNIVERSITY EXAMINATION

Thursday, 23rd April 2009

INSTRUCTIONS: There are **SIX (6)** questions in this examination and you are required to answer **ONLY FIVE (5)** of them in any order. All questions have the same weight. Question ONE (1) is **COMPULSORY. PLEASE KEEP YOUR ANSWERS AS PRECISE AND CONCISE AS POSSIBLE. GOOD LUCK!**

DURATION: 3 Hours

1.

   a. Define the following terms
      i. Agent
      ii. Rational agent
      iii. Agent function
      iv. Agent program

   b. List the four basic kinds of agent programs that embody the principles underlying almost all intelligent systems

   c. Given the following well-formed formulas, formally show that $S \lor R$ follows. Do not generate more than 10 more formulas before concluding.
      i. $\neg(\neg Q) \land Z$
      ii. $\neg W$
      iii. $(\neg W \land Q) \Rightarrow \neg P$
      iv. $Q \Rightarrow (S \lor P)$
      v. $(P \land Q) \Rightarrow R$

d. For each of the following develop
- A PEAS description and
- Properties (Fully observable, Deterministic, Static, Discrete) Of the task environment

    i. Automated cab driver
    ii. Intelligent medical diagnosis machine

2.

a. What are the four components used for formulating a problem as search
b. What are the four components that are usually employed in measuring the performance of a search algorithm?
c. Consider the following scenario:

Three missionaries and three cannibals are on one side of a river, along with a boat that can hold up to a maximum of two people. These people have to cross to the other side of the river in such a way that at no time should the cannibals outnumber the missionaries in one place because the cannibals might eat the missionaries.

    i. Formulate this as a search problem
    ii. Come up with a heuristic function h(n) that can be used in guiding the search for this problem?[hint: think of the number of people to be on the other side of the river]
    iii. What is h(start-state) where start-state is defined in your formulation above.
    iv. Show that your heuristic is 0 for the goal state.
    v. Draw the search tree returned by greedy best-first search and show the order in which these people cross the river. Do not return to parent node.

3.

a. Define the following terms
    i. Admissible heuristic
    ii. Consistent heuristic
    iii. Best-first search
    iv. Local search

b. Consider the following map (not drawn to scale).
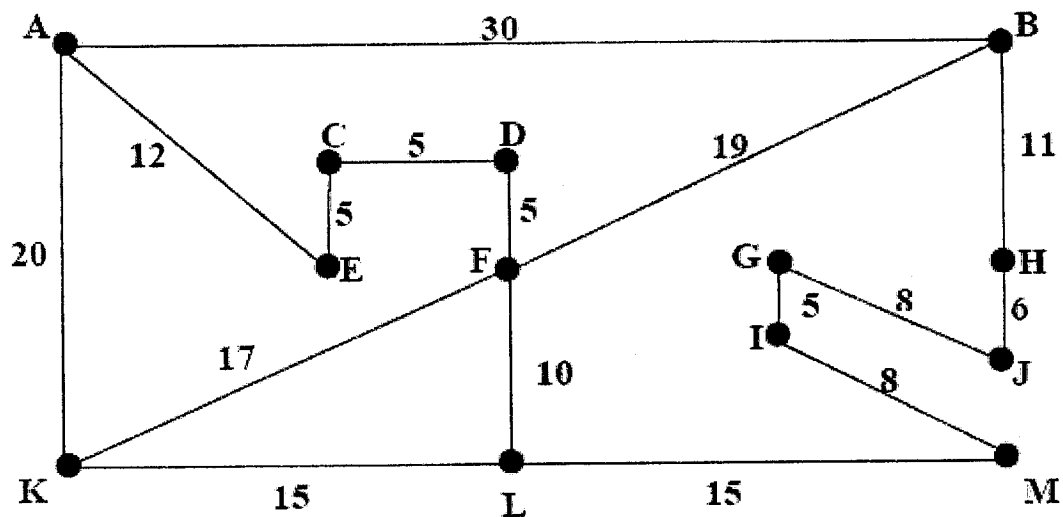
You are to work out a route from town A to town M. You should not re-visit a town that you have already passed through.

- G(n) = The cost of each move as the distance between each town (shown on map).
- H(n) = The heuristic for each town. These distances are given in the table below

A	56	E	29	I	8		
B	22	F	30	J	5		
C	30	G	14	K	30		
D	29	H	10	L	15	M	0.00

i. Is the heuristic admissible?

ii. Use the A* algorithm to work out a route from town A to town M. Provide the search tree for your solution, showing the
   1. order in which the nodes were expanded and the
   2. cost at each node.

iii. State the route you would take and the cost of that route.

iv. What is the cost of that route?

4.

a. Define the following as applied to propositional logic agents,
   i. Entailment
   ii. Model of a sentence
   iii. Sound inference rule.
   iv. Unsatisfiable sentence

b. How is entailment related to model of a sentence
c. How is unsatisfiability relate to inference rules
d. Hence show that the Modus Ponens inference rule is sound
e. Consider the following:

> If it is raining then it is hot and humid. If it is not raining or just hot, then it is not wet. It is wet if it is dumpy.

   i. Describe a set of propositional letters which can be used to represent the knowledge base.
   ii. Translate the KB into propositional logic using your propositional letters from part a.
   iii. Is it Dumpy? Answer this question by using logical inference rules with the KB

5.

a. Consider the search space below, where *S* is the start node and *G1* and *G2* satisfy the goal test. Arcs are labeled with the cost of traversing them and the estimated cost to a goal is reported inside nodes. Arrows indicate unidirectional navigation For each of the following search strategies, indicate which goal state is reached (if any) and list, *in order*,

   - all the states *popped off of the FRINGE list*. When all else is equal, nodes should be removed from OPEN in alphabetical order.
   - The path returned
   - The cost of the path returned

   i. Uniform Cost
   ii. Beam (with beam width = 2 and using)
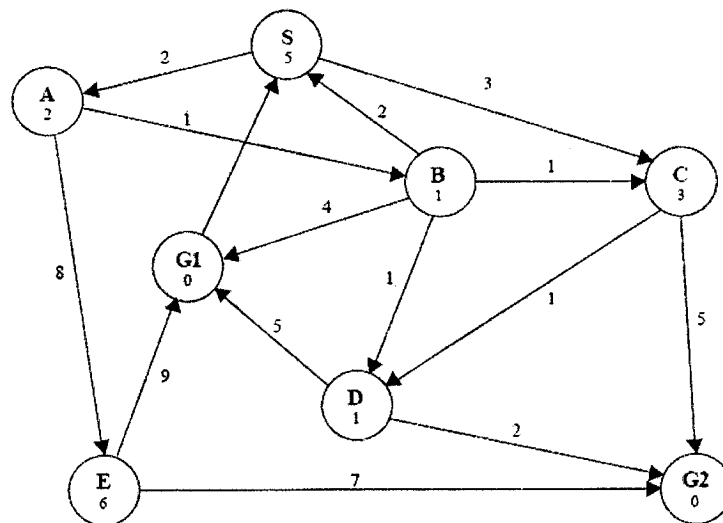
b. Shown below is the game tree where the root node is the MAX node
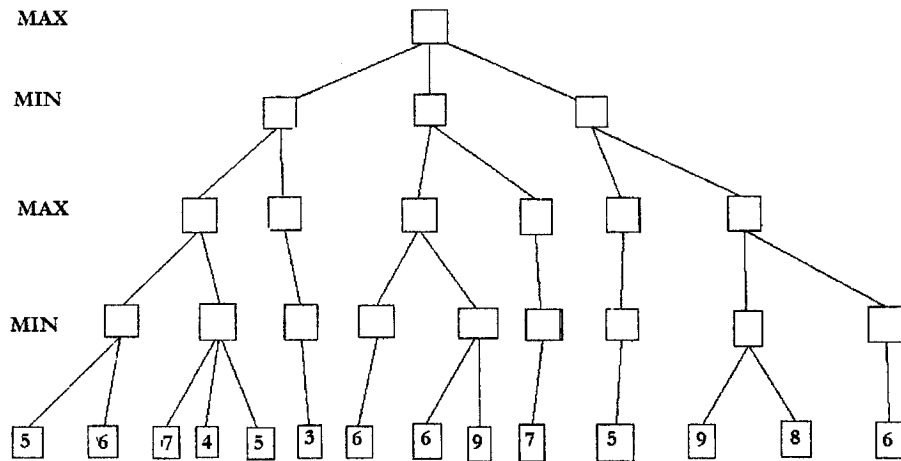
Assume that:
- the tree is explored by minimax (and alpha-beta prunning) in a left to right manner
- the numbers beneath the leaves of the tree are the evaluation function values for the corresponding states
  i. Write in the boxes the minimax values for each state. Indicate the move chosen by MAX(the computer) as its first move and the branches that are pruned.

6.

a. Explain the following terms as applied to constraint satisfaction problems
   i. Forward checking
   ii. Constraint propagation
   iii. Complex constraint
   iv. Constraint graph

b. Briefly describe the three heuristics that are used in the variable and value assignment order used in CSPs. For each heuristic, state the purpose and how variables or values are identified in the process of assignment.

c. Mrs. Green has just finished partitioning her flower garden into sections A to E according to the diagram below. She intends to plant her flowers. Currently she has seeds for the red flowers, blue flowers, and purple flowers. She wants each partition to have distinct coloured flowers from those in the adjacent sections. She has plenty seeds of red flowers and very limited quantities of purple flowers. Naturally she wants to use as much of the seeds of red flowers as possible, followed by the blue ones. The largest portion E cannot be assigned the purple flowers for fear that it might be too big for the available seeds of the purple flowers. You have been hired help Mrs. Green to come up with colouring scheme for her garden.

i. Formulate this as a Constraint Satisfaction Problem.
ii. Draw a constraint graph.
iii. Show the order in which the partitions are assigned colours following the three heuristics outlined above. State assumptions you have taken in resolving ties not solved by the heuristics.
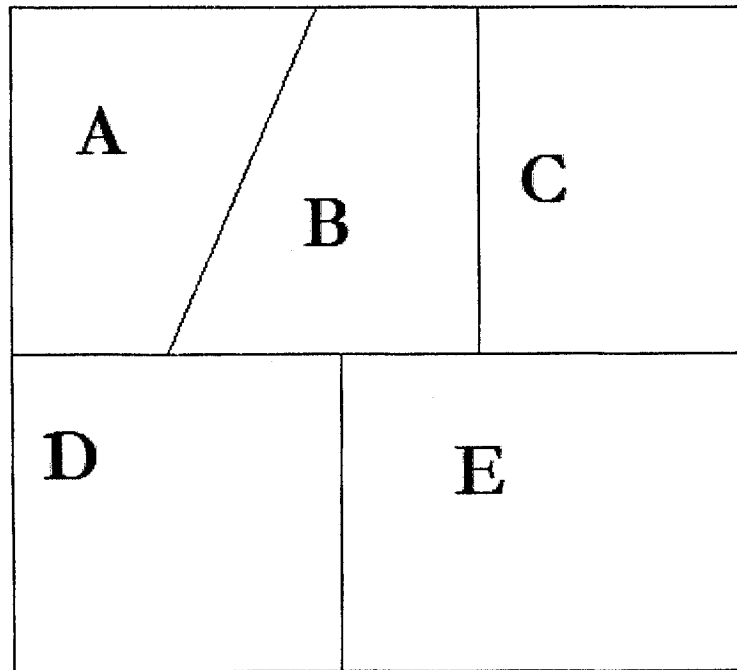
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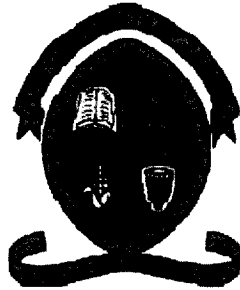
THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

DEPARTMENT OF COMPUTER STUDIES

CST3141 Object Oriented Analysis and Design

Semester One Exam 2008/2009

Tuesday, November 25th, 2008

Instructions:

Answer All Questions in Section A and B.

Answer any Two Question in Section C

Duration: 3hrs

Make sure that you type your Name and the Computer Number on your answer sheet.

Section A.

Answer all Questions.

1. Which of the following best describes composition?
   A) A package of model elements.
   B) A set of realizations for a single use case.
   X) A relationship between a whole and its parts.
2. Which of the following best describes how composition differs from aggregation?
   A) A part cannot be removed from a composition, whereas a part can be removed from an aggregation.
   B) A part can belong to only one composition, whereas a part can belong to more than one aggregation.
   C) A part that belongs to a composition cannot have associations with any other classes, whereas a part that belongs to an aggregation can have associations with other classes.
3. How does generalization increase the opportunities for software reuse?
   A) A generalization hierarchy can be extended to include new subclasses with minimal effort.
   B) Generalization aids the encapsulation of software components.
   X) Generalization allows a group of software components to be treated as a single whole.
4. Information used to develop use case diagrams comes from:
   A) Class Diagrams
   B) Sequence Diagrams
   C) Customer Requirements
   D) Designers best guess
5. Which statement best describes actors in a use case diagram:
   A) Actors are limited to humans that interact with the system being designed.
   B) Actors are limited to systems that interact with the system being designed.
   C) Actors are any entity outside the system being designed that interact with it.

6. If you want to plan project activities such as developing new functionalities or test cases, which of the following OOAD artifacts is the most useful?
   A) Sequence diagrams
   B) Use cases
   C) Domain model
   D) Package diagrams

7. If you need to show the physical relationship between software components and the hardware in the delivered system, which diagram can you use?
   A) Component diagram
   B) Deployment diagram
   C) Class diagram
   D) Network diagram

8. Which technique do most Object Oriented methods propose to describe the **functionality and scope** of a system?
   A) Use cases
   B) a statechart diagram
   C) flow charts
   D) Entity Relationship Diagrams

9. Which list of characteristics describes best an **Object Oriented** system?
   A) Layered architecture, modularity, reusability
   B) Encapsulation, abstraction, inheritance, polymorphism
   C) Data modelling, modularity and subtypes
   D) Inheritance, classes, concurrency, reusability

10. What is true about **UML**?
    A) UML is a standardised approach for use case modelling.
    B) UML supplies a set of notations used in the design of applications.
    C) UML is a methodology for designing and maintaining computer systems.
    D) UML stands for Unified Method Language.

11. What does **High Cohesion** mean?
    A) It means that all the classes work very closely together, which is a good principle.
    B) It means that all the classes work very closely together, which should be avoided.
    C) It means that each class does one thing well, which is a good principle.
    D) It means that each class does one thing well, which should be avoided.

12. The scenario portion of a use case description lists:
    A) All steps for every possible thing that might happen in the use case
    B) The most commonly-occurring steps during the use case (normal or Typical path)
    C) Answer B above plus the main exception path
    D) A discussion of what the developer thinks might happen during the use case

13. (6 Points) Match the appropriate descriptions to the diagram. There may be more than one correct choice that matches.

    _____Use Case Diagram   A. Dynamic View of Design
                                            B. Static View of Design
    _____Class Diagram   C. User View of Design
                                            D. Language of User
    _____Sequence Diagram   E. First Diagram Developed

Section B
Answer all Questions
1. **Question 1**
    1.1. What is an Actor and what is a use-case? Describe, in detail, the importance of Actor and a use-case in use-case based modeling of software systems. [5 marks]

    1.2. Your boss has been reading about UML and calls you into his office. He says, "I see that use cases can be derived from other use cases via inheritance and I understand that from basic OO. What I'm confused about is <<extend>>. Supposedly this handles variation in use cases, but I thought that's what inheritance is for? What's the difference between these two?" i.e. Inheritance and extension. [5 Marks]

    1.3. Mention at least three visual notations (UML Diagrams) that can be used when modeling behavior. [3 pts]

    1.4. What is a UML Use Case Diagram, and when should I use it? [2 Marks].

    1.5. What does coupling and Cohesion refer to in OOAD.[3 Marks]

    1.6. What are the guiding principles in system decomposition regarding Coupling and Cohesion. [2 Marks]

    1.7. The registrar wants to add to their on-line capability by allowing those professors and students with personal digital assistants (PDAs), such as Palm handheld devices or appropriately equipped mobile phones, access to the registrar.s system. Specifically we want students to be able to view the on-line course catalog and register or un-register for courses, just as they do from their computers. Professors will be able to post grades and obtain class listings. The course catalogs and listings should be able to be downloaded to the PDA so that they can be accessed off-line. Students and professors will have to apply for separate and different access to the system. The system must be available at all times and totally secure.

        1.7.1. Identify 5 Functional requirements.[5]

        1.7.2. Identify at least two Non Functional Requirements[2]

        1.7.3. Identify 4 use cases by providing the actors, use case names, and brief descriptions (2 or 3 Sentences) of both the use-cases and participating actor.[3]

Section C

Answer any two Questions.

1. **Question 1**

   The University admissions Department keeps records on all students and staff members within the university. The information stored about each person includes their name, address, affiliated department and course in terms of students. All people within the system are assigned a unique ID number. Both undergraduate and post graduate students attend the university. Undergraduate students must take subjects worth a total of 10 points. Each semester, but must not take more than 5 subjects in any semester one semester. Each Subject is worth between 1 and 5 points and subjects are taught by one or more staff members. Postgraduate students may take subjects, or have all points requirements fulfilled by performing research. All research postgraduate students are assigned a staff member as their thesis supervisor.

   The System should allow students to register for subjects or to drop them. Staff members should be allowed to sign up to teach a subject, add a new subject and delete a subject from the system.

   1.1. Identify the Actors and use-cases in the University Admission system (Just List them).[4 Marks]

   1.2. Construct a class Diagram, Illustrating the relevant classes (attributes and Operation), and their relationship based on the facts about a university admission department.[12 Marks]

   1.3. OOAD promotes the following design goal divided into five categories: performance, dependability, cost, maintenance, and end user. Assign one or more categories to each of the following goes: [4 Marks]

      1.3.1. _____Users must be given feedback within one second after they issue any command.

      1.3.2. _____The Ticket Distributor must be able to issue train tickets, even in the event of a network failure

      1.3.3. _____The housing of the ticket Distributor must allow for new buttons to be installed in case the number of faces increase

      1.3.4. _____The Automated Teller Machine must withstand dictionary attacks (i.e., users to discover a identification number by systematic trial).

2. Question 2

2.1. For the five requirement statements below, indicate what type of requirement it is, Functional (F), Usability (U), Reliability (R), Performance (P), or Scalability / Supportability (S).[10]

    2.1.1. _____ Someone who has taken a basic UML course shall be able to create a class diagram without referencing the on-line help or other help documentation.

    2.1.2. _____ The system shall encrypt all transaction data and sign it with the user.s private digital signature.

    2.1.3. _____ The system shall handle a maximum load of 20 million transactions in a 24-hour period.

    2.1.4. _____ The system shall be able to accommodate an unlimited number of users by adding additional processing nodes to the corporate network.

    2.1.5. _____ All users of the system will be able to create an account and select their own passwords. The only restriction is that the user name and password combination must be unique.

A. Prepare a Use-case Diagram for a simple credit card validation system based on the following Text.[6 Marks]

A simple system is to be developed to support the management of credit card transactions. Customers will use their credit card when buying an item or a service from a retailer. During the processing of the customers bill the customer credit card must be checked with the card company. The system will allow the customer to check their account status and pay outstanding debt. The credit card company should also be able to manage the account including issuing bills, changing credit limits and canceling cards.

B. Produce a description and flow of events for one of the use-cases in your diagram. Devise two scenarios, one main and one alternative/exceptional for this use-case. Note that three descriptions are expected, one for the use-case and two scenarios. [8 Marks]

3. Question 3

3.1. Construct a **Class Diagram** for the order processing system described below.[14 Marks]

— Each order consists of one or more order lines.

— Each order line corresponds to a particular product. Each order line has a product description, price, quantity and a field that indicates the status of this order line.

— A product can appear on many orders.

— A customer can place many orders, but each order belongs to only one customer.

— Each order has an order number, date and customer number.

— Customers can be either businesses or individuals.

— All customers have a name and address. Business customers also have a contact name, credit rating and available credit.

— Individual customers may have a credit card number on file.

Remember to include as much detail as possible, such as attributes, operations, associations, constraints (Multiplicities), etc...

3.2. Based on the following Sequence Diagram, Draw a UML Class Diagram identifying all the operations, properties and relationships that are in the classes involved. [6 Marks]
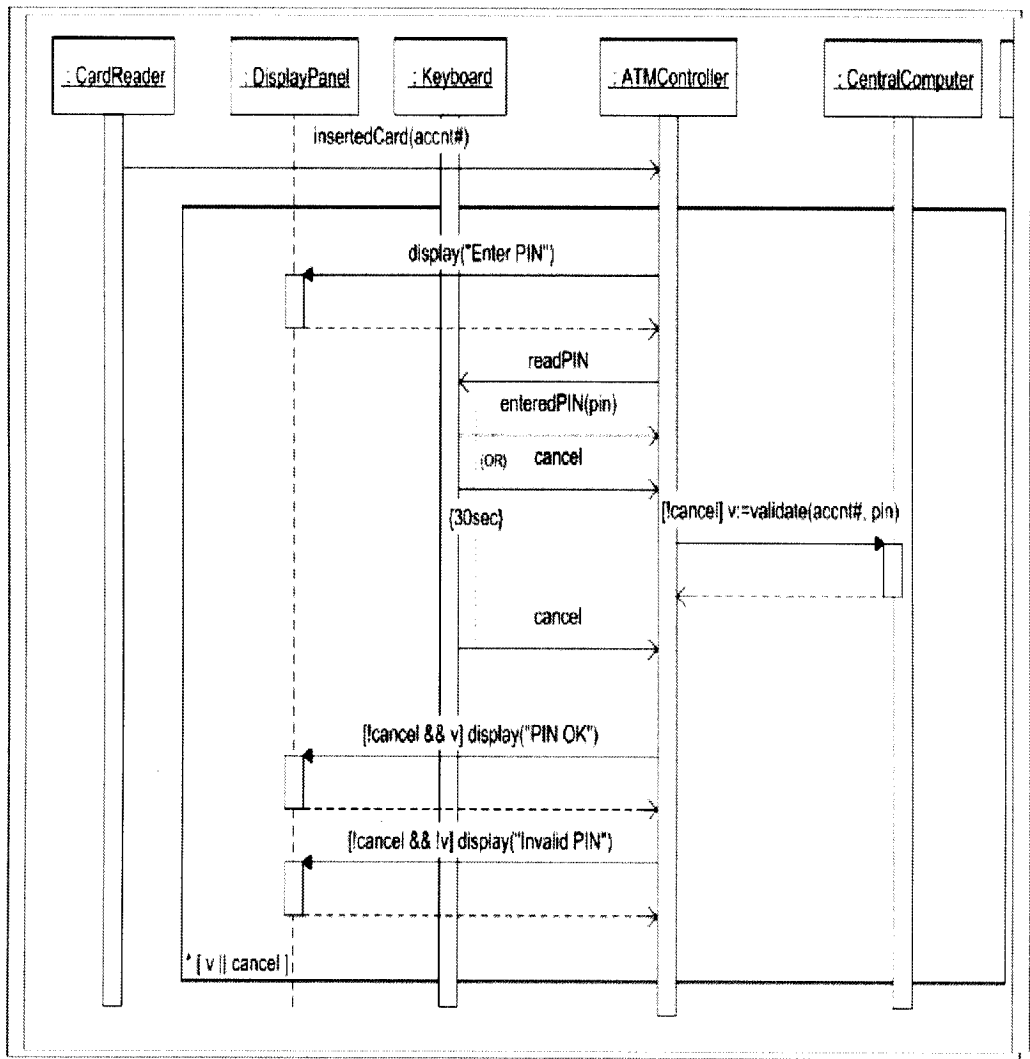
4. Question 4

Case Study
ACMA Company is in need of a warehouse management system to control movement and storage of materials within its warehouses.

This company offers the services of its warehouses and container yards to customers all over the country. It offers transport services to transport customers' goods. The operations include order redistribution within warehouses, Freight forwarding between origin and destination warehouses and handling transport services. All kinds of items can be stored in warehouses. Each item can be classified in to various categories according to the storage type. The warehouse is divided into cubicles based on the storage requirements. It is important that the location of certain items should be separated from others. e.g. chemicals and food items.

The following people will be connected with the warehouse system:
Foreman, Warehouse worker, Container yard Supervisor, Truck driver and assistant, Office personnel and Customers. Office personnel receive and accept orders from customers. The foreman in the warehouse is responsible for accepting the distribution order. Customers own their items in the warehouses and give instructions on where and when they want them to be transported. All items should be entered into a database before they are taken in to the warehouse. Container yard Supervisor handles the operations inside a container yard, such as security of the trucks parked within the yard where the Driver and the assistant break journey.

Order Distribution Scenario
A customer approaches the office of the Company with a list of items to be dispatched to various destinations in the country. The office personnel check the list, note the destinations and identify the storage type corresponding to each item by referring to an item type classification book.

Before a transit, all the items are expected to be at a specific location belonging to the customer. Thus, the original location of all the items for a specific transit is the same. The items in the order, which should be transported to the same destination, should arrive on the same date.

For a particular transit from the origin, a pre-defined route is obtained from a reference book. A route is a set of intermediate container yards between the origin and destination warehouses. The expected period that is allowed to be spent at each intermediate container yard is also specified. Another duration specifying the period to be spent on the road between successive container yards or container yards and warehouse as the case may be is also given.

After deciding the route, the office personnel phone the origin and destination warehouses to inquire about the space availability to store the items. The foremen at such warehouses check their logs for the availability of space for those items and determine whether there is sufficient space. If space is available, he makes a reservation of the space for the expected

period at that time. If any of the two warehouses faces a difficulty of handling the storage, the reservations in respect of the customer order is not done and the order is not accepted.

However, if space can be reserved in both warehouses, the order is accepted and the customer is given an order number. Thereafter, the customer is free to arrange for his own transport of the consignment to the warehouse at the origin. In the alternative, the company is prepared to undertake the assignment. Order form contains order number and details of each item including item_ number, item_name, quantity, unit of measure (Weight, volume, etc.), original location, destination of the item and expected date of final arrival. The form also contains a provision for the customer to indicate any special requirements under remarks.

Freight forwarding scenario
A freight is the movement of items between any 2 warehouses. All items in a given freight go to the same warehouse. When freight is forwarded, a Freight forwarding form is filled at the origin warehouse. Each Freight forwarding form consists of the name of the foreman, freight no, current location of freight, destination of freight, intermediate container yards, and also for each item its order number, item number, name, quantity, weight, container id, truck registration number, expected date and the Remarks of the customer.

A freight is created at the origin warehouse on the route. After selecting the items for dispatching, they are stored in containers. The number of containers used depends on the requirements and whether items can be stored together or not. A single truck can carry only one container. The number of trucks is then assigned accordingly to the number of containers. The location of the freight in transit should also be tracked. Even though there is a pool of trucks available at each warehouse, there may be some trucks under repair at anytime and others may be in transit. Once dispatched, the space allocated in a specific warehouse becomes available.

4.1. For the above case study, Office Personnel can be identified as an *Actor*. Identify the Use cases which are responsible for the business actor 'Office Personnel' (Or Use-cases used by the actor 'Office Personnel'). [4 Marks]

4.2. In addition to the actor Office Personnel, name other *Actors* one should identify for the system at the design stage. [4 Marks]

4.3. Identify SIX (06) potential classes for the above system. [6 Marks]

4.4. Following is a Use case diagram for the given system. Identify the Actors / Use cases for labels A-F from the given list.[6 Marks]

Customer, WarehouseWorker, Foreman, CheckSpaceAvailability, CancelReservedSpace, ReserveSpace, CheckTruckAvailability, AssignContainers, RejectOrder, AcceptOrder.
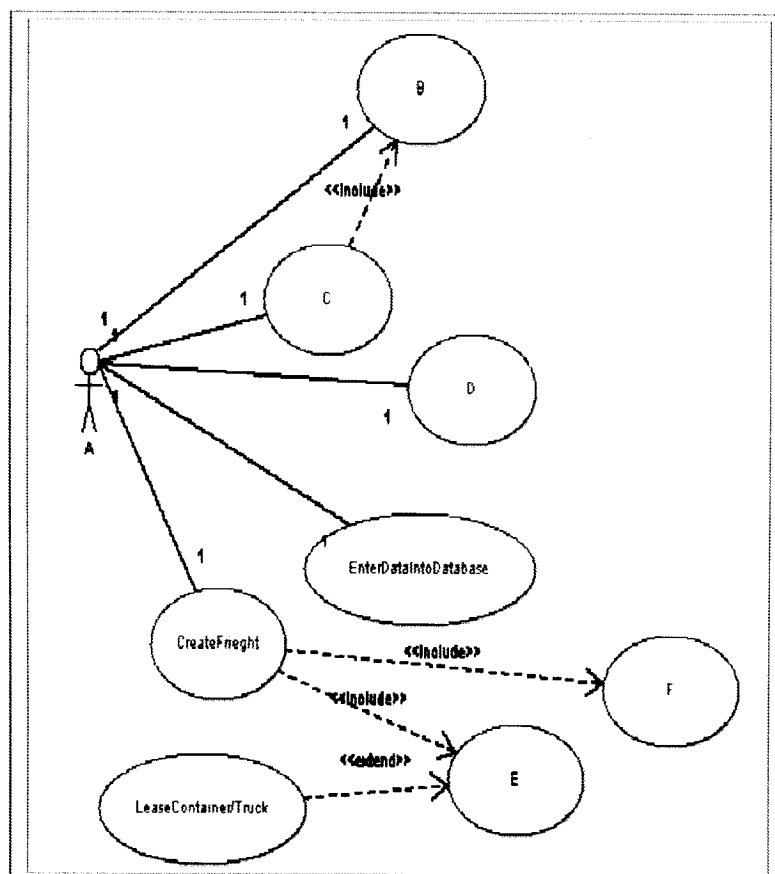
GOOD LUCKY.

UNIVERSITY OF ZAMBIA

School of Natural Sciences

Department of Computer Studies

CS4012 Final Exam

Advanced Operating and Distributed Systems

Time 3 Hours
4/28/2009

This exam has two sections. Answer all questions from section A. Each question in Section A carries 4 points. Answer any three questions from Section B. Each question in Section B carries 20 points.

Section A

1. Two real-time processes are running on a computer. The first one runs every 25 msec for 10 msec. The second one runs every 40 msec for 15 msec. Will RMS always work for them?

2. Computing has for a long time been CPU-centric. One of the attempts to change this is Sun Microsystems Jini. What is Jini? State the four methods that are defined on the Javaspace that is used by Jini clients and services for communication.

3. Most computer science multi-media technology is driven by the entertainment industry. Audio music samples are usually 16 bits in size and sampled on two channels. A Compact Disc holds 74 min of music or 650 MB of data. Make an estimate of the compression factor used for music. Sensational Zambia artists, Petersen and Shy-man shy-izo, propose a double compression factor so that Audio CDs can have more tracks. How will this affect storing data on Compact Discs?

4. Consider the following way to encrypt a file. The encryption algorithm uses two n-byte arrays, A and B. The first n bytes are read from the file into A. Then $A[0]$ is copied to $B[i]$, $A[1]$ is copied to $B[j]$, $A[2]$ is copied to $B[k]$, etc. After all n bytes are copied to the B array, that array is written to the output file and n more bytes are read into A. This procedure continues until the entire file has been encrypted. Note that here encryption is not being done by replacing characters with other ones, but by changing their order. How many keys have to be tried to exhaustively search the key space? Give an advantage of this scheme over a mono-alphabetic substitution cipher?

5. Self-extracting archives, which contain one or more compressed files packaged with an extraction program, are frequently used to deliver programs or program updates. Briefly discuss the security implications of this technique.

6. As Internet cafes become more widespread, people are going to want ways of going to one anywhere in the world and conducting business from them. Describe a way to produce signed documents from one using a smart card (assume that all the computers are equipped with smart card readers). Is your scheme secure?

7. When the TSL instruction is used for multiprocessor synchronization, the cache block containing the mutex will get shuttled back and forth between the CPU holding the lock and the CPU requesting it if both of them keep touching the block. To reduce bus traffic, the requesting CPU executes one TSL every 50 bus cycles, but the CPU holding the lock always touches the cache block between TSL instructions. If a cache block consists of 16 32-bit words, each of which requires one bus cycle to transfer, and the bus runs at 400 MHz, what fraction of the bus bandwidth is eaten up by moving the cache block back and forth?

8. A 14-GB disk with 1000 cylinders is used to hold 1000 30-sec MPEG-2 video clips running at 4 Mbps. They are stored according to the organ-pipe algorithm. Assuming Zip's law, what fraction of the time will the disk arm spend in the middle 10 cylinders?

9. How must the implementation of send and receive differ between a shared memory multiprocessor system and a multicomputer, and how does this affect performance?

10. Can uncompressed black-and-white NTSC television be sent over fast Ethernet? If so, how many channels at once?

Section B

1.

    a) Consider a secret-key cipher that has a 26 × 26 matrix with the columns headed by *ABC ... Z* and the rows are also *ABC ... Z*. Plaintext is encrypted two characters at a time. The first character is the column; the second is the row. The cell formed by the intersection of the row and column contains two ciphertext characters. What constraint must the matrix adhere to and how many keys are there? **[10 points]**

    b) Give a simple example of a mathematical function that to a first approximation will do as a one-way function. Elaborate. **[10 points]**

2. Operating Systems design has been highly affected by a new paradigm of applications know as multi-media applications. Operate system design has had to evolve to support multimedia.

a) Give an example multimedia in use? What two characteristics of multimedia are fundamental when considering Operating System design? [5 points]

b) What is video on demand and near video on demand? [5 points]

c) Outline the steps involved in encoding an image with JPEG. [5 points]

d) Three periodic processes, each displaying a movie are running. The frame rates and processing requirements per frame are different for each movie. Suppose that each of the three processes is accompanied by a process that supports an audio stream running with the same period as its video process, so audio buffers can be updated between video frames and that all three of these audio processes are identical. How much CPU time is available for each burst of an audio process? [5 points]
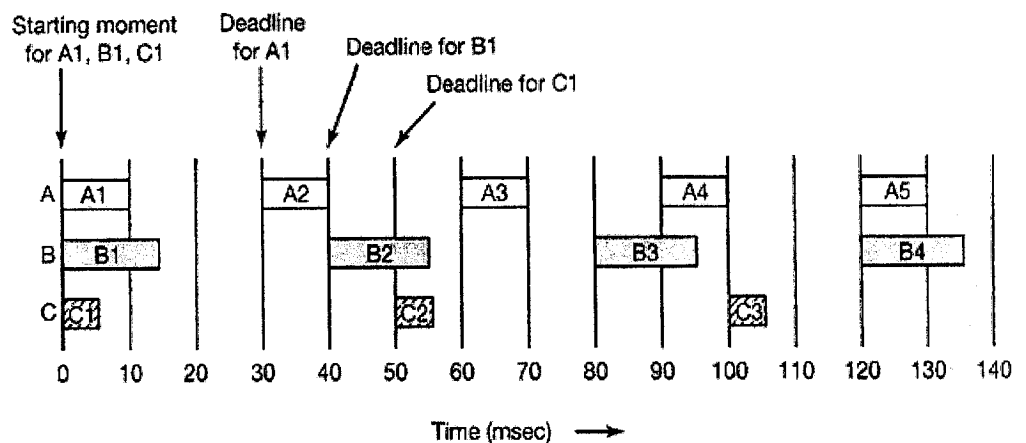
3.

a) Briefly outline the two file organization strategies that can be used with non-contiguous movie storage. [5 points]

b) What are the conditions that processes must meet in order for the RMS algorithm to apply on them? [5 points]

c) What is Zipf's law? How does it relate to the pipe organ algorithm? [5 points]

d) The CPU of a video server has a utilization of 65%. How many movies can it show using RMS scheduling? [5 points]

4.

a) If a CPU issues one memory request with every instruction and the computer runs at 200 MIPS, about how many CPUs will it take to saturate a 400-MHz bus? Assume that a memory reference requires one bus cycle. Now repeat

this problem for a system in which caching is used and the caches have a 90% hit rate. Finally, what cache hit rate would be needed to allow 32 CPUs to share the bus without overloading it? [10 points]

b) Briefly outline and explain the three organizations for multiCPU systems. [10 points]

5. One of the fundamental aspects of an operating system is its security. There are many techniques that are used to employ security in an Operating System.

    a) What is cryptography? **[5 points]**

    b) Define a capability and access list. Compare and contrast the two. **[5 points]**

    c) Define a mechanism - hardware and software - for authenticating users based on their finger prints. **[5 points]**

    d) Protection mechanisms though necessary have an impact on system performance. Briefly outline how protection mechanisms impact system performance. **[5 points]**

The University of Zambia

School of Natural Sciences

Computer Studies Department

EXAM:	**APRIL 2009 EXAM - SEMESTER TWO FINAL**
COURSE:	**CST4122 – FUNDAMENTALS OF COMPILERS**
DURATION:	**3 HOURS**
VENUE:	**NEW DINING HALL**

INSTRUCTIONS

- *__This paper contains seven (7) questions__*
- *__ANSWER A TOTAL OF FIVE QUESTIONS__*
- *All questions carry equal marks (20 marks)*
- *Clearly number your answers*
- *Use the marks as a guide to the detail required in your answers while keeping your answers concise and relevant.*

GOOD LUCK!!

QUESTION ONE

a) What are the ``front-end'' and ``back-end'' components of a compiler? What distinguishes the ``front-end'' from the ``back-end''? **[6 marks]**

b) Given the following high level statement; *position: = initial + rate * 60,* show the resulting transformations through the front-end phases of a compiler as discussed in class. Assume all identifiers are declared to be real numbers and 60 by itself is an integer. **[14 marks]**

QUESTION TWO

a) Outline three roles of the lexical analyzer. **[3 marks]**

b) A legal string begins with from 1 to 3 a's, is followed by 0 or more b's, c's, or d's, and ends with at least one e.

    i. Create a regular expression to accept legal strings (and only legal strings). **[3 marks]**

    ii. Create a nondeterministic finite state machine to accept legal strings (and only legal strings), **USE THOMPSONS ALGORITHM.** **[7 marks]**

c) Minimize the following DFA **[7 marks]**
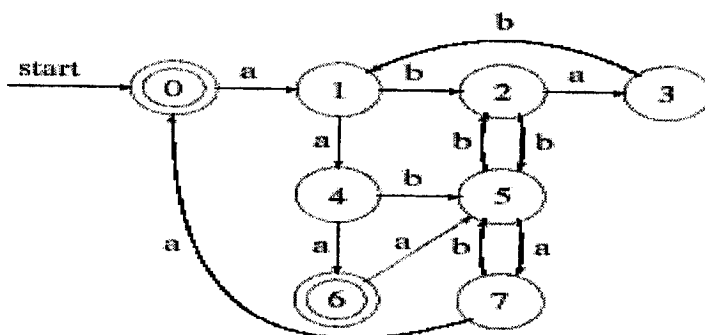
QUESTION THREE

a) Outline three roles of the Parser. **[3 marks]**

b) Consider the following grammar:

E → id |

!E |

E && E |

(E)

where id, !, &&, (, and) are terminals.

i. Prove that the grammar is ambiguous by finding a string and showing its two different syntax trees. **[6 marks]**

ii. Eliminate left-recursion from the grammar. **[4 marks]**

c) Consider the following First and Follow sets:

First(S) = {b, ε}

First(T) = {b, ε}

Follow(S) = {a, $}

Follow(T) = {a, b, $}

Give the simplest grammar (fewest productions and shortest right-hand sides) that produces these sets. As usual, S is the start symbol. **[7 marks]**

QUESTION FOUR **[20 marks]**

a) Consider the resulting NFA from question 2(b.ii) above,

i. Convert the NFA to a DFA, show the DFA transition table and the resulting DFA diagram.

ii. Show the sequence of moves made by the DFA in processing the following input strings; aee, aaabcde

----

QUESTION FIVE   [20 marks]

a)   Consider the following simple grammar for assignment statements with expressions involving addition or subtraction:

   1)   stmt -> ID ':=' expr

   2)   expr -> expr '+' NUM

   3)   expr -> expr '-' NUM

   4)   expr -> NUM

   i.   Construct the transition diagram of a predictive parser from the grammar

   ii.   Write the parsing procedures in pseudo code

   iii. Trace the parser for input; a:= 1 + 2 - 3

QUESTION SIX

a)   Consider the following grammar with terminal symbols; a b +, non-terminal symbols S, A, B where S is the start symbol and productions

   (P1)   S → A + B

   (P2)   S → B

   (P3)   A → a A

   (P4)   A → ε

   (P5)   B → b B

   (P6)   B → ε

   i.   Compute FIRST and FOLLOW for this grammar.   [4 marks]

   ii.   Consider the following LL(1) parsing table for a predictive table parser:

	a	b	+	$
S	P1	P2	P1	
A	P3		P4	
B		P5		P6

where Pi refers to the ith production in the above grammar. Detail how the sentence a + b would be parsed with a predictive table parser using this table. For each step of the process give the parser action, input and stack state.

                                               [4 marks]

4

iii. Is the parsing table given in (c) the correct LL(1) predictive parsing table for this grammar? If not identify and correct the errors in the table.

[4 marks]

b) The following grammar is clearly not LL(1),

A → A + B | A - B | B
B → C * B | C / B | C
C → (A) | int

i. Transform the grammar to make it LL(1)?

[2 marks]

ii. Construct the parsing table for a predictive parser for this grammar

[6 marks]

QUESTION SEVEN

a) Consider the following grammar;

S → A + B

S → B

A → a A

A → ε

B → b B

B → ε

i. Construct an SLR parsing table for this grammar.   **[15 marks]**

ii. Show behaviour of parser on string a + b.   **[5 marks]**
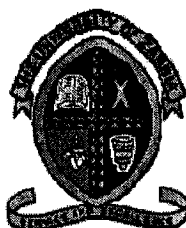
THE END

The University of Zambia
School of Natural Science
Department of Computer Studies

<u>*FINAL EXAM SEMESTER II – April 2009*</u>

<u>Computer Graphics (CST - 4132)</u>

Instructions

1. There are **two sections**, A and B and a total of **six questions** in this question paper.

2. **Section A** has **two** questions while **section B** has **four questions**

3. You are required to **answer a total** of **five questions only**

4. Each question carries **20 marks**

5. **Answer all** questions in **section A** and any **three** questions in **section B**

Date: **Wednesday 15ᵗʰ April 2009**

Time: **09:00hrs – 12:00hrs**

Venue: **New Dining Hall**

<u>NOTE: Do not open this paper until you are told to do so</u>

SECTION A – Answer all the questions in this section

1) QUESTION ONE

a) What is Computer Graphics? [1 Marks]

b) Define the following terms [3 Marks]
   i)   Dot Size
   ii) Pixel
   iii) Projection

c) Give two reasons why it is very important to study Computer Graphics [2 Marks]

d) Given the point of a rectangle as A (-2,-3), B (-8,-3), C (-8,-9) and D (-2,-9).
   Perform each of the following transformations on the above rectangle to compute
   the final coordinates and then sketch the final rectangle with the computed
   coordinates as A', B', C' and D' [10 Marks]

   i)   Translation by T = (12,-9)

   ii) Rotation about the origin in the clockwise direction at 45°.

   iii) Scale in the Y direction by a scale factor of 4 and in the X direction by a scale
        factor of 2

   iv) Shear in the X direction by a shear factor of 3 and in the Y direction by a
        shear factor of 5

a) Let $X = \begin{pmatrix} 1 & 4 & -2 \\ -5 & 3 & 2 \\ -1 & 1 & 2 \end{pmatrix}$ and $Y = \begin{pmatrix} 7 & 2 & -11 \\ 9 & 7 & 3 \\ 6 & -3 & 1 \end{pmatrix}$; Compute the

   following [4 Marks]

   i)   8X

   ii) 6Y

   iii) Y x X

2) QUESTION TWO

    a) Define the following terms [2 Marks]

        i) Hue

        ii) Cell Decomposition

    b) Computer graphics is used today in many areas of the Industry, business, government, education and entertainment. List four uses of Computer Graphics and give a very brief explanation of each usage. [6 Marks]

    c) Let $X = \begin{pmatrix} 2 & 3 & 5 \\ 7 & 4 & 6 \\ -1 & 1 & 2 \end{pmatrix}$ and $Y = \begin{pmatrix} 1 & 4 & -2 \\ 5 & 2 & 3 \\ 6 & -3 & 1 \end{pmatrix}$; Compute the following [6 Marks]

        i) Y^T

        ii) The Inverse of Matrix Y

    d) Given the point W in three dimension as (6,-3,2) [6 Marks]

        i) Computer the coordinates of the final point W' if W is translated with a translation T (3,-1, 8) and then followed by a shear in the Y direction with a shear factor of 4

        ii) Rotate the point W about the z-axis in the clockwise direction at 45° about the origin and then Scale it in the X direction with the scale factor 2

Section B – Answer any three questions in this section

3) QUESTION THREE

a) The diagram below shows the computer monitor which uses a Cathode Ray Tube (CRT) display technology. With the help of a well labelled diagram, briefly describe how the CRT works. **[4 Marks]**
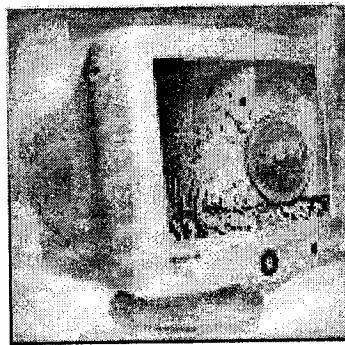
b) Given the Vectors $v = (6,2,)$ and $u = (-7,4)$; Compute the following; **[5 Marks]**

   i) The angle between the vectors v and u

   ii) The magnitude of $\|VU\|$

c) Given the vectors p=(-2,7,-4), q=(5,-3,6) and r = (1,-8,9). Computer the Cross product of the three vectors **[3 Marks]**

d) Input devices are an important component when coming up and during the usage of Computer Graphics Applications. Briefly explain how each of the following works **[8]**

   i)   Data Tablet

   ii) Mouse

   iii) Trackball

   iv) Joystick

4) QUESTION FOUR

a) Using the diagram below show that; **v . u = || v || || u || cos (t)**; [3 Marks]
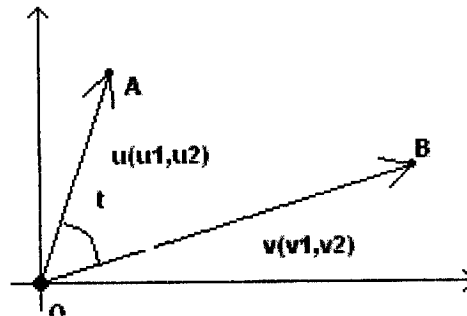
b) Calculate the value of sv and $|sv|$ when $s = 3$, $v = (2, -3, 1)$, where s is a scalar quantity and v is a vector quantity **[3 Marks]**

c) One of the most useful technologies in the filed of computer graphics apart from display technologies is the Hard Copy Technologies. Examples of these technologies include Pen plotters, Laser printers, Film recorders, Thermal-transfer printers, Dot–matrix printers and In-jet Printers. **Briefly** *explain* how each of the following below works **[6 Marks]**

   i) **Pen plotter** giving examples to *Flatbed Plotter* and *Drum Plotter*

   ii) Ink-jet Printer

d) The need to model objects as solids has resulted in the development of a variety of specialized ways to represent them in a field of Computer Graphics. Give a brief description for each of the following representation **[8 Marks]**

   i) Boundary Representation

   ii) Constructive Solid Geometry

   iii) Sweep Representation

   iv) Spatial Partition Representation

5) <u>QUESTION FIVE</u>

a) Define the following terms [3 Marks]

   i) Achromatic Light

   ii) Dynamic Range

   iii) Luminance

b) Give a brief description for each of the following Colour Models for raster graphics. [8 Marks]

   i) RGB Colour Model

   ii) CMY Colour Model

   iii) The YIQ Colour Model

   iv) The HSV Colour Model

b) With the aid of the diagrams, compare and contrast between the two types of Projections namely *Parallel* and *Perspective* [4 Marks]

c) Let $A = \begin{pmatrix} 8 & 3 & 5 \\ 7 & 2 & 6 \\ -2 & 1 & 4 \end{pmatrix}$ and $B = \begin{pmatrix} 9 & 4 & -2 \\ -6 & 5 & 8 \\ 7 & -3 & 1 \end{pmatrix}$; Solve the following [5 Marks]

   i) $5A + B$

   ii) $4B - 3A$

   iii) Determinant of A

6) QUESTION SIX

a) With the help of a well labelled diagram, **give** a brief description on how each of the following display technologies works **[6 Marks]**

   i) Vector Graphics

   ii) Raster Display

b) Creation of the photo using a synthetic camera metaphor in 3D using 2D devices usually occurs through a series of steps. Name the steps required. **[3 Marks]**

c) *Requicha* provides a list of properties desirable in **Solid Representation Modelling**. List all the six properties **[3 Marks]**

d) Solve the following equations for x, y and z by using the inverse of the Matrix method. **[8 Marks]**

$$x + 4y + 2z = 8$$
$$2x - 6y + 3z = 12$$
$$-3x + 9y - z = -6$$

END OF EXAMINATION PAPER

THE UNIVERSITY OF ZAMBIA

DEPARTMENT OF COMPUTER STUDIES
SECOND SEMESTER EXAMINATION 2008

CST 4252: ELECTRONICS FOR COMPUTING IV

TIME: 3 HOURS
INSTRUCTIONS: ANSWER ANY FOUR QUESTIONS
                   TOTAL MARKS 100
                   ALL QUESTIONS CARRY EQUAL MARKS

1. a) Make brief notes on the following [9]
   i) Sources of interference and how to remedy them.
   ii) Comparison of differential encoding schemes.

   b) Find the trigonometric Fourier expansion for the waveform given below [16]

$f_n = 1/T$
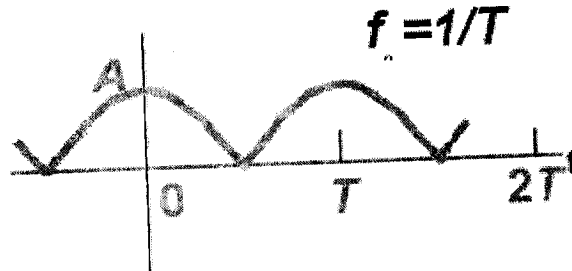
2. a) i) If a 128 symbol state modem is designed to transfer data at a rate of 1.048 Mbps, what is the minimum bandwidth for the transmission cable if Baseband signaling is used? [6]

   ii) What is the maximum S/N ratio (in dB) that can be tolerated using this cable? [6]

   iii) Find the E_b/N_o ratio in dB [4]

   b) What Signal to Noise ratio (S/N) is required to achieve a bandwidth efficiency of 1.5 for NONCASK, COFSK, COHPSK and DPSK? Assume that the required error rate is 10^{-4}. [9]
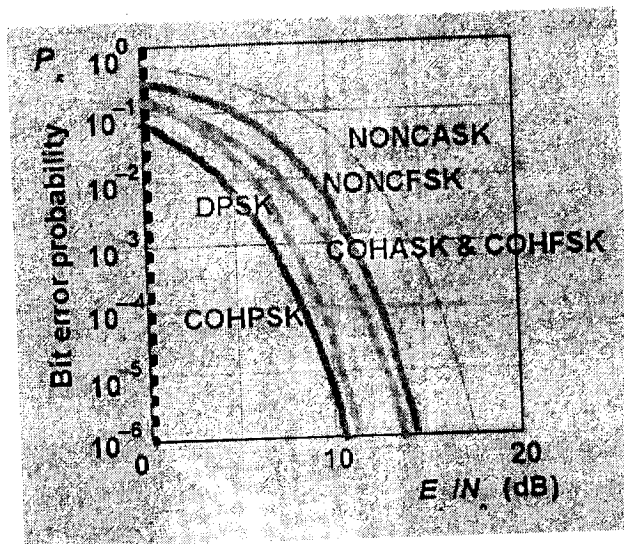
3.   **a)**   [9]

   i)   What two mechanisms cause frequency errors within a
        communications link using ASK modulation.

   ii) Explain the following terms
        a.   adjacent channel interference
        b.   co-channel interference
        c.   multipath interference

   b)   A link has an average thermal noise power of –300 dBm at a
        temperature of 15°C . At what temperature would thermal noise power
        reduce by half?

                                                                    [7]

   c)   A cable is measured to have a flat gain response with frequency over the
        band of interest, but is found to have a phase response that changes
        proportionally with frequency. If the group delay response is 50 ns for
        every 2 MHz, what is the phase increase per MHz.

                                                                    [5]
   d)   Draw a constellation diagram for a four level ASK modulation format
        using $\cos(\omega_c t - 45°)$ carrier when the modulation input is   [4]

        i) a four level bipolar signal.
        ii) a four level unipolar signal

4.

   a)   Explain the difference between coherent and non coherent FSK(using
        PLL) modulation. Include the block diagram of the detection circuit.

                                                                    [11]

   b)   A coherent binary ASK data system has a phase error that cause a 25 %
        reduction of the recovered signal power. What is the phase error?

                                                                    [6]

   c)   A vector modulator is fed with a perfect quadrature sinewave at the
        input, but there is a small phase error of 5° between the notional
        quadrature inputs of the carrier signal. What will be the ratio in dB
        between the sum and difference outputs of the vector modulator as a
        result of this phase error?

                                                                    [8]

5.

a) i) What is differential encoding and what is its advantage? **[4]**

ii) Draw the waveform of the binary sequence 11001010111 using Manchester and differential Manchester encoding. **[8]**

b) An ASK format is used to transmit data at a rate of 50,000 bps over a cellular phone link with bandwidth occupying the frequencies from 400Hz to 8400 Hz. **[13]**

    i) How many symbol states are required in order to achieve this level of performance?

    ii) If the capacity of the channel is 80 kbps, what is the maximum S/N (in dB) ratio needed for noise free communication.

    iii) What would be the number of symbol states if Baseband transmission is used with the same bandwidth.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 112: INTRODUCTION TO HUMAN GEOGRAPHY II

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. Define culture and show how Africa was developing in the cultural sphere before colonialism.

2. Define resources and suggest ways in which 'potential resources' can be transformed into 'actual resources' in Africa.

3. Explain the meaning of 'natural resource tenure', and show why it is important to study land tenure in any given community.

4. Define industrialization and suggest possible lessons that Africa can learn from the experiences of England with respect to the promotion of this process.

5. Describe Rostow's model of economic growth and show whether it is applicable to the experiences of African countries.

6. Compare and contrast the neo-Malthusian and neo-Marxist theories of population and explain whether they are relevant to the situation in Africa.

END OF EXAMINATION.

CANDIDATE'S COMPUTER NUMBER: ....

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 175: INTRODUCTION TO MAPPING TECHNIQUES IN GEOGRAPHY

PAPER I: PRACTICAL
MAPS AND AIR PHOTOGRAPHS

TIME: Three Hours

INSTRUCTIONS: Answer all 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:
A4 Metric graph paper
A4 Tracing paper
Topographic Map Sheet 1628 A4

FOR USE BY EXAMINER

Question	Examiner's Mark	Moderator's Mark
Q1		
Q2		
Q3		
Q4		
Q5		
Total		

SECTION A: GENERAL QUESTIONS

Answer all questions in this section in the spaces provided on this question paper.

1. (a) What are the two major sources of distortion on vertical air photographs? [2 marks]

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(b) Assuming that an air photo survey is carried out in the vicinity of the University of Zambia's Great East Road Campus at a height of 3,800 metres above the ground and the camera used has a focal length of 152 millimetres. Answer the questions below:

(i) What is the mean scale of the air photograph? [3 marks]

(ii) The distance between the two ends of the Goma Lakes is 150 metres, how long will the distance be on the air photo? [3 marks]

2

(iii)   The length of the Biology building in the air photograph is 0.3 millimetres long. What is the length of the building on the ground? [3 marks]

(iv)   Assuming that the length of an ordinary air photograph is 25 centimetres by 25 centimetres (25 cm x 25 cm), what is the equivalent ground area in square kilometres? [3 marks]

(c)   Using the contour method, draw an annotated diagram to show a conical hill at a 20 metre contour interval with a river flowing on the slope with its source near the summit. [2 marks]

2. Write short explanatory notes on all of the following:

(a) Grid references [3 marks]

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(b) Categories of map symbols [3 marks]

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(d)   With the help of a diagram, describe an annular drainage pattern and
        briefly, explain the characteristics of the topography on which it develops.
        [3 marks]

(e)   Draw a line scale in metric units for a map drawn on a scale of 1:20,000,
        given that the maximum space available is 19 centimetres. (4 marks)

(e)   Characteristics of a good map symbol [3 marks]

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3.   (a)   Convert the scale of 1:50,000 to a scale in words. [3 marks]

(b)   Express 1: 6,000,000 as a scale in words. [3 marks]

(c)   Calculation of gradient on a topographic map [3 marks]

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(d)   Oblique air photographs [3 marks]

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(c)   Using a scale of 1:100,000, calculate the dimensions to scale of an area measuring 20 kilometres by 12 kilometres (20km x 12km) [2 marks]

(d)   Express one centimetres to a kilometre as a scale in figures [2 marks]

(e)   Why should the vertical scale on a profile be exaggerated? [2 marks]

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(c)   Using a scale of 1:100,000, calculate the dimensions to scale of an area measuring 20 kilometres by 12 kilometres (20km x 12km) [2 marks]

(d)   Express one centimetres to a kilometre as a scale in figures [2 marks]

(e)   Why should the vertical scale on a profile be exaggerated? [2 marks]

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Answer question four in the spaces provided on this question paper and question five on either a sheet of A4 metric graph or plain papers provided.

4. (a) When was the first edition of map sheet 1628 A4 published and by whom? [2 marks]

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    (b) Identify and name the dominant type of vegetation found in Lusengezi National Forest No. 204. [1 mark]

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    (c) In which direction does the Lusitu River generally flow? [2 markr]

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    (d) Using map evidence only, explain how one could read a Four-Figure Grid Reference ol map sheet 1628 A4. [4 marks]

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(e)   What drainage pattern does the Namatelo River system generally exhibit? [1 mark]

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(f)   What pieces of evidence are there on Map Sheet 1628 A4 to show that some of the villages have administrative functions? [2 marks]

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(g)   What is the approximate size of Lusengezi National Forest No. 204 in square kilometres and state the method that you have used to measure the area? [2 marks]

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(h)   What is the Six Figure Grid Reference of Headman Sinadambwe's village along the Lusengesi River Valley? [2 marks]

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(i)   Determine the direction of Peter Majansi Village in Grid Square 4796 from the road junction in Grid Square 4999 as a compass direction and also as a bearing from Grid North. [2 marks]

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(j)   Calculate the average gradient along a straight line between Grid
        Reference Point 540002 and the summit of Nalula Hill in Grid square
        5401 in degrees. [3 marks]

(k)   If you were travelling northwards to Ngangula along the D367 road, what
        other Map Sheet would you require? [1 marks]

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(l)   What drainage feature is associated with Bungua Hill? [1 mark]

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(l)   Along what relief feature does the D500 road to Fumbo Mission pass
        south of northing 88? [1 mark]

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(n)   Using map evidence only, suggest two possible reasons that could have
        influenced the selection of the site of Chief Sinadambwe's headquarters.
        [2 Marks]

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(o)   Using map evidence only, identify and name the major occupation of the inhabitants of the area covered by Map Sheet 1628 A4. [2 marks]

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(p)   What is the general relationship between the major roads and settlement on Map Sheet 1628 A4? [2 marks]

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5.   On a sheet of A4 metric graph or plain papers provided, draw a map on a scale of 1:100,000 extending from eastings 39 to 51 and northings 90 to 02. On your map show the followings features:

(i)   Chalala and Kayubila/Mulamba rivers

(ii)   The D500 and D 387/ D 501 roads

(iii)   Lusengezi National Forest No. 204

(iv)   Jake Mulendemai Village

(v)   Siakalinda School

(vi)   Shade the area above 800 metres [20 marks]

END OF EXAMINATION

12

THE UNIVERSITY OF ZAMBIA

DIRECTORATE OF DISTANCE EDUCATION

2008 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 Atlas is allowed.

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1. Explain how rainfall and soils influence agricultural activities in tropical Africa.

2. With the use of a diagram, explain the theory of Continental Drift .

3. 'African religions and philosophy are still relevant to the present age'. Discuss.

4. Explain the meaning of Neolithic Revolution and show how it was experienced in Africa.

5. Account for the existence of regional disparity in economic development in Ghana after independence.

6. Compare and contrast the strategies for economic development that were followed in Kenya and Tanzania after independence.

END OF EXAMINATION

2008 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

GEO 212: GEOGRAPHY OF ZAMBIA

TIME: Three hours

INSTRUCTIONS: Answer any **four** questions.
All questions carry **equal marks**. Use of a Philips' University Atlas is allowed. Candidates are encouraged to use illustrations wherever appropriate.

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1.   Write short explanatory notes on **all** of the following.

   a. Ashley and Maxwell's (2001) five principles for a successful rural development strategy,
   b. Advantages and disadvantages of using geothermal energy,
   c. UN Habitat's definition of a slum,
   d. Ferrallitic Soils,
   e. The pre-colonial migrations between AD 1500 and AD1700.

2.   Discuss the factors that influence the distribution of rainfall in Zambia.

3.   'Despite convincing successes scored by some agriculture- based countries in using the powers of agriculture for poverty reduction and as an engine of growth, agriculture has not been used to its full potential in Zambia'. Discuss.

4.   Discuss the distinct aspects of Zambia's location and show its advantages and disadvantages.

5.   Examine the assertion that 'privatization of the mines has done more harm than good to the mining sector in Zambia'.

6.   Discuss the factors constraining the rapid growth of tourism in Zambia and suggest ways in which the government can overcome them.

END OF EXAMINATION

TIME: THREE (3) HOURS

INSTRUCTIONS: ANSWER ANY FOUR QUESTIONS. ILLUSTRATE YOUR
                ANSWERS WHEREVER POSSIBLE. USE OF AN APPROVED
                ATLAS IS ALLOWED.

1.   Describe the geomorphic and tectonic processes that have acted on Zambia's land surface and the features they have produced.

2.   What are the main geologic systems found in Zambia? Demonstrate how geology has influenced relief in Zambia.

3.   Examine how socio-economic development has impacted on the quality of the biophysical environment in Zambia.

4.   Outline the problems that the urban poor in Zambia face and explain how they cope.

5.   Describe the trend in Zambia's socio-economic development since 1964.

6.   'A nation's population is both an *agent* for, and a *beneficiary* of, development.' Discuss.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
DIRECTORATE OF DISTANCE EDUCATION

2008 ACADEMIC YEAR DISTANCE EDUCATION FINAL EXAMINATIONS

GEO 272: TECHNIQUES IN GEOGRAPHY II

TIME   :   **THREE HOURS**

INSTRUCTIONS :   **Answer FOUR questions**
                           ALL questions carry equal marks
                           Use of a calculator is allowed.

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1. Blood cholesterol levels were recorded for a number of persons sampled in a medical study group and the data presented in Table 1 were obtained. Answer the questions below.

Table 1: Blood Cholesterol Levels for Sampled Persons

239	212	249	227	218	310	281	330	226	233	223	161	195	233
249	284	245	174	154	256	196	299	210	301	199	258	205	195
227	244	355	234	195	179	357	282	265	286	175	195	163	297

    a) Calculate the Arithmetic mean for the data presented in Table 1.

    b) Compute the Median for the data presented in Table 1.

    c) Compute the Mode for the data presented in Table 1.

    c) Which one of the values you obtained above is the most suitable measure of location among the values you obtained. Defend your answer.

2. Write short explanatory notes on each of the following:

    a) Statistics as a science;

    b) The superiority of the ratio scale as compared to the interval scale;

    c) Distinction between class boundaries and class limits;

        a. Continuous as compared to descrete data
        b. Inferential statistics

3. A random sample was taken from three political parties and questioned regarding their opinion toward a tax reform programme. Do the data presented in Table 2 indicate that the patterns of opinion are significantly different among the three political parties? Use the 0.01 significance level.

Table 2: Opinions in of party members on a tax reform progrogramme

Party	Favour	Indifferent	Opposed
A	138	83	64
B	64	67	84
C	125	52	34

4.   To determine the maximum stopping ability of cars when their brakes are fully applied a chosen number of cars were to be driven at different speeds and the distance each required to come to a complete stop is was determined. The various initial speeds selected for each car and the stopping distances recorded are given in Table 3.   Assuming that the all data presented in the said Table 3 were randomly collected and conform to Chebyshev's theorem; would one be right to conclude that the distance each car requires to cover before stopping is significantly a function of its specific speed? Aim at a 99 percent accuracy in obtaining your results.

Table 3: Data on Speed and Stopping distance of Selected cars

Initial Speed (Km/ph)	Stopping distance (Metres)
16.3	20
26.7	20
39.2	30
63.5	30
51.3	30
98.4	40
65.7	40
104.1	50
155.6	50
217.2	60
18.0	15
25.5	12
160.0	75
200.0	48

Source: Hypothetical data.

5. Presented in Table 4 are a number of fish ponds and the area each one of them covers. Assuming that data from each of these samples are skewed, would one be justified to conclude that the areas covered by number of ponds in Zemba, Mang'ombe, Chinsali and Kaoma are significantly different. Use the 0.05 level of significance.

Table 4: Sizes of Fish Ponds (in Square Metres) in Zemba, Mangombe, and Kaoma Areas

Zemba	Mang'ombe	Chinsali	Kaoma
12	16	25	38
45	08	14	06
75	10	11	29
11	22	17	21
85.5	25.9	10	04.6
14	34	06	14
99	14	15	23
77	28	19	25
66	17	24	
44			

6. Twelve pigs aged one month each were fed on the same type of food according to the periods indicated in Table 5. Establish whether there is a relationship between the two variables to show that the longer the time a pig spends eating the more weight it gains after one month. Data presented in Table 5 is meant to assist you make a justifiable decision. Answer the questions below.

Table 5: Relationship between the time (in hours per day) a pig spends eating and the weight (in Kg) it gains after one month

Time	Weight gained
12	18
10	11
05	10
16	25
04	08
11	16
08	14
09	12
13	20
15	24

i)   Plot your data on the graph paper that is provided to you.
ii) Producer a regression equation.
iii) Interpret your simple regression equation.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 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 an approved calculator is allowed.

1. A random sample of n_1 =288 voters registered in Province A showed that 141 voted in the last general election. Another random sample of n_2 =216 registered voters in Province B showed that 125 voted in the most recent general election. Do these data indicate that the population proportion of voter turnout is higher in Province B than in Province A at 0.05 level of significance?

2. The type of raw material used to construct stone tools found at the Archaeological site X is shown in Table 1. A random sample of 1486 stone tools was obtained from a current excavation site.

Table 1: Distribution of stone tools at Archaeological Site X.

Raw Material	Regional Distribution of Stone Tools (%)	Observed Number of Tools at Current Excavation Site
Basalt	61.3	906
Obsidian	10.6	162
Welded tuff	11.4	168
Pedernal chert	13.1	197
Other	3.6	53

Source: Hypothetical

At 0.01 level of significance, test the claim that the regional distribution of raw materials fits the distribution at the current excavation site.

3. Measurements were made on random samples of three kinds of soil and yielded the following results on infiltration rates in mm/hour as shown in Table 2:

1

Table 2: Infiltration Rates for three types of soils

Soil Type	Infiltration rates (mm/hour)									
A	4	6	3	5	2	8	2	2		
B	6	2	3	3	4	2	4	4		
C	5	4	8	7	9	6	3	1	4	5

Source: Hypothetical

Assuming that the population distribution from which the three samples were drawn cannot be verified, test the claim that the three kinds of soils have different infiltration rates at 0.01 level of significance.

4. (a) A GEO 474 student undertaking research on the river discharge worked out his summaries as follows:

$\bar{x}$ = 530 litres/ sec

s = 165 litres/sec

(i) What assurance can this student give his supervisor that he had captured recordings between 530 and 700 litres/sec?

(ii) How possible was it for the student to record water discharge below 270 litres/sec?

(iii) Assuming that the student had a score of 1 500 litres/sec of water in his data set, what advice would you give him if you were his supervisor?

(b) A fruit juice manufacturing company carried out thirty (30) tests on the various juices it produced in order to establish the shelf life (in months). The findings are shown in Table 3.

Table 3: Shelf life of thirty (30) varieties of fruit juices (in months).

24	20	19	21	24	24
25	24	21	27	30	24
23	28	24	24	19	21
26	25	24	22	24	19
25	24	25	23	23	22

Source: Hypothetical

(i)   Calculate the: a) Mean
                       b) Median
                       c) Mode

ii)   Confirm whether the shelf life of these juices conform to Chebyshev's rule.

5.   Use the two randomly distributed data sets presented in Table 4 to determine if any of them is a function of the other. Aim for the 99 percent accuracy level in your analysis.

Table 4: Land cleared (in hectares) per week and number of labourers working at the same pace per week

Land cleared per week	20	35	15	10	16	40	22	38	4	42	12	30	8	20
Number of labourers	18	30	24	8	16	35	20	32	5	42	9	28	25	22

Source: Hypothetical

6. Study Figure 1 and answer the following questions:

   a) Determine the simple regression equation

   b) Explain your simple regression equation.

   c) Draw the line of best fit on Figure 1

   d) Determine the weight of a person who consumes 114 Kilograms of lean white meat per day.

END OF EXAMINATION

WEIGHT PER KG.
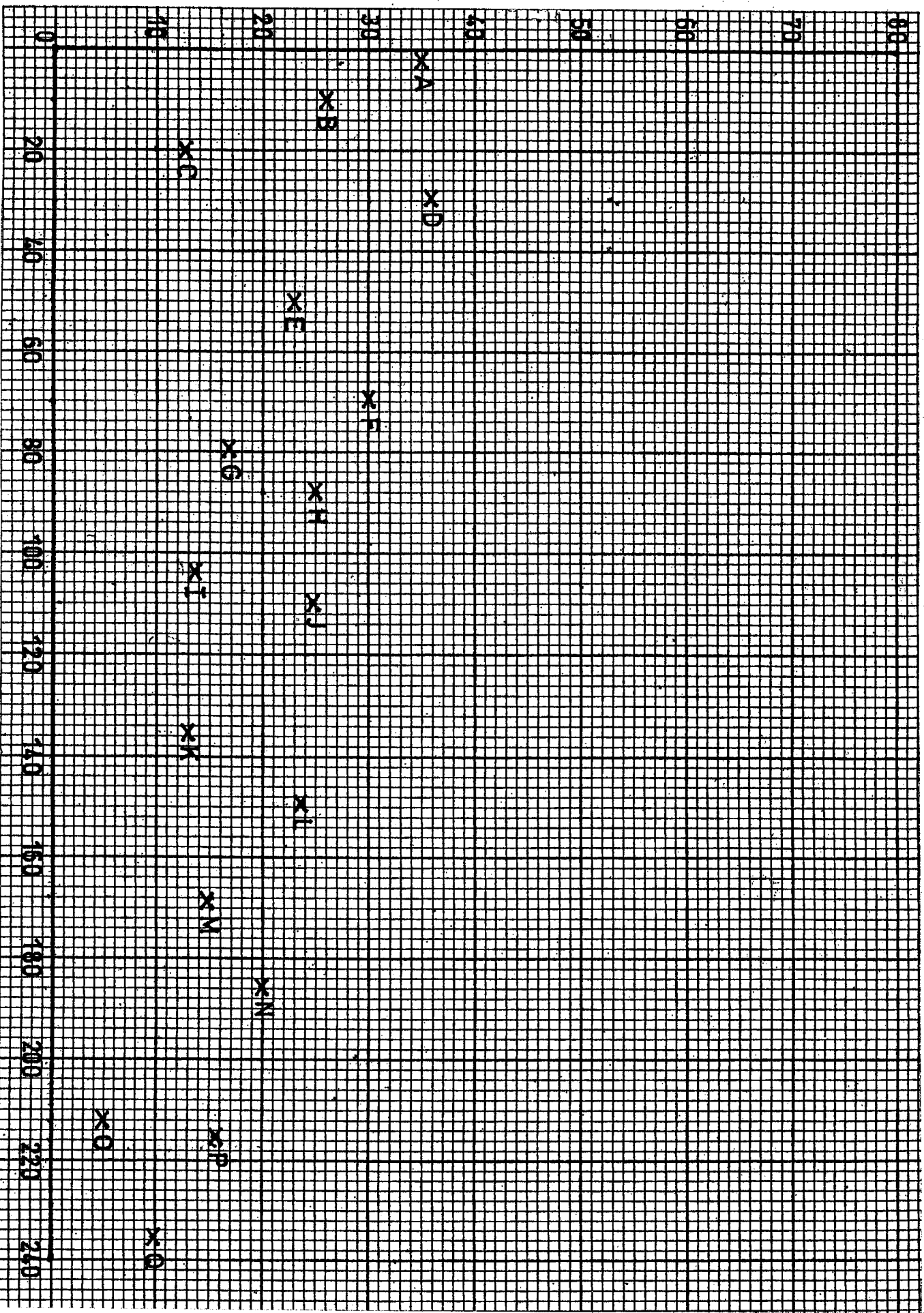
THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER EXAMINATION

GEO 482: ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT II

TIME   : Three hours

INSTRUCTIONS: Answer any <u>FOUR QUESTIONS</u>. All questions carry equal marks.

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1. The current Global Economic Crisis has many negative social, economic, political as well as ecological connotations. What are the major ecological challenges arising from this economic crisis.

2. Give an elaborate exposition of the social, economic as well as ecological effects of acid deposition.

3. Proverbs 22 verse: 1 of the Bible tells us that the poor and the rich have one thing in common; they are both created by the Lord. Various research findings also indicate that the poor and the rich affect the environment in multiple ways. Explain.

4. 'Wetlands have different definitions and descriptions, but despite such diversity, they have one thing in common'. They are all threatened. Discuss

5. Fisheries are critically dependent upon the water environment. Various types of pollution as well as climate change affect fisheries. Elucidate

6. Explain the waste management concepts, using the waste management hierarchy

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END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 492: NATURAL RESOURCES ECONOMICS

Time: Three hours

Instructions: Answer any <u>four</u> questions.
All questions carry equal marks.
The use of an approved calculator and Phillips University Atlas is allowed.
You are encouraged to use illustrations wherever appropriate.

1.   Explain how the investment of inframarginal rents can result in the maintenance or improvement economic output of a country.

2.   Demonstrate the effects of using private and social discount rates in public projects.

3.   Evaluate the use of the Contingent Valuation Method (CVM) in the evaluation of natural resources.

4.   Describe an economic approach that can be used to select a pollution control method by a regulatory body.

5.   Describe the basic concepts that were used to develop the bio-economic model of fisheries management.

6.   Discuss the implications of including off site environmental effects on the benefits of converting a forest for agricultural purposes.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 495: ENVIRONMENTAL HAZARDS AND DISASTERS

TIME: Three Hours

INSTRUCTIONS: Answer any four questions. All questions carry equal marks. The use of a Philip's University Atlas and a certified calculator is allowed. Candidates are encouraged to make use of illustrations wherever appropriate.

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1. With the help of specific examples, outline and discuss any two contrasting models of risk perception.

2. 'Land use planning has been identified as one way of reducing vulnerability to disaster but it has some practical limitations'. Outline and discuss the major practical limitations of this strategy with reference to Zambia.

3. 'Risk assessment depends on the availability of a good database accumulated over a long period of time but this is not the case for many threats, especially the newer technological hazards where the historical database may be quite inadequate to support a reliable assessment of risk'. How would you assess risk in such a case?

4. 'The Kafue River has in the immediate past experienced plant infestations which threatened the ecosystem as well as hydro power generation.' Outline and discuss the measures that were undertaken by the relevant authorities and their limitations.

5. With the help of examples, explain Smith's (2000:38) contention that "the world trend is probably towards more disaster related deaths and damages despite the many positive steps being taken to reduce disasters".

6. With the help of an annotated diagram, discuss the contention that hazards exist at the interface between the natural events and human use systems.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 922: GEOGRAPHY OF REGIONAL PLANNING AND DEVELOPMENT

TIME: **Three** hours

INSTRUCTIONS: Answer any **four** questions. Use of a Philips' University atlas is allowed. Candidates are encouraged to use illustrations wherever appropriate.

1. Explain the reasons why development theorists differ in opinion on the fate of the world's poorest nations.

2. 'Africa has continued to experience social and economic crises despite some countries having gone through Structural Adjustment Programmes'. Discuss.

3. Explain how high population growth, religion, illiteracy, disease, and culture retard the development process.

4. Discuss the assertion that 'Globalization is irreversible and irresistible', (Blair in Buckman, 2004).

5. "Imagine Zambia without Copper" (Ezekwesili, 2009). As a GEO 922 student how would you advice the Government to diversify the economy through the agricultural sector in order to enhance economic growth.

6. Examine how railway corridors are potential areas of economic development.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 932: URBAN GEOGRAPHY

TIME: Three hours
INTRUCTIONS: Answer any **four** questions
All questions carry equal marks.
Candidates are encouraged to use illustrations wherever appropriate.

1. Write short explanatory notes on **all** of the following;
   a) The urban routeway
   b) Characteristics of the urban informal sector
   c) The colonial city
   d) Urban systems
   e) The Location theory of urban growth

2. Discuss the contention that unplanned settlements are 'slums of hope', outlining the social, economic and cultural contributions of these areas.

3. "The battle for a clean environment will be lost and won in cities" (Tannerfeldt and Ljung, 2006:64). Discuss.

4. Evaluate the intended impact of the Urban and Regional Planning law reform process being undertaken by the Ministry of Local Government and Housing.

5. 'Cities exert influences which are not proportional to their size'. Analyse this statement in light of the significance of urban places in Africa.

6. Explain how Urban Geography has developed as a field of study.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 952: GEOGRAPHICAL HYDROLOGY

TIME: Three hours

INSTRUCTIONS: Answer any FOUR questions.

All questions carry equal marks. Candidates are advised to make use of illustrations and examples wherever appropriate.

1.   Discuss the river basin planning approach using the United States of America and India as case studies.

2.   What are the major factors affecting evapotranspiration of a region and outline the appropriate methods that can be applied to estimate evapotranspiration.

3.   Outline and explain the factors that affect the interception loss from vegetation.

4.   Discuss the major techniques used in determining soil moisture.

5.   Diagrammatically illustrate the major components of a hydrograph and discuss the assumptions made when constructing hydrographs.

6.   With the use of a diagram explain the Soil-Plant-Atmosphere-Water (SPAW) System and critically discuss its relevance to hydrology.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 955: GEOMORPHOLOGY

TIME: Three hours

INSTRUCTIONS: Answer any FOUR questions.

All questions carry equal marks. Candidates are advised to make use of illustrations and examples wherever appropriate.

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1. Write short explanatory notes on ALL of the following:

    a) Regional metamorphism
    b) Primary seismic waves
    c) Froude Number
    d) Probable maximum flood
    e) Buried and exhumed paleosol

2. Discuss how the Plate tectonics theory helps geomorphologists understand the interrelationships of rocks, earthquakes and volcanism.

3. 'Climamorphogenetics emphasizes that different climatic regions experience different morphological processes'. Discuss.

4. Diagrammatically outline the evolutionary occurrence of channel planforms found in Zambia and distinguish their characteristics.

5. Discuss the major characteristics of Mäckel's three physiographic regions of Zambia.

6. With the use of diagrams outline the typical bed forms in the lower and upper flow regimes for alluvial sand bed channels.

END OF EXAMINATION

UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATION
GEO 962: BIOGEOGRAPHY

TIME: Three hours

INSTRUCTIONS: Answer any four (4) questions

All questions carry equal marks.

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1. Write short explanatory notes on all of the following:

    a) Climatic relicts

    b) Taxonomical classification of living organisms

    c) Ecological tolerance

    d) Natural selection

    e) Speciation

2. "…..the Theory of Island Biogeography is not of merely academic interest"
    (Cox and Moore, 1985:116). Discuss.

3. In what ways and to what extent can the nature of the biota of mammals and flowering plants that developed on each continent be attributed to the gradual fragmentation of continents and the climatic changes that took place during Cenozoic era?

4. Critically analyse the factors that influence the distribution and abundance of plants and animals on the surface of the earth.

5. Imagine you have been appointed as a Park Manager of the National Park located adjacent to human settlements in Luangwa Valley in Zambia. The park is prone to perennial burning. Explain the factors you will take into consideration when developing and implementing the fire management plan for the National Park.

6. Discuss the role of domestication of plants and animals in the development of modern agriculture.

END OF EXAMINATION

GEO 971: AIR PHOTOGRAPHY (PAPER I)

INSTRUCTIONS: ANSWER ALL QUESTIONS. **TIME:** 3 HOURS

1.　a)　Explain and illustrate the part of the electromagnetic spectrum often used in aerial photography. (5 marks)

　　b)　Why is the principle of spectral response patterns used in the study of earth surface features recorded on aerial photographs? (5 marks)

2.　Explain on how the following may aid in aerial photo interpretation:

　　a)　Shape　　　b)　Site or place　c)　Texture　　　(15 marks)

3.　Explain the differences in the structure and function between true colour and colour infra-red films.　(10 marks)

4.　What do you understand by the following remote sensing terms:

　　a) Oblique airphotos　　　b) Drift errors　　　c) Panchromatic film
　　d) Airphoto ground distance　　　e) Relief displacement
　　　　　　　　　　　　　　　(10 marks)

5.　What is a flight plan?　　　(10 marks)

6.　Give the main types of commonly used airphotos (not films), explaining their characteristics, advantages and disadvantages.　(10 marks)

7.　How may airphotos be used in soil surveying?　(10 marks)

8.　How is airphotography used in locating and mapping of the extent of water bodies?　(10 marks)

END OF EXAM

GEO 971 – AIRPHOTOGRAPHY (PAPER II)

INSTRUCTIONS: ANSWER ALL QUESTIONS. TIME: 3 HOURS

1. A client asks you to take normal size airphotographs of an area 300km long and 30 km wide. Assuming a flying height of 10000m, camera focal length of 150mm, forward overlap of 30% and a side lap of 20%:

    a) Determine how many airphotos would be required to cover the whole area. (5 marks)

    b) If your client complains that the number of airphotos you have determined in 1a, above, is too many what options would you suggest to reduce the number? (5 marks)

2. You are studying the vegetation cover in Luangwa North Game Reserve area to determine whether the vegetative cover is shrinking or expanding. You have a choice of using any one or combination of the following remote sensing materials: true colour, false colour, infra-red black and white and ordinary black and white airphotographs, all taken in 1980, 1989, and 1999. As an expert in airphoto interpretations, provide the following:

    a) your selection of the most suitable remote sensing material to use in this assignment. Give reasons for your selection. (5 marks)

    b) an outline of the approach you would use to determine the magnitude and rate of change in the vegetation cover. (5 marks)

3. a) The distance between UNZA bus stop and Lusaka International Airport road junction measures about 500mm on a map with a scale of 1:25 000. The same distance measures about 600mm on an airphoto. What would the scale be on the airphoto? (5 marks)

    b) A tree appears on a two stereo airphoto pair. On photo 'A' the difference between the top and base of the tree is 4mm while on airphoto 'B' the difference is 2mm . Assuming the distance between the two principle points is 10cm, determine how high above the ground the plane was fying when it took the photographs. (5 marks)

4. Explain the likely disturbances that may occur when Electromagnetic Radiation is propagated through the atmosphere. (10 marks)

5.   A building appears on an airphoto with a relief displacement of 3mm and a radial distance from the principle point of 10cm. If the flying height was 10000m above datum:

        a. determine the height of the building (5 marks)
        b. how are the radial distance and flying height related to displacement? (5 marks)

6.   How is remote sensing applied in water resources surveys? (10 marks)

7.   How is information registration done on airphotography? (10 marks)

END OF EXAM

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER EXAMINATIONS

GEO 972 - SATELLITE REMOTE SENSING AND GEOGRAPHIC
INFORMATION SYSTEMS

TIME: Three hours
INSTRUCTIONS: Any four questions
NOTE: All questions carry equal marks

1.   Write short explanatory notes on ALL of the following:

      a)   Electromagnetic energy
      b)   Scanning mechanisms
      c)   Image pixel
      d)   Low pass and high pass filters
      e)   Feature space

2.   Discuss the current status of satellite remote sensing.

3.   Explain the differences between the Landsat Thematic Mapper (TM) and SPOT 4
      High Resolution Visible (HRV).

4.   'Satellite imagery data are not always perfect'. Explain.

5.   Explain the steps undertaken in supervised classification and the advantages of
      such a classification procedure.

6.   Explain the view that a Geographic Information System (GIS) is a decision
      support process.

END OF EXAMINATION

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINTAION

GEO 995: ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT I

TIME   : Three hours (3 hrs)
INSTRUCTIONS: Answer any <u>FOUR QUESTIONS</u>. All questions carry equal
               marks.

1. Why should all Nations cooperate in the essential task of eradicating poverty as an indispensable requirement for sustainable development?

2. If carrying capacity 'blames' anyone, it 'averages' the blame. It blames the rich for using too many resources, as well as the poor for being too numerous. Elucidate.

3. Provide a theoretical exposition as to why poverty must not only be understood in the sense of inadequate income but holistically as a deprivation of a series of basic needs.

4. Discuss the notion that 'Population problems are a consequence of social problems which are a result of economic problems resulting from political structures in a country'.

5. What is carrying capacity and what can cause the carrying capacity of an environment to change over time?

6. Human societies have been altering the earth since time immemorial. But the pace and scale of degradation that is taking place today is historically new. Discuss.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS – FEBRUARY 2008

GG322: STRATIGRAPHY AND REMOTE SENSING

PRACTICAL

PAPER II

TIME: THREE HOURS
ANSWER: ALL QUESTIONS. NEATLY DRAWN SKETCHES/ DIAGRAMS
          RECOMMENDED FOR A FULL MARK.

1   (a) What does following abbreviations stand for?
     (i) UTM   (2 marks)
     (ii) TIFF   (2 marks)
     (iii) EMR   (2 marks)
     (iv) GPS   (2 marks)
  (b) Differentiate between the following:

     (i)   TIFF and GeoTIFF ....   (4 marks)
     (ii) Spectral Signature and Spectral Response   ....   (4 marks)
     (iii) Path and Row...   (4 marks)
     (iv) Cross-track and Along-track scanners.............................   (4 marks)

  (c) With neatly labeled sketches, where possible differentiate between the following:
     (i)   Vector Model and Raster Model   (4 marks)
     (ii) Aerial photographs and satellite images   (4 marks)
     (iii) Transmission and Reflection   (4 marks)
     (iv) Passive and Active Sensors   (4 marks)
     (v)   Energy and Radiation   (4 marks)

2. (a) List the sensor systems known today ……………………....................……   (5 marks)
  (b) How many satellites are required to get an accurate GPS position?
     Explain your answer……………………………………………………….(4 marks)
  (c) In what ways can you improve accuracy in a GPS set-up?................   (2 marks)
  (d) List the data sources i.e. various forms of data that you could enter into a GIS
     project   ……………………………………………………….(5 marks)

3. As a Geologist, you have been assigned to undertake a research study in Zambia.

(a) You decide to select 2 aerial photos so that you can undertake an initial photo-geological interpretation. You are therefore required to:

(i) Provide a fully annotated photogeological interpretation on the portion that you are able to obtain a stereo vision i.e. able to see in three dimensions. ……………………………………………………………(30 marks)

(ii) Provide a description of the photogeology i.e. the geology of the annotated area……………………………………………..(10 marks)

END -- GOOD LUCK

THE UNIVERSITY OF ZAMBIA
Directorate of Distance Education

2008/9 ACADEMIC YEAR
SECOND SEMESTER FINAL EXAMINATIONS

M111:   **Mathematical Methods I**

TIME ALLOWED: Three (3) Hours

INSTRUCTIONS :   Answer any **Five** (5) questions from this paper
Omission of essential working may result in loss of marks
Calculators and Mathematical tables are **NOT** allowed in this
paper

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1.   (a)   Let U = [–7 , 10] be the universal set, and let A = (–2 , 8), B = [1 , 8]
   and C = (–7 , 6) be subsets of U.
   Find
   (i) $A \cap (B - C)$
   (ii) C'
   (iii) $(A \cup C)'$

   (b)   (i)   Express $\dfrac{2\sqrt{3}+1}{2-\sqrt{3}}$ in the form $a + b\sqrt{3}$ where a and b are rational
   numbers.
   (ii)   If α and β are roots of the equation $x^2 + 4x - 2 = 0$, find the sum
   $\dfrac{1}{\beta^2} + \dfrac{1}{\alpha^2}$

   (c)   Solve the inequality $\dfrac{x}{x-3} \geq \dfrac{1}{2}$

2.   (a)   (i)   Let $(1 + 3i)z = 5(1 + i)$. Express z in the form $a + bi$ where a and b
   are rational numbers.

   (ii)   Express $1.4\overline{54}5$ in the form $\dfrac{a}{b}$ where a and b are integers.

   (b)   Prove the identity $\dfrac{1 - \cos 2A + \sin 2A}{1 + \cos 2A + \sin 2A} = \tan A$

   (c)   Let $f(x) = -2x^2 + 11x - 15$. Find the maximum or the minimum point of
   $f(x)$. Hence sketch the graph of $f(x)$.

3. (a) The table below shows an operation '*' on a set G = { 1 , 5 , 7 , 11 }.

*	1	5	7	11
1	1	5	7	11
5	5	1	11	7
7	7	11	1	5
11	11	7	5	1

     (i)   Is the operation a binary operation? Give reason for your answer.
     (ii)   Is the operation commutative?
     (iii)   Evaluate (5 * 1) * 11 and (5 * 7) * (7 * 11)

   (b) Let $f(x) = \dfrac{2x}{3x - 2}$ and $g(x) = \dfrac{1}{x^2}$
     (i)   State the domain of f and the range of g.
     (ii)   Find the composite function $(fog)(x)$.
     (iii)   Find the inverse of $f(x)$.

   (c) The graph of $f(x) = 5 + 2\cos(x + k)^0$, $0 \le x \le 360^0$ passes through the point (30° , 5).
     (i)   Find the smallest value of k
     (ii)   Solve the equation $f(x) = 4$.

4. (a) Evaluate the following limits:
     (i) $\lim\limits_{x \to -2} \dfrac{x^2}{3x^2 + 7}$
     (ii) $\lim\limits_{x \to 3} \dfrac{x^2 - 9}{2x^2 - 5x - 3}$
     (iii) $\lim\limits_{x \to \infty} \dfrac{3 + 2x - 5x^2}{2x^2 + 7}$

   (b) Differentiate the function $f(x) = \dfrac{1}{x}$ from the first principle.

   (c) Let $f(x) = -3\cos(2x - \pi)$, $0 \le x \le 2\pi$
     (i)   Find the amplitude, the shift and the period of $f(x)$.
     (ii)   Sketch the graph of $f(x)$.
     (iii)   Find the values of x such that $f(x) = \dfrac{3}{2}$.

5. (a) Given that $x = 2$ is a root of the equation $\alpha^2 x^2 + 2(2\alpha - 5)x + 8 = 0$
   (i) find the possible value(s) of α
   (ii) Hence find the corresponding value of the other root.

   (b) The complex numbers z_1 and z_2 are given by;
   $z_1 = 24 + 7i$ and $z_2 = 4 - 3i$

   (i) Express $\dfrac{z_1}{z_2}$ in the form $a + bi$ where a and b are rational numbers.
   (ii) Given that $z_1 + \alpha z_2$ is real, where α is a real number, find the value of α.
   (iii) Given that $z_1 + (p + iq)z_2 = 0$ where p and q are real numbers, find p and q.

   (c) Determine with reasons whether each function below is even, odd or neither:
   (i) $f(x) = x^3 - \dfrac{3}{x}$
   (ii) $g(x) = x^2 - x + \sin x$
   (iii) $h(x) = 5 + 3\cos 2x$

6. (a) Find $\dfrac{dy}{dx}$ of the following functions:
   (i) $y = x\cos(3x^2 + 1)$
   (ii) $y = \ln(x^3 - 2x^2)$
   (ii) $y = \dfrac{\sin x}{1 + \cos x}$

   (b) Given that $f(x) = \sqrt{2 - x}$
   (i) State the domain and the range of $f(x)$
   (ii) Sketch the graph of $y = f(x)$

   (c) Let $x - 2$ be a factor of $f(x) = x^3 - x^2 + ax + b$.
   (i) Find a relation between a and b
   (ii) Given that the remainder when $f(x)$ is divided by $x - 3$ is 10, find the values of a and b
   (iii) Hence factorise $f(x)$ completely.

   End of Exam

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES
Department of Mathematics & Statistics

SECOND SEMESTER FINAL EXAMINATIONS

April, 2009
M112—MATHEMATICAL METHODS II -A

Time allowed : THREE(3) HOURS

Instructions : There are seven(7) questions. Attempt **ANY FIVE (5)** questions. All

questions carry equal marks. Show all your working to earn full marks.

NO CALCULATORS!!

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1. (a) If $(a + x)^n$ is expanded in increasing order of x, find

   (i) the value of n if the coefficients of x^2 and x^{n-2} are equal.

   (ii) the value of a if the coefficients of the second and third terms are equal and $n = 15$.

   (b) Prove by mathematical induction that for all natural numbers $n \geq 1$,

   (i)
   $$\frac{1}{(1)(3)} + \frac{1}{(3)(5)} + \frac{1}{(5)(7)} + \cdots\cdots + \frac{1}{(2n-1)(2n+1)} = \frac{n}{2n+1}.$$

   (ii) Solve for real values of x:
   $$2^{\frac{2}{\log_5 x}} = \frac{1}{16}.$$

   (c) (i) Write down the first three terms in decreasing powers of x in the expansion of $(x^2 - \frac{2}{x^4})^{\frac{1}{2}}$.

   (ii) Determine the range of values of x for which the expansion in part (i) is valid.

2. (a)   Let $y = f(x) = x^3 + 3x^2 + 3x + 1$.

(i)   Find the turning points, (if any).

(ii) Find the points of inflection, (if any).

(iii) Hence sketch the graph of $y = f(x)$, indicating all the necessary points.

(b)   (i) Express the following as a single logarithm to base 2;

$\log_8 2 + c \log_8 d - r \log_8 s$.

(ii) Evaluate the following integral: $\int_0^{\frac{\pi}{4}} \tan^2 x \, dx$.

(c)   Prove by mathematical induction that for all natural numbers $n \geq 1$,

$$1 + \cos^2 \theta + \cos^4 \theta + \ldots \ldots + \cos^{2n} \theta = \frac{1 - \cos^{2n+2} \theta}{\sin^2 \theta}.$$

3. (a)   A three-sided fence is to be built next to a straight section of a river, which forms the fourth side of a rectangular region. The area is to equal 1800m². Find the dimensions of the fence which minimize the perimeter.

(b)   Evaluate the following integrals:

(i) $\int x \sec^2 x \, dx$

(ii) $\int_1^2 x(x-1)^{15} dx$.

(c)   Given that $1 - i\sqrt{3}$ is a root of the equation $z^4 + 2z^3 + 5z^2 - 2z + 36 = 0$, find all the other three roots.

4. (a)   (i) Sketch the curve with equation $y = x^3 - x$.

(ii) Hence find the area of the finite region enclosed by the curve and the x-axis.

(b)   (i) Express

$$\frac{x^2 + x + 1}{(x+1)(x^2+1)} \quad \text{into partial fractions.}$$

(ii) Hence prove that

$$\int_0^1 \frac{x^2 + x + 1}{(x+1)(x^2+1)} dx = \frac{3}{4} \ln 2 + \frac{\pi}{8}.$$

(c)   Express the following sum of binomial coefficients as a single binomial coefficient of the form $\begin{pmatrix} n \\ r \end{pmatrix}$, where n, r are positive integers with $r \leq n$:

$$\begin{pmatrix} 7 \\ 3 \end{pmatrix} + \begin{pmatrix} 8 \\ 5 \end{pmatrix} + \begin{pmatrix} 7 \\ 3 \end{pmatrix}.$$

5. (a) (i) Express the complex numbers $z = \sqrt{3} + i$ and $w = 1 - i\sqrt{3}$ in the polar form.

(ii) Express $\frac{1 - i\sqrt{3}}{(\sqrt{3} + i)^{15}}$ in the form $a + ib$ where a and b are real.

(b) Solve the equation $\log_9(x - 5) + \log_9(x + 3) = 1$ for real values of x.

(c) (i) Find $\frac{dy}{dx}$ given that $y = 2^{x^2 + 1}$.

(ii) Evaluate the following definite integral:

$\int_{-\frac{\pi}{4}}^{\frac{\pi}{4}} \cos 2x \cos 5x \, dx$.

6. (a) Find the fourth roots of $-81i$ and display them on the Argand diagram.

(b) Show that $8^n - 3^n$ is divisible by 5 for all natural numbers $n \geq 1$.

(c) Given the following system of equations

$$4x + 2y - 3z = 2$$

$$2x + y = 1$$

$$5x + 3y + z = 0,$$
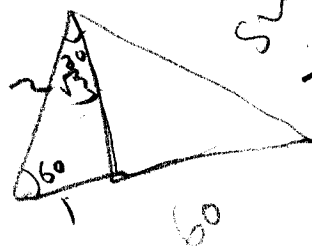
(i) write the system of equations in matrix notation $AX = B$, specifying A, X and B.

(ii) Hence, use Cramer's rule to solve the system of equations for x, y, z.

7. (a) Let $A = \begin{pmatrix} 1 & 0 \\ 1 & 1 \end{pmatrix}$. Prove by mathematical induction that $A^n = \begin{pmatrix} 1 & 0 \\ n & 1 \end{pmatrix}$ for all natural numbers $n \geq 1$.

(b) (i) Obtain the term independent of x in the expansion of $(2x^3 - \frac{1}{x})^{20}$. [You may leave your answer in terms of factorials]

(ii) Let $A = \begin{pmatrix} 1 & 2 & 1 \\ 4 & 0 & 2 \end{pmatrix}$ and $B = \begin{pmatrix} 3 & 1 & -2 \\ -4 & 5 & 2 \end{pmatrix}$. Find $B^T A$, where B^T means B transpose.

(c) Given the matrix $A = \begin{pmatrix} 1 & 2 & 3 \\ 3 & 1 & 0 \\ 2 & 2 & 1 \end{pmatrix}$, find the adjoint of A, that is adj$A$.

END.

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

UNIVERSITY SEMESETER I EXAMINATIONS- 2009

M114 – MATHEMATICAL METHODS II -B

INSTRUCTIONS: 1. Answer any **four (4)** questions.
2. All questions carry equal marks.
3. Show all the necessary work to earn full marks.
4. Write down the questions attempted in one of the columns on the front page of the main booklet.
5. Use of calculators is **not** allowed.

TIME ALLOWED: Three (3) hours.

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1. (a)   By using the substitution $t = \tan \dfrac{1}{2}x$, prove that

(i) $\operatorname{cosec}x = \dfrac{1+t^2}{2}$ and $\cot x = \dfrac{1-t^2}{2t}$

(ii)   Use the result that $\operatorname{cosec}x - \cot x = \tan \dfrac{1}{2}x$, show that

$\tan 15^0 = 2 - \sqrt{k}$, and state the value of k,

(b)   The function f is defined for all real x by $f(x) = \cos x^0 - \sqrt{3}\sin x^0$

(i)   Express $f(x)$ in the form $R\cos(x+\theta)^0$, where $R > 0$ and $0^0 < \theta < 90^0$

(ii)   Solve the equation $|f(x)| = 1$ giving your answers
in the interval $0^0 \le x \le 360^0$

(c)   Find the equation of the tangent line to the curve $x^3 + y^3 = 2xy$
at the point $P(1,1)$

(d)   Find the value of k such that $4x^2 - 15xy + ky^2 = 0$
represents a pair of straight lines.

1

2 (a)   Given the equation of the circles

$$x^2 + y^2 - 6x + 7 = 0 \text{ and } x^2 + y^2 + 2x - 8y - 1 = 0$$

(i)   Show that the circles touch externally.
(ii)   Find the coordinates of their point of contact.
(iii)   Find the equation of their common tangent.

(b) $\underline{a} = 3i - 2j - k$, $\underline{b} = 3i - 5j + 2k$ and $\underline{c} = i + pj + qk$,

(i)   Find the angle between $\underline{a}$ and $\underline{b}$
(ii)   Find the constants p and q given that $\underline{c}$ is perpendicular to $\underline{a}$
        and $\underline{c}$ is perpendicular to $\underline{b}$
(iii)   Using values of p and q found in (ii), find a unit vector perpendicular
        to both $\underline{a}$ and $\underline{c}$

(c)   Given the equation of the curve $f(x) = \dfrac{1}{3}x^3 - 2x^2 + 3x$

(i)   Find the x and y intercepts
(ii)   Find the stationary points.
(iii)   Test the nature of the stationary points
(iv)   Find if any the point(s) of inflection.
(v)   Sketch the graph of the curve labeling all the necessary features.

(d)   Evaluate $\displaystyle\int_{\ln 2}^{\ln 3} e^{3x}\, dx$

3 (a) A square cardboard ABCD is of side 8 meters. A square of x meters is removed from each of corners and the remainder is folded to form an open tray of depth x meters and volume V metres^3

(i)   Show that $V = 64x - 32x^2 + 4x^3$

(ii) Find the value of x for which $\dfrac{dV}{dx} = 0$

(iii) Show that the value of x gives the maximum value of V

(iv) Find this maximum value of V.

(b) Find the area A of the region in the XY plane bounded by the graphs of
$$2y = 16 - x^2 \text{ and } x + 2y = 4$$

(c)

(i)   Find $r > 0$ and θ given that $r\,cis\,\theta = (-\sqrt{3} - i)^8$.

(ii) Show that $\sinh^{-1} x = \ln(x + \sqrt{x^2 + 1})$

(d)

(i)   Find $\displaystyle\int e^{3x} \sqrt{1 + e^{3x}}\, dx$

(ii) Show that $\dfrac{d}{dx}\left[\sin^{-1}(\cos x)\right] = -1$

4 (a) Discuss and sketch the graph of the equation labeling the direct ices, center and focus (foci)

$$9x^2 + y^2 - 36x + 8y + 43 = 0$$

(b) Find the inverse of the matrix

$$A = \begin{pmatrix} 1 & 0 & 2 \\ -2 & 2 & 1 \\ 1 & 1 & 2 \end{pmatrix}$$

and hence solve using the **inverse method** the system of equations

$$x + z = 3$$
$$-2x + 2y + z = 2$$
$$x + y + 2z = 4$$

(c) A spherical balloon is blown up so that its radius increases at a constant rate of $0.01\,cm\ s^{-1}$. Find the rate of increase in the volume when the radius is 5cm.

3

5 (a) Prove by mathematical induction that for all positive integers $n \geq 1$

$$5^{2n} - 1 \text{ is divisible by } 24$$

(b) In the binomial expansion of $\left(1 + \dfrac{x}{n}\right)^n$ in ascending powers of x , the

coefficient of x^2 is $\dfrac{7}{16}$. Given that n is a positive integer,

(i) Find the value of n.

(ii) Evaluate the coefficient of x^3 the expansion.

(c) Solve for x the equation
$$4\cosh x + 8\sinh x = 1$$
for all real values of x giving the root as a natural logarithm.

(d)

(i) Evaluate $\displaystyle\int_0^1 \dfrac{x^2 - 1}{(x^3 - 3x + 1)^6}\, dx$

(ii) Find $\displaystyle\int x e^x \, dx$

END OF EXAMINATION

4

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF MATHEMATICS AND STATISTICS

2008 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

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1. (a) (i) Evaluate $\lim\limits_{x \to 1} (3x - 2)(2x + 3)$

   (ii) Find the derivative of $f(x) = x^2 + 6x$ from first principles.

   (b) (i) Find the equation of the tangent to the curve $y = 2x^2 + 3x - 1$ at the point $(1, 4)$.

   (ii) Evaluate $\int_0^1 x(x^2 + 1)dx$

   (c) Evaluate $\int \dfrac{x + 1}{(x^2 + 2x - 5)^2}\, dx$

2. (a) Find $\dfrac{dy}{dx}$ if

   (i) $y = \dfrac{x^2 + 1}{2x - 3}$

   (ii) $(x + 2y)^2 = x$

   (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) A counter is drawn from a box containing 10 red, 15 black and 5 yellow counters. Find the probability that the counter is
   (i) red
   (ii) not black
   (iii) black or yellow

1

3. (a) Determine if the function $f(x) = \begin{cases} 3x - 2, & x \le 2 \\ x^2, & x > 2 \end{cases}$

is continuous at $x = 2$.

(b) A continuous random variable X has the following probability density function

$$f(x) = \begin{cases} kx^2, & 0 \le x \le 2 \\ 0, & otherwise \end{cases}$$

(i) Show that $k = \dfrac{3}{8}$

(ii) Find $P(0 \le X \le 1)$

(iii) Find $E(X)$

(iv) Find $Var(X)$

(c) From a group of 5 men and 3 women, 4 are chosen to serve on a committee. Find the
(i) total number of ways of choosing the committee.
(ii) probability that 2 men and 2 women are chosen.

4. (a) The following data represent marks of 20 students in a mathematics test:

14　9　26　20　29　16　10　34　20　25
28　27　24　21　32　22　30　17　18　25

(i) Construct a grouped frequency distribution table taking equal classes intervals 5 – 9, 10 – 14, ...
(ii) Construct a frequency histogram and a frequency polygon on the same axes using the classes in (i) above.

(b) The probability function for a discrete random variable X is given as

x	−2	−1	0	1	2	3
$P(X = x)$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{5}$	y	$\frac{1}{5}$	$\frac{1}{6}$

(i) Show that $y = \dfrac{1}{10}$.
(ii) Find the cumulative distribution function of X.
(iii) Find $P(X > -1)$
(iv) Find $E(X)$

(c) Consider the word MATHS. Find the number of ways of arranging
(i) all the letters of this word in a line.
(ii) three letters chosen from this word in a line.

5. (a) Given the set of numbers
   $$7 \quad 7 \quad 2 \quad 3 \quad 4 \quad 2 \quad 7 \quad 9 \quad 4$$
   Find the
   (i) range
   (ii) mode
   (iii) median
   (iv) mean using the assumed mean $\bar{x}_a = 4$
   (v) variance

   (b) A box contains 4 black, 6 white and 2 red balls. A ball is picked at random from the box and not replaced. A second ball is then picked. Find the probability that the
   (i) first ball picked is white and the second ball picked is red.
   (ii) second ball picked is black.

   (c) Evaluate $\int \sin^{-1} x \, dx$

6. (a) If events A and B are such that $P(A) = \dfrac{1}{3}$, $P(B) = \dfrac{1}{4}$ and $P(A \cap B) = \dfrac{1}{10}$.
   (i) Find $P(A \mid B)$.
   (ii) Find $P(A \cup B)$.
   (iii) Determine if A and B are mutually exclusive.
   (iv) Determine if A and B are independent.

   (b) The probabilities that a girl goes to school by car, bicycle or on foot on any given day are 0.2, 0.3 and 0.5 respectively. The probabilities of her being late by these methods are 0.6, 0.3 and 0.1 respectively.
   (i) Find the probability that she is late for school.
   (ii) If she is late, find the probability that she went to school on foot.

   (c) Find $\dfrac{dy}{dx} = \dfrac{\cos x}{1 - \sin x}$

END OF EXAMINATION

The University of Zambia
School of Natural Sciences
Department of Mathematics & Statistics

2008/9 ACADEMIC YEAR
SECOND SEMESTER FINAL EXAMINATIONS

M212 – MATHEMATICAL METHODS IV

INSTRUCTIONS: 1. Answer any **Five (5)** of the seven Questions Only.
2. All questions carry equal marks.
3. Show all essential working to obtain full marks.
4. Indicate the question number for each question attempted on the cover of the main answer book.

TIME ALLOWED: Three (3) hours.

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1. (a) (i) Find the symmetric equations of the line which is orthogonal to the direction vectors of the lines

$$L_1 : x = -2 - 3t, \ y = 1 + 4t, \ z = -5t \ ;$$
$$L_2 : x = 3 + 7t, \ y = -2 - 2t, \ z = 8 + 3t$$

   (ii) Find the parametric equations for the line tangent to the curve

$$\mathbf{R}(t) = e^t \mathbf{i} + e^{-t} \mathbf{j} + \sqrt{2}\, t \mathbf{k}$$

   and an equation for the plane normal to the curve at the point $P(1,1,0)$.

   (b) (i) Find the distance between the planes Π_1 and Π_2

$$\Pi_1 : 6x + 9y - 18z = 17 \ ;$$
$$\Pi_2 : 2x + 3y - 6z = 6$$

   (ii) Find the area of the triangle with vertices $P_1(1,3,5)$, $P_2(2,-1,3)$ and $P_3(-3,2,6)$

1

2. (a) The plane curve is given by the equation

$$\mathbf{R}(t) = (\ln \sin t)\mathbf{i} + (\ln \cos t)\mathbf{j}.$$

Find the unit normal vector to the curve at $t = \dfrac{\pi}{6}$.

(b) For the space curve given parametrically by

$$x = 3t^2, \; y = 2t^3, \; z = 3t.$$

(i) Find its length from $t = 0$ to $t = 4$.

(ii) Find its curvature κ in terms of the parameter t.

3. (a) Use the definition of limits to show that $\lim\limits_{(x,y)\to(3,-1)} (x - 7y) = 10$.

(b) (i) If $z = \dfrac{xy}{x-y}$, show that

$$x^2 \frac{\partial^2 z}{\partial x^2} + 2xy \frac{\partial^2 z}{\partial x \partial y} + y^2 \frac{\partial^2 z}{\partial y^2} = 0$$

(ii) If $w = \sin xyz$, $x = s^2 r$, $y = r^2 s$, $z = r - s$, use the chain rule for partial derivatives to find $\dfrac{\partial w}{\partial r}$ and $\dfrac{\partial w}{\partial s}$.

4. (a) (i) Use partial derivatives to approximate the number

$$\sqrt{(0.01)^2 + (4.05)^2 + (2.96)^2}.$$

(ii) A right circular cone is measured and found to have diameter 10 cm and slant height 13 cm. There is a maximum error of 0.03 cm in the measurements. Use the total differential to find the maximum error in the calculation of the curved surface area.

(Curved surface area $= \pi\left(\dfrac{D}{2}\right)l$, where l is the slant height).

(b) A surface is defined by a function $f(x,y) = 2x^3 - 24xy + 16y^3$. Determine the nature of its critical points. ·

2

5. (a) Solve the differential equations:

(i) $(x^2 - y^2)dx - 3xydy = 0$, $y(1) = 0$.

(ii) $\dfrac{dy}{dx} + y = xy^2$.

(b) Show that the given differential equation is exact

$$(3x^2 - 2xy + 2)dx + (6y^2 - x^2 + 3)dy = 0,$$

and, hence find its general solution.

6. (a) Solve the second order differential equations:

(i) $y'' + y' - 2y = 0$, $y(0) = 4$, $y'(0) = 1$

(ii) $y'' + y' = e^{-x}$

(b) Solve the differential equation

$$y'' + y = \cos x$$

7. (a) Find the distance of the point $P_0(1,-2,3)$ from the plane through the points $P_1(1,3,5)$, $P_2(2,-1,3)$ and $P_3(-3,2,-6)$.

(b) (i) Prove that if f is any differentiable function, then $z = f(x^2 - y^2)$ is a solution of the partial differential equation
$$x\frac{\partial z}{\partial y} + y\frac{\partial z}{\partial x} = 0.$$

(ii) By eliminating the constants A and B, find a differential equation satisfied by the family of curves given by

$$y = Ae^{2x} + Be^{-3x}.$$

END OF EXAMINATION

The University of Zambia

Department of Mathematics and Statistics

END OF SEMESTER 2 EXAMINATIONS 2009

M222 - LINEAR ALGEBRA II

Time allowed: Three (3) hrs
Instructions: (i) Answer any 5 questions.
               (ii) All questions carry equal marks
               (iii) Show all essential working to earn full marks

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1. (a) Define the terms

(i) An **inner product** on a vector space V
(ii) **Similar matrices** A and B

(b) (i) Show that $\sum_{i=1}^{4} \alpha_i \beta_i$ is an inner product on $V_4(\mathbb{R})$.

(ii) Show that similar matrices have the same characteristic polynomial.

(c) (i) Find the length of the vector $(i - 1, i + 1, -i + 1)$ in $V_3(\mathbb{C})$ with inner product $\langle u, v \rangle = \sum_{i=1}^{3} u_i \bar{v}_i$

(ii) Show that the matrices $\begin{pmatrix} 1 & 2 \\ 0 & -1 \end{pmatrix}$ and $\begin{pmatrix} 1 & 0 \\ -2 & -1 \end{pmatrix}$ are similar.

2. (a) Define the following terms

(i) An **eigenvalue** of a matrix A
(ii) The **minimum polynomial** of a matrix A

(b) (i) Prove that if n is any positive integer and λ is an eigenvalue of A with corresponding eigenvector x, then λ^n is an eigenvalue of A^n with corresponding eigenvector x

(ii) Prove that the minimum polynomial of a matrix is unique.

1

(c) (i) Find the eigenvalues and corresponding eigenvectors of the matrix $\begin{pmatrix} 0 & -\sqrt{3} \\ \sqrt{3} & 0 \end{pmatrix}$ over $\mathbb{C}$.

(ii) Find the minimum polynomial of the matrix $\begin{pmatrix} 1 & 2 & 4 \\ 0 & 1 & -1 \\ 0 & 0 & -3 \end{pmatrix}$

3. (a) Define the following terms

(i) An **orthogonal matrix**
(ii) A **QR factorization** of a matrix A

(b) (i) Let A be an orthogonal matrix. Prove that $\det(A) = \pm 1$ and A^{-1} is also orthogonal
(ii) Prove that if $A \in M_n(\mathbb{R})$ is an orthogonal matrix, then $||Ax|| = ||x||$ for all $x \in \mathbb{R}^n$.

(c) (i) Show that the matrix $\begin{pmatrix} \cos x & -\sin x \\ \sin x & \cos x \end{pmatrix}$ is an orthogonal matrix and find its inverse.
(ii) Find a QR factorization of the matrix $\begin{pmatrix} -2 & 1 \\ 3 & -1 \end{pmatrix}$.

4. (a) What is meant by the terms

(i) The **orthogonal complement** of a subset S of an inner product space V
(ii) The **direct sum** of a vector space V

(b) (i) Let V be a finite-dimensional vector space over a field $\mathbb{K}$ and let U be a subspace of V. Prove that there exists a subspace W of V such that $V = U \oplus W$ and $(V : \mathbb{K}) = (U : \mathbb{K}) + (W : \mathbb{K})$
(ii) Let V be a vector space and U and W be subspaces of V. If $V = U + W$, prove that $V = U \oplus W$ if and only if $U \cap W = \{0\}$.

(c) (i) State the Gram-Schmidt Orthogonalization Theorem.
(ii) Use the Gram-Schmidt Orthogonalization procedure to the vectors $v_1 = (1, 0, 1)$, $v_2 = (1, 0, -1)$ and $v_3 = (0, 3, 4)$ to obtain an orthonormal basis for $V_3(\mathbb{R})$.

5. (a) What is meant by the terms

(i) **Characteristic polynomial** of a matrix A

(ii) A **diagonalizable linear transformation** T

(b) (i) Prove that a square matrix A is invertible if and only if 0 is not an eigenvalue of A.

(ii) State the Cayley-Hamilton Theorem.

(c) (i) Find a spectral decomposition of the matrix $\begin{pmatrix} 0 & -3 \\ -3 & 0 \end{pmatrix}$.

(ii) Diagonalize $\begin{pmatrix} -4 & 3 \\ 0 & 2 \end{pmatrix}$

6. (a) Define the following terms

(i) **Orthogonally similar** matrices

(ii) A **real quadratic form** on a vector space V

(b) (i) Prove that the eigenvalues of a real symmetric matrix are all real.

(ii) Find $\begin{pmatrix} 2 & 3 \\ 0 & 1 \end{pmatrix}^{-3} \begin{pmatrix} 1 \\ 1 \end{pmatrix}$.

(c) (i) Draw a graph of the conic section $x^2 - 2xy + y^2 = 4$.

(ii) Find an orthogonal matrix P such that $P^t A P = \text{diag}(\lambda_1, \lambda_2)$, where $A = \begin{pmatrix} -2 & 1 \\ 1 & -2 \end{pmatrix}$.

END OF EXAMINATION

3

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF MATHEMATICS & STATISTICS

UNIVERSITY SECOND SEMESTER EXAMINATIONS

APRIL 2009

M232 - REAL ANALYSIS II

INSTRUCTIONS

1. Answer any **five(5)** questions.

2. All questions carry equal marks.

TIME ALLOWED: Three (3) hours

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF MATHEMATICS & STATISTICS

UNIVERSITY SECOND SEMESTER EXAMINATIONS

APRIL 2009

M232 - REAL ANALYSIS II

INSTRUCTIONS

1. Answer any **five(5)** questions.

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THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF MATHEMATICS & STATISTICS

UNIVERSITY SECOND SEMESTER EXAMINATIONS

APRIL 2009

M232 - REAL ANALYSIS II

INSTRUCTIONS

1. Answer any **five(5)** questions.

2. All questions carry equal marks.

TIME ALLOWED: Three (3) hours

1. (a) Define the following:

    (i) a sequence in $\mathbb{R}$.

    (ii) a bounded sequence in $\mathbb{R}$.

    (iii) a convergent sequence in $\mathbb{R}$.

    (iv) a limit point of a sequence in $\mathbb{R}$.

  (b) If $a \in \mathbb{R}$ and $|a| < 1$, prove that the sequence $\{a^n\}_{n=1}^{\infty}$ is convergent.

  (c) Show that the limit point of a convergent sequence is also a limit of a sequence.

---

2. (a) Let $\{x_n\}_{n=1}^{\infty}$ be a sequence in $\mathbb{R}$.

    (i) Define a subsequence of a given sequence.

    (ii) State when we may write $+\infty = \lim\limits_{n \to \infty} x_n$.

  (b) Given the sequence $\left\{ \dfrac{1}{2}, 2, \dfrac{1}{3}, \dfrac{2}{3}, 3, \dfrac{1}{4}, \dfrac{3}{4}, 4, \dfrac{1}{5}, \dfrac{4}{5}, 5, \ldots \right\}$ of real numbers. Determine a subsequence $\{x_{n_k}\}_{k=1}^{\infty}$ such that $+\infty = \lim x_{n_k}$ and show that $+\infty = \lim x_{n_k}$

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3. (a) Let $S \subset \tilde{\mathbb{R}}$ (the extended real numbers). Define the following:

    (i) $\sup S$

    (ii) $\inf S$

  (b) Let $\{x_n\}_{n=1}^{\infty}$ be a sequence in $\mathbb{R}$. Define the following:

    (i) $\overline{\lim} x_n$

    (ii) $\underline{\lim} x_n$

  (c) Let $\{x_n\}_{n=1}^{\infty}$ be a sequence in $\mathbb{R}$. Suppose that $\overline{\lim} x_n = \underline{\lim} x_n$, prove that $\lim x_n$ exists.

---

4. (a) Define a Cauchy sequence in $\mathbb{R}$.

   (b) If the sequence $\{x_n\}_{n=1}^{\infty}$ in $\mathbb{R}$ is a Cauchy sequence, prove that it converges.

   (c) Let $\{x_n\}_{n=1}^{\infty}$ be a monotonically increasing sequence in $\mathbb{R}$. Show that
   $$\sup\{x_n : n \in \mathbb{N}\} = \lim_{n \to \infty} x_n$$

---

5. (a) Define the following:

   (i) an alternating series of real numbers.

   (ii) an absolutely convergent series of real numbers.

   (iii) a reaarrangement $\sum b_n$ of a series $\sum a_n$.

   (b) Suppose $\sum a_n$ is dominated by $\sum b_n$ and if $\sum b_n$ converges absolutely, prove that $\sum a_n$ converges absolutely.

   (c) State without proof D'Alembert's ratio test hence decide whether the series $\sum_{n=1}^{\infty} \frac{n^n}{n!}$ converges or diverges.

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6. (a) Define the following:

   (i) a convergent series of real numbers.

   (ii) a uniformly convergent functional series on a subset A of $\mathbb{R}$.

   (iii) a power series of real numbers.

   (b) State and prove the Cauchy-Maclaurin integral test theorem.

   (c) Show that the series $\sum_{n=1}^{\infty} \frac{1}{n^p}$ converges if $p > 1$ and diverges if $0 < p \leq 1$.

■ END OF EXAMINATION ■

3

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
Department of Mathematics & Statistics

2008 ACADEMIC YEAR
SECOND SEMESTER FINAL EXAMINATIONS

M 292 : INTRODUCTION TO PROBABILITY

TIME ALLOWED: Three (3) Hours

INSTRUCTIONS:
(i) Answer any **Four** (4) questions out of the five (5).
(ii) Full credit will only be given when all the essential working is shown.
(iii) Write your computer number in all the answer booklets, and indicate on the main answer booklet the questions you have answered.

---

1. (a) Define the following:

   (i) Independence of two events.

   (ii) Partition of a sample space.

   (iii) Permutation.

   (b) (i) Prove that the value of the correlation coefficient of any two random variables X and Y is always in the interval $[-1, 1]$ i.e. $e_{XY} \in [-1, 1]$.

   (ii) Three missiles whose probabilities of hitting a target are 0.6, 0.7 and 0.8 respectively, are fired at a target. Assuming independence, what is the probability that the target is hit.

   (iii) A days production of 100 fuses is inspected by a quality control inspector who takes a random sample of 10 fuses without replacement and tests them. If she finds 2 or fewer defective fuses, she accepts the entire lot of 100 fuses. What is the probability the lot is accepted if it contains 20 defective fuses?

   (c) A random variable X, has a commulative distribution function (cdf)

$$F_X(t) = \begin{cases} 0 & \text{if } t < -1 \\ \dfrac{1}{3} & \text{if } -1 \le t < 0 \\ \dfrac{5}{6} & \text{if } 0 \le t < 2 \\ 1 & \text{if } t \ge 2 \end{cases}$$

    (i)   Find the probability function of X.

    (ii)   Find the mean and variance of X.

2.   (a)   Define the following:

    (i)   Conditional probability of event B given event A.

    (ii)   A random variable.

    (iii)   Moment generating function.

    (b)   Given that X is a Binomial random variable i.e. $X \sim B(n, p)$.

    (i)   Derive the moment generating function (mgf) of X.

    (ii)   Using the mgf in (i) derive the mean and variance of X.

    (c)   Let X and Y be the concentration levels of two pollutants in parts per million (ppm) at a certain of a body of water. If the joint probability density function is given by:

$$F_{X.Y}(x, y) = \begin{cases} \dfrac{x + y}{8000}, & 0 < x < 200, \ 0 < y < 200 \\ 0 & \text{otherwise} \end{cases}$$

    (i)   Find the marginal probability density functions of X and Y.

    (ii)   Find the conditional probability density function of X given that Y = 10 ppm.

    (iii)   Find the probability that the concentration level of X will be at most 14 ppm given that Y = 10 ppm.

3.   (a)   Define the following:

    (i)   Negative Binomial random variable (no pdf expression).

    (ii)   Commulative distribution function.

    (iii)   Covariance of X and Y.

(b) Let X and Y be two random variables with joint probability density function given by

$$F_{X,Y}(x, y) = \begin{cases} \dfrac{2}{3}(x + y)e^{-x} & , \quad 0 < x < \infty, \ 0 < y < 1 \\ 0 & \quad otherwise \end{cases}$$

Find the following:

(i) Marginal probability density functions of X and Y.

(ii) Covariance of X and Y.

(c) (i) If X has a Poisson distribution with $P(X = 0) = 0.2$, find $P(X > 3)$

(ii) A man and a woman decide to meet for lunch at Manda-hill at the sub-way. If each person independently arrives at a time uniformly distributed between 12:00 hrs and 13:00 hrs. Find the probability that the first to arrive has to wait longer than 10 minutes.

(iii) A worker who drives to work has 7 traffic lights on her route. The probability that any of the traffic lights is red (she has to stop) when she reaches it is 0.20, and that the traffic lights are far enough apart to operate independently. Let X be the number of traffic lights she has to stop. Find $P(X \geq 5)$.

4. (a) Define the following terms:

(i) Independence of two continuous random variables X and Y.

(ii) Correlation coefficient of two random variables X and Y.

(iii) Conditional probability function of Y given X = a.

(b) (i) The probability that a certain type of electronic component will fail during first hour of operation is 0.005. If 400 of these electronic components are tested independently, find the probability that at most three will fail during the first hour.

(ii) A door to door salesman will say he has a good day when in fact he did with probability 1, but the probability only 0.6 that he will say he had a good day when, in fact he did not. Only $\dfrac{1}{4}$ of his selling days are actually good ones. What is the probability that he has a good day if he says he had a good day?

(c) Let X be a random variable with Geometric distribution i.e. $P(X = x) = P(1 - P)^x$, $x = 0, 1, 2, 3, \ldots$.

(i) Derive the moment generation function (mgf) of X.

(ii) Using the mgf in (i), find the mean and variance.

5. (a) Two random variables X and Y have a joint probability function given by:

$$F_{X,Y}(x, y) = \begin{cases} e^{-\frac{x}{y}} e^{-y} & 0 < x < \infty, \ 0 < y < \infty \\ 0 & otherwise \end{cases}$$

Find the following:

(i) Marginal probability density function of Y.

(ii) Moment generating function of Y.

(iii) Conditional probability function of X given Y = 3.

(iv) $P(X > 2 \mid Y = 3)$.

(b) (i) State Chebyshev's inequality.

(ii) Consider the discrete random variable X with the following distribution

x	-1	0	1	2
$P(X = x)$	$\dfrac{1}{4}$	$\dfrac{1}{4}$	$\dfrac{1}{4}$	$\dfrac{1}{4}$

(iii) Find the mean and variance of X.

(iv) Compute $P\left(\dfrac{1}{3} - \dfrac{1}{2}\sqrt{\dfrac{19}{2}} < X < \dfrac{1}{3} + \dfrac{1}{2}\sqrt{\dfrac{19}{2}}\right)$ and compare with the bound given by Chebyshev's inequality.

(c) Given that a random variable X has commutative distribution function given by

$$F_X(t) = \begin{cases} 0 & if \ t < -1 \\[2mm] \dfrac{x^2 + 2x + 1}{16} & if \ -1 \le t < 3 \\[2mm] 1 & if \ t \ge 3 \end{cases}$$

(i) Find the probability density function of X.

(ii) Find the mean and variance of X.

END   GOOD LUCK!

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES
Department of Mathematics & Statistics
SECOND SEMESTER FINAL EXAMINATIONS

May, 2009
M412—FUNCTIONS OF A COMPLEX VARIABLE II

Time allowed : THREE(3) HOURS

Instructions : There are six(6) questions. Attempt **ANY FIVE (5)** questions. All

questions carry equal marks. Show all your working to earn full marks.

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1. (a)   If the function $f(z)$ is analytic and bounded throughout the complex plane,

prove that it is identically constant.

   (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)   Verify the Mean Value theorem for the case when $f(z) = (z+1)^2$ and

$z_0 = 0$ is the centre of some circular disk of radius R.

2. (a) State the Maximum Modulus Principle.

(b) Verify the Maximum Modulus Principle when $f(z) = (z-1)^2$ and the region R is the triangular region with vertices at the points $z = 0$, $z = -2$ and $z = i$.

(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) $f(z) = ze^{\frac{1}{z}}$.

(ii) $f(z) = \frac{\sin z}{z}$.

3. (a) Without using the Residue theorem, by integrating $f(z) = \frac{ze^{iz}}{z^2+a^2}$ around a suitable contour, prove that

$$\int_0^\infty \frac{x \sin x}{x^2 + a^2} dx = \frac{\pi}{2e^a}, \quad \text{where} \quad a > 0.$$

(b) Let C denote the circle $|z| = 2$ described in the positive sense. Determine the value of $\Delta_c \arg f(z)$ for the function

$$f(z) = \frac{z^2 + \left(\frac{1}{2} + \frac{i\sqrt{3}}{2}\right)}{z}.$$

(c) Find the residue at $z = 0$ of the function $f(z) = \frac{1}{\sin z}$.

4. (a) State and prove the Cauchy Inequality theorem.

(b) Verify the Cauchy Inequality theorem for the function $f(z) = \log(1 + z)$ if z lies on the circle $|z| = \frac{1}{2}$.

(c) Let G be an open set which is a-star shaped. Prove that if γ_0 is the curve which is constantly equal to a then every closed rectifiable curve in G is homotopic to γ_0.

5. (a)   (i)   State Rouche's theorem.

(ii) Using Rouche's theorem, find the number of roots of the equation

$z^5 - 12z + 14 = 0$ that lie in the annular domain $1 < |z| < \frac{5}{2}$.

(b)   Evaluate

$$\int_C \frac{f'(z)}{f(z)}dz$$

if C is the circle $|z| = 3\pi$ for

$$f(z) = \frac{2\cos z - \sqrt{2}}{(z-1)^2(2z+3)}.$$

(c)   (i)   Let $\gamma, \rho \quad [0,1] \to G$ be two closed rectifiable curves in a region G. Define homotopy between γ and ρ.

(ii) If γ is homotopic to ρ, denoted by $\gamma \sim \rho$, prove that the relation '$\sim$' is a symmetric relation.

6. (a)   (i)   State the residue theorem.

(ii) Using the residue theorem, show that

$$\int_0^\infty \frac{x^2}{(x^2+9)(x^2+4)^2}dx = \frac{\pi}{200}.$$

(b)   Given the function $f(z) = \frac{1}{z^2(1-z)}$, find the Laurent series expansion in powers of z for $f(z)$ in the region $0 < |z| < 1$.

(c)   State Schwarz Lemma.

END.

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR
SECOND SEMESTER FINAL EXAMINATIONS

M422: MODULE AND FIELD THEORY

TIME ALLOWED: Three (3) Hours

INSTRUCTIONS : There are two sections in this paper
Answer **Five (5)** questions from this paper and **at least Two (2)**
from each section

Section A: Field Theory
Answer **at least Two**(2) questions from this section.

1.   (a)   Define
         (i)   an algebraic extension F of a field K
         (ii)   a perfect field

     (b)   Let F be a finite field of characteristic p. Show that F is perfect.

     (c)   Consider the polynomial $f(x) = x^2 + 2x + 2$ in $Z_3[x]$
         (i)   Show that $f(x)$ is irreducible over Z_3

         (ii)   Let $F = \dfrac{Z_3[x]}{\langle x^2 + 2x + 2 \rangle}$ and let α be a zero of $f(x)$ in F. Express in

             terms of α the elements of F. Hence , if possible, express $f(x)$ as a
             product of linear factors in F[x].

2.   (a)   Define or state
         (i)   a splitting field
         (ii)   the Kronecker's theorem

     (b)   Let K be a field and $f(x)$ a non zero polynomial of K[x]. Show that there
         exists a splitting field F for $f(x)$ over K

     (c)   Consider the Galois extension $Q(\sqrt{2}, \sqrt{5})$ of Q, where Q is the field of
         rational numbers. Let α be a non identity element of the Galois group
         $G(Q(\sqrt{2}, \sqrt{5}): Q)$.
         (i)   Show that α has order 2
         (ii)   Determine any fixed field of { e , α }where e is the identity.

3. (a) Define
    (i)   a normal extension L of a field K
    (ii)   a normal closure of an extension L of a field K

    (b) Let α be the real cuberoot of 2 and consider the polynomial $f(x) = x^3 - 2$ in Q[x], the polynomial ring over the field of rational numbers.
    (i)   Show that the extension $Q(\alpha) : Q$ is not a normal extension
    (ii)   Obtain the normal closure of the extension $Q(\alpha) : Q$

    (c) Let F, E and K be fields such that F is an extension of E and E is an extension of K. Let $a_1, a_2, a_3, \ldots, a_m$ be elements of F that are linearly independent over E and $b_1, b_2, b_3, \ldots, b_n$ be elements of E that are linearly independent over K.
    (i)   Show that the *mn* products $a_i b_j$, $i = 1, 2, \ldots, m$, $j = 1, 2, \ldots n$ are linearly independent
    (ii)   If further [F : E] = m and [E : K] = n where *m* and *n* are real numbers. Show that the *mn* products $a_i b_j$ in (i) form a basis of F as a vector space over K .

4. (a) Define
    (i)   an automorphism of a field F
    (ii)   a radical extension of a field F

    (b) Let F be an extension of a field K. Show that the set of all K – automorphisms of the field F forms a group under the composition of functions.

    (c) (i)   Determine the Galois group of the polynomial
               $f(x) = x^4 - 4x^2 + 5 \in Q[x]$
        (ii)   Determine whether the polynomial $f(x) = x^5 - 10x + 5 \in Q[x]$ is solvable by radicals.

Section B – Module Theory:
Answer **at least Two** (2) questions from this section

5. (a) Define each of the following terms
   (i) M is a <u>finitely generated</u> R – module
   (ii) the element m of an R – module M is a <u>torsion element</u>

   (b) (i) Show that if each element m of an R – module M has a unique expression of the form $m = \sum_{i=1}^{t} r_i m_i$, $r_i \in R$,

   then each m_i is a torsion free element.
   (ii) Prove that the subset T of an R – module M defined by
   T = { $m \in$ M : m is a torsion element }, is an R – submodule of M, and that the quotient module M/T is torsion – free .

   (c) Prove that if M is a torsion free module over a principal ideal domain R then it is free

6. (a) Define each of the following terms as applied to left R – module :
   (i) an R – module M is an <u>internal direct sum</u> of $M_1, M_2, \ldots\ldots, M_r$
   (ii) the module M is R – free .

   (b) (i) Let M be an R – module , and let M_i $(i = 1, 2, \ldots\ldots, n)$ be submodules such that the conditions
   $M = \sum M_i$ and $M_i \cap \sum_{i \neq j} M_j = \{0\}$ hold.
   Then prove that $M = \oplus \sum M_i$
   (ii) Let the R – module M be freely generated by subset
   $X = \{M_1, M_2, \ldots\ldots, M_s\}$ and N be freely generated by the subset
   $Y = \{e_1 (= (1,0,0,\ldots,0)), e_2 (= (0,1,0,\ldots,0)), \ldots e_s (= (0,0,\ldots,0,1))\}$
   Then prove that $M \cong N$.

   (c) Show that the $\mathbf{Z}$ – module $\mathbf{Z}$ is $\mathbf{Z}$ – free, hence determine whether
   $\mathbf{Z}_n = \{z \in \mathbf{Z} \bmod n\}$ is $\mathbf{Z}$ – free.

7. (a) Define each of the following terms as applied to R – modules M
    (i)   a <u>torsion submodule</u> T of M
    (ii)   a <u>free R – module</u> F

   (b) Given that a submodule N of an R – module M and the quotient module
       M/N are both finitely generated, then show that M is also finitely
       generated.

   (c) Let M be a finitely generated module over a principal ideal domain R.
       Then prove that $M = T \oplus F$, where F is a free R – submodule of M and T
       is a torsion submodule of M.

__End of Exam__

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF MATHEMATICS & STATISTICS

UNIVERSITY SECOND SEMESTER EXAMINATIONS

APRIL 2009

M432 - REAL ANALYSIS VI

INSTRUCTIONS:

1. Answer any **five(5)** questions.

2. All questions carry equal marks.

TIME ALLOWED: Three (3) hours

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1. (a) Let (X, d) be a metric space and $\{x_n\}_{n=1}^\infty$ a sequence in X.

   (i) When is $\{x_n\}_{n=1}^\infty$ called a Cauchy sequence?

   (ii) When is X said to be complete?

   (b) The usual metric on $\mathbb{R}$ is $d : \mathbb{R} \times \mathbb{R} \to \mathbb{R}$ defined by $d(a, b) = |a - b|$. Prove that $\mathbb{R}$ is a complete metric space.

   (c) If (X, d) is a metric space, $\{x_n\}_{n=1}^\infty$ and $\{y_n\}_{n=1}^\infty$ cauchy sequences in X, prove that with the usual metric, the sequence $\{d(x_n, y_n)\}_{n=1}^\infty$ converges in $\mathbb{R}$.

2. (a) Let X and Y be linear spaces over a field $\mathbb{F}$. Define the following:

   (i) a norm on X.

   (ii) a linear transformation $L : X \to Y$.

   (b) (i) Prove that the norm function $\|.\| : X \to \mathbb{R}$ from X onto $\mathbb{R}$ is continuous.

   (ii) Let X be a linear space. Let $\|.\| : X \times X \to \mathbb{R}$ be a norm on X. Prove that $|\|x\| - \|y\|| \le \|x - y\|$ for all $x, y \in X$.

   (c) Let $X = \mathcal{C}[0, 1]$, Prove that $\|f\| = \max\limits_{0 \le x \le 1} |f(x)|$ defines a norm on X.

3. (a) Define the following:

   (i) a Banach space.

   (ii) an operator on a normed linear space X.

   (b) Let X and Y be normed linear spaces and L a linear transformation of X onto Y. Prove that the following are equivalent.

   i. L is continuous.

   ii. L is continuous at the origin.

   iii. there exists a real number $K \ge 0$ such that $\|L(x)\| \le K\|x\|, \forall\, x \in X$.

   iv. If $B = \{x : \|x\| \le 1\}$ is a closed unit ball in X, then the image $T(B)$ is a bounded set in Y.

[TURN OVER]

2

4. (a) Let X and Y be normed linear spaces and $L \in \mathcal{L}'(X, Y)$. Let

$$
\begin{aligned}
N &= \inf\{M \in \mathbb{R} : \|L(x)\| \leq M\|x\|, x \in X\}, \\
P &= \sup\{\|L(x) : x \in X, \|x\| \leq 1\} \quad \text{and} \\
S &= \sup\{\|L(x)\| : x \in X, \|x\| = 1\}
\end{aligned}
$$

Prove that $\|L\| = N = P = S$.

(b) Let X, Y and $\mathcal{L}(X, Y)$ be normed linear spaces. Further, let $\|L\| = \sup\{\|L(x)\| : \|x\| \leq 1\}$ be the norm on $\mathcal{L}(X, Y)$. Prove that if Y is a Banach space, then so is $\mathcal{L}(X, Y)$.

(c) Show that l_2 with an inner product of two vectors

$$
\begin{aligned}
x &= (x_1, x_2, \ldots, x_n, x_{n+1}, \ldots) \\
y &= (y_1, y_2, \ldots, y_n, y_{n+1}, \ldots)
\end{aligned}
$$

defined by $\langle x, y \rangle = \sum_{i=1}^{\infty} x_i \overline{y_i}$ is an inner product space.

5. (a) Let X be a normed linear space over a field $\mathbb{F}$. Define the following:

(i) the conjugate space X^* of X.

(ii) a bounded linear functional f on X.

(b) Prove that a linear functional f defined on a normed linear space X is bounded if and only if it is continuous.

(c) Prove that the space $(l_p^n)^*$ is isometrically isomorphic to l_q^n, where $\dfrac{1}{p} + \dfrac{1}{q} = 1$.

6. (a) Define the following:

(i) a Hilbert space H.

(ii) an orthonormal set S in a Hilbert space H

(b) (i) Let X be an inner product space. Let $x \in X$, prove that $\{x\}^{\perp}$ is a closed subspace of X.

(ii) Let H be a Hilbert space. Prove that $\|x\|^2 = \sum |\langle x, e_i \rangle|$ for all $x \in H$ implies that $\{e_i\}$ is a complete orthonormal subset in H.

(c) If M is a proper closed linear subspace of a Hilbert space H, prove that there exists a non zero vector z_0 in H such that $z_0 \perp M$.

■ END OF EXAMINATION ■

3

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
Department of Mathematics & Statistics

2008 ACADEMIC YEAR
SECOND SEMESTER FINAL EXAMINATIONS

M 962 : TIME SERIES ANALYSIS

TIME ALLOWED: Three (3) Hours

INSTRUCTIONS: In the following questions $\{a_t\}$ denote a zero mean white noise process with variance σ_a^2 and B is the back shift operator.

Answer any **Five (5)** questions. All questions carry equal marks.

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1. (a)   The following tables represent number of holidays booked at Zambezi Sun (measured to the nearest 10) and the centered four – quarterly moving Averages respectively:

Bookings

	Q_1	Q_2	Q_3	Q_4
2006	220	260	260	350
2007	200	240	240	330
2008	220	280	310	390
2009	250			

Centered four quarterly moving average

	Q_1	Q_2	Q_3	Q_4
2006			*	265.0
2007	260.0	255.0	255.0	262.5
2008	276.25	292.5	303.75	
2009				

(i)   Give the missing value where * is appearing in the moving averages table.

(ii)   Assuming an additive model, calculate the seasonal component for each quarter.

(b) The following table gives monthly unemployed females between ages 20 and 25 in Lusaka from January 2008 to December 2008 (in thousands).

January	February	March	April	May	June
375	384	383	326	344	375
July	August	September	October	November	December
419	424	429	399	376	288

Obtain the one – step ahead forecast for the monthly unemployed females for January to December 2008 using the simple exponential smoothing with initial value $\hat{x}_1 = x_1$ and smoothing parameter $\alpha = 0.5$.

(c) The value of the Ljung – Box test statistics based on the first 20 sample autocorrelations of a time series is 23.23. Let $\Pr ob. \left\{ \chi^2_{(20)} \rangle 31.4 \right\} = 0 \cdot 05$.

Give a conclusion about the autocorrelations of the generating process.

2. (a) Let $Z_1, Z_2, ..., Z_n$ be an observed time series from a stationary stochastic process $\{ Z_t \}$. Let r_k be the kth autocorrelation of the time series.

    (i) Write the formula for r_k.
    (ii) Give an estimator of the standard error of r_k.

(b) The following sample autocorrelations were obtained from a time series of length $N = 200$ observations

k	1	2	3	4	5	6	7	8	9	10
r_k	−0.38	−0.08	0.11	−0.08	0.02	0.00	0.00	0.00	0.07	−0.08

Test the following hypothesis

    (i) $\rho_1 = 0$
    (ii) $\rho_2 = 0$
    (iii) $\rho_3 = 0$

where ρ_k represents the kth autocorrelation of the stationary stochastic process from which the above time series has been observed.

(c) Let $\{ a_t \}$ be a zero mean white noise process. Determine which of the following processes are second order stationary

    (i) $X_t = (-1)^t a_t$
    (ii) $X_t = a + bt + a_{t-1}$
    (iii) $Z_t = a_{t-1} \, a_t$

3. (a) Let $\{ Z_t \}$ be a stochastic process described by
$$\dot{Z}_t = 0 \cdot 75 \, \dot{Z}_{t-1} - 0 \cdot 5 \, \dot{Z}_{t-2} + a_t$$

(i) Show that $\{ Z_t \}$ is stationary.

(ii) Find the first four autocorrelations of $\{ Z_t \}$ and display them on a correlogram.

(iii) State what pattern the correlogram should reveal.

(b) The first ten partial autocorrelations of a time series of 250 values are given in the following table:

K	1	2	3	4	5	6	7	8	9	10
$\hat{Q}_{KK}$	.67	$-.45$	$-.04$	$-.08$	.05	$-.01$	.03	$-.01$	$-.04$	$-.01$

Discuss with appropriate tests of hypothesis if these sample PACF indicate an AR(2) process.

(c) Let $\{ X_t \}$ be a zero mean weakly stationary process with autocovariance function $r_K = \alpha^k$, $K \geq 0$. Consider another process $\{ Y_t \}$, where

$$Y_t = \frac{1}{2} \left(X_t + X_{t-1} \right).$$ Let Γ be the first autocovariance of the process $\{ Y_t \}$.

Show that $\Gamma = \left(\dfrac{1 + \alpha}{\alpha} \right)^2$.

4. (a) Consider the ARIMA (0, 2, 2) process

$$(1 - B)^2 Z_t = (1 - 0.9B + 0.5B^2) a_t.$$ Let the AR representation of this process be $Z_t = \Pi_1 Z_{t-1} + \Pi_2 Z_{t-2} + \ldots + a_t$.

(i) Find the first four Π weights.

(ii) Given $Z_{20} = 15.2$, $Z_{19} = 17.8$, $Z_{18} = 19.1$, forecast Z_{21} and Z_{22}.

(b) Consider the process $(1 - B) Z_t = (1 - \theta B) a_t$.

Explain what characteristics the sample ACF of a time series and it first difference series should have for the above model to be appropriate description of the time series.

(d) Suppose a process $\{ Z_t \}$ is generated according to $Z_t = a_t + \cdot 5 \, (a_{t-1} + \ldots + a_1)$ for $t \geq 1$.

(i) Investigate if $\{ Z_t \}$ is stationary.

(ii) Investigate if $(1 - B) Z_t$ is stationary.

3

5. (a) Show that for the stationary process $Z_t - \phi Z_{t-1} = a_t - \cdot 5\, a_{t-1}$.

     (i) $\quad \gamma_0 = \left(\dfrac{1.25 - \phi}{1 - \phi^2} \right) \sigma_a^2$

     (ii) $\quad \gamma_1 = \left[\dfrac{\phi(1 \cdot 25 - \cdot 5\phi) - \cdot 5}{1 - \phi^2} \right] \sigma_a^2$

(b) Assume the process of part (a) was fitted into an observed time series for which $\hat{\sigma}_z^2 = 10$ *and* $\hat{\rho}_1 = 0 \cdot 5$. Find initial estimates for ϕ *and* σ_a^2.

(c) Consider the process $(1 - 1.2\,B + \cdot 6\,B^2)(X_t - 30) = a_t$ where $\sigma_a^2 = 1$. Suppose we have the observations $X_{28} = 34.7$, $X_{29} = 32.8$, $X_{30} = 27.1$.

     (i) Forecast X_{31} and X_{32} at $t = 30$.

     (ii) Find the 95% forecast limits for the forecasts in (i).

     (iii) Suppose observation at $t = 31$ turns out to be $X_{31} = 31.3$. Update the forecast for X_{32}.
You may use the following updating equation:

$$\hat{Z}_{n+1}(l) = \hat{Z}_n(l+1) + \psi_l [Z_{n+1} - \hat{Z}_n(1)]$$

6. (a) The stationary process $Z_t = a_t + \theta a_{t-1}$ was fitted to a time series which has the following sample statistics

$$\hat{\gamma}_0 = 4, \quad \hat{\rho}_1 = 0 \cdot 25$$

Estimate θ and σ_a^2 to 2 places of decimal.

(b) Let $\hat{Z}_n$ represent one step ahead forecast of Z_{n+1} made at time n for the process of part (a). Show that $\hat{Z}_n = \hat{\theta} Z_n - \hat{\theta}^2 Z_{n-1} + \ldots (-\hat{\theta})^n Z_1$.

(c) The following data was observed on the time series of part (a).

T	94	93	92	91	90
Z_t	1.1	2.1	$-\cdot5$	2.6	-1

Estimate $\hat{Z}_{94}$.

END OF EXAMINATION.

THE UNIVERSITY OF ZAMBIA

School of Natural Sciences
PHYSICS DEPARTMENT
University Examinations 2008/9

P198: *Introductory Physics-II*

(OPTION B)

Instructions: In addition to Q_1 which is compulsory and for which you use the answer sheet provided, answer **four (4)** more questions. They are of equal marks. All necessary calculations must be clearly shown. Clearly indicate on the answer script cover page which questions you have attempted.

Time: 3 hours   **Maximum marks: 100**

Do not forget to write your computer number, clearly on the answer book.

===

Formulas, data you might find useful:

$$\Delta Q = mc\Delta T \; ; \; \Delta Q = mL_f \; ; \Delta Q = mL_v \; ; \; \frac{\Delta Q}{\Delta t} = \frac{kA\Delta T}{\Delta x} \; ; \; \Delta L = \alpha L_o \Delta T \; ; \; PV = nRT$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \; ; \quad PV^\gamma = \text{ constant, } \quad \Delta Q = \Delta U + P\Delta V \; . \quad \Delta S = \frac{\Delta Q}{T} \quad ; \quad e = 1 - \frac{Q_L}{Q_H} \; ;$$

$$e = 1 - \frac{T_L}{T_H} \; ; \; E = \varepsilon \sigma T^4 \; ; \; COP = \frac{Q_L}{Q_H - Q_L} = \frac{T_L}{T_H - T_L} \; ; \; \Delta W = P\Delta V \; ; \; c_v/R(N_2) = 3.48;$$

$$C_v = \frac{3}{2}R \text{ (mono)} = \frac{5}{2}R \text{ (diatomic)}; \; c_p = \frac{5}{2}R \text{ (mono)} = \frac{7}{2}R \text{ (diatomic)}$$

$$\Delta W = nRT \ln\left(\frac{V_f}{Vi}\right) \; ; P_1 V_1^\gamma = P_2 V_2^\gamma \; ; K.E_{av.} = \frac{3}{2}kT \; ; \; \Delta Q = nC\Delta T$$

$$V = V_o(1 + \gamma\Delta T) \; ; \; F = kx. \; P_A = 1 \times 10^5 Nm^{-2}. \; T = 4\pi^2 \frac{l}{g} \; ; \; \omega = 2\pi f \; ; \; a = -\omega^2 x \; ; \; F = kx;$$

$$\omega = \sqrt{\frac{k}{m}} \; ; \; k = \frac{2\pi}{\lambda} \; ; v = \omega\sqrt{(x_o^2 - x^2)} \; ; \; P_a + \frac{1}{2}\rho v^2 + \rho g h_1 = P_b + \frac{1}{2}\rho v_2^2 + \rho g h_2 \; ;$$

$A_1 v_1 = A_2 v_2$; $F_D = 6\pi\eta r v_t$; $\gamma = 3\alpha$; $E = k\dfrac{Q}{r^2}$; $V = \dfrac{kQ}{r}$; $E = -\dfrac{\Delta V}{\Delta x}$; $Q = CV$

$E = \dfrac{1}{2}QV$; $\dfrac{1}{C_{eq}} = \dfrac{1}{C_1} + \dfrac{1}{C_2} + \dfrac{1}{C_3} + ... + \dfrac{1}{C}$; $C_{eq} = C_1 + C_2 + C_3 + ... + C_n$

$\sum I = 0.$; $\sum V = 0$; $e = -\dfrac{\Delta\phi}{\Delta t}$; $P = IV$; $F = qE$; $C = \dfrac{\varepsilon_o A}{d}$

$F = BIL$; $F = qvB\sin\theta$; $E = \dfrac{1}{2}qV$; $P = IV = I^2 R$; $F = qvB$; $F_c = \dfrac{mv^2}{r}$; $v = \omega r$

$\dfrac{f}{f'} = \left[1 - \left(\dfrac{v_l}{v_w}\right)\right] \bigg/ \left[1 - \left(\dfrac{v_s}{v_w}\right)\right]$; $I(\text{dB}) = 10\log_{10}(I/I_o)$;

$R_{eq} = \sum R_i$; $\dfrac{1}{R_{eq}} = \sum \dfrac{1}{R_i}$;

1 rev = $360^\circ = 2\pi$ rads

Volume of sphere $V = \dfrac{4}{3}\pi r^3$

Area of sphere = $4\pi r^2$

Electronic charge, $e = 1.6 \times 10^{-19}$

$P_A = 1.01 \times 10^5$ Pa

$\rho_w = 1000$ kgm^{-3}

1 calorie = 4.18 J

Specific latent heat of fusion for ice, $L_f = 335 \times 10^3$ J/kg

Specific latent heat of vaporization for steam, $L_v = 2.26 \times 10^6$ J/kg

Specific heat capacity of water, $c_w = 4.2 \times 10^3$ J kg^{-1} K^{-1}.

Wherever necessary use :

$g = 9.8 \text{m/s}^2$ 　　　　　　　　　　　　. 1 metric ton = 1000 kg

$P_A = 1.01 \times 10^5 \text{ N/m}^2$

1 cal. = 4.18 J

$\varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{Nm}^2$

$c = 3 \times 10^8 \text{ m/s}$

$h = 6.63 \times 10^{-34} \text{ J-s}$

1 pascal = 1 N/m^2

$1\text{eV} = 1.6 \times 10^{-19} \text{ J}$

$e = 1.6 \times 10^{-19} \text{ C}$

$m_e = 9.11 \times 10^{-31} \text{ kg}$

$k = 9 \times 10^9 \text{ Nm}^2/\text{C}^2$

$\mu_0 = 4\pi \times 10^{-7} \text{ N/A}^2$

$\rho_{water} = 1000 \text{ kg/m}^3$

$G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$

Efficiency of a Carnot engine, $e = 1 - T_2/T_1 = \dfrac{work\ done}{input\ heat\ at\ high\ temperature}$

Q1: (A) In simple harmonic motion, it is found that the total energy of a system

    (a) is independent of the amplitude;
    (b) is inversely proportional to the amplitude;
    (c) depends on the square of the amplitude
    (d) is independent of the mass of the oscillating object.

  (B) When there are no frictional effects in simple harmonic motion, the total mechanical energy of a system

  (a) changes with time;
  (b) varies with displacement;
  (c) slowly dissipates itself as heat;
  (d) is constant.

  (C) For frequencies up to a few thousand cycles per second, the compressions and rarefactions of longitudinal waves in a fluid are

    (a) adiabatic
    (b) isothermal;
    (c) stationary;
    (d) transverse.

  (D) Computing the Carnot efficiency by idealizing a real engine gives

    (a) the real efficiency;
    (b) a possible value for the efficiency;
    (c) an upper limit to the efficiency
    (d) the lower limit to the efficiency

  (E) A Dewar flask in which liquid nitrogen is stored is silvered on the outside so that

    (a) the container will be readily identifiable;
    (b) absorption of radiant heat is minimized
    (c) the volatile contents will be shielded from electric fields
    (d) heat will not be conducted over the surface of the flask.

(F) A steel wheel bearing is 1 mm smaller in diameter than an axle. The bearing can be made to fit the axle without removing any material by

(a) warming the axle sufficiently till the bearing fits
(b) cooling the bearing sufficiently till it fits
(c) cooling both parts till the bearing fits
(d) warming the bearing sufficiently till it fits

(G) Capacitors of different capacitances connected in parallel have

(a) The same electric field intensities between their plates;
(b) The same charge;
(c) A resultant capacitance that is less than the sum of the individual capacitors;
(d) The same voltage between their plates.

(H) The heat generated per coulomb of charge when a 2A current passes through a 10 Ω resistor is

(a) 20 joules/coulomb
(b) 20 watts
(c) 5 joules/coulomb
(d) 40 watts

(I) Kirchhoff's rules in electric circuit network analysis are derived from

(a) the work-energy theorem
(b) the conservation of momentum
(c) the conservation of energy
(d) the conservation of energy and electric charge laws

(J) When a moving charged particle enters a uniform magnetic field in a direction parallel to the field lines, the particle experiences

(a) A change in direction
(b) A change in the velocity magnitude
(c) No change in its motion
(d) Changes in its energy

Q2: (a) Define simple harmonic motion (S.H.M) [2]

(b) A body of mass 200 gram is executing simple harmonic motion with an amplitude of 20 mm. The maximum force which acts on the mass is 0.064N. Calculate

(i) its maximum velocity [6]
(ii) its period of oscillation [3]

(c) The equation $y = a\sin(\omega t - kx)$ represents a plane wave travelling along the x-axis, y being the displacement at the point x at time t. Given that $a = 1.0\times10^{-7}$m, $\omega = 6.6\times10^{3}$ s^{-1} and $k = 20$m^{-1}, Find

(i) the direction of the wave and state how you arrive at your answer; [2]

(ii) the speed of the wave; [5]

(iii) the maximum speed of a particle of the medium due to the wave. [2]

Q3: (a) Define specific *latent heat of fusion* for a material and the *specific heat capacity of a material*. [4]

(b) The graph, figure 1, refers to an experiment in which an initially solid specimen of nitrogen absorbs heat at a constant rate. Nitrogen melts at 63K, and the specific heat capacity of solid nitrogen is 1.6×10^{3} JKg^{-1}K^{-1}. Calculate

(i) the specific latent heat, L_f of fusion of nitrogen [5]

(ii) the specific heat capacity of the nitrogen in its liquid form. [3]
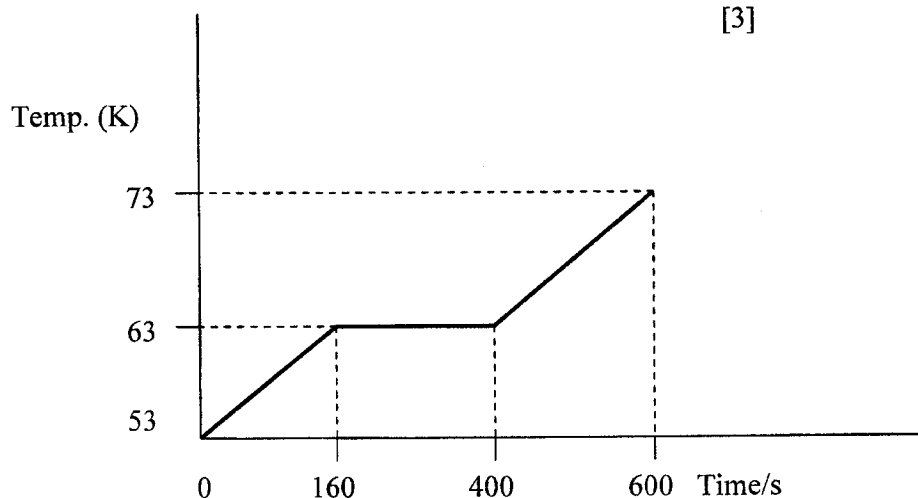
Figure 1

(c)   A gas undergoes a cyclic process *ABCDA*, figure 2. Table 1 shows the increase
        in internal energy, ΔU, which takes place during each of the changes A to B,
        B to C and C to D. It also shows that in both of sections A to B and C to D,
        no heat is supplied to the gas.

Table 1

	Increase in internal energy/J	Heat supplied to gas /J	Work done on gas/J
A to B	1200	0	
B to C	-1350		
C to D	-600	0	
D to A			

Using the first law of thermodynamics and any necessary data from the graph, complete
the table. You will find it helpful to proceed in the following order: [8]

(i)   work done on gas from A to B and C to D

(ii)   work done on gas for B to C and D to A

(iii)   Heat supplied to gas for B to C and D to A

(iv)   Increase in internal energy for D to A.
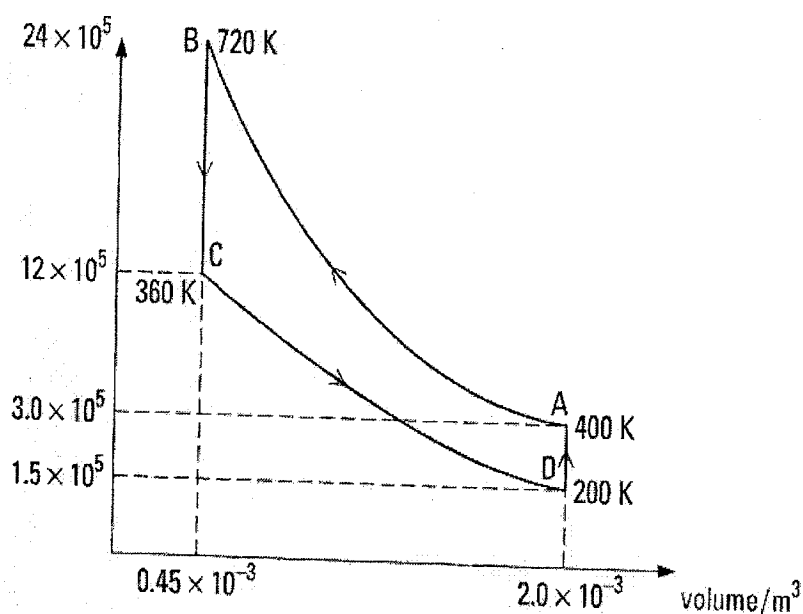
Figure 2

Q4: (a) Air is streaming past a horizontal airplane wing 10m long and 2m in width, such that its speed is 120ms⁻¹ over the upper surface and 90ms⁻¹ at the lower surface. If the density of air is 1.3 kgm⁻³, find

(i) the difference in pressure between the top and the bottom of the wing. [4]

(ii) find the gross lift on the wing and its mass equivalence. [3]

(b) A large tank contains water to a depth of 1m. Water emerges from a small hole positioned at a height h from the bottom of the tank in the side of the tank, figure 3. Using Bernoulli's principle and necessary approximations, show that the velocity v at which water emerges from the hole is given by

$$v = \sqrt{2g(1-h)}$$ [7]

1m

h
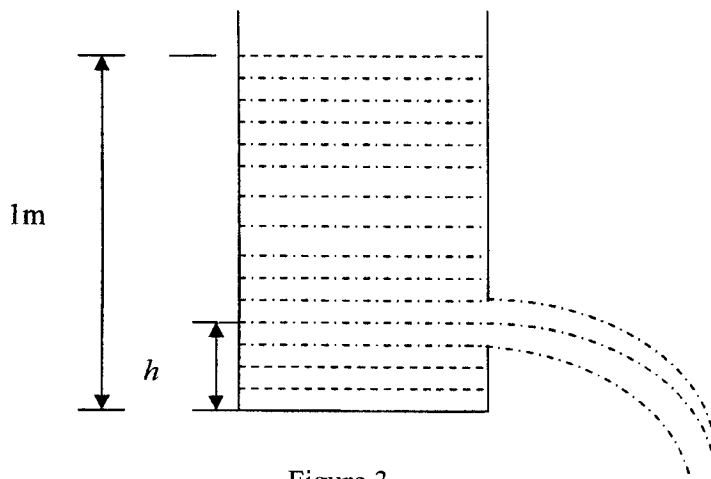
Figure 3

(c) When a small spherical object falls through a fluid of viscosity η, its speed v increases but the motion is impeded by the force of air resistance F_r. Show that the object eventually reaches a constant velocity called **terminal velocity**, v_t, given by

$$v_t = \frac{2r^2}{9\eta}(\rho_s - \rho_f)$$

where r is the radius of the sphere, while ρ_s and ρ_f are the densities of the sphere and fluid respectively. [6]

Q5: (a) A hollow aluminium cylinder is to be fitted over a steel piston. At 20°C the inside diameter of the cylinder is 0.99% of the outside diameter of the piston. To what common temperature should the two pieces be heated in order that the cylinder just fits the piston? $\alpha_{steel} = 11 \times 10^{-6}\ {}^oC^{-1}$ and $\alpha_{aluminium} = 24 \times 10^{-6}\ {}^oC^{-1}$.

[8]

(b) (i) In engineering tables of thermal expansivities, values for γ (the average coefficient of cubical expansion) are usually not given. State a reason for this omission . [3]

(ii) Starting with a regular cube, figure 4, of side l_o, show that the coefficient of linear expansion α and the coefficient of volume expansion γ are related by $\gamma = 3\alpha$ Clearly state all the necessary approximations. [9]
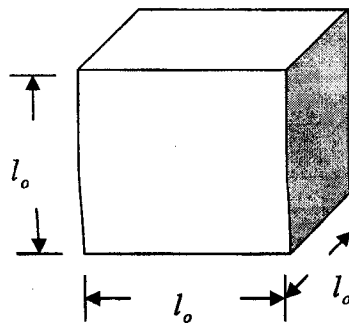
Figure 4

Q6: (a) If in a certain region the net electric field is zero, can we confidently say the electric potential in the same region is zero? Explain. [2]

(b) (i) Three point charges, $Q_o = -5\mu C$, $Q_1 = +3\mu C$ and $Q_2 = +4\mu C$ are positioned as shown, figure 5. Calculate the **magnitude** and **direction** of the resultant electric field E_R at point P located 3 m directly above Q_1.
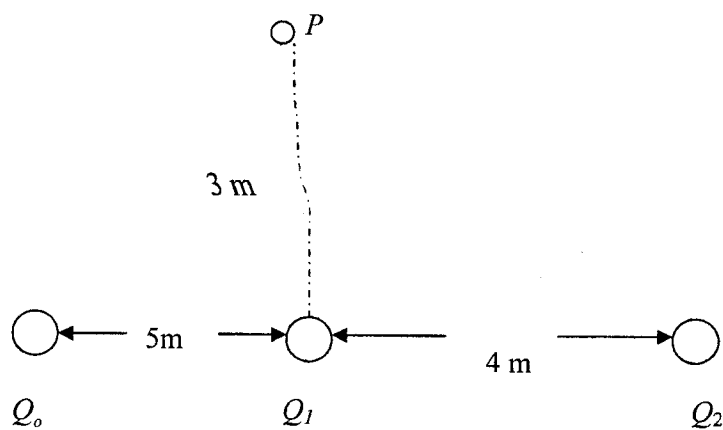
[9]

Figure 5

(ii) Calculate the electric potential at P in figure 5   [4]

(c) Figure 6 is a plot of the variation of an electric potential V with distance x in a certain region of space. From this plot derive a plot of the variation of the electric field with distance, $E(x)$.   [5]
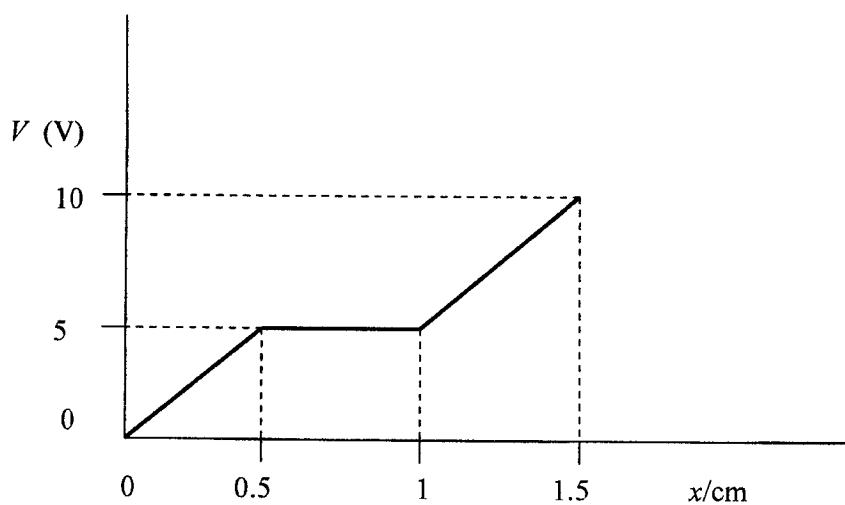

Figure 6

Q7: (a) A constant electric field $E(x)$ is parallel to the x axis. In what direction can a charge (negative or positive) be displaced in this field without any external work being done on the charge? Support your answer with a brief explanation. [3]

(b) A 200µF capacitor is charged by connecting it to a 40V battery. The battery is then removed without discharging the capacitor. Later, a 50µF uncharged capacitor is connected in parallel with the 200µF capacitor. Find the

[10]

    (i) initial charge Q_o stored on the 200µF capacitor when connected to the 40V battery;

    (ii) potential difference V between the plates of the 200µF capacitor when connected to the 50µF capacitor;

    (iii) charge Q that has been transferred from the 200µF capacitor to the 50µF capacitor in the process.

(c) (i) Explain why the *potential difference* between the terminals of a battery is not always the same as its emf. [3]

    (ii) A bulb is used in a torch which is powered by two identical cells in series, each of emf 1.5V. The bulb then dissipates power at the rate of 625 mW and the potential difference across the bulb is 2.5V. Calculate the internal resistance r of each cell [4]

Q8: (a) A thin copper rod 1 m long and mass 50g carries a current through it such that the rod just floats in a magnetic field of 2T. Calculate the value of this current. [3]

(b) (i) State Kirchhoff's two laws for electric circuit analysis.

[2]

In figure 7, $R_1 = 2\Omega$, $R_2 = 6\Omega$, and $R_3 = 4\Omega$. The two batteries have voltages of 24V and 27V each. Use Kirchhoff's rules to calculate the

values of I_1, I_2 and I_3 and state the meaning of any negative currents that may result from your analysis.   [6]
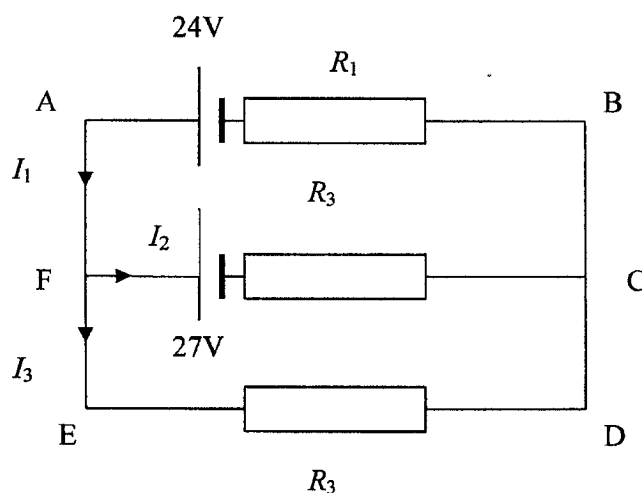

Figure 7

(c) A singly charged (short of an electron) positive ion has a mass equal to 2.5×10^{-26} kg. After being accelerated through a potential difference of 250V, the ion enters a magnetic field of 0.5T along a direction perpendicular to the field. Calculate

   (i)   the radius of the path of the ion in the magnetic field;   [6]
   (ii)   the frequency of rotation of the ion in Hz   [3]

END OF EXAM